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# INTERPRETING THE FUNCTION OF BISON DRIVE LANES AT HEAD-SMASHED-IN BUFFALO JUMP, ALBERTA

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled Interpretting the Function of Bison Drive Lanes at Head-Smashed-In Buffalo Jump, Alberta submitted by Maureen Rollans in partial fulfilment of the requirements for the degree of Master of Arts.

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## ABSTRACT

The lines of stone piles which are commonly associated with bison jump sites have not received the scholarly attention which they deserve. This thesis proposes a method to translate the form of these lines, visible in the archaeological record, into information about the drive techniques which prehistoric peoples used to move game toward traps. The method involves formulating multiple propositions about possible uses of drive lines, deducing the form of drive line which would effectively control bison movement when used in the manner proposed, and testing these form implications upon data from archaeological sites, in order to evaluate the relative applicability of the propositions to specific sites. In addition to archaeological data, ethological and ethnographic information is important in formulating the propositions, deducing the implications and evaluating the results. The method is tested upon archaeological data from Head-Smashed-In Buffalo Jump, Alberta. Some of the artificial drive structures were used in conjunction with human ~~hazers during~~ communal bison drives at the site, but many of the individual line markers were effective in controlling the movement of bison, similar to the effect of scarecrows, without the presence of humans. Although further research is needed, the study methodically evaluates the untested assumptions made by most plains archaeologists, illustrates the importance of ethological and ethnographic information in interpretation, and indicates the potential for drive line studies to clarify the drive techniques, the nature of cooperation, and the importance of knowledge of animal behavior, in the subsistence strategies of prehistoric peoples.

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# CHAPTER 1:

# PUTTING STONE LINES INTO PERSPECTIVE

Common archaeological features in the Northwest Plains are lines made up of rock walls or piles of stone. Most often, these lines are associated with bison kill sites or topographic features which could potentially serve as kill sites. Similar features are often mentioned in historical sources describing the communal bison drives of various Indian groups. These facts have persuaded most plains archaeologists to believe that the stone features are remnants of prehistoric drive lane systems--lines which the Indians used to funnel bison toward traps. Until recently (see Brink and Rollans 1986), little consideration has been given to exactly how the lines functioned. In an attempt to remedy this situation, this thesis will first place the study of drive lanes in a broader perspective, thereby setting the stage for the discussion of their function which follows in later chapters.

## SUBSISTENCE STRATEGY

Stuart Marks, in his study of the hunting system of the Valley Bisa of Zambia, stresses the basic distinction between studies of human and animal ecology:

> All predators show preferences in their selection of prey, and the selectivity of many natural predators corresponds to their structural and behavioral adaptations....Valley Bisa hunters are also selective predators. Unlike studies of natural predators, however, studies of man's environmental relationships must take into account variables other than biological attributes. Between man and his environment is interjected a "middle term"--technology and belief-based perception which influences his selectivity and use of resources (1976: 205).

Human-environmental interactions cannot be studied as if they existed in a purely physical and biological context, determined only by evolutionary forces beyond the perception of the humans involved. Perception and knowledge of the physical world are culturally based and they, along with the technology available to the people, determine the nature of the human-environmental interaction. These concepts are illustrated in Figure 1.

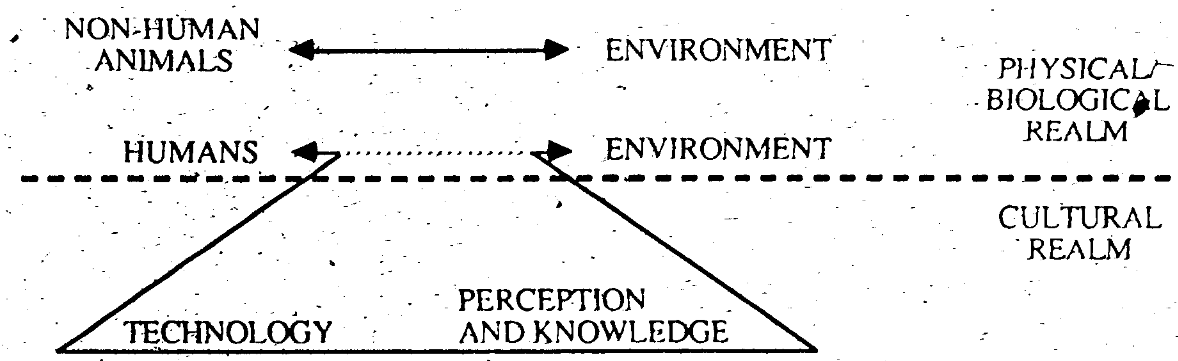



Figure 1: Diagram of human-environmental interactions. These interactions are seldom direct or strictly physical and biological, unlike those of non-human animals and their environment.

Because they are so closely tied to human biological well-being, subsistence practices have been subject to a greater amount of theorizing than any other class of human-environmental interactions. Currently, the most popular theoretical body influencing subsistence studies, particularly studies which are pertinent to archaeological problems, is optimal foraging theory (see Winterhalder and Smith 1981). The human subjects of optimal foraging studies are assumed to be completely rational beings. They choose the most efficient among all possible types of subsistence behavior--in other words, the behavior which is within their technological capabilities and which will maximize food returns (usually measured in calories or another nutrient), minimize expenditures in work effort (in calories), and pose no threat to the future supply of resources (Wilkinson 1972: 118). Although technology continues to mediate between humans and their environment (in a way similar to Figure 1), the essential fact that human perception and knowledge are "belief-based" is usually ignored: perception which is not consistent with empirical fact would not be expected in an optimal subsistence system because erroneous perception would place the people at an evolutionary disadvantage. The optimal foraging model is itself entirely belief-based, coming out of a thoroughly western capitalist background. Western economic concepts of efficiency and rationality cannot be universally applied; it is questionable whether they can be applied even to the grand evolutionary scale, but they certainly should not automatically be applied to interpretations of the archaeological evidence of daily practices and motives of specific individuals.

In order to understand subsistence interactions, a more emic approach is required, for which Marks' model provides a suitable starting point. The subsistence strategy lies wholly within the cultural realm of human-environmental interactions. Two stages of subsistence decisions are involved: 1) definition of the human needs and the resources available, and 2) formulation of specific intentions and strategies which will fulfill those needs.

In the first of these stages, humans define their subsistence options according to their belief-based perception of the physical/biological realm which was illustrated in Figure 1. Human needs are not purely physical in nature; they include such non-material needs as social contact and emotional well-being. Although the numbers and variety of requirements may be great, each need is weighted differently in determining subsistence choices. The potentially exploitable resources, in turn, may depend as much upon cultural belief as upon the physical properties of the environment.

The second stage of subsistence decisions includes those aimed at satisfying as many high priority subsistence requirements (which were defined in the first stage) as possible. The target resource, both type and quantity, is chosen from available resources with the aim of fulfilling many of these needs. Optimal foraging theory assumes that the behavioral strategies practiced to obtain these target resources have developed simply because they are the most efficient means of obtaining material necessities such as calories, nutrients, or non-food resources. However, the strategies and subsistence methods themselves can satisfy non-material requirements of the human group by fostering cooperation, sharing, status enhancement, or other socially valuable processes. Although efficiency may be one of the considerations in these subsistence decisions, it is seldom the primary organizing concept.

In determining the strategy for obtaining the desired resources, humans must consider the available items of material culture and knowledge about how to use them (both of which fall under the category of technology), and detailed knowledge about the nature and behavior of species in their environment. Human technology and knowledge provide power and flexibility in subsistence practices which is unequaled by the environmental relationships of any other species. The importance of knowledge in subsistence strategy must not be underestimated; the most rudimentary technology can be compensated in subsistence strategy by a sophisticated knowledge of the environment. Similarly, as the level of technology increases, the amount of environmental knowledge necessary to achieve subsistence goals, particularly through hunting, tends to decrease (Laughlin 1968).

Because the target resources in a hunt are mobile, strategies to obtain the animals must include not only location, transportation and preparation of the resource (which are common to all types of subsistence practices), but also pursuit and immobilization (after Laughlin 1968). Although killing and butchering an animal usually depend upon technology to a large extent, stalking and pursuing the animal are activities which, in most societies, depend almost entirely upon knowledge about game behavior. No degree of technical competence can compensate for a lack of such knowledge, for the hunter can only kill an animal if he can locate it and get within the effective range of his weapons before the animal takes flight.

## COMMUNAL HUNTING

Cooperation is often an integral aspect of subsistence strategy. However, theorists have had difficulty in explaining the worldwide popularity of communal hunting strategies using purely economic criteria. Hayden (1981: 369) suggests that communal hunting is never as efficient as individual hunting: "To obtain the highest return per unit of time and energy expended on searching for a mobile resource, the best strategy would seem to be to cover as much area as possible per person." However, because communal hunting is sometimes more reliable (i.e. it has higher rate of success) than individual hunting, it is practiced under certain conditions:

> ...it may be appropriate to use communal techniques only within certain limits of game density, and when obtaining a given quantity of meat per day per group is more important than the attendant increase in work effort per pound of meat yielded. Such conditions are most frequently encountered in areas where plant resources are scarce and where game is at least periodically above a certain density threshold...(*ibid.*: 370).

Driver (1986) expands upon Hayden's economic model. Firstly, he questions Hayden's position that communal hunting is inherently inefficient; under conditions of dense concentrations of animals or a lack of advanced technology in a society, communal hunting is not only more reliable but also perhaps more efficient than individual hunting. Secondly, he suggests that, where the production of a surplus is a high priority, the reliability of a hunting method is more important than its efficiency. Finally, he suggests that, when dealing with dense prey aggregations, communal hunting decreases search and handling time which compensates for the overall loss of efficiency; an important and very tenuous assumption here is that searching for game is done individually even when the hunting is communal.

Although these economic considerations could enter into the decision to hunt communally, non-economic considerations, ignored in Hayden's and Driver's models, are also important. Periodic large gatherings of people occur in many hunting and gathering societies and are important occasions for exchanging information and goods and reinforcing tribal solidarity. A large scale communal hunt is often the focus for such gatherings, but the hunt is largely an excuse to hold a gathering of much broader social significance. Although the hunts make the gathering possible through the provision of sufficient resources, the organization and cooperation necessitated by the hunting methods are as important for promoting communication and solidarity as they may be for capturing large quantities of game. Individual hunting during a large social gathering is often forcefully restricted; what might prove an easy and efficient kill for some of the individual hunters would prove counter-productive to the group because many animals would be frightened away from the hunting range. The benefits of communal hunting are not purely economic, and it is not surprising that non-economic motives may contribute to the popularity of the technique, despite its possible lack of efficiency.

Whether the reasons for making the decision to hunt communally are social, economic, or a combination of the two (which is much more likely), the precise method which is chosen must be reliable--it must have a high success rate. Reliability is not an intrinsic characteristic of the form: the mere cooperation of people in a hunt does not ensure either promotion of group solidarity or a high probability of killing large numbers of animals. On the contrary, an ineffective communal hunting method would not result in the procurement of resources necessary to feed the group involved, it would frighten the target animals away from the vicinity of the gathering, and it would cause frustration and mistrust among participants, generally producing a heavy strain on social relations. Whereas the ill-effects of a poor individual hunting strategy can be offset somewhat by sharing or trading of resources, failure in a cooperative effort results in more general hardship. For these reasons, a communal hunting strategy must be reliable if it is to be practiced on any regular basis, even if the primary reasons for undertaking the hunt are social.

DRIVING GAME

The popularity of the drive method for hunting certain species of animals attests to the overall effectiveness of the procedure. Elephants have been driven in Asia (Graham 1924: 53-55), gazelles in Africa (Musil 1928: 26-27), reindeer in Europe (Lowie 1923, Ingold 1980), emus and kangaroos in Australia (Roth 1897: 96-97, 100), vicuñas in South America (Tchopic 1946: 519), and caribou, deer, rabbits, antelope and bison in North America (Anell 1969). The traps used to make the ultimate capture are diverse--nets, corrals, pits, natural traps--but the steps which precede the ultimate capture share many similarities. The secret of an effective drive practice is making the game want to go in the direction of the trap. The hunters must ensure that the most convenient route available to the animals, and the one which appears to hold the only chance for escape, is the route toward the trap. The animals cannot be aware of the impending danger until it is too late for them to change their course. This drive process is extremely difficult, particularly if the trap or entrance to the trap is small, as is usually the case in order to minimize the opportunities for escape once the animals have been confined.

Drives would be included in the category of pursuit activities practiced as part of a hunting strategy (after Laughlin 1968). However, whereas most pursuit or stalking activities involve the hunter moving close enough to the animal to attempt a kill, driving entails controlling the movement or fleeing of an animal to get it within the confines of the trap. To ensure that the game reacts in the desired manner, the drivers must plan their strategy according to an intimate knowledge of the behavior of the animals. The drivers must know exactly what to do and where to go, for momentary mistakes could result in the escape of some or all of the prey. Once the animals are in the trap, their mobility is so severely limited that the kill itself is comparatively easy (Driver 1986), and sometimes death occurs without further human intervention, as is the case when animals are driven off cliffs.

Although technological items are rarely used in pursuit activities, drives involve an exception. Occasionally weapons are used in directing the animal movement, but most often groups have used artificial structures in order to make the drive process more reliable. Generally, the structures consist of paired lines of various composition (eg. brush, stones, people) which converge in a V-shape towards the trap (see Figure 2 to clarify terminology). The role of these lines in the drive procedure may be entirely passive (eg. as blinds for hunters) or more active, with a direct effect on animal movement (eg. as scarecrows or fences). Whatever their role, the presence of these lines at the boundaries of the drive lane, sometimes in conjunction with human participants, appears to affect the behavior of the game being driven. Through proper form and placement of these lines according to an understanding of animal behavior, hunters attempt to achieve greater control over the movement of the game.

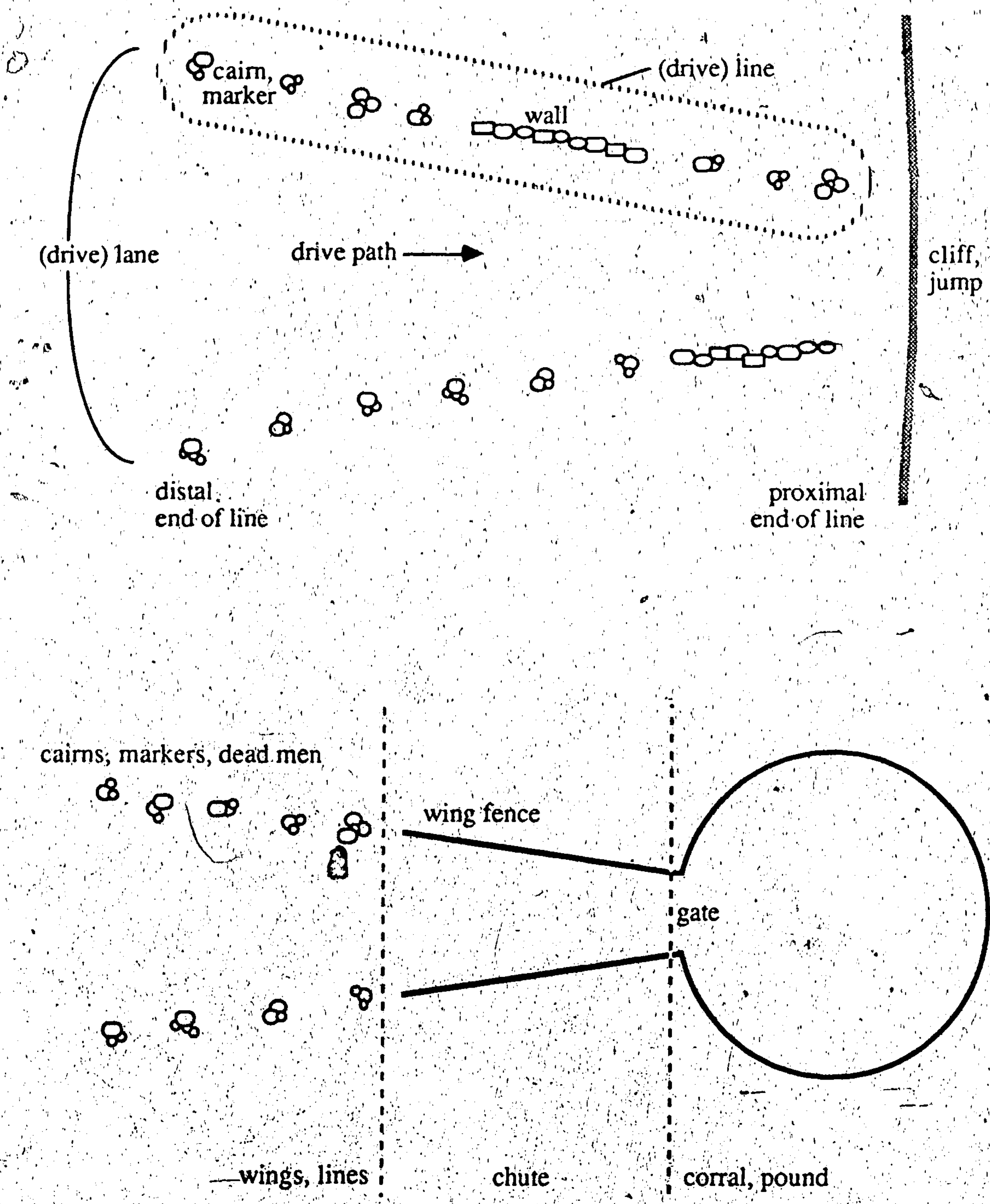



Figure 2: Drive lane terminology used in this thesis, illustrated for two common drive techniques--jumps and pounds (or corrals).

In northern Europe, people built converging lines of regularly spaced stone or sod piles which were "dressed" in old skin clothing before each drive; near the trap, people stationed along the lines wave objects and make noise thereby exciting the reindeer into a frantic rush toward the trap and the waiting hunters (Ingold 1980: 56-58). In the Plateau area of North America, hares were driven down lanes bounded by net fences which the rabbits were unable to cross; when the hares reached the area where the fences converged, hunters moved the net fences to close off the escape route and proceeded to kill the animals which were trapped (Egan and Egan 1917: 236). Gazelles in Africa were driven along 1.5 m high stone fences into a stone corral which had breaks in its wall at intervals and pits placed outside these breaks; as they attempted to escape out of the corral, the gazelles would fall into the pits (Musil 1928: 26-27). In all of these examples, once the animals are driven within the lane bounded by drive lines, these lines have a very practical purpose in the drive process, making the task of the hunters much easier.

## THE ARCHAEOLOGICAL STUDY OF DRIVE LANES

Where they have been preserved in a recognizable form, the artificial structures used in drives are valuable archaeological features. The direct benefit of a thorough study of the lanes is that it can illuminate details of the drive methods of people who made and used the lanes. However, a comprehensive understanding of drive lanes has much broader implications. The lanes hold clues to the nature and importance of cooperation involved in large scale communal hunting ventures, cooperation which was a necessity of large scale drives but which also may have been considered a major benefit of the hunting method.

Drives lanes also offer a unique opportunity to understand an archaeologically obscure aspect of hunting strategy. Archaeological evidence of hunting behavior usually consists of the bone and weapons which are associated with the actual kill. The nature of the kill site and the population profile of the animal remains can provide only general and indirect information about the stalking and pursuit activities that made the kill possible. Material remains which could illuminate the decisions being made or the knowledge being displayed during prey pursuit are almost non-existent. Drive lanes are the exception. They are evidence of the appropriate fusion of technology and perception of the nature of human needs and environmental resources.

The potential of drive lanes to clarify a number of broad anthropological issues is great. However, this potential cannot be achieved through the drive lane research methods which have commonly been practiced in the past--mapping of the lanes and description of their form. Interpretive methods must be developed to move from the form of drive lanes to their function during communal drives. If we can, through such methods, gain a better understanding of drive practices, we have also contributed to the understanding of the larger issues of cooperation in subsistence practices, pursuit activities in hunting strategy and the importance of technology, perception and knowledge in determining the nature of human-environmental interactions.

# CHAPTER 2:

# METHODOLOGICAL CONSIDERATIONS

The problem at hand is to design a method for studying the form of drive lines and using that information to interpret how the lines were utilized. Binford has long advocated the development of middle range theory as a means of investigating the contemporary archaeological record (statics) with the aim of elucidating past behavior (dynamics). Middle range theory approaches the following problem: "What conditions of dynamics, not available for observation, produce the forms and structures observable as static patterning in the archaeological record?" (Binford 1977: 6 - 7). However, the production of the drive structures is not central to the problem at hand; rather, it is the behavior which occurred during communal drives in the context of those drive lines which is of interest. Much of this behavior did not leave any archaeological traces: it did not alter the archaeological record at all. Although Freeman has suggested (1968: 265) that such an activity cannot be reconstructed, this chapter presents a research method which will be used to elucidate one example of this type of archaeological problem.

## MULTIPLE WORKING PROPOSITIONS

The first step entails developing a comprehensive list of propositions concerning the function of drive lines within the total context of communal drives at the site under investigation. Eventually, these propositions will be rigourously evaluated in order to determine which ones best clarify the archaeological record and the dynamic subsistence system of which it was once a part. The philosophical basis of this type of study were succinctly presented by T. C. Chamberlain (1897: 160):

> In developing the multiple hypotheses, the effort is to bring up into view every rational explanation of the phenomenon in hand and to develop every tenable hypothesis relative to its nature, cause, or origin, and to give to all

of these as impartially as possible a working form and a due place in the investigation.

At this point in the procedure, because unreasonable propositions are eliminated later on through testing, the sources of the proposed solutions to the archaeological problem are immaterial: propositions can freely be drawn from ethnographic, ethological, or archaeological sources, or purely from the imaginative mind.

The benefits of working with multiple hypotheses in problem solving are that personal biases are minimized and the possibility of multiple explanations can be explored. It is, by its very nature, a thorough and fertile method of inquiry. The propositions tested in the course of this paper cannot properly be called hypotheses, however, because they do not assert "a relationship between two or more independently monitored variables said to be operative in the empirical world" (Binford 1977: 2). Although the statements are to be evaluated in a manner analogous to what Chamberlain called "hypotheses", "proposition" is a more suitable label for the statements to be tested in this paper.

## DEVELOPMENT OF TEST IMPLICATIONS

Once the propositions have been developed, they must be evaluated. The archaeological data concerning drive line form and its physical context can be collected to test propositions on how the lines were used, even if that use did not change the form or placement of the lines. Schiffer (1976: 49 - 51) states:

> Because the attributes of tools make them more or less suitable for behaving in a certain way, the precise specification of behavior can lead to a listing of the attributes a conjoined element [a tool in a living context] must have possessed....These inferences are made possible by application of correlates that state relationships between morphological attributes of objects and behavior....Naturally this kind of activity definition can lead to the construction of test implications for any hypothesized activity....

In our particular multiple propositions, we must specify the behaviors to be tested--i.e. the precise ways in which humans may have used the lines in an effort to move game toward the trap. From these, we must deduce the attributes of the lines used in each activity; these attributes will be the implications of each proposition for the archaeological record. The correlates which make the inference of such attributes possible are primarily behavioral characteristics of the prey species, particularly during drive situations. A knowledge of ethology will allow us to deduce the form of line which would have the greatest chance of successfully controlling the animal movement when used in the manner proposed.

In a similar way, Wilkinson (1975) used knowledge of musk ox behavior to formulate hypotheses and their implications for archaeological investigation. He states:

> given a knowledge of the physiological and behavioral attributes of animals in prehistory, it is possible to predict with a sufficient degree of accuracy optimal patterns of exploiting these resources, and to forecast the types of traces which these would leave in the archaeological record (1972: 118).

In his study of musk ox exploitation, Wilkinson (1975) is interested in postulating only general patterns of exploitation; however, these methodological considerations could also be used to illuminate the details of subsistence behavior. Although it is not necessary to accept the teleological existence of an optimal foraging strategy in order to use Wilkinson's approach, behavior which is entirely inefficient could not be predicted.

As was argued in the last chapter, a communal hunting technique must be reliable in order for a group to afford to practice it regularly. Because the building of artificial lines used in drives is such a widespread subsistence practice, it can be argued logically that the lines must be important in increasing the reliability of drives. In many cases, the labour involved in drive line construction is sufficient to argue for functional purpose in design, and therefore, for some degree of efficiency in behavior. For groups today who retain some knowledge of past hunting techniques, legends, myths, and ritual should be associated with the drive lanes if their design were not wholly functional (based entirely upon animal behavior). If such ritual is absent in the group today, design elements which appear to have been purposeful (i.e. not random) are assumed to have served an efficient function in the overall drive technique. Ethological information, therefore, can be used to illuminate their function.

Before making a direct analogy between the animal behavior today and their behavior in the past, however, careful consideration must be given as to how behavior of the prey species has changed since the period during which the lanes were used. Wilkinson felt reasonably secure using the analogy between modern musk ox behavior and that of their prehistoric counterparts in his interpretations because the animals have not changed anatomically during the period in question, they live in the same areas of the world as they did in the past, and they have had little increase in contact with humans. For almost any other species studied, however, the conditions for a direct analogy will not be so ideal. Problems can be minimized by choosing to study the behavior of animals as anatomically similar to the prehistoric population as possible, living in as similar an environment as possible, and having as little contact with man as possible. Although direct observation of the animals by the archaeologist is desirable, information can also be obtained from zoological publications and interviews with experts whose experience with the animals in all situations can outweigh the value of other sources of information. Where increased human contact or changes in environment have been recent, historical descriptions of the animals can supplement observations of animals today.

Although we are testing multiple propositions, and therefore are not ruling out the existence of multiple explanations, we must deduce the implications as though the proposition is the sole function--i.e. as though the drive lanes were used reliably and efficiently in only the manner proposed. The possibility of multiple explanations can be assessed in the evaluation stage of the investigation. The test implications, therefore, should state the efficient form of a drive lane which was used in the manner proposed.

## COLLECTING THE ARCHAEOLOGICAL DATA

The collection of archaeological data on drive line form must be consistent and rigorous if the testing of propositions is to be productive, because line form is the only archaeological evidence of a very complicated set of behaviors. The state of preservation of the structures must be good or the agents of disturbance must be well-understood; it is essential to be able to reconstruct closely the form of at least parts of the lines in order to interpret the behavior which occurred in their context.

A description of pertinent aspects of the environment at a site is essential to the interpretation of the archaeological remains. The topography and surficial geology of the land traversed by lines must be described. The climate in the area would have affected the drive methods which could have been practiced and the way in which the lines have changed since they were last used. And, finally, descriptions of the vegetation indicate which resources would have been available to the grazing game and to the humans (both for food and for construction materials).

Criteria for the recognition of features must be explicit in order to avoid confusion and inconsistency. The basic elements in the structures--the cairns, line markers, stakes, walls, or whatever they may be--are not always easily distinguished from natural or culturally unrelated features such as historic fence lines. The identification of lines and the description of their form depends upon a competent definition of the line markers.

It is also necessary to understand the general nature of the drive lane system. Drive lane structures rarely consist of single lines, and systems of lines must be delineated and their probable relationships understood. This can only be accomplished through a thorough survey of the area. Drive lines usually cover vast areas of land but are often difficult to locate because of the small size and diffuse arrangement of the markers. The ideal survey method would be to divide up the study area into small plots, choose a large random sample of plots, and to search these plots through foot traverses and perhaps subsurface testing. Unfortunately such surveys are beyond the capabilities of most projects. The best alternative is to rely initially on the experience of the people living or working in the study area, for the features are obvious enough, once located, that they have usually been recognized by people who have spent time travelling across the land. Once the archaeologists have located some of the markers, they can walk along the lines for their full extent, noting regularities in the form and placement of the lines. Eventually, some patterns in line positioning emerge, and localized surveys for previously unknown lines can be carried out in probable locations. All lines that are located should be carefully illustrated on detailed topographic maps.

A sample of lines from this system should be mapped in greater detail, marker by marker. The sample should be chosen to represent well-preserved lines from all areas in the system, both near to and far away from the trap. Where possible, lines should be mapped in their entirety in order to determine changes in the placement of markers over the length of a single line. The essential information to be gained from such procedures includes approximate number of markers in the system, the precise shape of the lines, and the distance between markers. In association with the mapping, detailed descriptive notes on the micro-topography traversed by the lines should be made. Although the observation of lines from a distance is often difficult because of the present obscurity of the markers, the positions of markers can be emphasized using flags or people; this type of observation is essential to clarify the relationships among the lines, the topography of the drive lane, and the location of the drive path.

The form of markers can only be understood through the excavation of a sample of the features. Once again, the sample should represent well-preserved markers from all lines and all areas of the system. The excavation procedure is only unusual in that it is seldom performed on drive line markers. The marker should be exposed to its base, and all elements in the feature should be measured and described (size, shape, and arrangement). Finally, the soil directly below the marker should be excavated to ensure that no components are missed. If the excavation of a large sample of cairns is impossible due to time or budget restrictions, the excavation of a small sample can be supplemented by surficial observation and/or probing the ground surface around additional cairns to determine the position and size of individual elements.

## COMPARATIVE EVALUATION OF PROPOSITIONS

The first stage in the evaluation of propositions involves analyzing the test implications. The nature of the test implications determines, to a large extent, the nature of analysis performed on the archaeological data. In general, the implications should be tested upon average computations, thereby determining the general functions of drive lines in the system; however, if there are obvious exceptions to the general case, or differences from one area of the system to another, these must not be obscured using average figures, but must be clearly identified.

If the archaeological data on line form meets but does not exceed the optimal characteristics (eg. for height or spacing of cairns) set forth in the test implication, the implication has been confirmed. A proposition can only be confirmed archaeologically, and can stand as a possible solution to the problem of drive line function, if all of the proposition's implications are confirmed. If, on the other hand, the archaeological data does not meet the optimal characteristics delineated in one or more test implications of a proposition, that proposition must be rejected. If the actual line form is such that it would perform reliably but not efficiently in the manner proposed (i.e. it exceeds the optimal requirement of line form set forth in the implication), the implication is only conditionally confirmed. A proposition with one or more implications conditionally confirmed and the other implications confirmed can itself be only conditionally confirmed. Conditional confirmation of a proposition means that the proposition stands as a possible partial explanation of line function; the characteristics of line form which are inefficient under one proposition are assumed to be essential for the line to be used in additional ways. Only if two or more conditionally confirmed propositions are complimentary, such that the line form efficiently functions in the combination of ways proposed, can the combined propositions be confidently accepted as a possible solution to the problem.

It is certainly possible that, through archaeological testing of the propositions in the manner proposed above, more than one proposition will be confirmed by the archaeological evidence. Although multiple functions for drive lines in a single drive technique are possible, it is also probable that not all propositions confirmed by archaeological evidence are equally likely solutions to the problem. After the initial testing using archaeological data, therefore, the evaluation procedure must rely upon additional sources of information.

General analogy is useful in the development of propositions, and the broader the base from which these analogies are drawn, the greater the chance of gaining a fresh and potentially more accurate understanding of the archaeological record. However, the comparative evaluation of propositions, when more than one has been confirmed using the archaeological data, involves a closer analysis of the analogies upon which the propositions were based. The relevance of the original source of the analogy largely determines the applicability of the proposition to the problem at hand, and therefore contributes to the confidence which we can place in that proposition in comparison with others which may have been confirmed through archaeological testing. In addition, the closer the details of the archaeological phenomena corresponds to those of the analog, the more likely the inferred details or functions will correspond. Binford (1972: 55) calls this the "probabilistic criteria": "The more numerous the similarities between analogs, the greater the probability that inferred properties are similar."

The use of analogy to inspire the development of propositions and to guide the deduction of test implications is consistent with an archaeological trend toward a more rigidly scientific use of analogies in the formation of models (Charlton 1981); these models are then tested against archaeological data. I propose an additional use of analogy in the comparative evaluation of propositions. Analogies from modern to prehistoric animal behavior can be used to suggest which of the proposed uses of drive lines and the associated line form would be most effective in controlling the animal movement. Confidence in a proposition must depend, in part, upon how reliable the resulting communal hunting method would be. This use of analogy is comparable to the direct historical analogies commonly used by archaeologists, in which continuity of behavioral traits is assumed between ethnographically known groups and their prehistoric ancestors.

Charlton (1981: 144) also claims that a more traditional use of analogy in archaeological interpretation must not be ignored:

> analogy as interpretive discovery is an important and valid approach to archaeological data....This use of ethnographic analogy does not establish it as a criterion of truth. It does put it forward as a means of exploration, extrapolation, and discovery beyond the points observed as data or facts.

Interpretive analogies will be used to further illuminate the drive practices by expanding beyond an interpretation based entirely upon archaeological data. Within the variety of proposed line functions, and within the confines of archaeological data, ethnographic and ethological analogies can be used to suggest possibilities for more precise forms of human behavior during drives and more precise forms of drive line markers as they would have looked at the time they were used. About the value of interpretive ethnographic analogies in particular, Coles (1973: 17) stated, "...ethnography will provide ranges of possible solutions to specific problems; [it will not] prove any particular answer, but...will indicate degrees of probability for the archaeologist to consider."

The methods employed in this paper are an attempt to escape some of the limitations of the archaeological record for elucidating past behavior. The organization is similar to that of many scientific studies in which hypotheses are defined, followed by a deduction of their implications for the archaeological record, and a test of these implications upon data from a sample site in order to evaluate each hypothesis. Although the nature of the problem at hand is not amenable to purely archaeological study because of the limited role of material culture in the activities in question, this investigation approximately follows the scientific format in order to achieve an explicitly stated and thorough analysis. The major departure from the rigidly scientific archaeological format is that the information used to evaluate propositions will not be only archaeological; ethological information and pertinent ethnographic and ethnohistoric evidence will also be considered in the evaluation of the propositions. The usefulness of the different types of data at different stages of the methodology are illustrated in Figure 3.

Figure 3 indicates that circular reasoning could be a problem, with the same bodies of data being used at different stages in the methodology. Before establishing propositions, the archaeologist has a limited knowledge about the form of drive structures, whether through direct observation, or through indirect sources. This knowledge is considered in conjunction with various types of general information--ethnographic descriptions of drive techniques, logical proposals set forth by other archaeologists, and general knowledge about animal behavior--in order to formulate as many potential functions of drive structures as possible. These propositions are independent of data from any one site: "no hypothesis is in any way logically dependent on actual data (either collected or potentially collectable) even though it may, in fact, have been derived from or confirmed by a set of actual data (Leblanc 1973: 200)." Using specific information about the behavior of the species in question, test implications (i.e. the formal characteristics of a drive structure that would have been effective when used in the manner proposed) are deduced. These implications are tested using specific

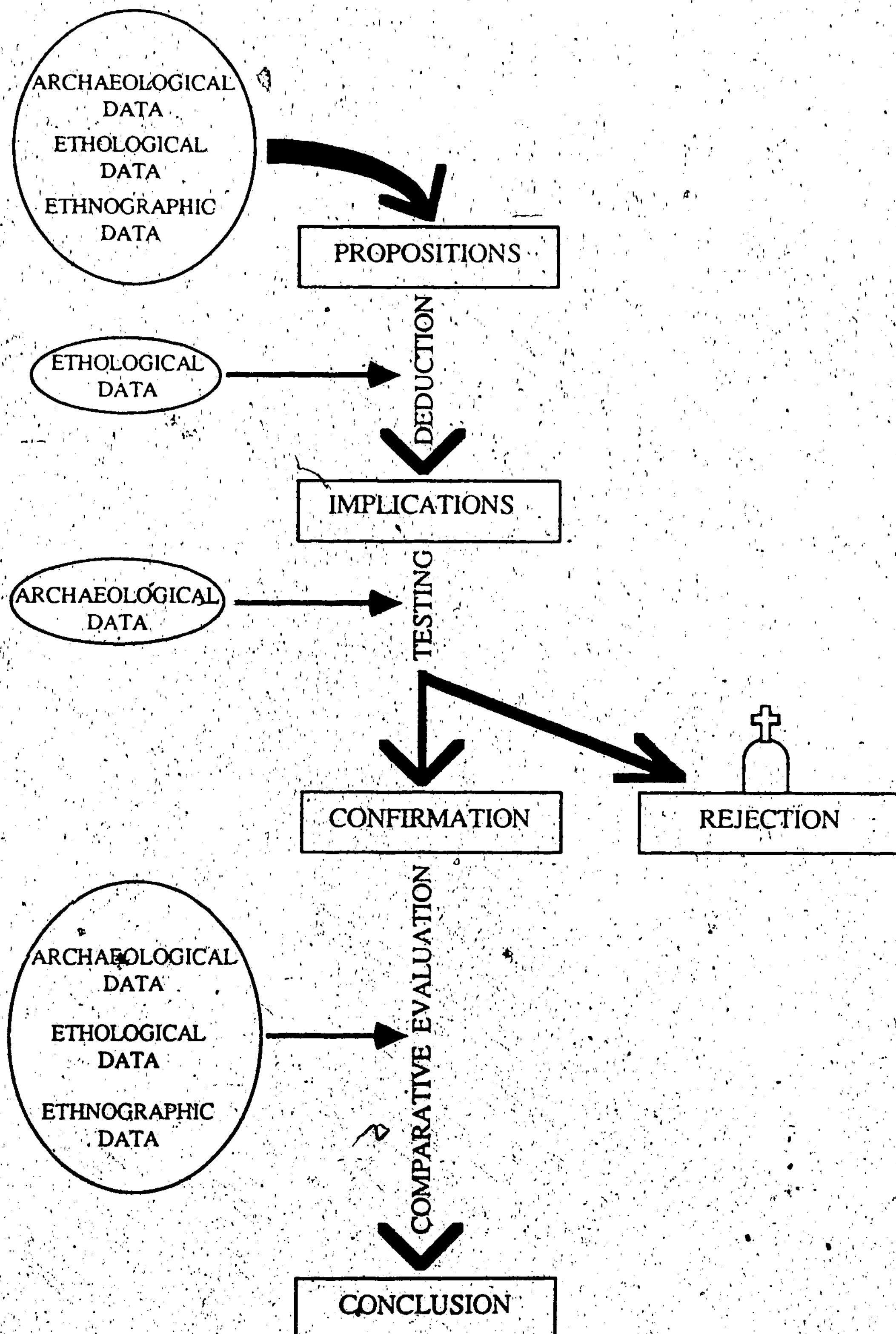



Figure 3: Diagram indicating the points of input of the different data sources used at various stages in the methodology.

quantitative archaeological data from the site under investigation. Propositions confirmed by the archaeological data are comparatively evaluated, again using a variety of criteria: 1) the relative strengths of archaeological support (i.e., the numbers and variety of confirmed implications), 2) the "probabilistic criteria" or degree of similarity between ethnographic analogs (Binford 1972: 55), and 3) the relative effectiveness of the proposed functions of drive structures (determined using ethological data to indicate which proposition would most reliably control animal movement).

Although the same general types of data (archaeological, ethnographic, and ethological) are used to derive and to evaluate propositions, the uses are independent, with general ideas and information used to derive, and site- and species-specific data used to evaluate. The same archaeological and ethological data are used in the deduction and testing of implications and in the comparative evaluation of confirmed propositions, but the data is used in two entirely different ways. In deduction and testing, the proposition is treated as though it was the only one being tested. In the comparative evaluation of several confirmed propositions, the same data must be reexamined in order to determine which proposition best explains the observed phenomena.

# CHAPTER 3:

# PREVIOUS RESEARCH ON BISON DRIVE LINES

## DESCRIPTIONS OF BISON DRIVE LANES

Bison drive sites on the Northwestern Plains of North America provide an ideal opportunity to test the methods outlined in the previous chapter because the three essential bodies of information are readily available. Although the introduction of the horse to Plains Indian culture decreased the importance of communal bison drives (Ewers 1955), there are many eye-witness reports of bison drive techniques and many ethnographic descriptions of the driving traditions. Large free ranging herds of bison are no longer a characteristic of the plains environment, but large herds are still present and available for study in game reserves, parks and private ranching operations. Remains of bison drive lane structures are particularly common in Montana but can also be found in Manitoba, Saskatchewan, Alberta and Wyoming and Idaho.

Conner (1962a: 1) provides a description of drive lines associated with a "typical Montana buffalo jump site":

> ...there are two or more lines of small piles of rocks on the prairie. The lines are generally in the shape of a "V" which almost, but not quite converge at the top of a cliff or cut bank. The piles of rocks in each line are normally five to ten yards apart. Some of the rock piles exceed a foot in height, but they often do not rise now above the level of the ground, and these are difficult to see. The rock lines vary from a few hundred yards to miles in length...

If the lines are still visible at a site, the descriptions in archaeological papers often consists only of a map of the general configuration of the lines (for example, Frison 1970a). Where verbal descriptions are provided, they usually contain little more detail than Conner's general description above--approximate size range of piles, approximate distance between piles, length of lines, and topographic position of lines (for example, Arthur 1962, Conner 1962b, Frison 1970b, Frison *et al.* 1978, Kehoe 1967, Malouf

1962). Arthur (1962) excavated rock piles or cairns in order to determine the original size and composition of the piles but he did not publish detailed descriptions of cairn form. When precise mapping of the drive lines has been undertaken, the detailed descriptions of line form which resulted (Agenbroad 1976 and 1978, Hlady 1970) have not contributed to a functional analysis of drive lines. Thus far, only one site, Head-Smashed-In Buffalo Jump in Alberta, has been subject both to detailed study of its line system and to careful interpretation of the function of this system (Reeves 1985, Brink *et al.* 1986, Rollans 1986, Brink and Rollans 1986).

APPROACHING THE PROBLEM OF DRIVE LANE FUNCTION

Often, archaeologists seem oblivious to the problem of function of drive lines and use misleading language when discussing the lines. Forbis (1962: 3), for example, states that "the Indians erected 'fences' in the gathering basin in order to funnel the buffalo toward a cliff" implying that the lines formed a physical barrier to the movement of bison which forced them to move toward the trap. Kehoe (1967: 82) reinforces this view: "the lines of rock piles caused the bison to run off the escarpment edge only in the spots desired by the Indians." Yet these stone drive lines do not resemble fences; they are neither solid, nor high enough to contain a bison. The walls of pounds or corrals, in contrast, were usually seven or eight feet high and so solid that no light could penetrate cracks in order to keep bison from charging at the walls (Kehoe 1973: 176).

In ethnographic and ethnohistoric accounts of Plains Indian bison drives, the line markers function either as camouflage for hazers or as scarecrow structures, referred to as "dead men". Most archaeologists have either explicitly or implicitly used direct historical analogies from these accounts to explain how the stone lines were used in prehistoric bison drives. For example, Arthur (1962: 17) quoted the ethnographer

Wissler (1910: 37) in order to explain the drive lines at the Emigrant Bison Drives in Montana:

> When conditions seemed favorable, he [the watcher] ordered all the young, able-bodied men, out to the lines where they took their stations behind the rock piles, concealing themselves under blankets or newly cut branches. . . Then, if the buffalo drifted into the wide entrance to the lines, the outlying men began to stampede them and as they moved forward, the men, concealed on their flanks arose shouting, waving blankets or brush, so as to keep them headed down the chute and to increase their fright.

Similarly, Agenbroad (1976: 5-6) suggested that the cairns at the Five Fingers and "Y" Jumps in Idaho were used as blinds for hazers but adds that they probably had some visual effect on their own, presumably as scarecrows or barriers. One ethnographic account (Medicine Crow 1978) claimed that cairns marked places where incense was burned; Agenbroad (1976: 6) implied that this is a possibility at some sites.

Where the cairns are obviously too small to act, in themselves, as any impediment to the movement of bison, archaeologists have suggested that perishable materials may have been added to the structures; such drive line markers would conform more closely to those mentioned in ethnohistoric accounts. Malouf (in Malouf and Conner 1962: 42) suggested that the cairns were used as bases for poles which in turn acted as scarecrows or fence posts. Reeves (1985: 93), on the other hand, stated that "perhaps the stones were used interlayered with dung to weigh down the buffalo chip piles."

Frison (1974: 16) was the first to offer an explanation based primarily upon archaeological data without analogy to ethnographic or ethnohistoric sources:

> The stone piles or drive lines in many locations are placed in such a way that someone familiar with bison can interpret them as a device for orienting the driver's position in relation to the herd. . . This seems so since the line of stone piles often follows a rise or the edge of an escarpment in such a way that a man could quickly approach and observe the drive lane ahead without revealing himself to the animals. Rapid movement of the drivers parallel to the herd was necessary since the drivers had to appear in the proper position to keep the herd headed in the right direction. The stone piles would have indicated very rapidly where to move in order to view the herd and establish a proper position in relation to it. If a driver's position was not exactly right, he could have ducked out of sight and moved either forward or back,

whichever was necessary, and then oriented himself with another stone marker for proper position.

Because bison jumps and possible drive lines were used for thousands of years on the plains, Frison is justified in attempting to extend beyond the bounds of direct historic analogies to ethnographic and ethnohistoric accounts of recent bison drives which describe features quite different from the ones present at his jump sites in Wyoming.

It is apparent from the above discussion that there is no consensus as to how stone lines functioned in communal bison drives on the plains. Although undoubtedly the subject of private musing and discussion, the function of drive lines was not the subject of public discussion between 1962 at the annual meeting of the Montana Archaeological Society (Malouf and Conner 1962) and 1985 at the Plains Conference (Brink 1985). The different purposes of drive lines proposed by plains archaeologists in the past are all equally valid. Before one of these functions can be confidently applied to an interpretation of the drive lines at a particular site, the various propositions must be thoroughly evaluated.

# CHAPTER 4:

# BISON ETHOLOGY AND MODERN DRIVE PRACTICES

## MODERN VS. PREHISTORIC BISON

For most of the past ten thousand years, millions of plains bison (*Bison bison bison*, commonly called "buffalo") roamed across the plains and prairies of North America. At the end of the last century, however, less than one thousand of the animals remained. Although bison have since made a comeback in numbers, the huge free-roaming plains herds are a phenomenon of the past. Today, bison are restricted to various North American game reserves and to private ranches. Their way of life has vastly changed, yet bison remain a thoroughly wild animal. The study of modern herds can, with caution, be used to understand the behavior of bison in the past.

Herds today vary greatly in their degree of management by humans. Large free-roaming herds reside in Yellowstone National Park, Wood Buffalo National Park, the Mackenzie Bison Sanctuary, and the Slave River lowlands (Reynolds *et al.* 1982: 1000); management of these herds and handling of the bison, particularly in Yellowstone and Wood Buffalo, is minimal. Other reserves and ranches have fenced boundaries, and their management programs include pasture rotation and yearly round-ups of all the animals to perform medical services and to cull the herd. Although most reserves attempt to keep their herds in as close to natural conditions as possible, most private ranchers are more interested in making the bison easier to handle and making their operations more profitable. The most common alteration to natural conditions which is performed by ranchers is to provide the herd with extra forage and water, but more drastic measures are sometimes taken including permanent division of the herd into age classes.

The degree of applicability of behavioral information gained from modern bison, then, depends upon the type of herd from which behavioral information is gained and the type of behavior in question. Behaviors which are most likely to have modified under modern conditions (i.e. restricted range, increased contact with man) include long distance herd movement, dominance relationships, and reactions to some stimuli (such as the presence of humans). Most of the scholarly studies of bison ethology have concentrated on herds which exist independently of humans and therefore represent the closest parallels with prehistoric herds. However, such studies rarely contain detailed information of the behavior of bison during driving situations. The best sources of this type of information are people who have had experience handling bison. Because the bison are driven one or more times a year and become familiar with the procedures used, this information can only generally enhance an understanding of the behavior of bison in prehistoric driving situations.

Europeans who explored and later settled in the West while the large herds of bison still existed were fascinated by the animals. Many of their observations have been recorded in various historic documents and can be used to verify the applicability of more modern observations.

The wood bison (*Bison bison athabascae*), which now exists in numbers only in Wood Buffalo National Park and the MacKenzie Bison Sanctuary, is a close relative of the plains bison. Anatomically, it is very similar to the plains bison. Behaviorally, many of the differences can be attributed to the very different environments of the two species, with the wood bison inhabiting the boreal forests of Canada. Only one study of the wood bison (Soper 1941) will be included in the following discussion, and this only to reinforce observations made of plains bison.

GENERAL BISON BEHAVIOR

Bison are very social ungulates. They rarely undertake any activity--whether travelling, eating, ruminating, or resting--alone. As is the case with most social mammals, there is a definite rank order among herd members which determines such factors as which animals will have priority in mating. However, the hierarchy does not determine the outcomes of all interactions. For example, although high ranking individuals can force lower ranking individuals to move aside, rank does not determine the leader in herd movements. This leader, usually an older cow, does not gain a following through force, but presumably through the proven reliability of her decisions (McHugh 1972: 165).

The senses of bison are variably developed. Their sense of smell is very acute and they rely most upon this sense to detect danger (McHugh 1958: 6). Early observers claimed that their eyesight was very poor (Dary 1974: 35), but McHugh claimed that they could distinguish the difference between a man on foot and a man on horseback from a distance of half a mile (1972: 149). Certainly, their ability to distinguish immobile objects is not good. Both McHugh (1958: 6) and Soper (1941: 399) stated that bison seem oblivious to motionless objects, whereas they immediately notice any movement: "Under favorable circumstances a man may approach and stand quietly exposed within a few yards of a buffalo without being noticed; at this range, however, a quick movement instantly registers" (Soper 1941: 399).

Bison may react to sensual stimuli in several ways. When a herd is startled by the scent of humans carried by the wind, by a loud noise or by sudden movement, the animals most often flee as a tight group. Because cows tend to be the most wary, they are often the leaders in such sudden herd movements (McHugh 1958). Flight is usually an immediate reaction to the scent of humans (Dary 1974: 34, McHugh 1958: 6, Meagher 1973: 47), and the sight of a potential threat more frequently causes flight than does sound (Meagher 1973: 47). The herd runs a short distance, some individuals will then turn around to try to determine through scent or sight the nature of the perceived threat, and then the herd may continue in the original direction (Soper 1941: 399). Interestingly, although wolves also prey upon bison, these predators can wander freely among herd members without causing disturbance (McHugh 1972: 225).

The most violent form of flight is the stampede. This form of herd movement is disorderly and unpredictable and is precipitated by often seemingly insignificant sudden external stimuli (Reynolds *et al.* 1982: 988). Although the herd follows a lead animal, the one which first reacted to the stimulus, it is extremely difficult for the lead animal to turn suddenly or stop because of the momentum of the rest of the herd (Dary 1974: 163-164).

Objects which may initially seem threatening to bison are eventually investigated (Daniel Spence, private bison rancher, Nebraska, pers. com. 1986). McHugh (1972: 211 - 212) described the way in which bison investigate novel objects or familiar objects in unusual contexts: an individual will move toward the object, stare intently at it, eventually move closer, and sniff at it or probe it with the muzzle or tongue. However, this curiosity is limited by wariness and the individual bison is easily startled into a retreat (*ibid.*). If an object juts out from the ground, such as a ~~tree, bush~~, boulder, telegraph pole or house, and poses no threat, the bison will usually rub hard against it, probably to relieve skin irritations (McHugh 1972: 150; Charles Blyth, Elk Island National Park, Alberta, pers. comm. 1986); this behavior has caused frustration to countless settlers (Dary 1974: 40 - 41) and bison ranchers.

Considering their large size, bison are capable of speed and agility. They run at speeds up to 60 km per hour (Fuller 1960) and have greater endurance than do horses (McHugh 1972: 171). They can travel up or down steep slopes and across rough terrain easily and quickly (Meagher 1973: 47, Jon Malcolm, National Bison Range, Montana, pers. comm. 1986). In bison drives today, pickup trucks or a good supply of fresh horses are needed to keep up with the herd over any distance.

Despite their agility, bison prefer to take the path of least resistance (Dary 1974: 182, McHugh 1972: 172, Reynolds *et al.* 1982: 988): "They established surprisingly direct routes through a complex of rolling hills, forded streams at points with gradual approaches and shallow water, and crossed steep-walled canyons at the only negotiable passes" (McHugh 1972: 235). Although they are certainly capable of climbing steep grades, they prefer gentle angles and switchbacks (Soper 1941: 401). Bison habitually follow such routes. Reliable trails over extremely rough terrain or toward water or mineral licks are quickly worn bare. In the past, these trails could be found all over the plains; early European travellers often followed the bison trails, believing them to be practical routes (Dary 1974: 180).

The wind direction may affect the movement of bison. Although zoologists observing herds have been unable to document the fact (McHugh 1972: 243, Meagher 1973: 47), early observers of the bison consistently stated that bison travelled into storms or cold winds (Dary 1974: 36). The historic reports indicate that bison tend to run into the wind, particularly when alarmed, but also during regular herd movements: John Cook, who hunted bison in the 1870's, observed a herd which consistently travelled into the wind for nine consecutive days, changing direction as the wind changed direction (Dary 1974: 168-169). Dary (*ibid.*: 169) suggested that bison run into the wind in order to detect any danger which might lie ahead. Private ranchers who have observed any relationship between bison movement and wind direction agree that bison tend to gather in the corner of the pasture closest to the direction from which the wind is coming. However, McHugh noted that a common activity in bison calling ceremonies among Plains Indian tribes was to appeal to spirit helpers to bring blizzards which would blow a bison herd toward the Indian camp (1972: 243). The relationship between wind and unforced herd movement is not clear.

## MODERN DRIVE PRACTICES

Humans wanting to direct the movement of bison today, as in the past, must have a detailed understanding of the behavior of the animal. Associations such as the National Buffalo Association and the American Buffalo Society have emerged to increase the flow of information about successful handling techniques and some reference books are available (eg. Jennings 1978) but the only way to become a competent bison handler is through experience. The experiences of modern bison handlers can illuminate the difficulties involved and possible techniques used in driving bison in the past. The discussion which follows, except where otherwise noted, is based upon interviews which I conducted with 17 competent handlers of private and public herds in Canada and the United States.

In most situations, it is much easier to lead bison than it is to drive them. In private ranching, commercial feed, or containers which are consistently used to hold this feed, can be used to lure bison in the desired direction. With this method, there is less excitement of the herd, less chance of injury to animals and humans and a much greater chance of success than there is with driving the herd. This method is most successful when the destination is one toward which the bison show either indifference or partiality, such as an ungrazed pasture. If pasture rotation follows a regular pattern, in private or public operations, the herd will often anticipate the change and will congregate at gates before they are opened.

Most public herds are not familiar with commercial feed, and therefore cannot be led in this manner in any situation. Even in private operations, it is very difficult to lure bison into corrals or other obvious traps. When leading is impracticable, pressure must be exerted from behind the herd to drive the animals in the desired direction. Bison will flee from oncoming humans, particularly if no feed is involved. Even if only one wary bison retreats, the remainder of the herd will tend to follow this leader. Additional drivers are usually placed along the sides of the herd to keep the animals from turning. Because of their speed and the protection they offer to their drivers, four-wheel drive vehicles are often used in modern bison drives, particularly along the sides of the herd where the danger to drivers is the greatest. Where the terrain is particularly rugged, horses must be used, but fresh horses and riders stationed along the drive route are often needed to keep up with the quick and agile bison.

Pressure is important, but untempered force will not result in a successful drive. The secret is to make the animals want to go in the direction that you want them to go: they must see the drive route as the course of least resistance--as the best opportunity to escape. Bison usually have favorite routes over the landscape and the handlers must become familiar with these routes through experience with driving or observing the bison; if these routes do not correspond with the drive path, they must be blocked off by drivers. Some pressure from behind is important to get the bison started in the desired direction, but too much pressure will cause them to panic, sensing a trap, and to break through the drivers positioned along the sides of the herd; if one bison escapes through the line of drivers, other bison will follow. Patience is an essential character trait of any bison handler; if the drive fails, the animals must be given a chance to calm down before another drive is attempted.

The wind direction is important to the success of the drive. Most handlers agreed that it is almost impossible to drive bison with the wind because they consistently try to break back toward the drivers and into the wind. Apparently, it is easier to drive bison when they can scent the danger ahead of them than it is to drive them with the wind.

Once the bison are moving, the drivers should remain a consistent distance behind them. This is necessary to ensure that the bison travel at a steady pace. If the bison are given a chance to stop, there is a greater chance that they will change direction. However, the faster the bison travel, the more difficult it is for drivers to control the direction of movement of the herd. As the animals get closer to the corral and crowded together, the resulting pressure causes them to move more quickly in their panic to escape. By the time they reach the corral, the animals should be travelling fast enough that the momentum of the herd forces the lead animals forward even after they become aware of the trap.

Artificial structures are constructed to improve the control of the bison movement in contemporary corralling operations (see Figure 2 for terminology). Wing fences are often constructed to be used in conjunction with regular pasture fences or a line of drivers to help keep bison moving in the desired direction. Bison must be driven at an angle to the fences, because bison could break through even the strongest fences if they run at them straight on (Jennings 1978: 140). Once the bison are within this chute, the drivers are spread out behind the herd in order to urge the animals forward. The two wings must be far apart at their distal ends so that the bison do not initially sense a trap; the distal parts of the fences do not have to be very substantial--a 1.25 m high barbwire fence is usually sufficient--as long as they provide an obvious barrier to the movement of the bison. The wing fences converge on the corral and must be particularly strong at their proximal ends, near the corral gate, to withstand the pressure of the increasingly crowded and nervous animals. If an animal does manage to escape through the wings, that section must be fortified before the same animal is driven through again, because it will attempt to escape at the same spot.

Sometimes, the chute will take sharp turns so that the bison cannot see the actual trap until they are almost within it. At these corners, which are usually rounded to avoid injury to the animals, people must be behind the fence making noise so that the bison change direction instead of heading through the fence (Jennings 1978: 135). Hazers stationed along the wings can also be used to urge bison through other high pressure sections of a drive, such as while crossing a stream or entering the corral. When brandished by hazers, objects such as flags, coats, or sticks with tin cans on the ends are effective in urging the bison forward.

The corral must be heavy, strong, and high. Although bison will attempt to get over or through even 2 m fences if they feel trapped, they usually do not attempt to break through any fence through which they cannot see (Jennings 1978: 140); a fence which appears to be solid will be the cause of fewer injuries to bison and drivers than a fence which is very strong, yet transmits light.

## BISON BEHAVIOR AND PREHISTORIC DRIVES

The prehistoric bison drive was a difficult process. The bison herds had to be moved from their natural grazing areas to the trap which was usually located several kilometres away. The convenient method of luring the bison with food into the trap was impossible, because the bison could not be habituated to artificial feed under prehistoric conditions of free-roaming herds. Driving was possible, but much more difficult even than modern techniques because of the absence of horses (during most of the period in question) and four wheel drive vehicles. The prehistoric drive route also had to follow the same direction as the prevailing wind so that the bison would not change their direction when they caught scent of the Indian camp located near the trap (Ewers 1949: 357). Archaeological drive sites corroborate the fact that prehistoric drives were carried out in the same direction as the prevailing wind (Malouf and Conner 1962: 44-45). However, bison do not like to be driven with the wind, and forcing them to travel in an unnatural course over great distances would have been extremely difficult. The drivers had to monitor the speed of the drive with care: over most of the drive distance, the drivers would have to move the bison slowly but steadily to maintain control; but as they neared the trap, the drivers would have to excite the herd into a full stampede, particularly if the trap were a cliff, to ensure that the lead bison did not have an opportunity to avoid the jump.

The archaeological remains at bison kill sites attest to the fact that prehistoric drives were, at least occasionally, very successful. Hunting theory suggests that communal drive techniques must also have been reliable. Under the difficult prehistoric drive conditions described above, the Plains Indians must have had a very detailed understanding of bison behavior in order to devise successful, reliable drive techniques. These people designed and built drive structures to be used in a particular way in an effort to increase the reliability of the overall drive strategy.

# CHAPTER 5:

# ETHNOGRAPHIC AND ETHNOHISTORIC ACCOUNTS OF PLAINS INDIANS' BISON DRIVE PRACTICES

The bison drive seems to have been an important hunting method on the plains for thousands of years, based upon present interpretations. Before horses became widespread, the communal drive was, logically, one of the few reliable ways to capture the quantity of bison necessary to support large social gatherings of people and to provide food stores for what could be precarious winter months. Once tribes acquired horses in number, the popularity and success of the chase on horseback rendered the drive, with its emphasis on planning and cooperation, virtually obsolete (Ewers 1955). By the time Europeans reached the plains, the drive was already declining in popularity, particularly among southern plains tribes. In the north, however, the technique continued to be practiced well into the 19th century. Many explorers and traders witnessed and wrote about these drives, either into corrals (also called pounds) or over cliffs. Later, ethnographers recorded detailed accounts of drive practices provided by native informants, some of whom had actually participated in the events.

## EVALUATION OF THE SOURCES

The literature cited in this chapter is diverse and specific sources are listed in Table 1. In order to eliminate the confusion of countless references, generalized descriptions of drive methods will not be followed by specific references. Exceptional statements, however, will be referenced.

Not all of these descriptions are equally applicable to the archaeological data being tested. The level of directness of reports--whether they come firsthand from European eyewitnesses, secondhand from interviews with informants who participated in the

TABLE 1: The sources consulted in this discussion, their level of directness, and the tribe whose practices they described.

| | PLAINS CREE | ASSINIBOINE | BLACKFOOT | OTHER OR UNSPECIFIED |
|---|---|---|---|---|
| FIRSTHAND | Brown 1919-20: 79-81,<br>Franklin 1969: 112-113,<br>Hector (in Palliser 1863: 70-71),<br>Hector and Vaux 1861: 249-250,<br>Hind 1971 Vol. 1: 355-359,<br>Kane 1925: 80-82,<br>McDougall 1896: 272-282 | Denig 1930: 532-534,<br>Henry (the Elder) (in Quaife 1921: 284-287),<br>Henry (the Younger) (in Coues 1897: 518-520),<br>Larpenteur 1898: 409-411,<br>M'Gillivray 1929: 42-44,<br>J. McDonnell 1889: 279-280,<br>De Smet 1972: 147-153 | Cocking 1908: 109 (may have been Gros Ventre),<br>Fidler 1792-1793: Dec 27-29,1792,<br>Henry (the Younger) (in Coues 1897: 576-577) | Harmon 1911: 285-287,<br>Lewis and Clark 1904 Vol. 2: 93;<br>Umfreville 1790: 160-162 |
| SECONDHAND | Mandelbaum 1979: 52-55,<br>Skinner 1914b: 524-527 | Audubon 1969 Vol. 2: 145-146 (also applies to Blackfoot and Gros Ventre) | Barrett 1921: 24-25,<br>Ewers 1968: 166-167,<br>Grinnell 1893: 228-232 | Skinner 1914a: 496-498 (Ojibway) |
| THIRDHAND (OR GREATER) | Jefferson 1929: 91-93 | Weekes 1948: 14-17 | Dempsey 1957: 1-2,<br>Kehoe 1967: 77-80,<br>R. McDonnell 1983,<br>Schaeffer 1978: 243-247,<br>Wissler 1910: 37 | Grinnell 1923 Vol. 1: 266-268 (Cheyenne),<br>Jenness 1938: 14-17 (Sarcee),<br>Medicine Crow 1978: 250-252 (Crow) |

event, or thirdhand from non-participant informants--connotes a degree of reliability of information. Table 1 lists the accounts referenced in this chapter, and their level of directness. This table only conveys the primary class of the author; however, even most eyewitnesses were not familiar with all aspects of the drive process which they described, and undoubtedly gained some of their information indirectly.

Most descriptions of drive practices specify the tribe to which they apply. Although it is usually impossible to correlate a specific archaeological site to a known ethnic entity, reports of tribes inhabiting the area being investigated may prove more useful than reports of distant tribes. More important than the ethnic identity of the tribe is the environment in which the reported drives were conducted; environment provides important parameters in the resources which can be used and the general techniques which can be employed in drives. Table 1 includes the tribe to which the descriptions refer. Areas inhabited by these tribes during the early historic period are illustrated in Figure 4.

The two most common classes of bison drives described in ethnohistoric and ethnographic sources were those into pounds and those off cliffs. Although most of the detailed descriptions of drive practices refer specifically to pound drives, most ethnographers considered the two to be variations on the same method (Grinnell 1893, Ewers 1955: 164-165, Schaeffer 1978:246-248, Wissler 1910: 37-52). I am assuming that, although the destinations were different between pound and cliff drives, the procedures used in driving bison were essentially interchangeable.

## THE FORM OF THE PLAINS INDIAN BISON DRIVE STRUCTURES

Other than the corral itself, the drive structures consisted of two long lines converging upon the gate of the corral or the edge of the cliff in a V-shape. The length of these lines varied; Denig (1930) suggested that it depended upon the number of people

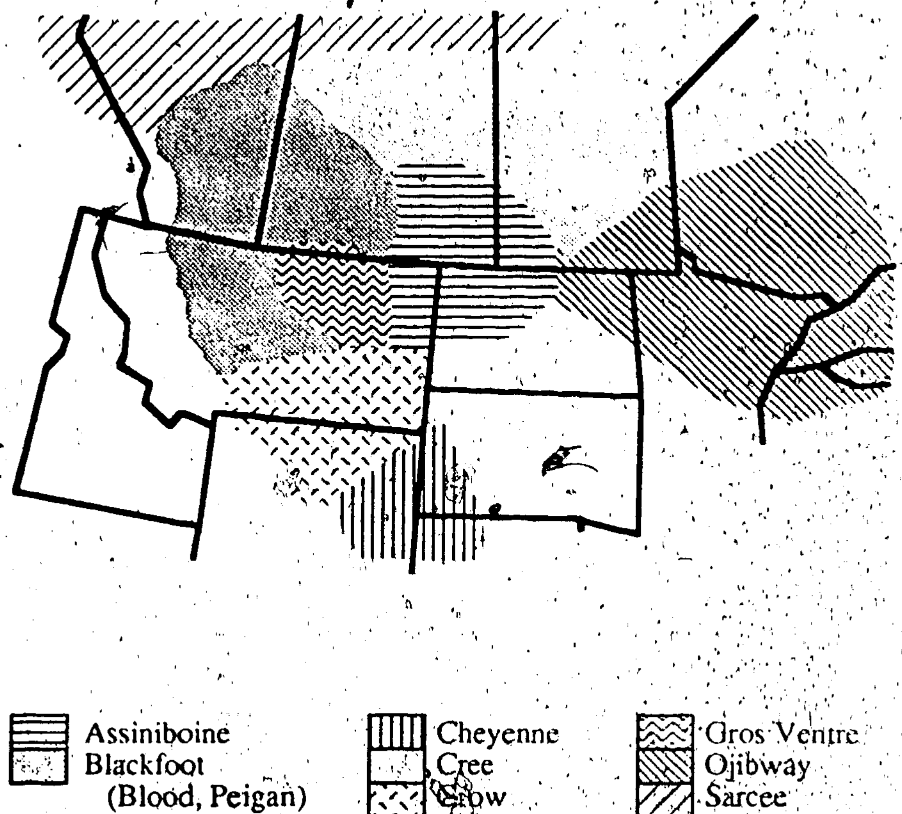



Figure 4: Map showing the general ranges during the early historic period of the tribes discussed in this chapter (after Murdock and O'Leary 1975).

available to help out. Most reports suggest that they were 1 to 2 miles (1.6 - 3.2 km) long.

The construction of these lines also varied. The basic element was the line marker which most often consisted of a pile of brush. Other materials used as markers include stakes or poles, or piles of dung, snow, earth, or stones. If stakes were used, materials such as hay, cloth, hide, or dung were sometimes placed or tied on to them. The size of the markers, when specified, ranged from knee-high (Fidler 1792-1793) to 15 ft. (4.5 m, Umfreville 1790) but was usually between 2 and 4 ft. (0.6 - 1.2 m).

Reports rarely contained specific information about the spacing of the markers, and those that did presented a tremendous range from "several feet" (Ewers 1968) to 50 yds. (45 m, Skinner 1914b); firsthand accounts consistently suggested that the markers were a maximum of 50 ft. (15 m) apart. The spacing of these markers was often stated to be variable with markers becoming closer together (and often larger) as the line approached the trap. For example, Alexander Henry (the Younger) stated:

> On each side of this entrance [to the pound] commences a thick range of fascines [bundles of sticks], the two ranges spreading asunder as they extend, to the distance of 100 yards, beyond which openings are left at intervals; but the fascines soon become more thinly planted, and continue to spread apart to the right and left, until each range has been extended about 300 yards from the pound. The labor is then diminished by only placing at intervals three or four cross-sticks, in imitation of a dog or other animal (sometimes called "dead men")...(in Coues 1897: 518).

As this example indicates, extending from the ends of the lines of markers was a chute constructed of solid fences of logs or brush. In most pound drives, this chute was about 100 yds. (90 m) long and ended at the gate of the corral. Sometimes this chute had a sharp corner just before the trap so that the bison could not see the corral until the last moment.

The function of the chute, with its substantial construction, is straightforward: it provided a visible barrier to the bison and forced them to enter the pound. The purpose of the line markers, however, is not so readily apparent. The most commonly stated purpose of the markers is to act as a blind, or hiding spot, for the hunters positioned along the sides of the drive lane. Other reports indicate that piles simply marked stations at which hunters waited for the bison to pass. Many of the ethnohistoric descriptions referred to the markers as "dead men" and some sources explicitly indicated that the markers functioned as scarecrows: Franklin (1969: 112) stated that the markers "...were intended to look like men, and to deter the animals from attempting to break out on either side." One unique report (Medicine Crow 1978) claimed that the markers were used as platforms upon which incense was burned prior to the drive.

Occasionally a third line was described which ran between the two main lines of the drive lane. Mandelbaum (1979: 52-55) illustrated a centre line identical in construction to the two main lines, but the function of this extra line is unclear. Grinnell (1893: 231) described a line of bison dung along the snow which bison apparently followed as they would a game trail. In a similar manner, a Blackfoot informant recently stated that bison robes were dragged down the centre of the drive lane in order to produce a trail which the bison followed (R. McDonnell 1983).

## HUMAN BEHAVIOR DURING DRIVES

The human behavior involved in bison drives was complex and coordinated. Rituals which preceded the drive ensured that the drive would be successful. Then, the herd had to be located, which was accomplished by a number of young men, usually called "runners". Once the herd had been located, often many kilometres from the pound or trap, one or more of the runners would try to get the animals moving while the other men returned to camp to inform the tribe that the final preparations could begin.

The initial part of the drive, before the bison entered the lane marked out by the drive lines, was a slow process, particularly during the pre-horse period. There was no way that a few men could control the movement of a stampeding herd; therefore, the runners had to be knowledgeable about bison behavior, skillful in their actions, and patient, content with moving the bison only short distances at a time. The two methods practiced by today's ranchers in moving bison were also practiced by the runners: leading (or luring) and driving. In either case, the wind had to be blowing from the herd toward the trap, first of all, in order to conceal the scent of the runner and the camp in front of the herd, and second, so that wind would carry the scent of the drivers who were behind the herd, driving the animals forward.

If the Indians were to be successful in leading the bison, the runners had to know how to make the bison want to follow them, because the natural reaction of bison to the presence of humans is to flee. The most commonly mentioned way to accomplish this was for the runner to disguise himself as a bison or a calf and to imitate their behavior. This technique would have taken advantage of the facts that bison follow leaders during herd movements, and during sudden herd movements they do not question the source of leadership (McHugh 1972: 155). The other technique mentioned in ethnohistoric and ethnographic sources is more mysterious but seemed to be equally effective: buffalo callers, as they were often called, enticed the bison to follow them presumably by arousing their curiosity. They might have performed unusual movement on their horse (Brown 1919-20), or beckoned to the bison with calls or motions.

Driving in the initial stages of the hunt involved gently frightening the bison so that they fled from the drivers, but not too quickly or too far. This was often accomplished by lighting small fires downwind from the bison, so that the scent of the smoke stimulated the herd to move. Other techniques involved shouting or producing other loud sudden sounds, or appearing suddenly from behind a natural blind to turn the course of the herd. After horses became available for use during drives, the herd could be moved more quickly because the drivers were better able to keep up. If a number of horses were available, the herd could be forcefully driven from the rear. Cree drivers apparently controlled the direction of the herd by riding up along its side, which provoked the herd leader to swing around and attempt to cut off the path of the horseman (Kane 1925, McDougall 1896, Mandelbaum 1979).

Once the herd had been guided between the lines of the drive lane, the role of the runners decreased in importance, and they often retreated to the side, leaving the task of the final capture to the rest of the tribe members. Some sources indicate that the lines provided an impetus for the bison to remain within the lane, and presumably that no human action along the sides of the herd was necessary (Cocking 1908, Hector and Vaux 1861); however, most sources mentioned hunters stationed along the lines. These people, sometimes only the male members of the tribe but often including women and children, had taken their places along the lines as soon as they had seen the herd approach.

In many accounts, there appears to have been a person stationed at each line marker. In some, however, people were only stationed along certain portions of the lines particularly near the trap. Although the people usually crouched behind the markers in order to be camouflaged, occasionally they would stand at the marker (Harmon 1911), lie down between markers (Henry (the Younger) in Coues 1897), crouch behind robes or brush piled near a marker (Umfreville 1790, Wissler 1910, Schaeffer 1978), or walk alongside the herd, presumably along the drive line (Grinnell 1923).

People stationed along the drive lines were often referred to "hazers" because their primary function was to urge the bison forward and to keep the animals from breaking out of the drive lane. Hazers accomplished this by rising up, yelling, and/or waving their arms or a bison robe. Some sources indicated that the hazers performed these actions as soon as the herd passed by their position while others indicate that they acted only if the bison appeared about to break through the line near their position. After the entire herd had passed their position, several reports indicated that the hazers joined in behind the herd to help drive them forward.

DISCREPANCIES BETWEEN
ETHNOHISTORIC AND ETHNOGRAPHIC ACCOUNTS

Although there is general agreement among all sources describing the drive practices of Plains Indians, there are some interesting discrepancies between firsthand accounts and descriptions from less direct sources. No historic sources contain mention of sharp corners in pound chutes, although this feature is described in ethnographic reports (Mandelbaum 1979, Skinner 1914b, Jefferson 1929). No historic sources contain mention of stone piles as markers, and although references to stone cairns are common in ethnographic accounts of the Blackfoot, they are not mentioned in the accounts of any other tribe except the Crow (in Medicine Crow 1978). Dung, on the other hand, is mentioned as a construction material only in historic reports. Reports of the purpose of the markers also shows some division: although the use of markers as camouflage for hunters is a common theme in both ethnohistoric and ethnographic sources, markers as scarecrows ("dead men") are only mentioned in historic descriptions. And, finally, there is a discrepancy in the enthusiasm with which the hazers behaved. Most ethnographic sources stated that the hazers had to be skilled and subtle in their movements, lest they frightened the animals into breaking through the fences (Weekes 1948, Schaeffer 1978, Barrett 1921). Yet, eyewitnesses usually claimed that the hazers did their best to frighten the animals into a wild stampede: "...the men hidden behind the snow banks sprang up, yelping, making a great demonstration, flourishing their robes, and discharging their firearms" (Skinner 1914a).

These discrepancies could partially be due to two factors. Firstly, European eyewitnesses were usually positioned at the termination of the drive, where the most excitement was generated and the most human involvement was necessary. Secondly, most firsthand accounts are of pound drives, which usually occurred in areas where wood was readily available.

CEREMONIALISM AND BISON DRIVES

It was stated in the methodology section of this paper that if ritual and myth were not focussed upon drive structures, it is likely that the structures had a design based upon function and reliability. The ceremonialism associated with bison and hunting is known primarily from ethnographic rather than ethnohistoric sources. The Plains Indian ceremonies practiced before each bison drive were of two types: those aimed at luring the herd near the camp, and those aimed at ensuring the overall success of the drive (Verbicky-Todd 1984: 11-25). Aspects of these ceremonies included songs to call to the bison, *iniskim* or buffalo stone ceremonies to lure the bison and to predict success in the hunt, and rituals associated with a tall pole located in the centre of the pound which ensured the success of the drive. Pre-hunt ceremonies were not focussed upon the drive lanes, or behavior carried out along the lines; only Medicine Crow (1978) reported a ritual directly associated with drive lanes--the burning of incense at the cairns.

Although the bison was an important character in Plains Indian myths, most of these myths deal with the general power and importance of the bison, rather than specific aspects of its behavior or appropriate hunting methods. Common mythical themes include the origin of bison, intermarrying between bison and humans, nurturing of humans by bison. On a hunting theme, Grinnell (1893: 142-143) recorded a myth about Old Man, the cultural hero of the Blackfoot:

> When he got to the north point of the Porcupine Mountains, there he made some more mud images of people, and blew breath upon them, and they became people.... They asked him, "What are we to eat?" He made many images of clay, in the form of buffalo. Then he blew breath on these, and they stood up; and when he made signs to them, they started to run. Then he said to the people, "Those are your food." They said to him, "Well, now, we have those animals; how are we to kill them?" "I will show you", he said. He took [the people] to the cliff, and made them build rock piles

> like this, >; and he made the people hide behind these piles of rock, and said, "When I lead the buffalo this way, as I bring them opposite to you, rise up."
>
> After he had told them how to act, he started on toward a herd of buffalo. He began to call them, and the buffalo started to run toward him, and they followed him until they were inside the lines. Then he dropped back; and as the people rose up, the buffalo ran in a straight line and jumped over the cliff.

In this myth, Old Man's instruction about drive lines and appropriate human behavior is not mystical but very straightforward and practical.

In a Crow myth recorded by Simms (1903: 285), drive lines play no part in the hunting method and the story line is much more fantastic:

> Once when Old Man Coyote saw some buffalo, he wanted to eat them and tried to think of a scheme to do this....
>
> Old Man Coyote said to [the buffalo]: "I'll tell you what let's do--we will run a race"--and all went to a level place with a steep cut bank at one end. Old Man Coyote said to himself, "I will go and put my robe over the edge of the bank," and turning to the buffalo, he said, "Just as we get to the place where my robe is we will all shut our eyes and see how far we can go with our eyes closed." The race was started, and just before getting to the robe, all of the buffalo shut their eyes and jumped over the steep cut bank and were killed; and Old Man Coyote feasted off of the dead buffalo.

Like all aspects of Plains Indian life-style, bison drives contained a strong ritual element. However, the most important hunting rituals and myths, the ones which are remembered even to the present day (eg. R. McDonnell 1983), are not directly associated with the drive lines. Knowledge about drive lanes and the behavior of humans in conjunction with the drive lanes, when it has been passed down, is practical rather than ceremonial (eg. Schaeffer 1978). It is appropriate, therefore, to assume that the design of drive lines and the human behavior associated with them have a firm functional rather than ritual basis, and that they contributed to the reliability of the drive methods practiced.

# CHAPTER 6:

# THE PROPOSITIONS AND THEIR IMPLICATIONS FOR THE ARCHAEOLOGICAL RECORD

The propositions presented below in bold text are organized in hierarchical levels (see Figure 5). Although more than one proposition can be accepted at any one level, the rejection of one proposition necessitates the rejection of all propositions subsumed by it. The test implications for the archaeological record are printed below each proposition in plain text, and these will be tested in a later chapter on data from a sample site. The deduction of the test implications was conducted under the assumption that the proposition being tested was the sole function of the cairns.

**I. The lines followed through the center of the drive path.**

1. The lines should follow through natural passes.
2. There should be no large obstructions along the path of the line. The line should contour around or through unavoidable obstructions.
3. The lines should not be associated in converging pairs.

**I.A. The line provided a natural path, similar to a game trail, which the bison followed.**

1. The cairns should be fairly close together (about 9 m apart according to Grinnell's (1893) description) and small but still distinguishable from the natural scatter of rocks in the soil (i.e.the line must be obvious to the bison without impeding their travel).
2. The cairns should be consistently spaced over the entire length of the line.

**I.B. The line provided an indication to the drivers of where to direct the herd.**

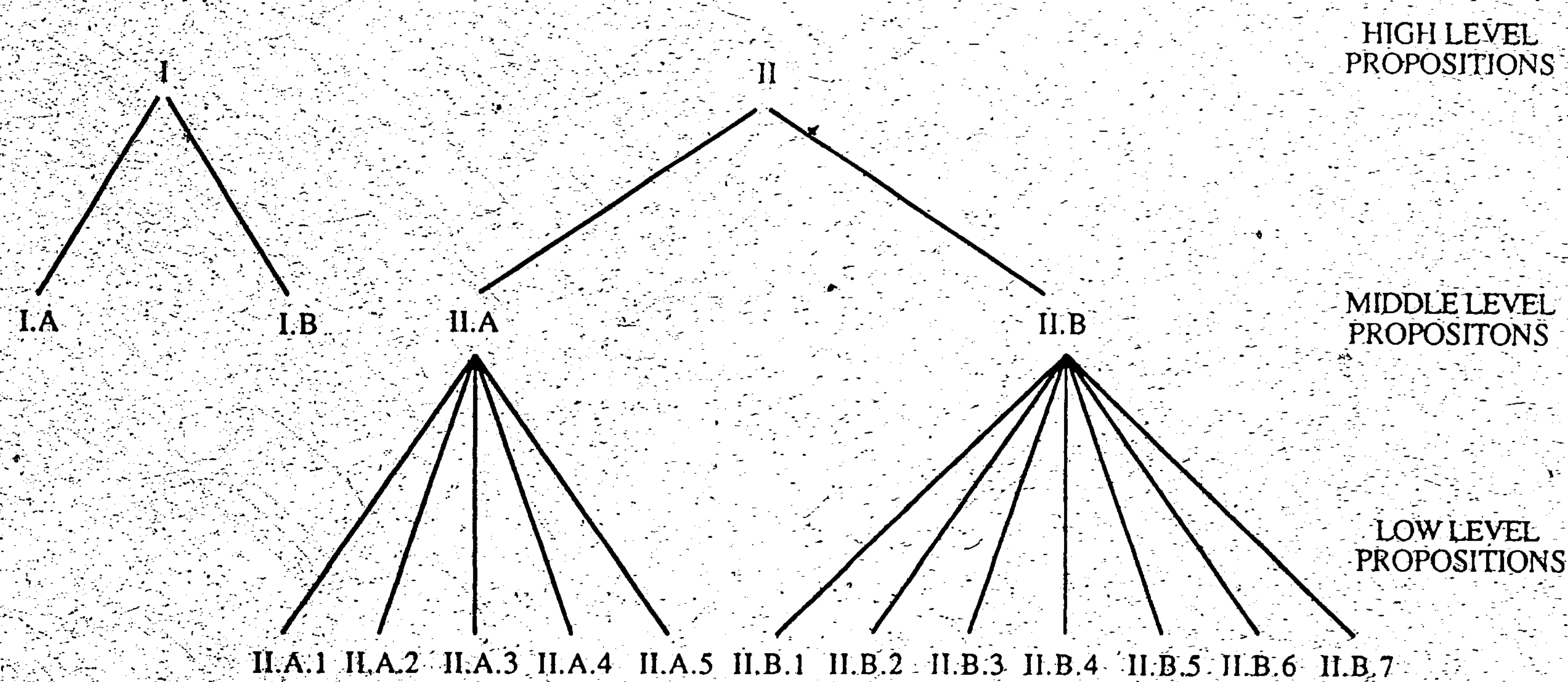



FIGURE 5: Diagram illustrating the organization of the propositions set forward in this thesis. The propositions become more specific as you move to lower levels. The rejection of a proposition automatically entails the rejection of all propositions subsumed by it.

1. The cairns should be quite large so that they are visible from a distance (i.e. at least 0.1 m higher than the vegetation and natural rock scatter) or there should be evidence that perishable materials augmented their size.
2. If the cairns were small (less than perhaps 0.5 m high) and inconspicuous, they would have had to be quite close together (less than 10 m) so that the line would be obvious at a quick glance. If they were large and conspicuous, they could have been far apart, as long as the drivers could see the next cairn after the one just passed.

**II. The lines marked the boundaries of the lane through which bison were driven.**

1. The lines should border natural lanes or passes.
2. The lines could incorporate natural obstructions (eg. cliffs, buttes).
3. The lines should be associated in converging pairs, especially near the termination of the drive.

**II.A. The lines--the cairns or whatever materials were added to them--directly limited the movement of the bison.**

1. The cairns had to be fairly close together along the entire length of the line in order to provide a barrier to bison, whether real or perceived.
2. Near the jump and in places where the bison habitually break out of the lane, the line should be fortified (cairns larger and/or closer together) to withstand the potential added pressure.

**II.A.1. The lines provided a physical barrier at the boundary of the drive lane which the bison did not cross, analogous to wing fences in modern corral structures.**

1. The cairns should be very large (1.25 m high) or there should be evidence that perishable materials were added to the structures to make them more substantial.

2. The cairns should be very close together (less than 1.0 m between them) along the entire length of the line.

**II.A.2. The lines appeared to the moving bison to be a physical barrier at the boundary of the drive lane (i.e. when viewed from an angle, the piles would appear to be closer than they actually were) (after Arthur in Malouf and Conner 1962: 42).**

1. The cairns should be very large (1.25 m high) or there should be evidence that perishable materials were added to the structures to make them more substantial.
2. The cairns should be fairly close together (less than 3 m between them) along the entire length of the line.
3. If the line is to look both solid and like a barrier, the path of the bison should be fairly near the line both on horizontal and vertical planes.
4. The line should be almost straight so that the bison are never traveling perpendicularly toward a section of the line.

**II.A.3. The cairns acted as scarecrows ("dead men") which the bison preferred not to approach.**

1. The cairns should be large (at least 1 m high) or there should be evidence that perishable materials were added to the structures to make them more formidable to the bison (larger, more unnatural, or more like the shape of humans).
2. The cairns should be fairly close together (several metres, depending upon how formidable they are to the bison) along the entire length of the line so that the bison have no desire to attempt to escape between them.

**II.A.4. The cairns acted as blinds for hazers.**

1. The cairns should be large enough to camouflage the hazers (a minimum of 0.6 m high and 0.4 m in diameter) or there should be evidence that perishable materials were added to augment the cairns.

2. The number of cairns in pairs of lines should be sufficient to conceal the number of hunters involved in the drive.

**II.A.5. The cairns marked stations for hazers.**

1. The cairns should be clearly distinguishable from the natural scatter of rocks in an area.
2. The number of cairns in pairs of lines should be sufficient to conceal the number of hunters involved in the drive.
3. The hazers along the lines must be visible from points along the drive path (ie. they must not be obscured by topography).

**II.B. The lines were constructed to provide future generations of hunters with a permanent record of information about the successful drive procedure.**

This covering proposition is untestable archaeologically although specific hypotheses subsumed by it can be investigated.

**II.B.1. The lines marked the boundaries of the drive lane, indicating the route to the drivers along the drive path.**

1. The cairns must be visible from points along the drive path (i.e.they must not be obscured by topography, and the cairns must be at least 0.1m higher than the vegetation or there must be evidence that perishable materials were added to the structures).
2. If the cairns were small (less than 0.75m high) and inconspicuous, they would have had to be quite close together (less than 10 m) so that the line would be obvious at a quick glance. If they were large and conspicuous, they could have been far apart, as long as the drivers could see the next cairn after the one just passed.

**II.B.2. The lines marked the route along the periphery of the drive lane where some of the hunters would walk in view of the bison.**

1. If the cairns were small (less than 0.5 m high), and inconspicuous they would have had to be quite close together (less than 10 m) so that the line would be obvious at a quick glance. If they were large and conspicuous, they could have been far apart, as long as the drivers could see the next cairn after the one just passed.
2. The hunters who are following the lines must be visible from points along the drive path (ie. they must not be obscured by topography).
3. There should be no large obstructions along the line route. The line should contour around or through unavoidable obstructions in order to make the route as easy to walk (or run) as possible.

**II.B.3. The topography concealed the hazers from the view of the bison and the cairns indicated the ideal location for the hazers, moving parallel to the drive, to suddenly show themselves to the bison (after Frison 1974).**

1. The line should follow the crest of a ridge or the edge of an escarpment. In that way, the line is visible to a hunter standing outside the lane but the hunter is not within view of the bison until he is standing near a cairn.
2. The cairns should not be close together or evenly spaced but rather should be placed far apart in strategic locations where the hunter's presence would be particularly effective.

**II.B.4. The lines indicated the locations along the route where extra caution had to be practiced.**

1. There should be marked fluctuations in the spacing and/or the size of cairns over the course of a line.
2. These fluctuations may correlate with topographic features which would be attractive escape routes to bison (but may

simply indicate the location where bison escaped during a previous drive).

**II.B.5. The cairns marked the locations where incense was burned before each drive (after Medicine Crow 1978).**

1. There should be evidence of heat or fire on cairn stones or in the matrix around them.
2. There should be a small enough number of cairns that incense could be practically burned at each one.

**II.B.6. The cairns marked the points where larger piles of perishable materials were to be built prior to each drive.**

1. The cairns should be clearly distinguishable from the natural scatter of rocks in an area.
2. There should be sufficient quantities of perishable materials in the vicinity of the line to make such manufacture possible.
3. There should be evidence of perishable materials in the matrix around the cairns.

**II.B.7. The stone clusters were an essential component of the otherwise perishable line markers (after Brink 1985).**

1. The cairns should be clearly distinguishable from the natural scatter of rocks in an area.
2. There should be sufficient quantities of perishable materials in the vicinity of the line to make such manufacture possible.
3. There should be evidence of perishable materials in the matrix around the cairns.

# CHAPTER 7:

# THE APPLICATION: HEAD-SMASHED-IN BUFFALO JUMP, ALBERTA

## BACKGROUND

Head-Smashed-In Buffalo Jump is located in the extreme southeastern corner of the Porcupine Hills (49° 42' Lat./113° 39' Long.), near the town of Fort Macleod, Alberta. It has been designated a World Heritage Site by UNESCO because it exhibits extensive and well-preserved archaeological deposits in the three constituent parts of bison jump sites: the drive lane system (in the standardized Canadian numbering system, this is designated by Borden numbers DkPk-2, 13, and 14, and DkPj-28, 29, and 30), the kill site, and the campsite/processing area (both kill and campsite fall under Borden number DkPj-1). All three of these areas, covering a total of more than 30 km$^2$, have been the objects of intensive archaeological investigation.

Junius Bird initiated the professional study of Head-Smashed-In Buffalo Jump (hereafter HSI) in 1938 with a brief archaeological test. Boyd Wettlaufer followed up in 1949 with tests of both the kill site and the processing area. Then, in the late 1960s and early 70s, Brian Reeves directed intensive excavations of the kill site, tested the campsite/processing area, and made a preliminary study of the drive lane system associated with the jump (Reeves 1978). The Archaeological Survey of Alberta undertook a four year study of the site in 1983, directed by Jack Brink. This project has included research on many aspects of the site and the area around it. I spent two field seasons (1983 and 1984) as a member of the Archaeological Survey project and conducted the fieldwork for my thesis in 1985. Two other students, Jack Brink and Susan Marshall are also working on graduate theses dealing with HSI.

ENVIRONMENTAL SETTING

The drainage basin of Olsen Creek forms the broad gathering basin for the site (Plate 1). Surrounding the basin are a series of buttes which rise approximately 150 metres from the basin floor. At the eastern extremity of the area is an escarpment, made up of a series of vertical sandstone faces and slump blocks, which drops down to an expansive plain; several sections of this face were steep enough to act as natural traps toward which bison could be driven. Immediately west of these cliffs, the land rises slightly toward an eastern chain of buttes and then slopes gently downward toward the bottom of the basin floor. The floor is gently rolling and dissected by the channels of Olsen Creek and its tributaries.

The land was shaped by both Laurentide and Cordilleran ice. The soil in some areas of the gathering basin is rocky, partially due to thin till deposits overlying the bedrock (Catto *et al.* 1983). Today, the major erosional force is the wind. Because a prevailing westerly blows almost constantly at rates up to 150 km per hour, exposed areas are heavily wind eroded and aeolian loess has been deposited in the sheltered areas of the gathering basin and on the plains to the east of the site.

In the summer, temperatures in the study area average 14°C, with daily highs often reaching 25-35°C. Although the winter average temperature is -10°C, chinooks coming out of the west may cause temperatures to suddenly rise as much as 15°C. The climate is generally dry but the amount of moisture increases toward the west; the average annual precipitation in the area is 40 cm, more than half of which is snow. Because of the wind and frequent chinooks, snow accumulation in most areas is slight.

The escarpment at HSI marks the boundary of two major grassland associations: the Mixed Prairie extends to the east and the Fescue Grassland lies to the west. The Wheatgrass-Needlegrass (*Agropyron-Stipa*) community dominates the plains below the cliff, while the Shallow Fescue (*Festuca scabrella-Phlox hoodii*) community is

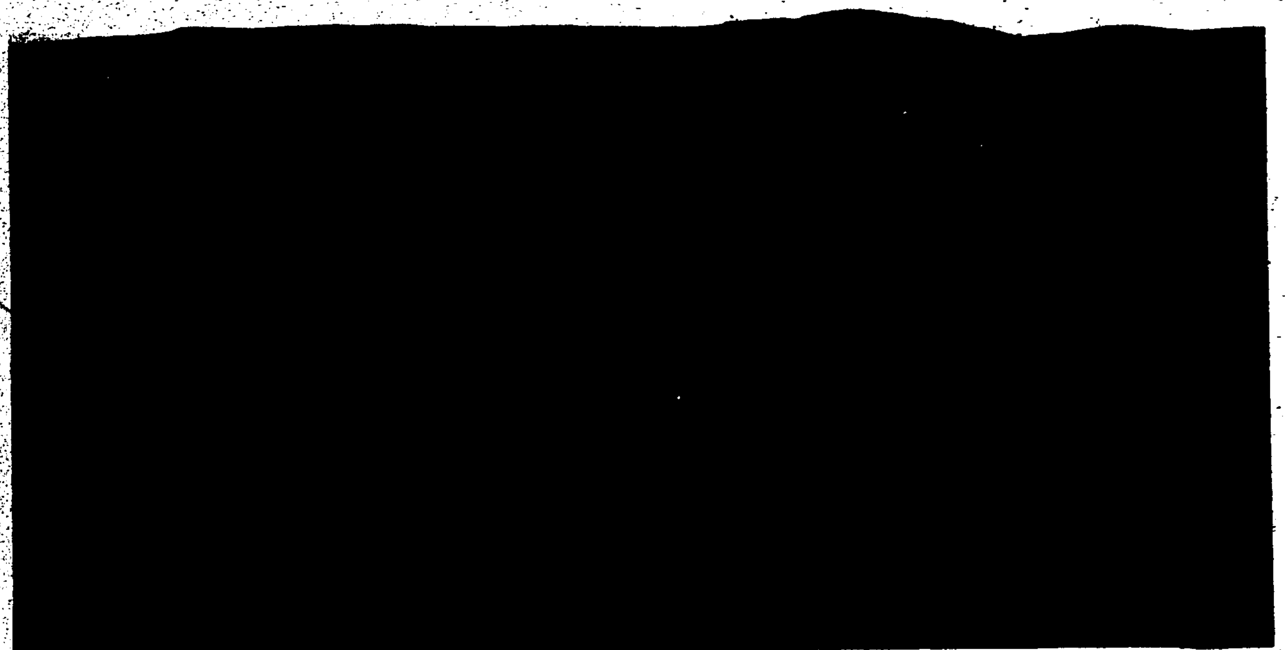


Plate I: The gathering basin of Head-Smashed-In, looking west. Notice the line of backfilled cairns in the foreground.

predominant in the gathering basin. In the northern and western portions of the gathering basin where there is more moisture, the Deep Fescue (*Festuca scabrella-Lupinus sericeus*) community, an extremely productive upland grassland, is abundant. Bison probably would have been attracted onto the prairie in the spring because of the large quantity of early green growth (Bailey 1984: 36). The gathering basin would have offered better grazing in the late summer and fall because, by that time of year, the soil moisture would have been depleted in the mixed prairie (*ibid.*: 48). The Shrublands community, dominated by saskatoon (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*), is limited to moist areas on north and east-facing slopes where evapotranspiration from wind and sun is minimized. A few stands of willows (*Salix interior*) are found in the gathering basin, primarily along streams, and aspen poplar (*Populus tremuloides*) is even more rare; both species of tree are more common further to the west. These shrubs and trees provided the only sources of wood in the immediate area. Shrub and tree cover may have been even more limited in the past due to the greater frequency and extent of natural fires (*ibid.*: 17).

## THE ARCHAEOLOGICAL DATA

Throughout the gathering basin runs a system of stone lines. Individual line markers are small cairns. Although the word "cairn" usually refers to a pile of stones used as a marker, it is here used to refer to a single layered cluster of two or more large stones, clearly distinguishable from the natural scatter of rocks in the soil. At present, the cairns are obscured by vegetation and drifting soil; they are very difficult to locate unless one is deliberately walking along the line. From close range, lines are readily recognizable as a linear arrangement of regularly, closely spaced cairns. The line system consists of all identified lines in and adjacent to the gathering basin, except those lines or portions of lines which are located on the Peigan Indian Reservation to the south of the study area and on lands for which access was denied (Figure 6). Many other features may once have been used as cairns or drive lines but have since been disturbed to the extent that their status as drive structures is questionable and a study of their original form is impossible; for reasons outlined in the methodology section of this thesis, these features have not been included in the present study.

The Line System

Because of the limited disturbance and tremendous complexity, the drive lane system at HSI is deserving of the scrutiny it has recently received (Reeves 1985, Brink 1985, Brink *et al.* 1986, Rollans 1986, Brink and Rollans 1986). Unlike the characteristic V-shape associated with many communal kill sites, the thousands of cairns at HSI are arranged in a complex maze of lines (Figure 6). The system can be divided into four subsystems. The set of lines (Area D) to the west of the main kill site (DkPj-1) appears to have been used to funnel bison from grazing areas in the west, northwest and southwest toward the jump. But the three other major sets of lines (Areas A, B, and C) appear to lead to other jumps situated along the same escarpment as DkPj-1. This proposition could be substantiated by finding the kill sites associated with these other sets of lines. In fact, current research by S. Marshall (Marshall and Brink 1986) has confirmed a definite kill site, designated the Calderwood Jump (DkPj-27), associated with the set of lines (Area C) immediately north of Area D (see Figure 10). Each set of lines will be briefly described in turn (for more detailed analysis, see Reeves 1985 and Rollans 1986). The areal maps (Figures 8-13) are detailed sections of the system map (Figure 6) and their locations within the system are illustrated in Figure 7. These maps are based upon Reeves' map of the HSI drive lane complex (1985) but have been altered to conform with my definition of the features.

Area A (DkPj-28, Figure 8): Most lines in this area appear to form two funnel-like arrangements which terminate at a formidable north-facing cliff. Two of these, A-1 and

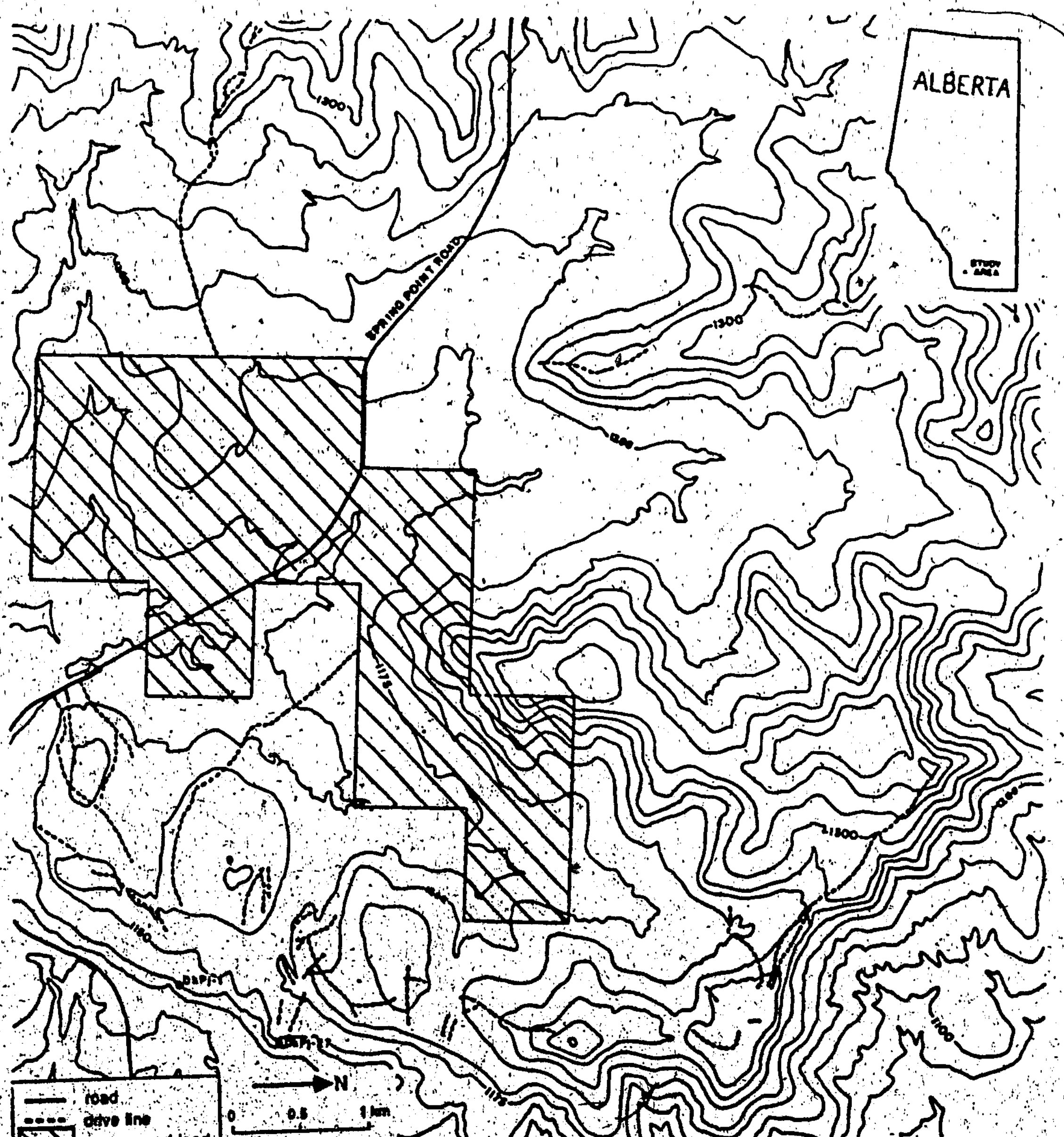



Figure 6: Map of the study area, showing the location of the drive lines. The area demarcated by diagonal lines was not studied due to lack of landowner permission. South of this study area (off the map) is the Peigan Indian Reservation, which also was not studied. Two bison jumps have been excavated in this area: Head-Smashed-In (DkPj-1), and Calderwood Jump (DkPj-27).

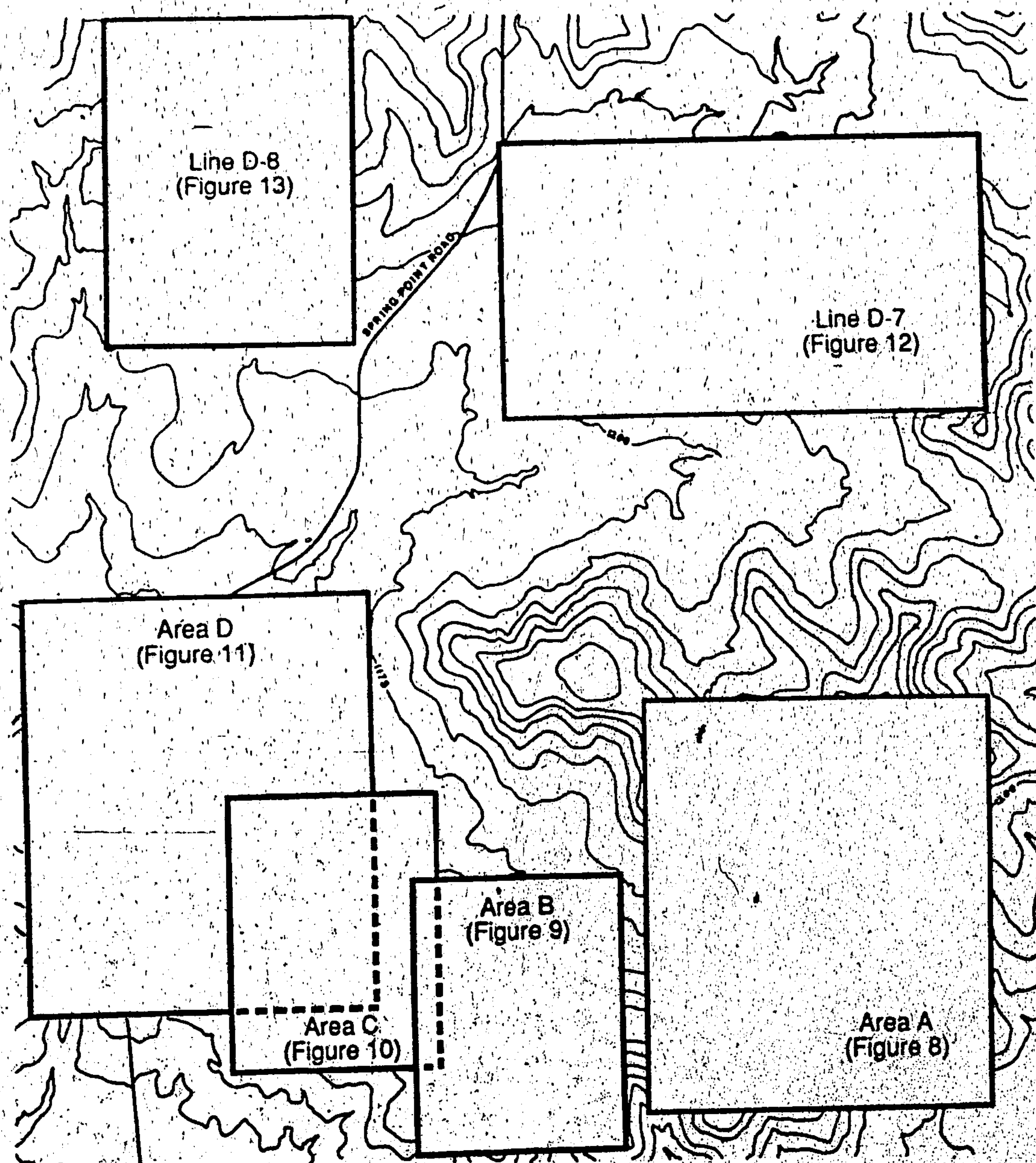



Figure 7: Map of the study area indicating the boundaries of the areal maps which follow in Figures 8-13.

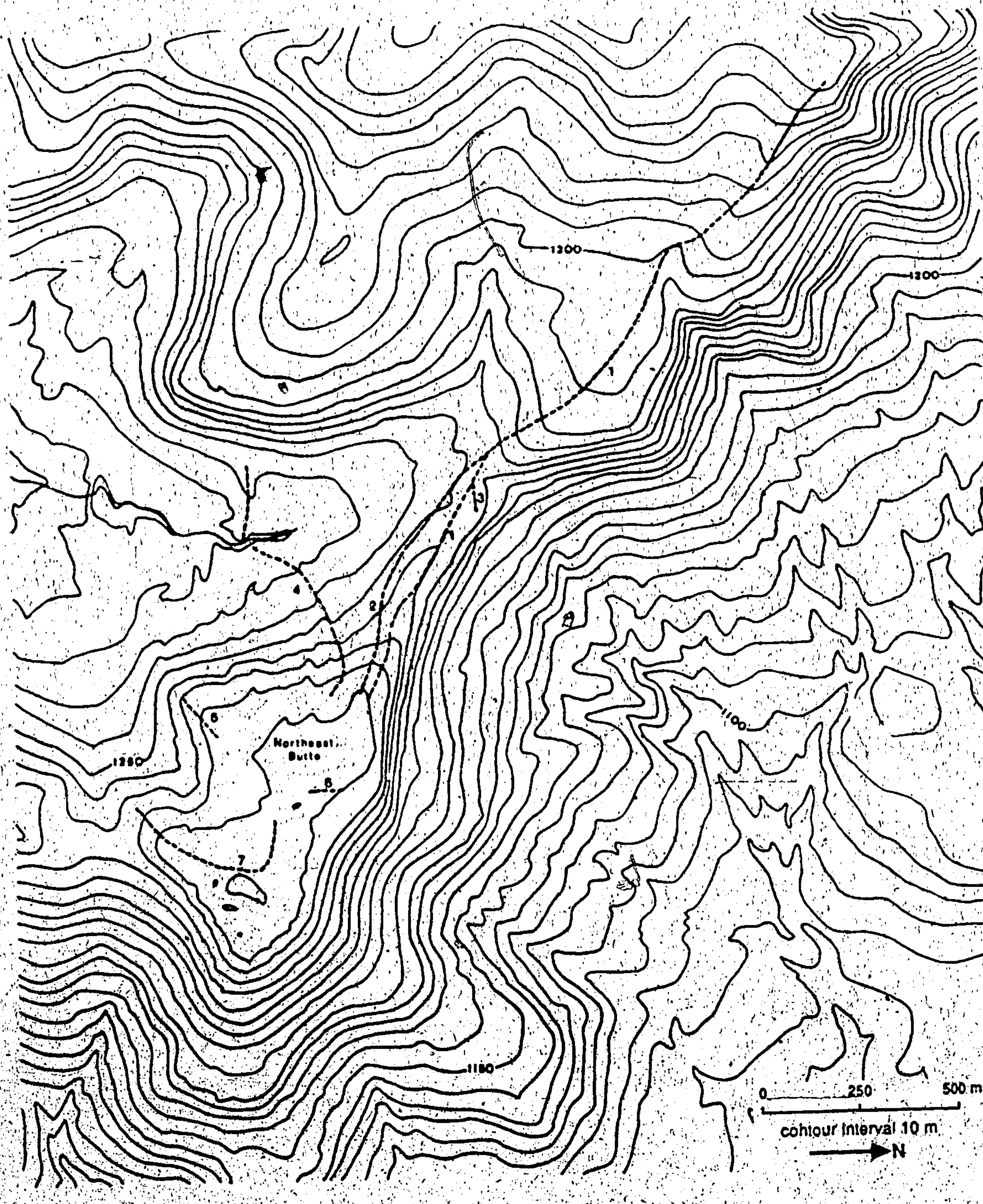



Figure 8: Map of Area A, showing the location of drive lines. The north-facing cliff directly north of line A-6 was the probable termination point of most bison drives in Area A. Line A-3 also ends just west of a steep slope which may have functioned as a jump.

A-4, could have been used to bring bison from the northwest, and turn them to the east as they ascend Northeast Butte. A-2 appears to be an alternate and probably more recent route for the southeast portion of A-1. Assuming that A-5 and A-6 were once part of the same line (as in Reeves 1985), this line (A-5/6) could have been used in conjunction with A-7 in drives which originated to the southwest of the butte.

At several points along the edge of the topographic bench paralleled by A-1, there are vertical faces which would have been steep enough to function as lethal jumps. One short line, A-3, splits off of A-1 and travels east to the abrupt edge of the bench. It is probable that the bison were not always driven all the way to the top of Northeast Butte but sometimes were turned suddenly and jumped off suitable cliffs along this lower bench.

Area B (DkPj-29, Figure 9): Between the Northeast Butte and the Vision Quest Butte there is no set of lines, presumably because there was no suitable cliff at that point along the topographic bench. However, in the pass to the south of this butte is a set of lines, several of which are now very difficult to follow. The most obvious line, B-6, begins along the southern face of the butte and travels southwest over rolling terrain. After splitting into two before descending into the pass, one fork (B-5) travels southeast where it probably joined with a line (B-4) on the north side of the natural pass (Reeves 1985); B-3 runs along the south side of this pass. Lines on the north slope of East Butte also appear to relate to this area and may have provided alternative southern drive lines to be paired during a drive with either B-3 or B-4. All lines in this area, with the exception of B-6, appear to have been used in bringing bison from the west toward the jump. The position of B-6 in relation to a possible drive lane is anomalous because the cairns would not have been visible from any distance either east or west of the line--there are too many small hills obstructing the view. A drive directly along the line is also unlikely because

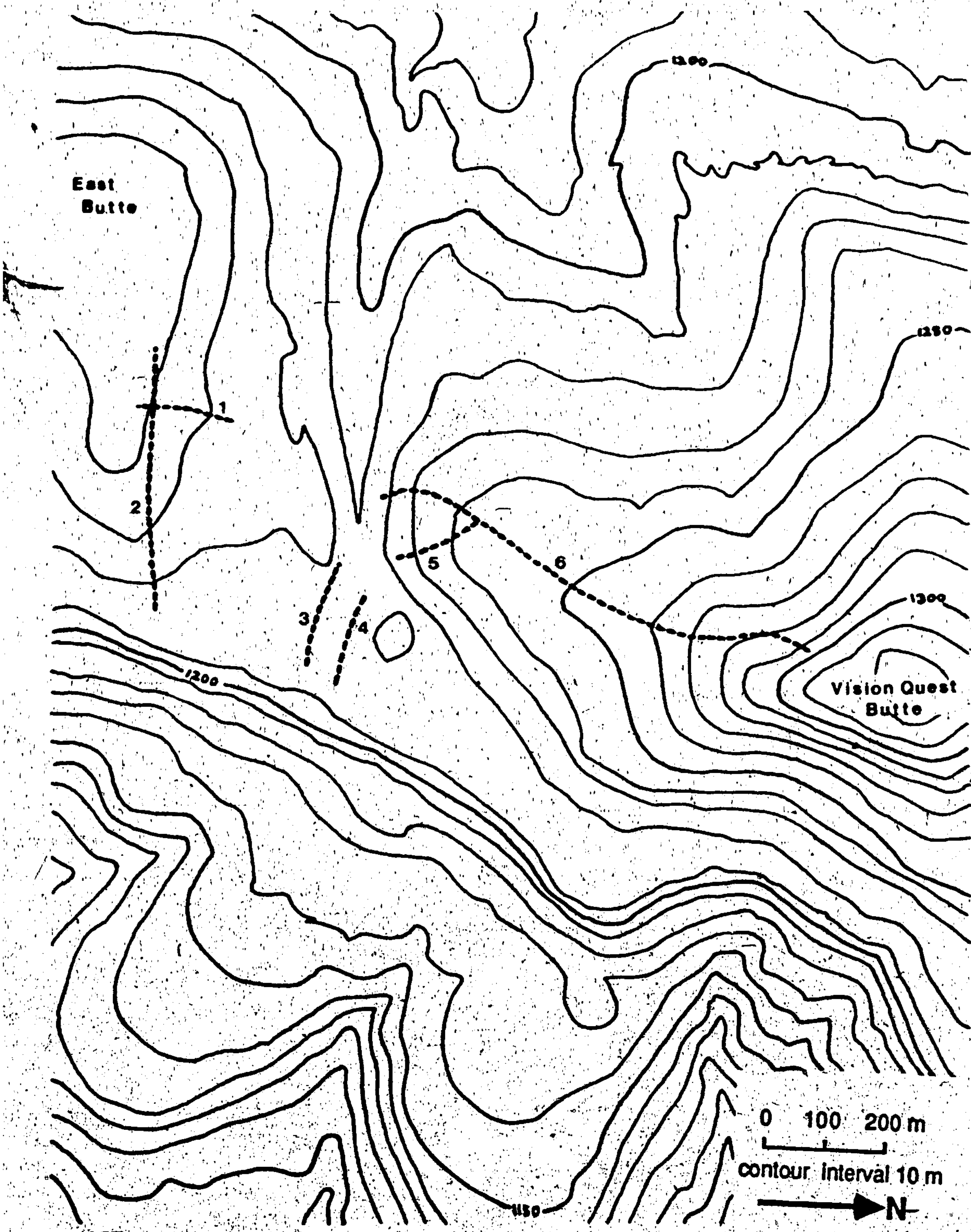



Figure 9: Map of Area B, indicating location of the drive lines.

the Vision Quest Butte at the northern end of B-6 would be a major obstruction to any drive.

Area C (DkPj-30, Figure 10): This is the most complicated set of lines in the HSI system, and the only area other than Area D which is associated with a known kill site (Calderwood Jump, DkPj-27). Most of the lines appear to have been used either to move the bison east through the main pass between East Butte and Southeast Butte (lines C-2, C-3, C-4, C-7) or to move them off East Butte at one of several gentle slopes onto the lower bench (lines C-5, C-6, C-8, C-11). In either case, the drive would eventually have moved through a lane formed by lines C-9 and C-10 which are situated on slight ridges just west of Calderwood Jump. C-1 is the only line in this area which does not appear to relate to Calderwood Jump, but may relate to a drive system for bringing animals from the northwest toward the main kill of HSI, DkPj-1.

Area D (DkPk 2, 13 and 14, Figures 11, 12 and 13): This system of lines is the only one which is clearly reminiscent of the classic V-shaped drive lane, with pairs of lines positioned at the edges of lanes extending for kilometres in several directions away from the jump, DkPj-1. This jump site was used periodically from 5400 B.P. up to the early historic period (Reeves 1978). The flexible system of lines could apparently accommodate drives originating in quite different areas of the gathering basin while retaining a single, suitable termination point. Although access to the land separating line D-7 (Figure 12) from line D-6 (Figure 11) was not obtained (see Figure 6), previous study of the system by Reeves indicated that the two lines do join (1985: 61). Similarly, access was not obtained for the land separating line D-8 (Figure 13) from the eastern portion of Area D; because of cultivation of the intervening area, Reeves (*ibid.*: 64) could not confidently make a connection between this line and any of the other lines in Area D. However, because of the manner in which D-8 contours around both north and south faces of broad knolls near its western end, it appears that the line acted as the northern

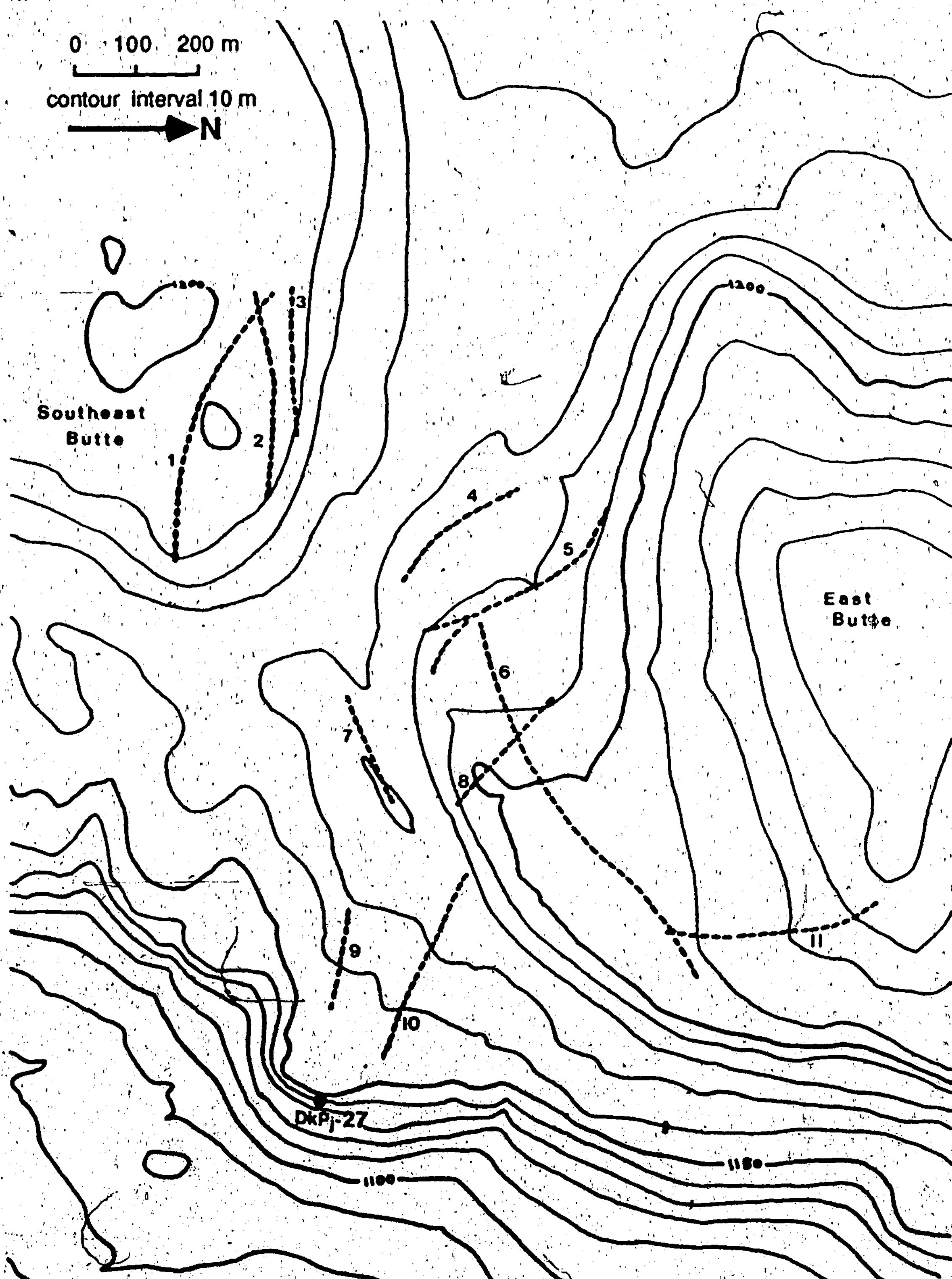



Figure 10: Map of Area C, indicating location of drive lines. The Calderwood Jump, DkPj-27 is located just east of the drive lines.

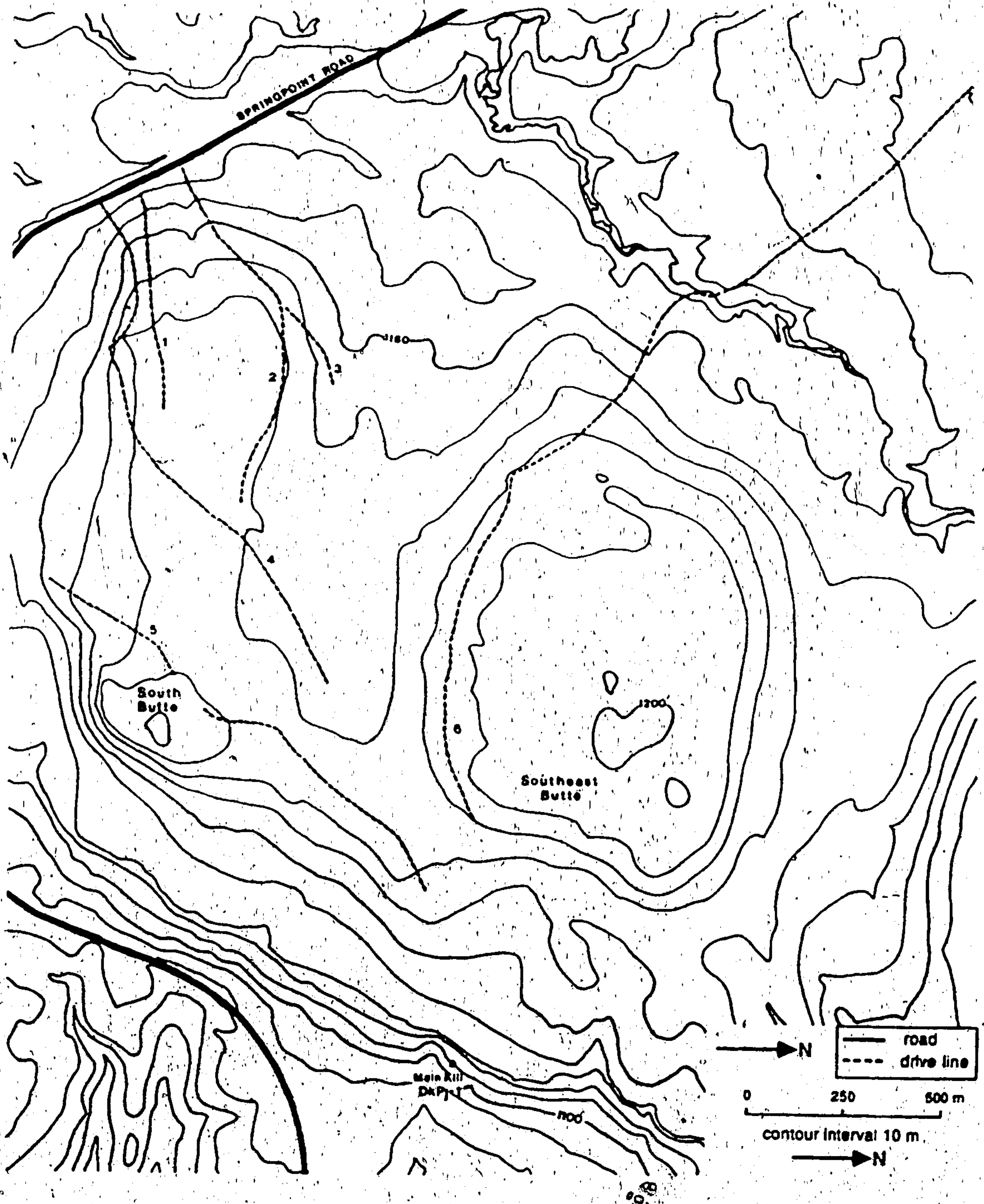



Figure 11: Map of Area D (eastern portion), indicating the location of the drive lines. The main kill site at Head-Smashed-In (DkPj-1) is located in this area. Lines D-7 (Figure 12) and D-8 (Figure 13) located further to the west are also thought to connect with lines in this area.

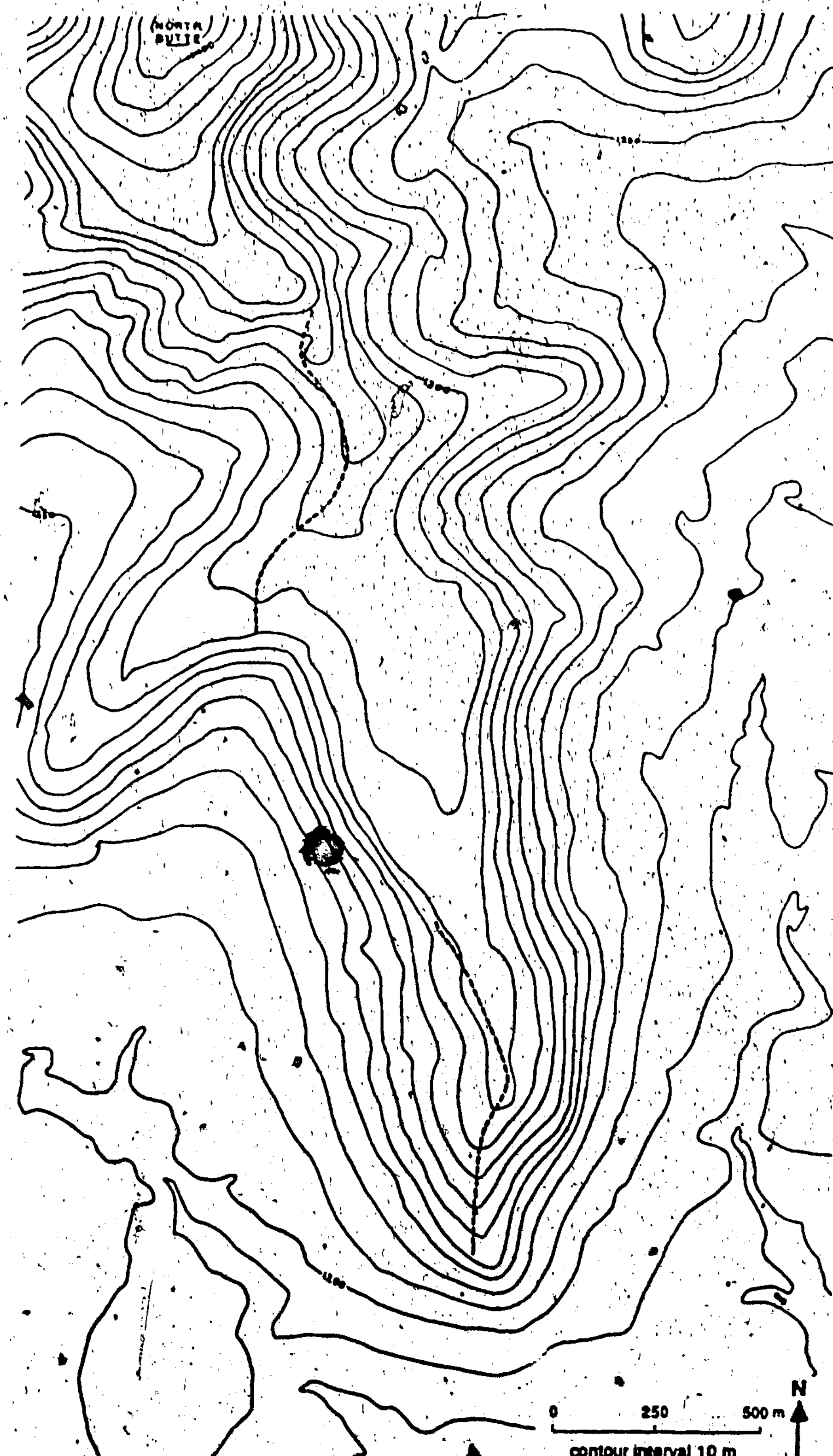



Figure 12: Line D-7, which probably connects with line D-6, although the area separating the two lines was not studied due to lack of landowner permission.

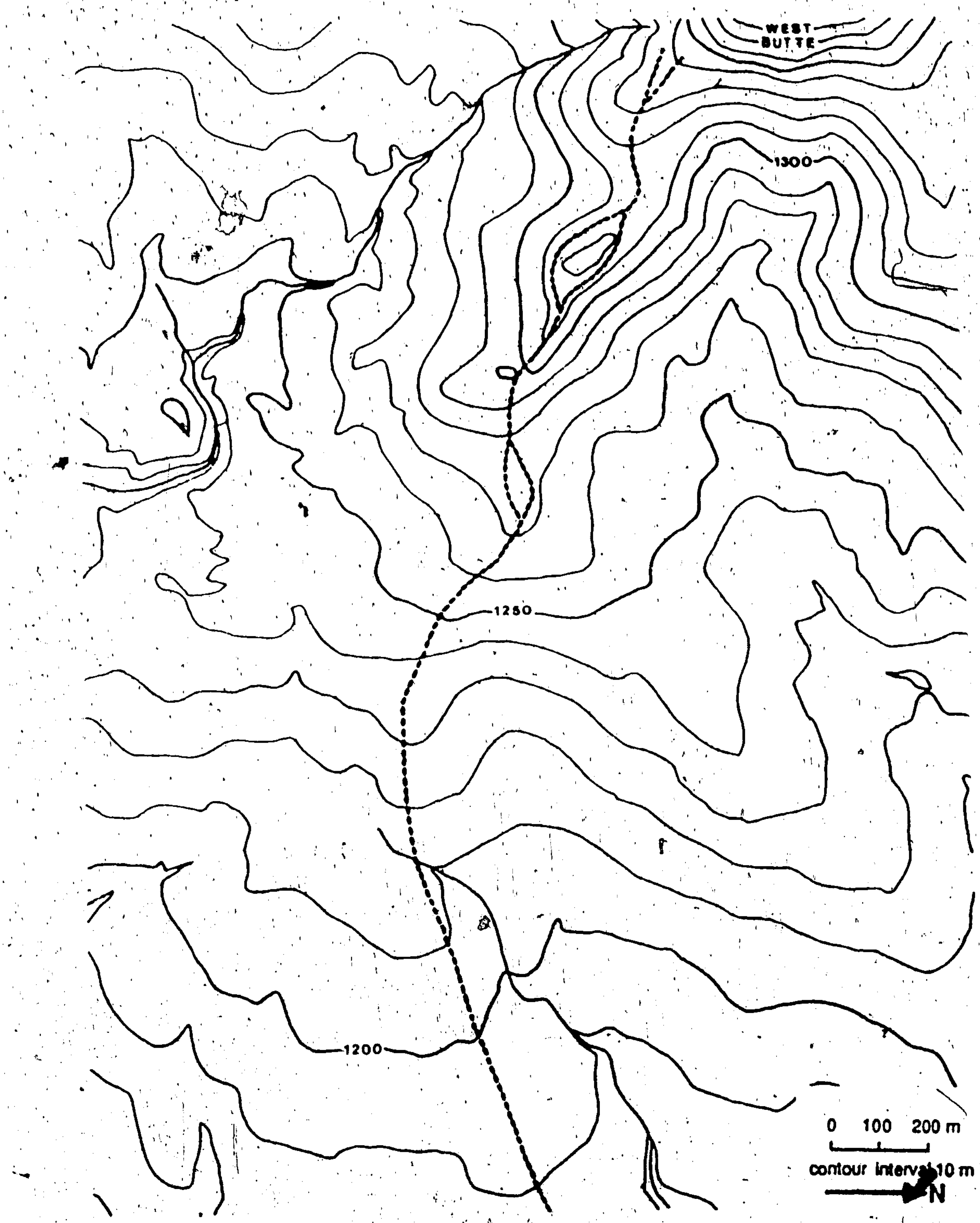



Figure 13: Line D-8, which is separated from the rest of Area D by cultivated land. Notice how the line splits to contour around broad knolls at its western end.

line of the drive lane during some drives and as the southern line during others; in other words, it appears that the people who constructed D-8 followed those contours in order to ensured that the line would be visible to drivers positioned either north or south of the line.

The lines closer to DkPj-1 border natural low passes (Figure 11). D-6, the longest line, runs west from near the jump along the entire south face of Southeast Butte, overlooking the main pass to the south, and then continues northwest across rolling country. The opposing border of the lane with D-6 could have been formed from a section of D-2 or D-3, and sections of D-4 and D-5. In addition, D-4 and D-5 are positioned on either side of a natural low area between the South Butte and an elevated area to its west. This pass could have been used to bring bison from the southwest. The only line which does not clearly fit into the system described is D-1 which runs across the top of a broad elevated area; perhaps it is an alternative path for the western portion of D-4.

The Line Data

From the population of lines described above (32 lines in all), 20 (62.5%) were chosen for detailed mapping. This sample contained complete or partial lines from each of the four areas. Each line in the sample was relatively undisturbed, at least over part of its length. Because of their clarity and apparent relationship with the main kill site at HSI, all of the definite lines in Area D were mapped. Detailed descriptions and illustrations of individual lines have been presented in Rollans (1986). Only the data required to test the implications listed in the previous chapter are presented below.

Table 2 presents a summary of data for the mapped lines. The lines are referenced according to their Area letter (A - D) and their line number within that area (eg. A-1). For general information, the first two columns include the number of cairns mapped, and whether the mapped portion represented the entire line or only a portion thereof. The

Table 2: Summary of data for all mapped lines. All linear or distance measures are in metres.

| LINE | # OF CAIRNS MAPPED | Was entire line mapped? | MIN. LENGTH (m) | AVERAGE DISTANCE BETWEEN CAIRNS proximal | distal | overall | EST. TOTAL # OF CAIRNS | FEATURE FOLLOWED BY LINE | FEATURES OBSTRUCTING LINE | POTENTIAL LINE PAIR | EXCEPTIONAL FEATURES/ COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A-1 | 168 | no | 2,040 | 3.3 | 4.6 | 3.0 | 680 | edge of topo-graphic bench | gulley | A-4 | The line is unusually crooked. There are apparently fortified sections with double lines or very close cairns. |
| A-3 | 29 | yes | 70 | 3.1 | 2.5 | 2.5 | 28 | | | | This short line forks off from A-1 and runs almost to the edge of a steep slope. |
| A-4 | 126 | yes | 750 | 4.1 | 5.8 | 3.6 | 208 | ridge | creek bed | A-1, A-2 | The line cuts across the natural pass of a broad creek valley to go up the side of Northeast Butte. |
| A-5 | 25 | no | 130 | 5.4 | 4.3 | 4.8 | 27 | ridge | | A-7 | The line may be connected to A-6 |
| A-6 | 17 | yes | 90 | 4.4 | 4.7 | 4.9 | 18 | | | A-7 | The line may be connected to A-5. |
| A-7 | 140 | yes | 540 | 3.7 | 2.9 | 3.0 | 180 | two ridges | | A-5, A-6 | The two ridges followed by the line intersect at almost right angles. The line curves almost 90° at this point |
| B-5 | 23 | yes | 150 | 5.1 | 5.2 | 5.2 | 29 | | | B-3 | This line forks off from B-6. It may be connected to B-4. |
| B-6 | 74 | no | 800 | 4.5 | 5.8 | 5.0 | 160 | | Vision Quest Butte | | The line would not be clearly visible unless the drive path was right along it. |
| C-5 | 27 | no | 400 | 4.7 | 4.8 | 4.6 | 87 | slight ridge | | | |
| C-8 | 20 | no | 230 | 4.3 | 4.7 | 4.6 | 50 | slight ridge | | | |
| C-10 | 32 | yes | 330 | 4.8 | 3.9 | 4.6 | 72 | slight ridge | | C-9 | |
| C-11 | 23 | yes | 350 | 7.6 | 6.5 | 6.9 | 51 | ridge | | | |
| D-1 | 57 | yes | 360 | 7.1 | 6.4 | 6.5 | 86 | edge of gulley | | D-5 | The line could not be traced across Spring Point Road. It may act as an alternate western extention of D-4. |
| D-2 | 115 | yes | 990 | 6.2 | 5.9 | 5.6 | 177 | side of gulley, edge of bench | | D-6 | The line could not be traced across Spring Point Road. It intersects with D-4. D-3 forks off from it. |
| D-3 | 41 | yes | 340 | 6.0 | 6.2 | 5.6 | 61 | | | D-6 | The line forks off from D-2. |
| D-4 | 208 | yes | 1,500 | 6.7 | 5.6 | 5.1 | 294 | edge of bench | steep slopes | D-5 | The line becomes extremely crooked in its western end and could not be traced across Spring Point Road. |
| D-5 | 141 | no | 1,180 | 4.8 | 6.9 | 4.9 | 241 | | South Butte | D-4 | The line was only mapped to the fence of the Peigan Indian Reserve. One section of the line has unique line markers--earth mounds. |
| D-6 | 311 | no | 2,540 | 6.4 | 6.6 | 4.9 | 518 | side of Southeast Butte | gulley, creek bed | D-2, D-3, D-4, D-5 | The line could not be mapped on unaccessible lands. It probably connects to D-7. It takes a jog as it crosses a gulley and a creek. |
| D-7 | 27 | no | 1,780 | 6.5 | 6.7 | 6.6 | 270 | side of topographic bench | cliff | | It is very difficult to follow along this line except at its northern end. It probably connects to D-6. |
| D-8 | 61 | no | 2,630 | 5.8 | 5.6 | 5.8 | 453 | ridge (western part of line) | creek bed | | This line contours around knolls apparently to be visible from the south and north. It could not be mapped on unaccessible lands. It may join with D-2 or D-4. |
| SYSTEM SUMMARY DATA | | | | | | | | | | | |
| Number of: lines mapped? 20 | cairns mapped? 1665 | | | | | Average 4.9m | Total 3,690 | Number of lines exhibiting feature: 14 | 8 | 13 | |

data for line length is a measure of the entire line, whether or not the entire line was mapped; the column heading of "minimum line length" reflects the fact that the line may originally have been longer than what the present extent of visible cairns can confidently demonstrate. The distance between cairns was measured from the center of one cairn cluster to the center of the adjacent cairn. The figures for average distance between cairns were computed for the proximal and distal ends of the lines, as well as an overall average. In order to make a comparison among lines more useful, the range of the distances used in these calculations was restricted, a step which will further be discusses and justified below. Within these restrictions, 10 consecutive distances between cairns were used in the calculations of proximal and distal averages. The estimated total number of cairns in the line when it was originally used was computed by dividing the minimum length of the line by the overall average distance between cairns. Any topographic feature along which a line follows is listed, as is any major topographic feature which obstructs the path of a line. Finally, the table includes the potential lines with which the line in question might have been paired (in the manner of characteristic V-shaped lanes) during drives.

Cairn spacing is a difficult topic to generalize, whether discussing differences between lines or among sections of the same line. Lines of cairns usually consist of closely, consistently spaced cairns approximately 3 to 6 m apart. However, along all lines, there are occasional large gaps between some cairns (Figure 14). All visible cairns were mapped, but the search for subsurface cairns was necessarily minimal, and usually consisted of probing around single stones in order to determine if additional stones could be located beneath the surface. From the fieldwork which I carried out, it is unclear whether the present gaps along lines are due to post-depositional factors or whether they were purposeful aspects of line design. I am assuming that large gaps (greater than 10 m) are due to poor visibility or sampling error and are not characteristic of the original

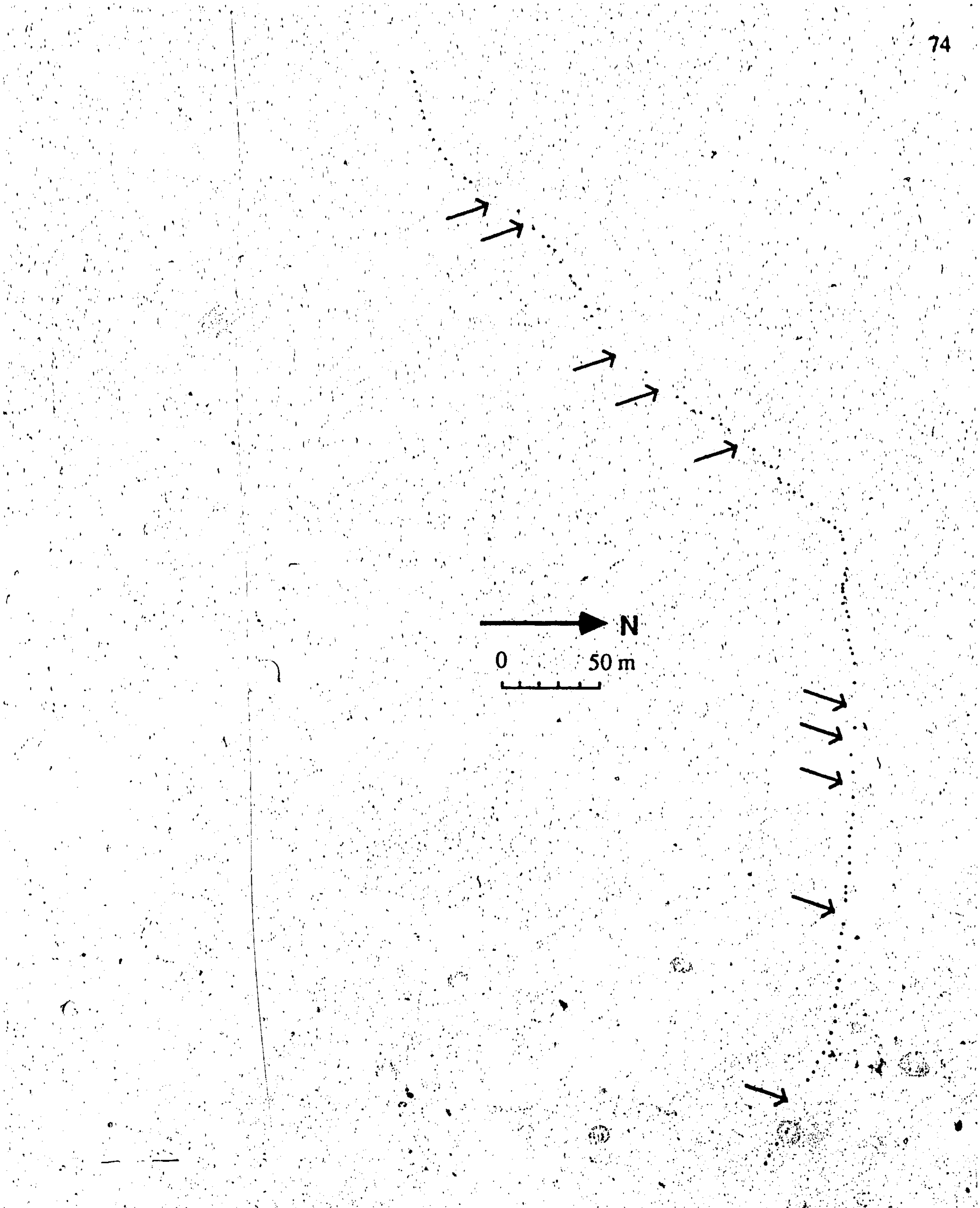


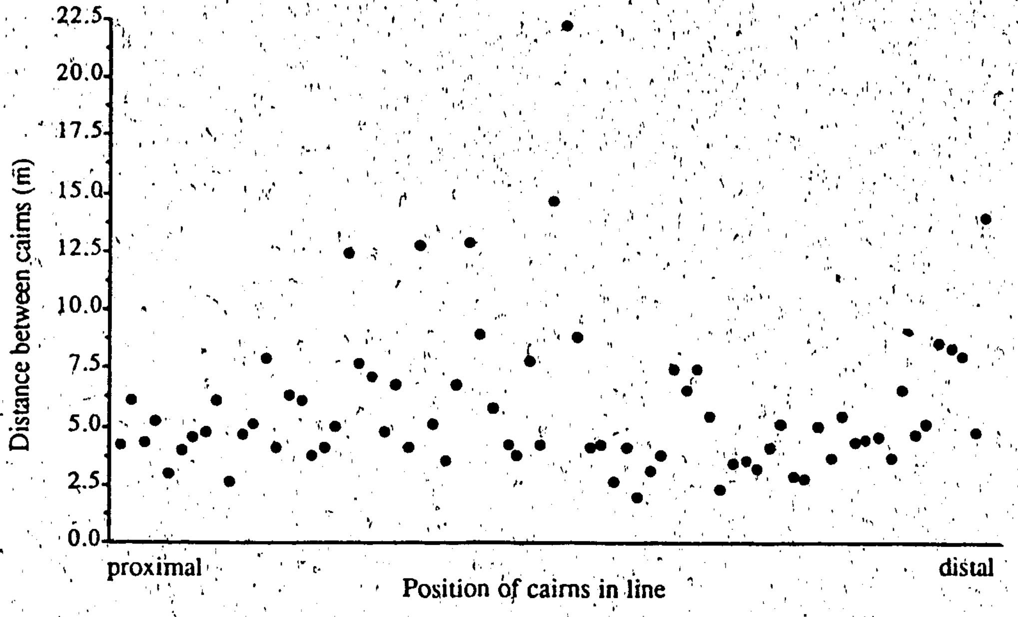

Figure 14: Detailed map of line D-2 showing the typical uneven spacing of cairns and the chaotic large gaps (>10 m, indicated with arrows) between some cairns.

line form because first, the gaps are the exception in most lines, not the rule--there is no line or portion of line with consistently widely spaced cairns; second, gaps are more common in low lying areas, such as gullies or slopes prior to the cliffs, which are areas of net deposition; and third, in areas where lines are close together and rocks are not naturally abundant in the soil (Areas C, and D), cairn stones may have been transferred from one line to a neighboring line, depending upon changes in the route of the drive or the strategies of the humans involved. Therefore, gaps larger that 10 m were not included in the samples used to determine the average distance figures in Table 2.

On the other hand, the distance between cairns is not so consistent as to appear that it was measured out by the people who constructed the line. Slight variations of several metres among neighboring cairns are normal occurrences. These smaller variations are not patterned--there are rarely sections of lines which contain consistently closer cairns than neighboring sections (Figure 15). Rather, the variation appears to be essentially random. For this reason, small gaps (smaller than 10 m) were included in average figures because they were assumed to be part of the natural variation in cairn spacing within the line.

As is apparent from the areal maps (Figures 8-13), the lines in the HSI system do not run right to the edge of the cliffs. The lines near the cliffs may have been obscured by the increased deposition caused by the gentle downgrade immediately to the west (south, in the case of Area A) of the cliffs. But whatever the reason for this phenomenon, little is known about the form of drive lines used in this crucial final part of the drive, just before the animals stampeded over the cliff. The only exception to this is line A-3 (Figure 16) which veers sharply off of A-1 and terminates just before a steep slope, now heavily overgrown with brush. These cairns are very close together compared to the cairns in most lines in the HSI system (see Table 2), but are only

a. Line B-1




b. A section of line A-1

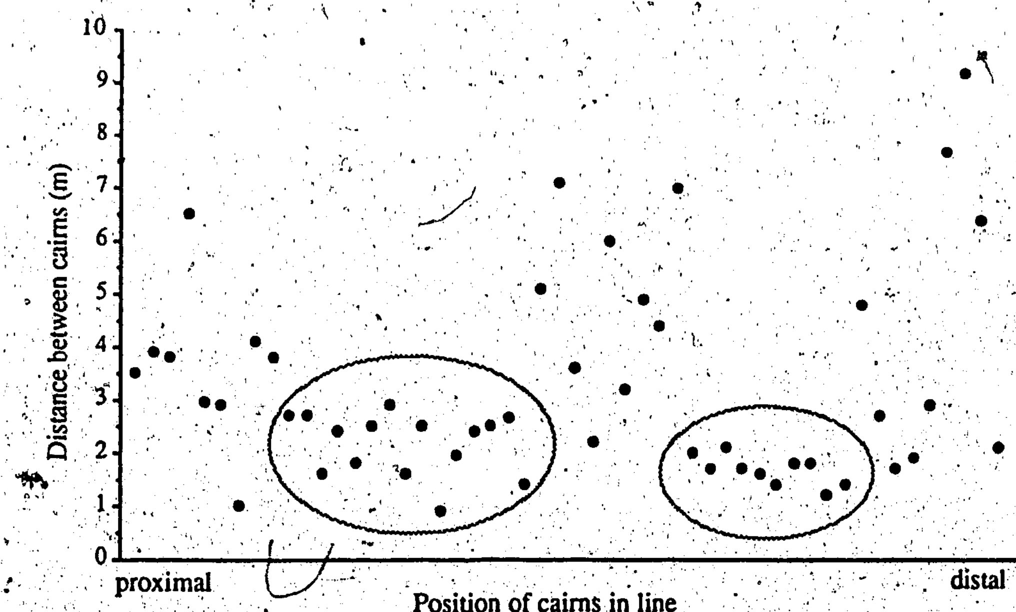



FIGURE 15: Scattergrams of cairn spacing. The cairns in (a) are randomly spaced, showing no patterned clusters and no trends toward increased spacing toward the distal end of the line. Illustration (b) shows two clusters of closely spaced cairns (which have been circled). This was the only obvious clustering of cairn distances in the entire sample of mapped lines.

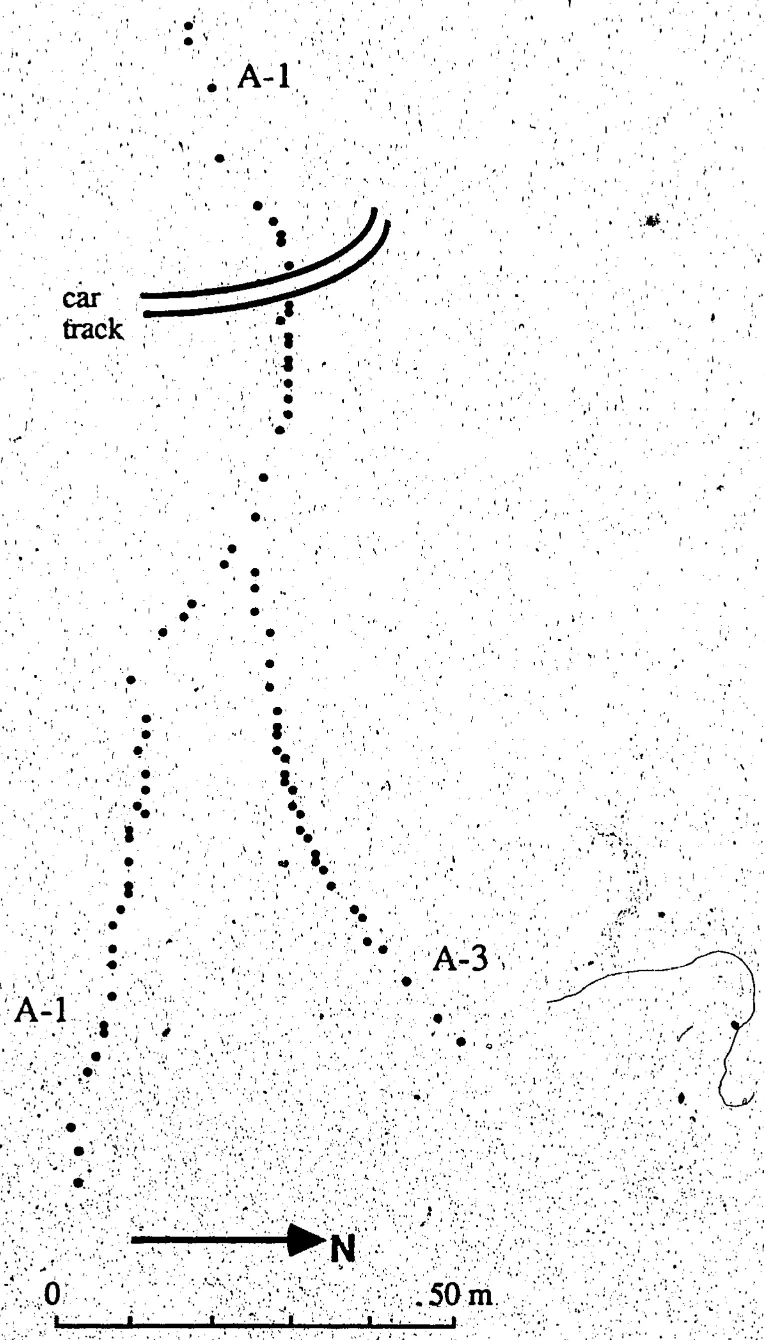



Figure 16: Detailed map of a section of line A-1 and line A-3. Note how close together the cairns are as A-1 crosses what is now a car track used to get from the 1250 m topographic bench onto the plains below (see also Figure 15).

slightly closer together than the cairns in the section of line A-1 from which A-3 originates.

The shape of a line appears to be related to many factors. Lines which follow topographic features follow the shape of that feature; for example, they may curve as the ridge curves (eg. line A-4), follow along a contour on the side of a bench (eg. line D-6), run along the edge of a steep slope (eg. line A-1). Where there are major obstructions in the path of a line, the line may change course (eg. line D-4 when it arrives at a steep slope), it may incorporate the obstruction (eg. line D-5 continues on either side of South Butte), or it may take a jog as it crosses the obstruction (eg. line D-9 at a creek channel). Minor deviations in the linear shape are common (Figure 17) but are not consistently associated with micro-topographic features; rather it seems that precise straightness was not a necessary feature of the line and was not emphasized during line construction.

The Cairn Data

From the population of all mapped cairns (over 1700 cairns in all) a sample of 43 (2.5%) was chosen for further analysis. Of these, 35 were fully excavated and the remaining 8 were studied from the surface, with the aid of metal probes to determine measurements. An additional 11 cairns from Area D, excavated by the Archaeological Survey crew in 1984, can be included in the discussion, although differences in methodology do not allow their quantitative measurements to be used in comparative tables. The sample is sufficient to indicate the general characteristics of cairns in the HSI system but cannot confidently demonstrate the regional variation that may exist. In order to illustrate the full variation in cairn form, the sample contains at least two cairns from each of 16 mapped lines, representing each of the four mapped sets of lines. Cairns from distal and proximal ends of lines are also represented.

Although there is a great deal of variability in the specific dimensions of the cairns, there is a general form which is recognizable throughout the system (Plate 2). The cairns

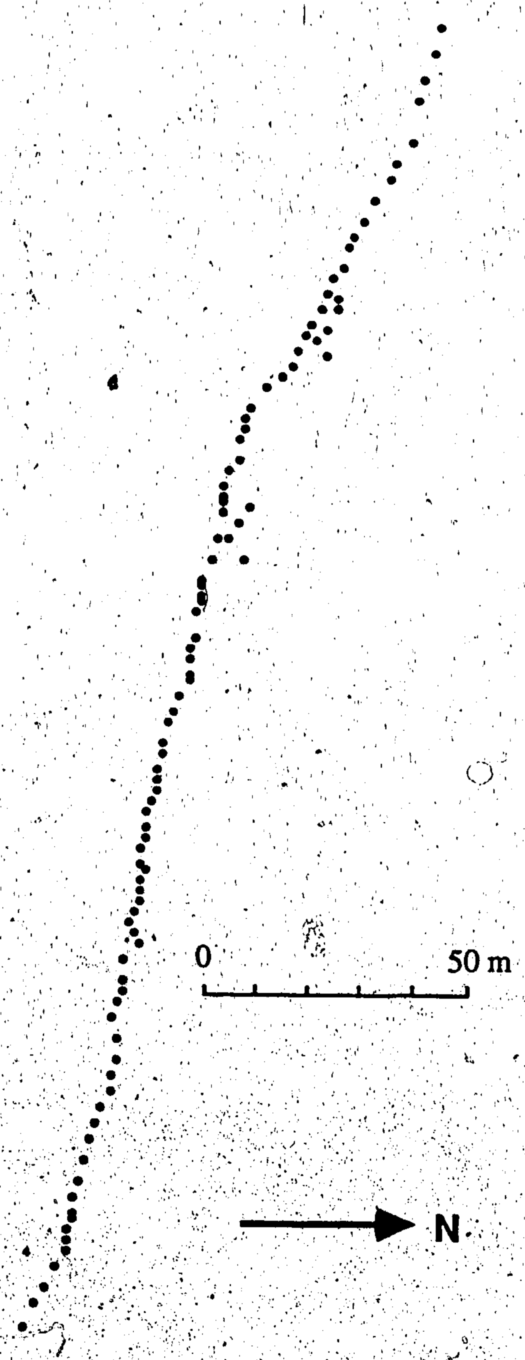



Figure 17: Detailed map of the northern-most section of line A-1. Note the slight irregularities in line shape, and the apparent short double rows of cairns.

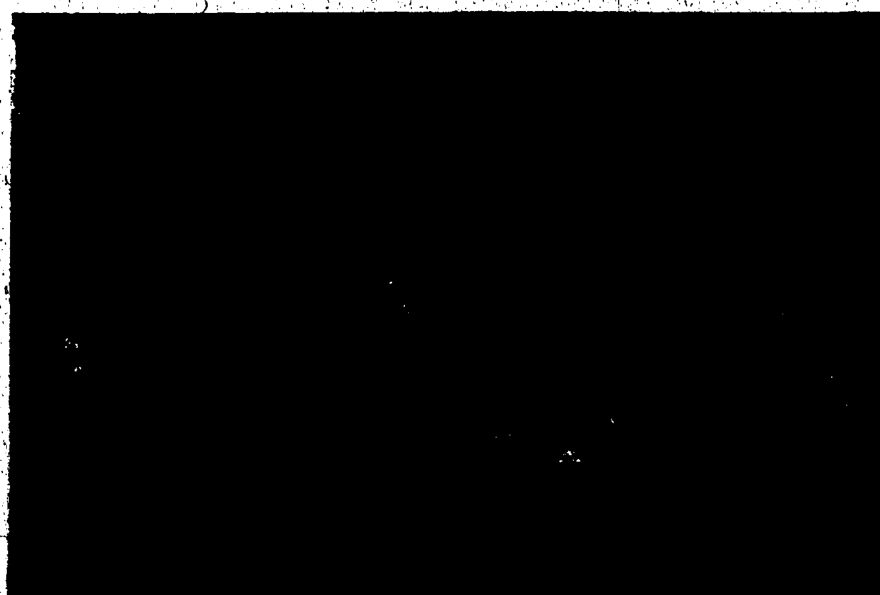


Plate 2: Photograph of cairn A-3-8 after excavation, illustrating the normal form of HSI cairns.

are simple single-layered clusters of stones. Most of the rocks in these clusters range from 10 cm to 25 cm in diameter. There is no evidence to suggest that these rocks were ever piled one on top of the other; even when the cairns are situated on a slope, their present tightly and consistently clustered form is not indicative of toppled piles. The clusters are roughly circular but vary with the shape of stones which comprise them. From the small sample for which data is available, and from impressions gained through a general knowledge of the system, it appears that the size of cairn and the number and size of stones vary as much within lines as between them.

In cairn excavations, there was no evidence that perishable materials were ever present to augment the structures. Bone preservation is generally good in the campsite area of DkPj-1 but no wood has been recovered in excavations of that area (Jack Brink, Archaeological Survey of Alberta, pers. comm.). In excavating the soil among and under cairn stones, any preserved wood or bone would have been recovered, and post molds would have been identified had they been present. Dung would not have been identified, but the use of sod would have been recognized by the excessive build-up of soil among or on top of cairn stones. The chances of recovering evidence of perishable materials using the methods which I employed were not great, even if perishable materials had been utilized during prehistoric drives.

There are only two obvious deviations from the generalized description of the HSI cairns. The first is the cairn form in line A-1 which is located in an extremely rocky area; the cairns in this line are consistently larger and contain more stones than most cairns in the system. A more marked deviation from the cairn form characteristic of the HSI system was used in a short section of D-5 which runs for 170 m and contains 42 markers (Figure 18). These structures are distinct round mounds of earth about 1 m in diameter and 0.2 m high (Brink *et al.* 1986: 314). Although there are a few rocks incorporated in the piles, they are not as prevalent nor as tightly clustered as in the more

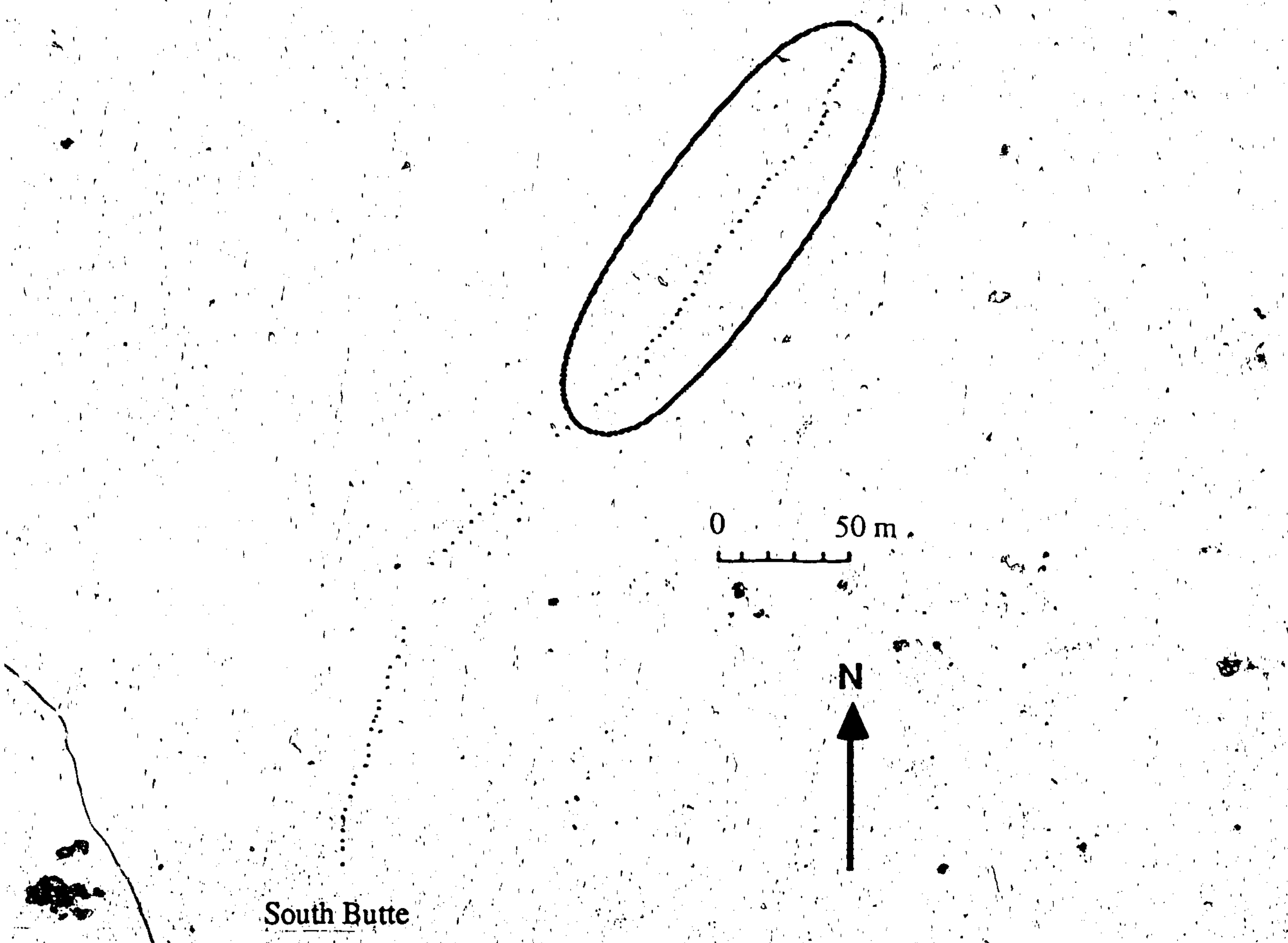



Figure 18. Detailed map of line D-5, northeast of South Butte. The cairns which are circled are actually mounds of earth with very few stones present; the cairns on either side of the circle are similar in form to other cairns in the Head-Smashed-In system.

common cairn form. The form of these piles is so unique and restricted in the HSI system that it is more likely due to differences in available materials than to differences in the function of the piles. Brink (*ibid.*) suggests that the naturally occurring stones are found lower in the soil profile in this area because of greater loess deposition. The difficulty involved in obtaining the preferred building materials (stones) in this localized area may have induced the manufacturers to depart from the more characteristic cairn form. The cairns extending from either end of this section are indistinguishable from other cairns in the HSI complex.

Table 3 summarizes the pertinent data recorded for each cairn. The number designation of the cairn indicates its position along the mapped portion of the line, with 1 being the most proximal cairn. The number of stones comprising the cairn, as well as any other cultural components found in the matrix among these stones is presented. An indication of the arrangement of these stones is provided: a tight cluster is one with less than 1 cm between the majority of adjacent cairn stones, a loose cluster averages more than 1 cm; and a ring indicates a complete or partial ring arrangement. Because the cairns are never perfectly circular, the average diameter is the mean of the maximum and minimum diameters. And finally, the maximum height could only be measured for excavated cairns and is the height of the tallest stone, since the cairns are single layers of stones.

Table 3: Summary of data for the study sample of cairns.

| CAIRN NUMBER | NUMBER OF STONES | AVERAGE DIAMETER (m) | MAXIMUM HEIGHT (m) | ARRANGEMENT OF STONES: TIGHT CLUSTER | LOOSE CLUSTER | RING | OTHER COMPONENTS |
|---|---|---|---|---|---|---|---|
| A-1-021 | 32 | 1.35 | 0.23 | X | | | none |
| A-1-022 | 10 | 0.73 | 0.14 | X | | | none |
| A-1-059 | 7 | 0.66 | 0.10 | X | | | none |
| A-1-060 | 6 | 0.63 | 0.20 | X | | | none |
| A-1-161 | 14 | 0.95 | 0.15 | X | | | none |
| A-1-162 | 22 | 0.87 | 0.15 | X | | | none |
| A-3-007 | 9 | 1.05 | 0.16 | X | | | none |
| A-3-008 | 10 | 0.75 | 0.13 | X | | | none |
| A-4-064 | 10 | 0.57 | | | | | |
| A-4-065 | 7 | 0.65 | | | | | |
| A-6-011 | 5 | 0.66 | | | | | |
| A-6-012 | 4 | 0.78 | | | | | |
| B-5-021 | 5 | 0.55 | 0.15 | | X | | none |
| B-5-022 | 12 | 1.04 | 0.15 | X | | | none |
| B-6-054 | 2 | 0.52 | 0.20 | X | | | none |
| B-6-056 | 12 | 0.72 | 0.20 | X | | | none |
| C-5-048 | 14 | 0.66 | 0.15 | X | | | none |
| C-5-049 | 8 | 0.57 | 0.15 | X | | | none |
| C-11-010 | 15 | 0.86 | 0.15 | | X | | none |
| C-11-011 | 14 | 0.79 | 0.20 | X | | | none |
| D-1-042 | 9 | 0.73 | 0.25 | X | | | none |
| D-1-043 | 5 | 0.56 | 0.18 | X | | | none |
| D-2-045 | 23 | 0.80 | 0.21 | X | | | none |
| D-2-046 | 12 | 0.61 | 0.12 | | | X | fragment of bone |
| D-2-102 | 6 | 0.63 | 0.22 | X | | | none |
| D-2-103 | 6 | 0.73 | 0.17 | | X | | none |
| D-3-033 | 18 | 1.03 | 0.15 | X | | | none |
| D-3-034 | 14 | 0.70 | 0.20 | X | | | none |
| D-4-086 | 8 | 0.78 | 0.20 | X | | | heat spall of chert |
| D-4-087 | 7 | 0.65 | 0.22 | X | | | none |
| D-4-196 | 4 | 0.55 | 0.14 | X | | | none |
| D-4-197 | 10 | 0.64 | 0.12 | | X | | none |
| D-5-112 | 5 | 0.95 | 0.14 | | X | | none |
| D-5-113 | 4 | 0.75 | 0.13 | | X | | none |
| D-6-008 | 16 | 0.65 | 0.17 | | | X | none |
| D-6-010 | 11 | 0.93 | 0.08 | X | | | none |
| D-6-265 | 4 | 0.37 | 0.19 | X | | | none |
| D-6-305 | 11 | 0.85 | 0.17 | X | | | none |
| D-6-306 | 22 | 0.98 | 0.22 | X | | | none |
| D-7-020 | 9 | 1.16 | | | | | |
| D-7-021 | 6 | 0.64 | | | | | |
| D-8-001 | 10 | 0.87 | | | | | |
| D-8-002 | 8 | 0.96 | | | | | |

SUMMARY DATA

COUNTS:

| | | | | | | |
|---|---|---|---|---|---|---|
| 43 cairns | | | 35 excavated cairns | 27 tight | 6 loose | 2 rings |

AVERAGES:

| | | | |
|---|---|---|---|
| | 10 stones | 0.76 m diameter | 0.17 m height |

# CHAPTER 8:

## ANALYSIS OF TEST IMPLICATIONS

The following is a systematic testing of each proposition in the order in which they were initially presented. For each proposition, there is a brief explanation including the background (or source) of the proposition, followed by a test of each implication against the archaeological data from Head-Smashed-In Buffalo Jump, and finally a brief summary of the confirmatory status (acceptance or rejection) of the proposition. The archaeological data used to test these propositions is summarized in Tables 2 and 3. Table 4 provides an accessible index of line illustrations in order to make the archaeological examples which are presented below easier to follow.

PROPOSITION I: The lines followed through the center of the drive path.

This possibility is seldom considered by plains archaeologists, yet early ethnographers did report the use of single lines down the center of drive lanes by Blackfeet (Grinnell 1893: 231) and Plains Cree (Mandelbaum 1979: 54). Rather than forcing an anomalous line to conform to the norm of V-shaped drive lines, it may be more useful for the archaeologist to consider this proposition.

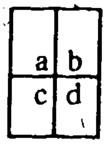
Test Implications for Proposition I

1. The lines should follow through natural passes.

   None of the lines run down the middle of topographic features which could act as natural passes--low, level areas bounded by ridges, long shallow gullies, or broad level expanses separating good grazing areas from potential jumps.

2. There should be no large obstructions along the path of the line. The line should contour around or through unavoidable obstructions.

TABLE 4: Key to the location of line diagrams.




| line number | illustrated on page no. | quadrant of page (areal map) |
|---|---|---|
| A-1 | 63, 77, 79 | b & c |
| A-2 | 63 | c |
| A-3 | 63, 67 | b |
| A-4 | 63 | b |
| A-5 | 63 | c |
| A-6 | 63 | c |
| A-7 | 63 | c |
| B-1 | 65 | a |
| B-2 | 65 | a |
| B-3 | 65 | a |
| B-4 | 65 | a |
| B-5 | 65 | a |
| B-6 | 65 | b |
| C-1 | 67 | a |
| C-2 | 67 | a |
| C-3 | 67 | a |
| C-4 | 67 | a |
| C-5 | 67 | b |
| C-6 | 67 | b & d |
| C-7 | 67 | c |
| C-8 | 67 | c |
| C-9 | 67 | c |
| C-10 | 67 | c |
| C-11 | 67 | d |
| D-1 | 68 | a |
| D-2 | 68, 74 | a |
| D-3 | 68 | a |
| D-4 | 68 | a & c |
| D-5 | 68, 82 | c |
| D-6 | 68 | b & d |
| D-7 | 69 | |
| D-8 | 70 | |

Several lines incorporate natural barriers into their paths, such as buttes (lines B-6 and D-5) or steep slopes (lines D-4 and D-7) which could prove treacherous if animals were driven too close. Other lines traverse features such as creek beds (line A-4) and gullies (line D-6) at particularly steep spots, which would not be expected if bison were to be driven along that path. Only one line, D-6, provides a clear example of a line contouring as it passes through an unavoidable creek bed. Other lines contour around broad topographic features, but the reason appears to be in order to ensure that the line is continuously visible from the drive path and not obstructed by the intervening land features.

3. The lines should not be associated in converging pairs.

Only 7 of the 20 mapped lines--A-3, B-6, C-5, C-8, C-11, D-7 and D-8--are not clearly associated with converging partner lines.

Status of Proposition I

None of these three implications have been supported by the archaeological evidence. This proposition has therefore effectively been rejected as a possible explanation of the general function of lines in the HSI system. Although propositions in a hierarchical position under it, I.A and I.B, are also automatically rejected, they will be discussed briefly to give an indication of how generally tenable these propositions are. The archaeological implications of these propositions will not be tested.

PROPOSITION I.A: The line provided a natural path, similar to a game trail, which the bison followed.

Ethological data supports the fact that bison tend to follow trails, both today and in the past. Ethnographic data (Grinnell 1893: 231, R. McDonnell 1983) suggests that Blackfeet attempted to produce artificial trails which the bison would follow during drives. Bison today also prefer to follow game trails when they are being driven

(R. Ellis, Fort Niobrara National Wildlife Refuge, Nebraska, pers. comm.). The above present a sound basis for this proposition and suggest that it should not be ignored in bison drive lane studies.

PROPOSITION I.B: The line provided an indication to the drivers of where to direct the herd.

This proposition is a logical possibility, given a line running within a natural lane. The line would provide a visual map for the drivers to follow and reduce the chance of a drive wandering off course. Because bison cannot be turned both suddenly and with control without the use of fences or walls, the drivers must be aware of their target destinations long before they reach them, hence the necessity of conspicuous line markers.

PROPOSITION II: The lines marked the boundaries of the lane through which bison were driven.

Most archaeologists assume that this is the role of stone lines, and indeed most ethnographic, ethnohistoric, and ethological reports indicate that lines should be positioned in this way. The lane, then, would be the most convenient route along which to drive bison toward the desired termination point, and the drive lines would mark the limits of the lane outside of which the bison were not to be permitted, ideally, to go.

Test Implications for Proposition II.

1. The lines should border natural lanes or passes.

There are few exceptions to this in the HSI system. Most lines follow the elevated boundaries of natural low passes, either along ridges or the sides of benches. Where the lane is generally rolling and no natural pass exists, the position of the line seems more arbitrary (eg. line D-6 northwest of Southeast Butte1). The anomalous lines are B-6, and D-1 which are not clearly bordering any natural pass, although there are natural passes in their vicinities.

2. The lines could incorporate natural obstructions (eg. cliffs, buttes).

At the boundaries of a lane, such obstructions would not hamper the movement of bison along the drive path. However, such obstructions would not be necessary for the lines to function in the manner proposed. Three of the lines, D-4, D-5 and D-7, do incorporate such obstructions (ie. they stop when they reach the obstruction and continue on the opposite side of the obstruction) apparently to aid in containing the animals within the lane. There are no lines which go around such obstructions without incorporating them. B-6, however, is anomalous because it travels north up the side of Vision Quest Butte in a way that bison could not easily be driven along the line and yet the line is not in an appropriate position to incorporate the butte as a barrier.

3. The lines should be associated in converging pairs, especially near the termination of the drive.

13 of 20 lines have a converging partner line for at least part of their length. Of the 7 lines without a pair, only A-3 is located near a cliff, where two lines would be expected to define the ever-narrowing lane. Further from the jump, the diverging lines would be so far apart that they could never both be functional during a single drive.

Status of Proposition II

All three test implications were affirmed by the archaeological data. But although the proposition appears to apply to the general case in the HSI system, lines A-3, B-6, D-1 do not possess all of the necessary characteristics and may prove exceptions; these will be discussed further in a later chapter.

PROPOSITION II.A: The lines--the cairns or whatever materials were added to them--directly limited the movement of the bison.

All ethnographic and ethnohistoric sources either state or imply that the lines not only defined the limits of the lane but also aided somehow in keeping the bison from escaping out of the lane. Brink (1985) has argued that there must be something about the lines themselves that affected the movement of bison; only that fact would explain their close spacing over several kilometres of the drive at HSI. Other archaeologists, when describing lines which "funnel" bison toward the trap, are intimating one of the propositions subsumed by this one.

Test Implications for Proposition II.A

1. The cairns had to be fairly close together along the entire length of the line in order to provide a barrier to bison, whether real or perceived.

Propositions subsumed under II.A are more exact about spacing requirements; the degree of closeness depends upon the precise way in which the lines control bison movement. The cairns in all lines tend to be close together along the entire length of line (less than 10 m apart along sections of line with fairly consistently spaced cairns).

2. Near the jump and in places where the bison habitually break out of the lane, the line should be fortified (cairns larger and/or closer together) to withstand the potential added pressure.

As previously discussed, cairn spacing is a suspect measurement about which to generalize. Cairn spacing in most of the lines is highly erratic. The scatter diagrams give a visual indication of the general lack of clustering and great range of this variation (see Figure 15). There is no strong correlation between increasing distance from the jump and increasing distance between cairns (the correlation coefficient when x=distance from jump and y=distance between cairns is always near 0). Even when comparing measurements between sections at the proximal and at the distal ends of the line, the trend toward greater distance between cairns as the distance from the jump increases is not strong (for this discussion A-5 and A-6 are considered to be part of one line, as are

D-6 and D-7). Of lines in which more than 40 cairns were mapped (in order to obtain samples with as many cairns separating the measurements as were used in them), 4 of 10 show a definite increase (>= 0.5 m) in the average distance between cairns between the proximal and distal sections of the line, 3 show little change, and 3 show a decrease. Of the lines for which fewer than 40 cairns were mapped, the results are similar: no lines show a definite increase, 4 show little change, and 3 show a definite decrease. There are very few drastic reductions in spacing from one consistently spaced sequence of cairns to another which would indicate fortifications at other points along the line. Similarly, although the data for cairn size is minimal, there is no obvious subjective trend (apparent during mapping of the lines) toward a decrease in cairns size with an increase in distance from the jump, nor are there clusters of particularly large cairns along lines. Only line A-1 presents an exception to this general lack of evidence of fortification: the cairns in one well-defined section of the line are both large and very close together (see Figures 15 and 16, and accompanying text discussion).

Status of Proposition II.A

The archaeological data supports the first implication but does not support the second. Fortification near the jumps may have been more apparent had more lines been located which travel nearer to the cliffs; A-3, the only line which runs to the edge of a cliff, also has the smallest mean distance between cairns of any line mapped. Fortifications in the form of humans positioned along the lines, which undoubtedly would have been the most effective type of fortification, would not result in archaeological evidence. Although there is a lack of archaeological support for the proposition that the lines directly limited the movement of the bison, there are enough convincing analogies from ethological and ethnographic sources of the validity of the proposition, that it will, at least tentatively, be accepted in order that we may examine the propositions subsumed by it more closely.

PROPOSITION II.A.1: The lines provided a physical barrier at the boundary of the drive lane which the bison did not cross, analogous to wing fences in modern corral structures.

The chutes in ethnohistoric and ethnographic accounts of pound drives and wing fences in modern bison handling practices provide the analogs for this proposition. In order to act as a wing fence, the stone line must present a clear obstacle to the movement of the bison.

Test Implications for Proposition II.A.1

1. The cairns should be very large (1.25 m high) or there should be evidence that perishable materials were added to the structures to make them more substantial.

In fact, the cairns average only 0.17 m high, and there is no evidence that other materials were used in the construction of the drive line marker.

2. The cairns should be very close together (less than 1.0 m between them) along the entire length of the line.

The cairns are an average of approximately 4.9 m apart (measured from the center of one cairn to the center of the adjacent cairn) and approximately 0.76 m in diameter and therefore an average of 4.1 m separates each. The only sections of line with cairns less than 1.0 m apart are along line A-1 where it crosses what is now a car path (see Figure 16).

Status of Proposition II.A.1

The archaeological data does not support either of the implications and the proposition must be rejected.

PROPOSITION II.A.2: The lines appeared to the moving bison to be a physical barrier at the boundary of the drive lane (i.e. when viewed from an angle, the piles would appear to be closer than they actually were) (after Arthur in Malouf and Conner 1962: 42).

This proposition is very similar to II.A.1 above except that the line need pose no actual obstruction to the path of the bison. Archaeologists have suggested that large cairns, when viewed from an oblique angle, would appear to be a fairly solid wall and that moving bison would not be aware of their actual insubstantiality, and hence would not attempt to escape through the line (Figure 19).

Test Implications for Proposition II.A.2

1. The cairns should be very large (at least 1.25 m high) or there should be evidence that perishable materials were added to the structures to make them more substantial.

   See Test Implication 1 of Proposition II.A.1.

2. The cairns should be fairly close together (less than about 3 m between them) along the entire length of the line.

   The lines in Area A in the northern part of the HSI system, specifically A-1, A-3, A-4, and A-7, would conform fairly well to this description, however lines in other areas definitely would not.

3. If the line is to look both solid and like a barrier, the path of the bison should be fairly near the line both on horizontal and vertical planes.

   Where paired lines are fairly close and the lane is narrow, this implication is supported (eg. the path between A-4 and its partner A-2, between B-3 and B-4, between C-9 and C-10). In some cases the topo- graphy is such that single lines would only be visible to the drivers and the bison if the drive was taking place near the line (eg. A-1, B-6, D-6 northwest of Southeast Butte). However, several of the lines (eg. C-2, C-3, C-4, D-2, D-6 along Southeast Butte, and D-7) are positioned high along broad benches

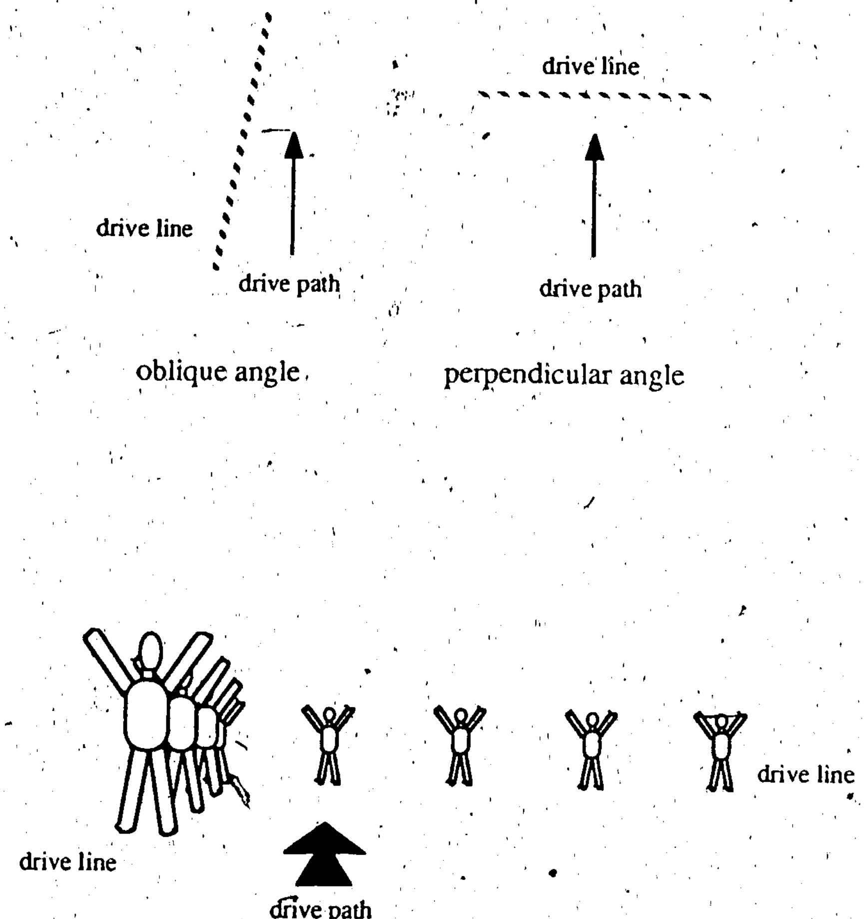



Figure 19: The angle of the drive path in relation to the drive line affects how close the line markers, whether cairns or people, appear to be to individuals traveling along the drive path. This illusion may not be perceived as clearly by bison as by humans because the eyes of the bison do not face entirely forward.

or ridges in such a way that they become visible only at substantial distances from the bases of those topographic features.

4. The line should be almost straight so that the bison are never traveling perpendicularly toward a section of the line.

None of the lines are perfectly straight and even slight deviations into the path of the oncoming bison could ruin the illusion. Some lines, such as A-7, curve sharply and the bison would simply break through the line if the cairns functioned in the manner proposed. Other lines, such as A-4 and C-5, are positioned almost perpendicularly to the probable path of the bison, presumably to help turn the bison toward the trap.

Status of Proposition II.A.2

The archaeological evidence does not support the use of lines as apparent barriers at HSI. More probably, the occasional illusion that the cairns were closer together than they actually were would simply increase the effectiveness of a line while it was being used in some other way to contain the bison (i.e. as scarecrows, or positional markers for hazers).

PROPOSITION II.A.3: The cairns acted as scarecrows ("dead men") which the bison preferred not to approach.

Drive line markers are often called "dead men" in the ethnohistoric reports of communal drive structures on the plains, indicating that early observers assumed that the markers were designed to imitate humans.

Test Implications for Proposition II.A.3

1. The cairns should be large (at least 1 m high) or there should be evidence that perishable materials were added to the structures to make them more formidable to the bison (larger, more unnatural, or more like the shape of humans).

See Test Implication 1 of Proposition II.A.1.

2. The cairns should be fairly close together (several metres, depending upon how formidable they are to the bison) along the entire length of the line so that the bison have no desire to attempt to escape between them.

Although ethological studies provide some intriguing ideas about what types of structures might have acted as scarecrows with bison, the "formidable-ness" of different cairn structures would have to be tested in drive situations. As they exist now at HSI, as small clusters of stone, the cairns are so unobtrusive that they would not frighten bison no matter how close together the cairns were. However, if you assume that other materials were added to the cairns, the spacing of cairns in lines in the HSI system (an average of 4.9 m separating cairns) generally conforms to this implication.

Status of II.A.3

The archaeological evidence from HSI does not support the use of cairns as scarecrows. Had there been evidence of other materials added to the cairns, both test implications could have been accepted; as the evidence stands they, and the proposition, must be rejected.

PROPOSITION II.A.4. The cairns acted as blinds for hazers.

Almost all ethnographic and ethnohistoric accounts of bison drives contained descriptions of hazers crouching behind piles of brush, dung, earth or snow and rising as the bison passed by. Ethological information and information from modern bison ranchers also suggest that hazing (including the presence of humans and their scent, noise, and motion) would be an effective means of directing bison movement.

Test Implications of Proposition II.A.4

1. The cairns should be large enough to camouflage the hazers (a minimum of 0.6 m high and 0.4 m in diameter) or there should be evidence that perishable materials were added to augment the cairns.

The cairns are large enough in diameter (an average of 0.76 m) to obscure a person but their average height (0.17 m) is not nearly enough. As has been stated, there is no evidence that other materials were used in the cairn construction.

2. The number of cairns in pairs of lines should be sufficient to conceal the number of hunters involved in the drive.

It is impossible to know how many hunters were involved in each drive at HSI but we can examine an extreme hypothetical example. Large prehistoric gatherings could have as many as 2000 to 3000 people (De Smet 1972) but most were much smaller. Because even women and children often acted as hazers, most of these people would have been involved in the drive either as hazers, drivers, or dispatchers at the trap. The longest known line in the system is D-6 which joins up with D-7. The distance separating these sections is about 2500 m so the total length of the original line would have been at least 6820 m. By taking the mean of the average for each section, the approximate average distance between cairns for the two sections is 5.8 m. Therefore, an estimate of the total number of cairns in this line alone is 1175; that same number of hazers could potentially be involved and this is not including the manpower which would have been needed in the final 600 m approach to the jump where no cairns have been located. The complete drive lane, utilizing this line and one other, would consist of many more cairns than would be required to conceal the hazers involved, except perhaps in the very largest communal drives of prehistoric peoples on the plains. Because there are more cairns than would be necessary under this proposition, this test implication is only conditionally accepted.

Status of Proposition II.A.4

The first implication was not met by the archaeological data from HSI and the second implication was only conditionally accepted. The archaeological data does not support the proposition that the cairns at HSI acted as blinds for hazers.

PROPOSITION II.A.5: The cairns marked stations for hazers.

At sites where cairns are not large enough to act as blinds, this is a logical alternative proposition. Hazers could have stood at these stations: people would have been more effective in controlling the bison movement than scarecrows. Alternatively, they could have crouched at the stations, perhaps hidden behind outstretched robes (Schaeffer 1978: 247).

Test Implications for Proposition II.A.5

1. The cairns should be clearly distinguishable from the natural scatter of rocks in an area.

The cairns at HSI are, by definition, clearly distinguishable. Yet, if their sole function was to mark a position along the line, clusters of an average of 10 stones each which are placed an average of 5 m apart are far more obvious than what would have been necessary. At that distance, cairns of 3 or 4 stones would have been sufficiently distinguishable along a line. This implication is only conditionally accepted.

2. The number of cairns in pairs of lines should be sufficient to conceal the number of hunters possibly involved in the drive.

See Test Implication 1 of Proposition II.A.4.

3. The hazers along the line must be visible from points along the drive path (ie. they must not be obscured by topography).

Many lines are situated along the sides or crests of ridges in such a way that the cairns or a person stationed at a cairn would stand out impressively against the sky when viewed from a point along the drive path. Other lines are partially obscured by small hills or ridges situated between the line and the drive path; however, these topographic features are not large enough to conceal an upright human standing at the cairn.

Status of Proposition II.A.5

All of the implications are at least conditionally supported by the archaeological evidence, and therefore the proposition that the cairns acted as stations for hazers is conditionally supported. The proposition, however, cannot be the only function of the lanes--there are too many cairns for each one to have marked a station for a hazer and the cairns are larger than necessary if they acted only as position markers.

PROPOSITION II.B: The lines were constructed to provide future generations of hunters with a permanent record of information about the successful drive procedure.

This high level proposition is untestable archaeologically although the specific propositions subsumed by it can be investigated. Although communal drives were an important hunting technique for Plains Indians, archaeological research has indicated that drives at any one specific jump site were by no means annual events (Reher and Frison 1980). Because many years could elapse between consecutive uses of the same trap, a permanent stone drive structure could have conveyed the information necessary to ensure a successful drive.

The main kill at Head-Smashed-In, DkPj-1, was used periodically over thousands of years, and the drive structures may have been part of the site from the beginning. The permanence of stone as a construction material, used in an activity of such importance from both subsistence and social points of view, must have lent the lines some ritual or mystic significance. The site, particularly the stone drive structures, would have served as a permanent monument to the hunting skill of the ancestors, and perhaps may have even been considered to be the direct product of the Old Man's legendary teachings (see Ceremonialism section of Chapter 5). Such reuse of old jump sites and drive structures would have engendered confidence in the hunters.

The propositions subsumed by this one are not based on the obvious ethnographic and ethnohistoric analogies. The drive structures which commonly appear in the archaeological record of the plains seldom resemble the drive lines which were described in the ethnohistoric reports. The use of stone cairns was never witnessed in ethnohistoric accounts although their use is described in ethnographic studies done in the early 20th century. It may be that these stone lines were used in ways not directly analogous to the practices described in the early reports. The handlers of modern bison, with whom I have spoken, agree that the small stone cairns characteristic of many bison kill sites on the plains could not have had any direct effect upon the behavior of the bison being driven. Some entirely original explanations may be required to explain the purpose of these lines.

PROPOSITION II.B.1: The lines marked the boundaries of the drive lane, indicating the route to the drivers along the drive path.

This is a logical proposition, and may have been a secondary function of the lines. The stones would have provided a permanent map of the successful drive routes. This map must have been visible from within the drive path and from some distance away so that the drivers would be aware of their targets and would not be forced to attempt quick (and therefore difficult) alterations in the direction of herd movement.

Test Implications for Proposition II.B.1

1. The cairns must have been visible from points along the drive path (i.e. the cairns must not be obscured by topography, and they must be at least 0.1 m higher than the vegetation or there must be evidence that perishable materials were added to the structure).

Because cairns are formed of a single layer of stone, there is little variation in their heights, which averages about 0.17 m. The most common species of grass in the gathering basin is rough fescue (*Festuca scabrella*) (Bailey 1984); depending upon climate and soil conditions and the amount of grazing, tussocks of rough fescue grow from about 0.3 to 0.9 m in height (Moss 1983: 92). The vegetation would obscure most cairns unless there was some other materials added to the cairn structure; however, excavations have not revealed evidence of any materials added to the cairns. In addition, there are few lines which are consistently visible from along the drive path because the rolling topography often obscures parts of the line; again, the addition of other materials to substantially increase the height of the cairns would eliminate this problem.

2. If the cairns were small (less than 0.75 m high) and inconspicuous, they would have had to be quite close together (less than 10 m) so that the line would be obvious at a quick glance. If they were large and conspicuous, they could have been far apart, as long as the drivers could see the next cairn after the one just passed.

The cairns at HSI are small (about 0.17 m high) and close together (averaging approximately 4.9 m apart), and therefore conform to the first option of this implication.

Status of Proposition II.B.1

Once again, although the second implication was met by the archaeological data, the cairns are too small to have functioned in the manner proposed, as a permanent map to the drivers along the drive path.

PROPOSITION II.B.2: The lines marked the route along the periphery of the drive lane where some of the hunters would walk in view of the bison.

This proposition combines the effectiveness of humans for defining the boundaries of the lane with possibilities that hunters were too few in number for one to be stationed at each cairn. The source analogy is with modern bison handlers who often use a semicircle of vehicles or horsemen behind and along the sides of the herd which they are moving toward the wing fences.

Test Implications for Proposition II.B.2

1. The hunters who are following the lines must be visible from points along the drive path (ie. they must not be obscured by topography).

   See Test Implication 2 of Proposition II.A.5.

2. If the cairns were quite small (less than 0.5 m high) and inconspicuous, they would have had to be quite close together (less than 10 m) so that the line would be obvious at a quick glance. If they were large and conspicuous, they could have been far apart, as long as the drivers could see the next cairn after the one just passed.

   See Test Implication 2 of Proposition II.B.1.

3. There should be no large obstructions along the line route. The line should contour around or through unavoidable obstructions in order to make the route as easy to walk (or run) as possible.

Obstructions should either be avoided if hunters are to walk along the lines, or else the markers should continue across the obstruction so that the hunter does not have any difficulty relocating the line on the opposite side of the obstruction. However, lines in the HSI system do not avoid obstructions, nor do they continue across them. Not all lines contain major obstructions (see Test Implication 2 of Proposition I for more detail).

Status of Proposition II.B.2

The archaeological data from HSI supports only two of three test implications. The incorporation of obstructions in some lines makes it unlikely that the lines in the HSI system marked the route along which hunters would walk.

PROPOSITION II.B.3: The topography concealed the hazers from the view of the bison and the cairns indicated the ideal location for the hazers, moving parallel to the drive, to suddenly show themselves to the bison (after Frison 1974).

This proposition has no ethnohistoric or ethnographic analogues. If the hazers worked closely together at strategic locations, yet retained their mobility so that fewer hazers would have been needed to man all of the cairns in a line, this proposition could be an effective use of drive lines.

Test Implications for Proposition II.A.3

1. The line should follow the crest of a ridge or the edge of an escarpment. In that way, the line is visible to a hunter standing outside the lane but the hunter is not within view of the bison until he is standing near a cairn.

Most lines do follow topographic features. However, many of these features, such as the ones followed by lines C-5, C-8, C-10, D-4 and D-5, are not exaggerated enough to conceal a hunter unless he or she was stationed far behind the cairn (at which point the cairns would no longer be visible to the hunter). Other lines follow part of the way up the side of a ridge rather than along the crest (eg. lines D-2, D-6, and D-7). Some lines follow definite crests for part of their distances (eg. lines A-1, A-4, A-5, and D-8), but even these lines traverse flat, or rolling land at some point.

2. The cairns should not be close together or evenly spaced but rather should be placed far apart in strategic locations where the hunter's presence would be particularly effective.

The cairns at HSI are generally close together and relatively evenly spaced.

Status of Proposition II.B.3

The data from HSI clearly does not support any of the implications; the proposition set forth by Frison must be rejected.

PROPOSITION II.B.4: The lines indicated the locations along the route where extra caution had to be practiced.

This proposition has a purely logical basis--that variations in cairn size and spacing could logically have been used to convey practical knowledge of potential trouble spots in the drive system down through the generations of communal hunters. Bison familiar with an area, whether through previous drives or simply during previous unforced herd movements, would become habituated to taking certain routes, including potential escape routes. Permanent markings of these locations would warn future hunters to take extra precautions.

Test Implications of Proposition II.B.4

1. There should be marked fluctuations in the spacing and/or the size of cairns over the course of a line.

Although there are fluctuations in spacing of cairns in lines, these are seldom marked (ie. drastic reductions in spacing from one consistently spaced length of cairns to another, see Figure 15). Similarly, although there is much variation in cairn size, there are few clusters of unusually sized cairns along lines. Variation is present in cairn size and spacing within the lines, but patterns in this variation are rarely obvious in simply walking along the line, and presumably could not have been a source of information in the past. Only line A-1 may support this proposition: at some points along the line there appears to be double rows of cairns (see Figure 17) and line A-2 may simply be an extended example of this twinning; the cairns along another section are both large and very close together (see Figures 15 and 16).

2. These fluctuations may correlate with topographic features which would be attractive escape routes to bison (but may simply indicate the location where bison escaped during a previous drive).

Line A-1 follows near the edge of a long escarpment, much of which is very steep. As the line crosses what is now a car path which is used to get from the topographic bench onto the plains below--a route which undoubtedly provided an easy escape route in the past--the cairns are large in diameter and close together (Figure 16). The double rows of cairns, however, are not correlated with topographic features.

Status of Proposition II.B.4

Except for the single case noted above (line A-1), there is no archaeological support for the use of cairns as cautionary markers at HSI.

PROPOSITION II.B.5: The cairns marked the locations where incense was burned before each drive (after Medicine Crow 1978).

This proposition is based upon a single ethnographic report for one group (the Crow). Medicine Crow's interpretation of the phenomena is that the incense was effective because the medicine man's magic was powerful. In the story Medicine Crow relates (1978: 250), incense is burned at four points along the line.

Test Implications for Proposition II.B.5

1. There should be evidence of heat or fire on cairn stones or in the matrix around them.

The cairn excavations revealed no evidence of fire except for a single heat spall of chert found in a cairn in line D-4. No fire broken cairn stones or ash were present in any cairn.

2. There should be a small enough number of cairns that incense could be practically burned at each one.

There are far too many cairns in the lines at HSI to make it a practical possibility that incense was burned at each one. Even in short drives, several hundred cairns would have been present in the drive lines. This implication suggests that, even if this practice occurred at HSI, it was a fairly inconsequential function of the cairns.

Status of Proposition II.B.5

There is no archaeological support for the proposition; in fact, the exceedingly large number of cairns in the system is a strong indication that they must have served some other function.

PROPOSITION II.B.6. The cairns marked the points where larger piles of perishable materials were to be built prior to each drive.

Archaeologists have suggested that cairns were simply markers for more formidable structures (Forbis, in Malouf and Conner 1962: 62-63). This proposition presents the possibility that the stones may have escaped the notice of eyewitnesses because they were obscured by the materials added on top of them.

Test Implications for Proposition II.B.6

1. The cairns should be clearly distinguishable from the natural scatter of rocks in an area.

The cairns at HSI are clearly distinguishable, by definition, and are actually larger or closer together than they would have to be to act as simple markers (see Test Implication 1 of Proposition II.A.5).

2. There should be sufficient quantities of perishable materials in the vicinity of the line to make such manufacture possible.

Brush at HSI is limited to low lying areas and some north and east-facing slopes. Although the greater frequency of natural fires in the past would have resulted in less brush cover in the area (Bailey 1984), there would have been enough brush available to substantially augment the cairns, with some effort in transportation. Dung would probably have been plentiful in the area, considering the quality of the grasses available for grazing bison. Because frequent chinooks melt most of the snow several times over the course of a winter, the accumulation in the area would not have been great enough to have used snow to build numerous large piles. Sod and earth are possible constituents, but they should be visible today in the archaeological features, as they appear to be in the unique cairns in a section of line D-5 (Figure 18).

3. There should be evidence of perishable materials in the matrix around the cairns.

In fact, there is no evidence of perishable materials in the matrix. In the one section of Line D-5 where earth or sod may have been used in the marker construction, there is no indication that a stone cairn formed the base of these sod piles.

Status of Proposition II.B.6

Many of the propositions previously discussed would be much more likely if the cairn structures were enlarged in some way. However, the archaeological data only conditionally supports the first implication, fully supports the second, and does not support the third; the possibility that the cairns acted as markers for where to pile other materials must be rejected.

PROPOSITION II.B.7: The stone clusters were an essential component of the otherwise perishable line markers (after Brink 1985).

Although similar to the proposition just discussed (II.B.6), this variation is considered because Brink suggests that stones would not be necessary to mark each location for perishable markers unless the stones were essential components of the final structure, not simply a base which contributed very little to the final height of the structure.

Test Implications for Proposition II.B.7

1. The cairns should be clearly distinguishable from the natural scatter of rocks in an area.

The cairns at HSI are clearly distinguishable small clusters of stone. Unlike the results of Test Implication 1 of II.B.6, however, these cairns may not have been any larger than was necessary to serve their purpose--the ideal size of the cairn would depend upon the purpose it was to serve in the final marker structure. This implication, therefore, can be accepted.

2. There should be sufficient quantities of perishable materials in the vicinity of the line to make such manufacture possible.

   See Test Implication 2 of Proposition II.B.6.

3. There should be evidence of perishable materials in the matrix around the cairns.

   See Test Implication 3 of Proposition II.B.6.

Status of Proposition II.B.7

Only one of the implications did not fit the archaeological data from HSI--the fact that there was no perishable remains among the cairn stones. However, on this basis the proposition that the cairns were an essential component of the final marker structure must be rejected.

# CHAPTER 9:

# COMPARATIVE EVALUATION OF PROPOSITIONS

## CONFIRMATORY STATUSES OF PROPOSITIONS

Table 5 summarizes the test implication results as they apply to archaeological data from Head-Smashed-In Buffalo Jump. The implication results are given as yes, conditional yes, no and inconclusive; exceptions are noted. If variation among lines does not allow generalization, the result is recorded as inconclusive. A proposition is rejected (in the final column) if any of the implications are answered negatively. It is accepted if all of the implications are answered affirmatively. However, if even one of the affirmative implication results is conditional, the proposition is only conditionally accepted. Inconclusive answers are ignored at this stage of the evaluation, but an inconclusive result is much weaker support than an affirmative result in comparative evaluations of several confirmed propositions.

As Table 5 indicates, only proposition II, that the lines marked the boundaries of the drive lane, is generally acceptable and, as a high level proposition, it deals with placement rather than with specific function of the lines. Proposition II.A.5, in which the cairns mark positions for hazers, is conditionally accepted in the table; however, if proposition II.A (that the cairns or people at the cairns directly limited the bison movement) is rejected because of a lack of evidence of line fortification, all propositions subsumed by II.A, including II.A.5, must also be rejected. Although it is possible that the actual function of the stone lines at HSI has not yet been formulated, none of the specific propositions set forth in this paper were found acceptable through analysis of their test implications.

The propositions which are rejected in Table 5 are not, however, all equally unlikely explanations. Perishable materials added to cairns (i.e. dung or brush in II.B.6

Table 5: Summary of the outcomes of testing each proposition using the archaeological data from Head-Smashed-In. Key words from propositions and implications are presented, followed by a one-word summary of the outcome of the test, followed by exceptions to the normative case.

| PROPOSITION | IMPLICATION 1 | IMPLICATION 2 | IMPLICATION 3 | IMPLICATION 4 | CONFIRMATION STATUS |
|---|---|---|---|---|---|
| I lines along drive path | through pass NO | no obstructions NO D-6 | no paired lines INCONCLUSIVE | | REJECT |
| I.A game trail | | | | | REJECT |
| I.B map for drivers | | | | | REJECT |
| [illegible] boundaries of lane | border pass YES B-6, D-1 | obstructions YES | paired lines YES A-3 | | ACCEPT A-3, B-6, D-1 |
| II.A limited bison movement | cairns close YES | fortifications NO A-1 | | | REJECT |
| II.A.1 wing fence | large cairns NO | very close cairns NO A-1 | | | REJECT |
| II.A.2 apparent barrier | large cairns NO | close cairns NO A-1, 2, 4, and 7 | line near path INCONCLUSIVE | line straight NO | REJECT |
| II.A.3 scarecrows | large cairns NO | close cairns YES | | | REJECT |
| II.A.4 blinds for hazers | large cairns NO | sufficient cairns Conditional YES | | | REJECT |
| II.A.5 stations for hazers | obvious cairns Conditional YES | sufficient cairns Conditional YES | visible hunters YES | | Conditional ACCEPT |
| II.B line conveyed information | untestable | | | | |
| II.B.1 map for drivers | visible cairns NO | small close cairns YES | | | REJECT |
| II.B.2 hunters walked along line | visible hunters YES | small close cairns YES | no obstructions NO D-6 | | REJECT D-6 |
| II.B.3 topography hid hazers | lines follow ridges NO | strategic cairns NO | | | REJECT |
| II.B.4 lines indicated caution needed | spacing fluctuations NO A-1 | topo. correlates NO A-1 | | | REJECT A-1 |
| II.B.5 sacrifice platforms | evidence of heat NO | few cairns NO | | | REJECT |
| II.B.6 markers for larger piles | obvious cairns Conditional YES | perishables in area YES | perishables present NO | | REJECT |
| II.B.7 integral part of larger marker | obvious cairns YES | perishables in area YES | perishables present NO | | REJECT |

and II.B.7) or used to fortify lines (i.e. people in II.A) may no longer be evident in the archaeological record at HSI, at least not using the methods which I employed in cairn excavation (see section on Cairn Data in Chapter 7). My excavations would have located preserved wood among or under cairn stones, although such preservation is unlikely in that environment, or post molds. Any materials other than sod which may have been piled on top of the cairn stones would decay without a trace. For these reasons, implications calling for evidence of materials added to the cairns, either to fortify the lines or to augment the size of the cairns, are inappropriate for the analysis of the HSI lines--it is unlikely that such evidence exists to be found. Certainly, if perishable remains had been present in the drive lines excavations at HSI, our confidence in accepting the propositions supported by such evidence would have increased. As it is, however, we must make the assumption that perishable materials, once present, have since decayed beyond recognition. This single assumption, justified by the preservation potential of the HSI lines and the lack of alternative acceptable explanations, allows us to reevaluate a number of propositions. Test implications demanding large cairns or augmented cairns (i.e. a stone base with other materials added to enlarge the structure) will be treated as though they obtained affirmative results.

Table 6 shows the revised status of the propositions, assuming that the drive lines had an original form which was consistent with, but not entirely revealed by, the archaeological evidence at HSI (i.e. cairns were augmented with perishable materials and people fortified the drive lines). Even with this assumption, 9 of the 18 propositions must be rejected due to lack of archaeological support: propositions I, and therefore I.A and I.B, II.A.1, II.A.2, II.B.2, II.B.3, II.B.4, and II.B.5. The propositions which are accepted only conditionally, because the line form at HSI would have effectively but inefficiently performed those proposed functions, are II.A.4, II.A.5, II.B.1, and II.B.6. The propositions which are consistent with the archaeological data, considering the

Table 6: Summary of the revised outcomes of testing the propositions, making the assumption that perishables (i.e. brush, dung, and/or people) were present in association with the drive structures, but have since decayed. Revisions from the outcomes in Table 5 have been accentuated with asterisks.

| PROPOSITION | IMPLICATION 1 | IMPLICATION 2 | IMPLICATION 3 | IMPLICATION 4 | CONFIRMATION STATUS |
|---|---|---|---|---|---|
| I<br>lines along drive path | through pass<br>NO | no obstructions<br>NO<br>D-6 | no paired lines<br>INCONCLUSIVE | | REJECT |
| I.A<br>game trail | | | | | REJECT |
| I.B<br>map for drivers | | | | | REJECT |
| II<br>boundaries of lane | border pass<br>YES<br>B-6, D-1 | obstructions<br>YES | paired lines<br>YES<br>A-3 | | ACCEPT<br>A-3, B-6, D-1 |
| II.A<br>limited bison movement | cairns close<br>YES | fortifications<br>*YES*<br>A-1 | | | *ACCEPT* |
| II.A.1<br>wing fence | large cairns<br>*YES* | very close cairns<br>NO<br>A-1 | | | REJECT<br>*A-1* |
| II.A.2<br>apparent barrier | large cairns<br>*YES* | close cairns<br>NO<br>A-1, 2, 4, and 7 | line near path<br>INCONCLUSIVE | line straight<br>NO | REJECT |
| II.A.3<br>scarecrows | large cairns<br>*YES* | close cairns<br>YES | | | *ACCEPT* |
| II.A.4<br>blinds for hazers | large cairns<br>*YES* | sufficient cairns<br>Conditional YES | | | *Conditional*<br>*ACCEPT* |
| II.A.5<br>stations for hazers | obvious cairns<br>Conditional YES | sufficient cairns<br>Conditional YES | visible hunters<br>YES | | Conditional<br>ACCEPT |
| II.B<br>line conveyed information | untestable | | | | |
| II.B.1<br>map for drivers | visible cairns<br>NO | small close cairns<br>*Conditional YES* | | | *Conditional*<br>*ACCEPT* |
| II.B.2<br>hunters walked along line | visible hunters<br>YES | small close cairns<br>*NO* | no obstructions<br>NO<br>D-6 | | REJECT<br>D-6 |
| II.B.3<br>topography hid hazers | lines follow ridges<br>NO | strategic cairns<br>NO | | | REJECT |
| II.B.4<br>lines indicated caution needed | spacing fluctuations<br>NO<br>A-1 | topo. correlates<br>NO<br>A-1 | | | REJECT<br>A-1 |
| II.B.5<br>incense platforms | evidence of heat<br>NO | few cairns<br>NO | | | REJECT |
| II.B.6<br>markers for larger piles | obvious cairns<br>Conditional YES | perishables in area<br>YES | ~~perishables present<br>NO~~ | | *Conditional*<br>*ACCEPT* |
| II.B.7<br>integral part of larger marker | obvious cairns<br>YES | perishables in area<br>YES | ~~perishables present<br>NO~~ | | *ACCEPT* |

assumption necessitated by preservational factors, are the high level proposition II, the middle level proppsitions II.B (which cannot be tested using archaeological data) and II.A, and the low level propositions II.A.3 and II.B.7.

Note that II.A.5 was conditionally accepted both before and after the assumption of augmented cairns was made (Tables 5 and 6). Small stone markers indicating hazer positions have rare analogs in the ethnographic record (Wissler 1910, Schaeffer 1978). Because proposition II.A.5 cannot stand alone as an explanation (it is only conditionally accepted), and because there are no other propositions which could be combined in an explanation with II.A.5 without assuming that the cairns were augmented, the assumption of augmented cairns must also apply to proposition II.A.5.

## PRELIMINARY EVALUATION OF CONFIRMED PROPOSITIONS

All of the tested and excepted possible functions of the cairns depend upon the fact that perishable materials were added to the cairns in order to make the drive line markers larger and more visible from a distance or that they were "manned" in one way or another. Propositions II.B.6 and II.B.7 (summarized below) suggest what purpose the stone cairns served in the final, largely perishable, structure. Because proposition II.B.6 is only conditionally accepted, the cairns themselves must have served some additional purpose than simply a marker indicating where to pile perishable materials. With proposition II.B.4 (that the cairn form and spacing communicated the points where extra caution was needed) already eliminated, the only remaining possibility is that the cairn stones were not only a marker for but also an essential component of the final structure (II.B.7). Proposition II.B.7, then, is firmly accepted, with the purpose of cairns as markers for the positions of perishable structures (II.B.6) constituting at most a secondary function.

There is no archaeological evidence of what types of perishable materials were employed. Because the cairn stones themselves can give little information as to how the materials were used, the precise form of the augmented cairns cannot be determined. However, the consistent basic form of the HSI cairns suggests that a single augmented cairn design was employed throughout the HSI system, whether or not these drive line markers were used in precisely the same way in all areas. In ethnographic and ethnohistoric sources, brush, dung, sod, and snow were mentioned as materials used in building drive line markers. All of these were available in the area, although brush and dung would have been the most likely constituents (see Test Implication 2 of II.B.5).

A stone base for a larger pile of materials is probably not the essential role of the stones in the final augmented cairn design because the stones would not add very much height to the pile and would serve no additional purpose. Malouf (in Malouf and Conner 1962: 42-43) suggested that the cairns were used to support substantial posts. There are several arguments against the proposition: firstly, most of the cairns are not ring shaped (see Table 3); secondly, even ring shaped cairns would not have provided the necessary support for a post considering the size of the stones and the strength of the wind in the area; and finally, the small and rare stands of willows and poplars in the area would not have provided sufficient resources to build the structures and the nearest source of large numbers of trees is the Old Man River, several kilometres from any of the lines. Reeves (1985: 93) suggested that the cairns stones were interspersed with dung in piles, thus ensuring that the dung would not be blown away; however, the observed clustering of the cairn stones is consistently tighter (see Table 3) than what this proposition would imply.

Brink's (Brink *et al.* 1986: 324-325) suggestion that the stones were used to prop up brush is more consistent with the archaeological evidence:

> Branches of small trees or shrubs could be wedged in between the rocks and thus held erect. If brush were to be used, rock cairns would likely be

essential, as the hard packed soils across the region would make planting the ends of the brush into the soil nearly impossible.

This augmented cairn design would probably not stand up well to the high winds of the area. More wind-resistant variations of Brink's design are illustrated in Figure 20: branches could have been sharpened, planted a short way into the ground and further supported with the clustered stones; or the ends of branches could have been bent to a ninety degree angle and one rock placed on the end of the branch while other rocks propped the rest of the branch upright (I have used a similar method in the area for propping up survey pins where there was no soil in which to plant them). Both of these variations of Brink's concept would have resulted in the observed archaeological remains, and, particularly with the second variation, it is unlikely than any evidence of the brush would be found in the archaeological record today. However, there is no direct ethnographic, ethnohistoric, ethological or archaeological support for this specific marker form, and other variations of structures equally consistent with the archaeological data could certainly have been used at HSI.

The preparation of the drive lines, if each cairn had to be augmented with other materials, would have entailed a great deal of labour and time. Although brush and dung would have been available in the area, they would not have been so plentiful that sufficient quantities could have been gathered close to the lines. Brush is particularly localized today and must have been transported over some distance. Bailey (1984: 17) also suggests that prairie fires were probably more frequent in the past, decreasing the amount of brush in the area of HSI. Gathering brush and constructing markers could not have taken place while bison were nearby or the herd would have fled the area. However, if a herd was several miles away from the outstretched drive lines, a work force of 100 people could probably have prepared the markers in one day (depending on the precise design of the structures). If the wind did not betray the presence of the

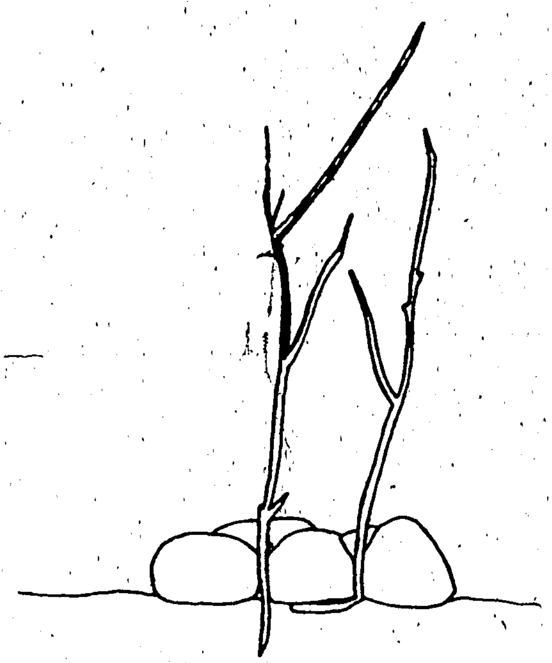


Figure 20: Two wind-resistent methods of supporting brush with cairn stones. Both would be consistent with the archaeological evidence of single-layered stone clusters.

humans, the bison would not have detected their activities. After the lines had been prepared, the herd could be brought into the lane.

These structures, composites of stones and perishable materials, functioned in at least one of the four remaining ways, described in propositions II.A.3, II.A.4, II.A.5, and II.B.1 (summarized below). The tested implications, allowing for the assumption necessitated by preservational factors at HSI, confirm the proposition that the structures could have acted as scarecrows (proposition II.A.3). At some points along the lines (because the propositions were only conditionally accepted), hazers could have been posted at markers (proposition II.A.5), or concealed behind markers (II.A.4). The final possible partial function of the lines could have been to guide the drivers along the drive path (proposition II.B.1).

The last three of the above propositions, II.A.4, II.A.5, and II.B.1, were only conditionally accepted because there were too many large, closely spaced cairns for the cairns to have efficiently functioned as blinds for hazers, stations for hazers, or a map indicating the route to the drivers. All three of these functions are complimentary--the acceptance of one would not preclude the acceptance of another. However, there exists no combination of these propositions which would explain the large number of closely spaced cairns in the HSI system. If, however, II.A.3, that the cairns functioned as scarecrows, is included in this complimentary set of propositions, the archaeological evidence (with the assumption of augmented cairns) would support any combination of propositions which would include II.A.3 and one or more of the conditionally accepted propositions above.

## CONCLUDING EVALUATION OF CONFIRMED PROPOSITIONS

The task which remains is to determine which proposition (i.e. II.A.3) or combination of propositions (i.e. II.A.3 and one or more of II.A.4, II.A.5, and II.B.1) provides the best explanation of how the stone lines at HSI functioned. The strength of the archaeological support, the strength of the ethnographic and ethnohistoric analogies, and the strength of the ethological support of the alternatives will contribute to the relative confidence which we can place in the possible explanations. Each proposition will be discussed in turn, including its potential relationships with the other propositions.

Because of the conditional acceptance of most of the remaining possible propositions, we have been able to conclude that some or all of the augmented cairns functioned as scarecrows. Some ethnohistoric reports indicate that the drive lane markers were intended to look like humans (Franklin 1969, Harmon 1911), like animals (Henry (the Younger) in Coues 1897), or simply that the markers frightened the bison (Cocking 1908, Hector and Vaux 1861). There was no consistent design for these structures: piles of dung or roots (Cocking 1908), stakes which might be topped with dung or hay (Franklin 1969, Harmon 1911), "spots" (piles?) of brush (Hector and Vaux 1861) or "three or four cross-sticks" (Coues 1897: 519). A similar variety of structures which are used to herd reindeer are effective because they rudely resemble humans or wolves (Ingold 1980: 56). Although bison do not flee from the presence of wolves (McHugh 1972: 225) they usually flee immediately upon detecting the presence of humans (Meagher 1973: 47). They also react adversely to movement (Soper 1941, McHugh 1972) and Harmon reported that humans stationed beside some stakes during drives kept the structures in motion "so that the buffaloes suppose them all to be human beings" (1911: 286). Bison react with curiosity tempered by fear to objects which are unfamiliar, or familiar objects in strange contexts (McHugh 1972: 211); in a drive situation, the bison's normal reaction of investigation would be impossible and the augmented cairns would likely elicit aversion. Although I have not heard of modern bison handlers building similar drive structures, at least one handbook suggests that such lines would be effective (Jennings 1978: 140). Bison handlers, with whom I have discussed the potential effectiveness of lines of scarecrows to control bison during drives, felt that movement (eg. flags blowing in the wind) would be essential in order to obtain the desired effect.

The basic form of the HSI cairns suggests a drive line marker design such as a stone base supporting upright branches (Figure 20). Perhaps flags of hide, hair or grasses which would blow in the wind could have been tied to these structures to make them more effective as scarecrows (Figure 21). Although it would have been been useful to have the cairns as a permanent marking system (as in Proposition II.B.6) and as a reliable supply of stones for building the otherwise perishable drive structures, permanent large piles of stone or other materials would not have been advantageous, at least for drives at HSI. The gathering basin for HSI would have been grazed frequently by bison, particularly in the late summer and fall (Bailey 1984). Whereas grazing bison would pay no attention to small stone clusters, larger structures, though perhaps strange and frightening at first, would soon have become familiar and ineffective as scarecrows. Because bison rub themselves upon any upright object, most of the markers would probably not survive from drive to drive. But to bison familiar with the gathering basin, the unaccustomed presence of the flagged brush markers would have been unsettling, particularly because the bison would not have the opportunity to investigate the structures during the drive. Even standing brush without any flagging, or some other design which would appear unexceptional under ordinary circumstances, would seem extremely unusual to bison when arranged in lines, closely spaced, along the drive lane. Although it would require a great deal of effort to prepare hundreds and perhaps thousands of these structures for each drive, the task would have been necessary to ensure the success of the drive.

It must be remembered that the lines of scarecrow structures need not have provided a strong psychological barrier to the bison movement because the bison had an

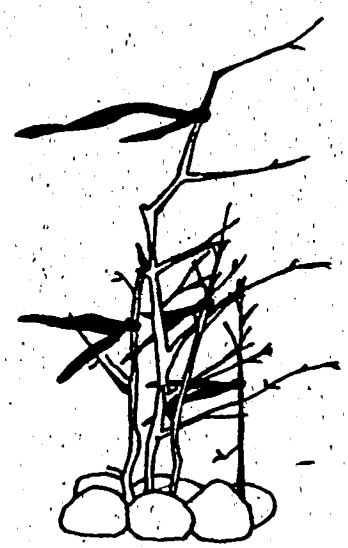


Figure 21: Design for a brush scarecrow which uses a base of stones to support the structure. Flags of hide tied to some of the branches would blow in the wind.

apparently clear route of escape ahead of them. As long as the route toward the trap remained attractive (i.e. the lane was not too narrow and the trap was concealed) the bison would have no impetus to test the lines. Because of the downgrade at the approach to most of the potential jump sites in the study area, and the flat expansive plain below them, the cliffs would not be apparent to the bison until the animals were very close to the brinks; (the exceptional approach, in Area A, will be discussed nearer the end of this chapter). As the drive got closer to the jumps, and the lane narrowed, the scarecrows would appear to be closer together than they actually were, and therefore more alarming, because the bison would be travelling closer to the line and at an oblique angle (see Figure 19).

That the stone lines were used to guide the drivers along the proper route is logically very probable, despite the lack of ethnographic analogy. However, the form of the drive lines and the labour involved in preparing the temporary markers is far too excessive for this function to have been considered foremost in the design of the lines. This was, at most, an incidental function of the drive lines.

Once the drive reached a point near the cliff where the lane was narrow and the bison had to be stampeded so that their momentum would make it impossible for the lead animals to avoid the jump, analogies with modern bison herding practices and ethnohistoric reports indicate that some sort of fortification was essential (Test Implication 2 of Proposition II.A). Because the archaeological data does not support fortification with a more substantial drive structure, these fortifications must have been in the form of humans. Thus, hazers were essential to the drive strategy at HSI; however, they need not have been positioned at the augmented cairns (Propositions II.A.4 and II.A.5), but could have acted independently of the cairns, constituting fortifications between the augmented cairns, or a human extension from the proximal ends of the drive line. As was stated in the description of the line system at HSI (Chapter 7), drive lines rarely run to the edges of cliffs, but rather end several hundred metres from the brinks; this could be a result of poor visibility but may also be an indication of the drive strategies employed in conjunction with this system.

Whether the drive line markers were used as scarecrows (Proposition II.A.3), positional markers for hazers (II.A.5), or camouflage for hazers (II.A.4), the consistent form of the HSI cairns indicates that the augmented cairns had a single design throughout the HSI system, such as the one illustrated in Figure 20 or 21. Wissler (1910) and Schaeffer (1978) indicated that cairns marked stations for hazers, but these cairns were small, not augmented, and the hazers were concealed behind outstretched robes. An augmented cairn would not be appropriate to mark stations for uncamouflaged hazers. Although the hazers, as "living scarecrows", would surpass inanimate markers in their abilities to keep bison within the drive lane, it would be redundant to mark the stations for these hazers with the scarecrow-like augmented cairns. Proposition II.A.5, that the cairns marked stations for hazers, therefore, is not a likely explanation of line function at HSI.

Uncamouflaged hazers would be more appropriate between the scarecrows rather than behind them. Henry (the Younger) (in Coues 1897: 519) described hazers lying down along the drive lines between markers in case the bison attempted to break through. However, the cairns at HSI are generally so close together that it would be unnecessary to position hazers between markers except at extremely high pressure points in the drive; and at those crucial points, the markers would not contribute appreciably to the effect of closely spaced hazers.

The final possibility is that uncamouflaged hazers extended from the drive lines toward the cliff, forming a human chute to force the stampeding bison over the cliff. Medicine Crow provides an intriguing description of such a fence based upon ethnographic information: "The hazers would take positions along the stone markers, holding and stretching robes between individuals, thereby forming a 'human fence' that waved and shouted as the drive accelerated " (1978: 252). I would contend that stone markers would be unnecessary with humans spaced so closely, and that such a fence would only be practical very near the termination of the drive. However, at that stage it would be very effective--the outstretched robes could have provided the illusion of a solid fence through which bison would not attempt to break (Jennings 1978; 140), and the hazers would have by then excited the bison into a headlong stampede.

The scarecrow design described previously, or some other large marker design utilizing a stone cairn, would have been appropriate to provide camouflage for hazers (Proposition II.A.4). In any discussion of drive line function, it is impossible to ignore the fact that by far the majority of ethnographic and ethnohistoric accounts report that hazers hid behind line markers and jumped up as the bison passed by, or if the bison threatened to break through the line. The markers in these accounts rarely afforded physical protection, but simply concealed the humans until the bison were near. In this way, the blinds introduced an element of surprise, heightening the alarming effect of the hazers, and made it more likely that the bison would have continued down the narrowing chute rather than attempting to reverse their direction. The camouflaged hazers would have been most effective near the proximal ends of the lines, where the lane was becoming narrow, and at other strategic points along the drive route where the danger of the herd's escape was particularly great. The close spacing of the cairns in the HSI system suggests that the hazers probably were hidden behind, rather than stationed between, the cairns. If the drive structures at HSI originally extended to the brinks of cliffs, they most likely would have provided camouflage for hazers; hazers were essential at this point in the drive, and uncamouflaged hazers standing between or behind the markers is not as likely an alternative (see discussion above). If, as the archaeological data may indicate, the lines ended well before the brinks, the augmented cairns at the proximal ends of the lines, and at other potentially dangerous sections of the drive line, could still have provided camouflage for hazers; however, the drive lines would have been extended toward the cliff by hazers, whose positioning was independent of cairns. Until the extent of the drive lines toward the cliffs is confidently determined, it is impossible to choose between these possibilities.

The HSI cairns were an essential part of augmented markers, most or all of which in turn functioned as scarecrows. Hazers were also active along the drive lines, camouflaged behind some of the augmented cairns and perhaps extending from the drive structures toward the cliffs in a human fence. An incidental function of the lines was to indicate the proper route to the drivers.

## EXCEPTIONS TO THE GENERAL CASE

Slight variations in line form from one area of the system to another are probably related to the specific requirements of the different drives situations, rather than completely different drive strategies. In Area A (Figure 8), for example, the cairns are particularly close together and some of the lanes are narrow (eg. between lines A-2 and A-4). These drive line features may reflect an increased effort to retain tight control of the movement of the animals in an unusual drive procedure, in which the herd was driven to the top of Northeast Butte where it was forced over a north-facing cliff. Although many wild animals tend to flee uphill from the source of danger, this behavioral characteristic is not pronounced in bison, who tend to take the course of least resistance. The drive structures had to appear particularly formidable so that the bison would not attempt to break through the lines, even though their only alternative course was to travel up the side of Northeast Butte (which would not be an obvious route of escape). The almost total lack of bones on the surface and in blow outs at the bottom of the probable jump site may indicate just how difficult or uncommon this type of drive was.

Some lines are more radical exceptions to the usual HSI line form. Although the extremely close cairns and double rows of cairns along sections of line A-1 may only be in response to the difficulties associated with the drives in that area (see above), it is also possible that they reflect unique functions of sections of this line. The obvious clustering of large cairns (Figures 15 and 16) would have communicated to drivers the dangers associated with the potential escape route which is now a car path (in the manner of Proposition II.B.4), whether or not such a function was intended. The extremely close cairns at this point, when augmented by perishable materials, would also have formed a short but fairly solid wing fence (Proposition II.A.1), effectively blocking off the escape route. Although most of line A-1 probably functioned in a similar way to the other lines in this area, some sections may have served specialized purposes.

Line A-3, running close to the brink of a cliff, should have a partner line to the southeast in order to keep the bison from escaping out of the lane (Test Implication 3 of Proposition II). There are two possible explanations for the line's absence: either it simply was not located--even A-3 escaped the notice of Reeves during his 1985 survey--or it never existed. Because A-3 forks off from A-1 less than 100 m from the cliff (Figure 8), the stampeding herd had to be turned very suddenly if they were to be driven off the cliff. An inanimate drive line on the outside curve of this corner, even if hazers were hidden behind augmented cairns and showed themselves at the last moment, would not accomplish this. Jennings offered two pieces of advice to modern bison ranchers:

> REMEMBER: there's never been a fence made that a buffalo herd at the gallop won't take out if they hit it head-on (1978: 140).

and

> Have a car or truck parked just outside the fence corner with some women and children in it yelling and honking to attract their attention so they'll turn instead of trotting right through the fence (*ibid.*: 135).

My contention is that the partner line for A-3 was formed of boisterous people. The bison would be aware of the hazers before reaching the corner (which would not be the case if the hazers were camouflaged) and would be anticipating a change of direction in order to avoid them. As the inside curve of the corner, line A-3 could have been less substantial--hence its construction of unusually close cairns.

The eastern extent of line D-6 (Figure 11), as it follows along the side of Southeast Butte, has all the normal characteristics of HSI lines. However, as the line crosses East Olsen Creek to the west of the butte, it jogs sharply, as though the line was contouring through the creek channel in order to make the line an easier path along which to travel. It is unlikely that, of all the lines in the HSI system, only D-6 would have hunters walking or running along it during drives; therefore, although D-6 constituted an exception to the rejection of Proposition II.B.2, the proposition probably does not apply to this line either. The contouring is more likely due to the unusual placement of the line, across gently rolling topography. If the drive path were too far from D-6, the herd could turn off course and be approaching the line perpendicularly before the animals caught sight of the augmented cairns; the dangers of the bison breaking through the line would be great. Only if the drive path was near the line would the augmented cairns remain within sight of the herd, keeping the bison headed in the desired direction. In this case, the line should contour as it travelled through the channel, thereby ensuring that the bison could take the course of least resistence and still be in the vicinity of the line when they reached the opposite bank.

Another exception within the HSI system is the unique design of drive line markers along a section of line D-5. The structures appear to have been piles of earth or perhaps sod, occasionally with stones in the matrix, but with no obvious cairn.

component. The size of these piles and their arrangement along the line are similar to the size and arrangement of the stone cairns along the remainder of D-5. These piles could have functioned in a similar way to other HSI cairns, with earth or sod, rather than stone, supporting a brush structure. The unique construction technique in this case may be related to resource availability (See Cairn Data in Chapter 7).

Lines B-6 and D-1 are not in good positions to act either as scarecrows or as blinds for hazers because they are not visible from any obvious drive path. If B-6 acts, as Reeves (1985) suggests, as part of a series of lines used to bring bison from the areas in the north (Area A) to jumps in the south (Areas C and D), it is in a particularly inconvenient spot--too far east to be visible from the natural broad north-south pass formed by East Olsen Creek, and too far west to be visible from the 1200 m topographic bench which runs from east of the Vision Quest Butte toward Area C (Figure 9). However, neither does the line run down the center of one of these possible drive paths. Because it does not conform with either of the two high level propositions (I and II), none of the more specific propositions can be considered as explanations. Yet the general form of line B-6 is indistinguishable from lines in other areas of the system. Perhaps the line is ritually significant, combining the importance of bison hunting with the importance of the vision quest (Hughes 1986) on top of the butte toward which the line runs.

Line D-1 (Figure 11) is also neither on the border of a natural lane nor in the center of a drive path, but its form closely resembles other lines in the HSI system. Although the line runs near D-4, within 25 m at one point, it is too far from the rim of the elevated land mass to be clearly visible from the plains to the south. It may have been an alternate western extension of line D-4, particularly if D-4 was connected during some drives to D-8. The functions of lines D-1 and B-6 cannot be determined confidently using the methods proposed here.

# CHAPTER 10:

# AN INTERPRETIVE SCENARIO

The following scenario is not presented as fact, but as an elaboration upon the drive techniques which have been set forward in the preceding sections of this paper, their probable effect upon bison behavior, and the richness of the interpretation possible using a variety of information sources.

## A HEAD-SMASHED-IN DRIVE

It was autumn. After months of dry summer heat, the prairie grasses were parched and brown. The bison had moved west, toward greener pastures in the Porcupine Hills. The leaves upon the saskatoon bushes were brilliant oranges, deep yellows. The time was right.

One by one the bands arrived at Head-Smashed-In. They knew of other cliffs in the area, but those had been used in recent years, and time had not yet diminished the incredible refuse from the successful kills of the past. Families set up their tipis near a small stream at the base of the deadly cliff. Each newly arrived party generated excitement and interest throughout the camp, as greetings and news were exchanged. Within days, the tribe had assembled.

As the next dawn broke, two young men set out from camp with the blessing of their medicine man. These were the buffalo runners, known and revered for their speed, endurance, and knowledge of the ways of the bison. The runners travelled west, always into the wind so that the bison would receive no warning of their arrival. Standing at the butte top above the cliff, the the entire gathering basin stretched before the runners. If no bison were visible, the runners continued west, confident that the herds would be grazing somewhere among those lush hills.

While the runners searched for the bison, the other members of the tribe prepared for the hunt, not only by making tools and weapons, but by performing the ceremonies to bring the bison near and to ensure the success of the drive. Rituals were performed in camp, symbols were carved into the stone above the cliffs, and young men ventured north to the Vision Quest.

At last, the runners sighted a herd of just about the right size, but many miles west of the camp. One of the runners started immediately and at full speed back to camp to tell the tribe. As soon as the news arrived, all of the available people went into the gathering basin to prepare the drive lines. These stone lines, a gift from the ancestors, ran through the gathering basin, indicating the drive routes in which success was sure to lie. Because the people knew where the runners had sighted the herd and knew the direction of the wind, they also knew which of the routes had to be made ready.

They gathered brush from the creek channels and hillsides, and tied strips of hide or hair to some of the branches. At each small cairn, they planted pieces of brush and clustered the stones tightly around the base of the branches. The brush, with leaves and flags flapping in the wind, made impressive scarecrows that stood out against the cloudless autumn sky. The people had to work quickly, for there were hundreds of cairns to prepare and each hour brought the herd nearer.

Meanwhile, the other runner carefully approached the bison. It was an ideal herd--a hundred or more animals, mostly cows and their calves (for the bulls kept at a distance now that the rut was over), all well grown and healthy, with thick robes. The runner, still downwind from the herd, was able to approach the grazing animals closely without being noticed. Through an intricate understanding of the nature of the bison, the secret of a runner's trade, the runner managed to coax some of the bison to follow him.

With some of the herd members heading off after the runner, the rest of the herd soon trailed after them. An old cow leading the herd would have changed direction, in order to travel against the wind, but the runner in the lead kept the herd travelling with the wind, and so concealed the scent of the Indian camp and hunters which lay ahead of them. The herd and runner moved eastward at a slow, leisurely pace. The animals had no reason to be wary and continued to follow after the runner. As the herd approached the outstretched drive lines, scouts relayed the information back to camp and the hazers took their positions behind some of the scarecrows.

As the herd continued on its course, the bison suddenly became aware of long lines of objects along the horizon, the likes of which they had never before seen. The objects seemed to be moving. Nervousness stirred in the animals and they followed the runner with greater intent along the path that seemed to lead to safety.

Because the hazers were so widely spaced along these distant sections of the lines, the hazers remained subdued and hidden behind the scarecrows; causing a commotion would only draw the bison's attention to their weak defenses along much of the line. The hazers knew that only if the bison threatened to break through the line could they jump up from their hiding places. The sudden appearance of humans from behind the scarecrows was usually enough to turn the herd back toward the cliff.

After the animals had passed these hazing stations, the hazers moved in behind the herd. Suddenly, the animals were no longer simply following a leader; they were attempting to escape from a definite source of danger--one which the animals could smell, hear and see behind them. The job of the runner was now complete, for he was no longer needed to lead the herd down the lane, and he ducked aside as soon as the opportunity arose.

Gradually the lane narrowed, and the scarecrows along its borders seemed to be ever closer together and more menacing. The animals rushed forward at increasing speeds as they became more frightened and intent upon escaping. The only clear pathway lay ahead of them.

As the herd approached the cliff, hazers, now positioned behind most of the scarecrows, leapt to their feet, shouting out and waving their arms to excite the animals into a full gallop. After the bison passed, the hazers joined in behind and drove the herd forward. Just before the brink, more hazers stood close together with bison robes outstretched to form a chute. The lead cow could see escape at the end of the chute, the open plains stretching before her, and she rushed forward. The pressure from hazers along the sides of the herd and from behind, and the wild desperation of the animals, built to a climax--the momentum of the herd forced the lead animals over the cliff even after the leaders realized their predicament. The animals, enough to supply the entire tribe with emergency winter rations of meat, lay dead or dying at the base of the cliff.

While the adults butchered and processed the bison carcasses, children returned to the gathering basin. Because brush was rare in the vicinity of the drive lines, the children collected the branches from the scarecrows and cached them in gullies and creek beds in case they were needed in later drives.

There was much work to be done before the meat began to spoil but no one complained. The atmosphere was of satisfaction and solidarity. This drive at Head-Smashed-In had been a complete success, owing to the cooperation of all members of the tribe who performed their ritual and hunting tasks with skill and confidence.

# CHAPTER 11:

# POTENTIALS AND PROBLEMS OF DRIVE LANE RESEARCH

## IMPLICATIONS FOR BISON DRIVE LANE RESEARCH

The interpretation of the prehistoric bison drives at Head-Smashed-In presented here should be applied critically to drive lane systems at other bison kill sites in the Northwest Plains. Although the game species was the same, the environment and the precise drive strategies employed may have varied from site to site. Details of drive line form have the potential to help clarify some of these differences.

Although detailed drive line data is not available for most jump sites, some obvious variation in cairn form and spacing is apparent. The lines which Kehoe (1967) described on the Blackfoot Indian Reservation in Montana seem to be very similar to the lines at HSI: cairns are now barely visible on the ground surface; they are 2-3 ft. (0.6-0.9 m) in diameter, 15 ft. (4.5 m) apart, and generally follow ridges. At the Keogh Buffalo Jump in Montana (Conner 1962), the cairns are 1.5 ft. (0.45 m) high and 5-7 yds. (4.5-6.3 m) apart. The lines at the Emigrant Bison Drives in Montana (Arthur 1962) are much more substantial, with cairns 3 ft. (0.9 m) high and only 6 ft. (1.8 m) apart. At the Harris Bison Runs in Manitoba (Hlady 1970), the cairns are few and widely spaced but extremely large--10 ft. (3 m) in diameter and 4 ft. (1.2 m) high. Although there is some question as to the nature of the kill at the Five Fingers and "Y" Jumps in Idaho (because of the abundance of projectile points in the lane and the peculiar form and arrangement of line markers), the markers show a tremendous variation in form: cairns range from 2 stones to 4 ft. (1.2 m) high piles, stone breastworks are 10-12 ft. (3.0-3.6 m) across, and stone fences are up to 4 ft. high (Agenbroad 1976).

The variation in line form among jump sites is impressive, yet plains archaeologists have generally assumed that the lines functioned in much the same way from site to site. Ethnography has provided most of the interpretive analogs, but these have rarely been examined closely. The result has been a virtual silence among archaeologists about the problem of drive line function. What is required is detailed study of stone line form, elimination of the assumptions about drive line function and an attempt to give all possible explanations an equal emphasis in the analysis, in the manner which has been set forth in this paper.

Ethnohistoric and ethnographic studies must be investigated more carefully. The limitations of both eyewitness and ethnographic accounts must be considered--neither can be taken as ultimate truth. It must be understood that more than one drive technique was practiced during historic times, and the prehistoric practices probably show similar variation and flexibility. And finally, the importance of bison behavior to the interpretation of bison drive lines cannot be over-emphasized. An understanding of bison behavior is essential to archaeological interpretations of bison kill sites because such an understanding was important in the decision-making processes of prehistoric bison hunters.

## EVALUATION OF THE INTERPRETATION METHOD

The significance of the method set forth in this paper is that it forces the investigator to examine assumptions and to consider possible explanations which might not otherwise receive attention. The method requires improvements, for although it identifies useful sources of data and methods of interpretation, it does not engender a strong degree of confidence in the results--the interpretation remains simply the best among a limited number of possibilities. Questions remain to be answered and the function of several lines remains obscure, not because of a lack of data on the line form but because of the incomplete scope of the propositions. More effort is needed to identify possible functions for the drive lines, particularly for the small stone cairns which are so common at Northwestern Plains bison jump sites.

The assumption of large markers should not automatically be made, particularly, as was the case at HSI, if no perishable marker components are identified. The search for perishables must be extensive, through careful and thorough excavation of cairns, and perhaps attempting more specialized types of analysis such as phytolith studies.

Phytoliths are "diversely shaped silica corpuscles formed within a variety of plant cells" (Bombin 1984: 11). Because phytoliths are very common among monocot species, most phytolith studies have concentrated upon those species. However, phytoliths are found in species throughout the plant kingdom (Rovner 1971). If shrub or tree species in the study area have identifiable phytoliths, I would suggest that soil samples from among the cairn stones might reveal evidence that brush augmented cairns. Positive evidence would be most likely if leafy branches were used in marker construction because phytoliths are most concentrated in the leaves of plants. In order to determine if phytoliths of shrub species are consistently associated with cairns, plant parts from species in the study area, soil from around cairn stones, and soil not associated with cairn stones would have to be analyzed for phytoliths. The use of dung to augment cairns would be more difficult to recognize by studying phytoliths, since the types and numbers of phytoliths in bison dung would probably be indistinguishable from phytoliths in the reference sample of plains soil. One potential avenue of analysis would be to consider bison food preferences--percentages of phytoliths from unpalatable plant species might be consistently different between cairn soil samples and reference samples.

The possibilities for substantial archaeological evidence of drive practices, however, are restricted by the nature of the activity and the limited role which material culture played in it. Confidence in the results of drive line studies must be increased through other avenues of information such as ethnographic analogy and experimental archaeology. There is a wealth of information regarding the relationship between line form and drive techniques in ethnographic and ethnohistoric literature which has not been fully tapped. Experiments driving bison using proposed techniques would be ideal to test the effectiveness of different drive techniques and structures, thereby increasing the numbers and specificity of test implications, and increasing the confidence we can place in our interpretations.

## DRIVE LINES AND HUMAN-ENVIRONMENTAL RELATIONSHIPS

Drive lines are an impressive example of the human use of technology to take advantage of the predictable behavior of animals. A reliable drive strategy relies heavily upon knowledge of animal behavior during all stages of the drive: in order to design and construct drive lines which will improve the reliability of the drive technique, to locate the herd, to bring the herd within the drive lines, to make effective use of those lines in moving the herd to the trap, and to so excite the animals that they are unable to avoid the trap.

The cooperation which was necessary to carry out a successful drive, the products of which benefitted the entire tribe, must have strengthened group solidarity. Because of the variation of tasks involved, the entire population could participate at some point during the drive: as preparators of the drive lines, as runners, hazers, butcherers and processors. Although some tasks conveyed more prestige than others (eg. medicine man, bison runners), each job was essential to the success of the venture.

The reliability of the drive technique, and large scale communal hunting practices in general, was paramount. Only if the techniques were reliable could large scale communal hunts, which were important for more than economic reasons, be practicable. That assumption of reliability is at the root of the interpretative method espoused here, a method which allows the researcher to translate the form of drive lines into information about the drive techniques associated with them. By understanding the drive techniques, we have a unique opportunity to better understand the nature and importance of cooperation and knowledge about the environment which made these and other prehistoric subsistence techniques possible.

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# APPENDIX 1:

## CHANGES IN LINE NUMBERS

While doing my field research and reports, I used Reeves' (1985) line number designations. However, because of the differences in our system maps, a new and simpler numbering system was more suitable for this thesis. The relationship between those original line numbers (Reeves 1985; Rollans 1986) and the revised ones used in this thesis are as follows.

| Original designation | Revised designation | Original designation | Revised designation |
|---|---|---|---|
| Calderwood Lane (CL-1*) | A-1 | C-16 | C-4 |
| A-5 | A-2 | C-12 | C-5 |
| CL-2* | A-3 | C-5 | C-6 |
| A-4 | A-4 | Old lane | C-7 |
| A-3 | A-5, A-6 | C-11 | C-8 |
| A-1 | A-7 | C-9 | C-9 |
| B-2 | B-1 | C-8 | C-10 |
| B-9 | B-2 | C-1 | C-11 |
| B-6 | B-3 | D-3 | D-1 |
| B-5 | B-4 | D-4 | D-2 |
| B-3 | B-5 | D-5 | D-3 |
| B-1 | B-6 | D-2 | D-4 |
| C-21 | C-1 | D-1 | D-5 |
| C-18 | C-2 | D-9 | D-6 |
| C-17 | C-3 | Elgin Lane (EL-1*) | D-7 |
| | | Dersch Lane (DL-1*) | D-8 |

* These designations appear only in Rollans (1986)