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CHAPTER 1

INTRODUCTION

A recurrent theme in studies of prehistoric and ethnographic subsistence and settlement systems is that there is a predictable relationship between features of the gross environment and patterns of human adaption. It is reasoned that patterns of resource distribution, abundance, and availability, for example, will have direct bearing on human subsistence strategies and that precise knowledge of these ecological conditions facilitates predictions of human behavioral responses. Traditionally, these variables have been treated subjectively in anthropological studies. In many cases the emphasis has been on identifying the composition of faunal assemblages and reconstructing the resource base and associated procurement technology, rather than on the underlying bases for economic decision making (Keene 1981: 7). To fully understand the relationship between hunter-gatherers, their environment, and the evolution of adaptive strategies, we must consider the bases for favoring one resource over another. In order to explicate the most effective strategies of exploitation, we need to consider resource availability, reliability, and stability. To deal with these problems the investigator needs precise data on the behavior of various plant and animal resources available to the study population. For example, when reconstructing settlement and subsistence

patterns, it is common for the anthropologist to state that the group spends a certain amount of time hunting big game. However, after detailed studies of hunters, it is obvious that the term big game hunting actually glosses over a great deal of cultural variability; because of behavioral and anatomical variation in the prey, the hunt for each species must be conducted in a different manner.

Recently, anthropologists have begun conducting detailed examinations of a single species and how it has been exploited by human populations (Rehner 1977; Schalk 1977; Speiss 1979). This species closely examines Rocky Mountain Bighorn Sheep (Ovis canadensis canadensis), historically a common big game mammal in the western United States and Canada. Some data are presented on the other subspecies of bighorn when detailed information is lacking for the Rocky Mountain Bighorn, especially in Chapters 4 and 5. Thinhorn sheep (Ovis dalli) of Alaska and the mountain sheep of Europe and Asia are only lightly touched upon (So when I mention mountain sheep and bighorn I am referring to Rocky Mountain Bighorn). Anatomical and behavioral data on bighorn sheep are collected from wildlife management, ecological and ethological sources. While these data have been presented elsewhere, this thesis summarizes them and makes them available to the anthropologist. Then, ethnographic and archaeological evidence relating to North American mountain sheep and their exploitation by Native Americans is examined on a regional basis, looking for

patterns. Finally, mountain sheep are evaluated as a resource, using criteria suggested by Jochim (1976) and several ideas are presented as to how the exploitation of mountain sheep might influence various aspects of culture.

There are a number of purposes behind why this thesis on mountain sheep and their hunters were written. First, I wanted to show that mountain sheep were generally a much more important resource then they are credited with being. While doing the analysis of material from sites excavated in the River of No Return Wilderness Area of central Idaho (Leonhardy and Thomas 1985; Leonhardy 1986), I noticed that mountain sheep made up more than 80% of the identified faunal remains. This high percentage of bighorn remains was also found at other sites in central Idaho (Homer 1986; Manion 1983) and the Northern Rocky Mountains in general (Husted ; Miller). Ake Hultkrantz, who conducted ethnographic fieldwork among the Tekudika Shoshone of Idaho and Wyoming noted the importance of mountain sheep: "The mountain sheep became as important to the Shoshone of the mountains as the buffalo to the Plains Shoshones. Their life was adapted to the demands of their game, the mountain sheep" (Hultkrantz 1974: 234). Yet, in several recent reconstructions of settlement and subsistence in the Northern Rocky Mountains, mountain sheep were hardly mentioned (Wright 1978). An important factor in this lack of recognition may be their present day low population. However, mountain sheep were much more numerous

prehistorically, and it was not until white contact in the nineteenth century that their population crashed (discussed more fully later in this chapter). As far south as the Great Basin, bighorn sheep were a prime prey species. "Ungulate remains from Great Basin sites are generally dominated by Bighorn sheep. Apparently, it is only during the historic period, with the extirpation of Bighorn sheep in the Great Basin that mule deer have increased in importance" (James and Pecotte 1983: 38).

A second purpose behind this thesis is to advance the idea that single species studies can be seen as building blocks in the construction of an understanding of a total subsistence economy (Jochim 1976: 84). Many valuable ecological studies have had this narrow focus: musk oxen (Wilkinson 1975), reindeer (Burch 1972; Speiss 1979), shellfish (Braun 1974), salmon (Schalk 1977), root crops (Bronson 1966), and bison (Rehner 1977; Arnold) have all been studied. The value of such studies is derived precisely from their narrow scope: by limiting the number of interrelated variables, it is much easier to examine their interaction and reaction to change.

Anthropologists concerned with the dynamics of human behavior can not continue to ignore the dynamics of the environment and its resources. Soils, water sources, plants and animals are not simply static factors to be selected or exploited; they show patterns of behavior themselves, which condition the timing, magnitude, and techniques of their use

and their reaction to this use. Many of the above mentioned studies are valuable in their explicit discussion of resource attributes such as spatial and temporal distribution and variability, which affect energy costs, yields, and reliability. As a result, not only can various resources be compared in similar terms, but the total subsistence economy of a group can be examined (Jochim 1979: 85). It is important that data on mountain sheep be compiled because, more than simply an opportune food source, sheep were a focal point of a high mountain lifeway for aboriginal peoples of several areas and cultural periods (Whitfield 1983: 1).

The final purpose is to provide data on mountain sheep for anthropologists interested in doing resource modeling for mountaine environments. Models attempting to provide a baseline for hunter-gatherer subsistence decision making have been proposed for a large number of different environments (See Jochim 1976; Keene 1981; Thomas 1973; Winterhalder and Smith 1981), but mountaine environments have been ignored. A majority of these models are based an a subset of evolutionary ecology known as optimal foraging theory. Optimal foraging models are based upon the Neo-Darwinian assumption that natural selection will favor foraging behavior that results in maximum fitness with regard to whatever constraints are operating. In other words, over time, there will be differential survival of those behaviors which best allow an individual or population

to achieve its life goals in a specific environment (Keene 1981: 8). Optimal foraging theory has been used by anthropologists to generate testable hypotheses about the "best" strategies for particular circumstances in such problem areas as site location, group organization, and dietary composition. These models require accurate quantitative data about the potential prey species involved. Ethnographic data about the utilization of the various species must be consulted because etic differences may be obscured by emic factors (Jochim 1983: 160). In order to construct accurate ecological models, we must have accurate data on the animals that interact with the human population.

The remaining portion of Chapter 1 contains a short section on the theoretical background for this paper and a brief general description of mountain sheep and their ecological adaption, as well as sections on the taxonomy, evolution and distribution of the species. Chapter 2 examines the anatomy of Bighorn sheep, including such things as the meat yield and its variability, non-food utility, grazing, and reproductive patterns. Chapter 3 deals with mountain sheep behavior, especially such aspects as the seasonal round, group structure, daily behavior, and escape behavior. Chapter 4 looks at the ethnographic record of interactions between man and mountain sheep. Topics such as the hunting and butchering of mountain sheep and their inclusion in ritual and ceremony are considered. Chapter 5 examines many of the same activities as Chapter 4, but from

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an archaeological rather than an ethnographic perspective. Chapter 6 deals with mountain sheep as a resource. First, looking at how compare to attributes that Jochim (1976) suggests influence prey selection by hunters and gatherers. Second, looking at how specialization in mountain sheep hunting might influence various aspects of the culture such as settlement pattern and social structure.

THEORETICAL BACKGROUND

Attempts by anthropologists to analyze human culture as ecologically adaptive have had an erratic history (Anderson 1973). Early twentieth-century anthropologists in the United States adopted particularistic and historical research approaches (Harris 1968). Led by Franz Boas and his students, these anthropologists cultivated an atmosphere of "theoretical austerity" (Hatch 1973: 224). They rejected broad materialist or ecological explanations, at least partly because these approaches were associated with determinism and ethnocentrism. There were attempts to correlate large-scale distribution of cultural patterns with regional features of geography, led by Mason (1905), Wissler (1926), and Kroeber (1939). But, while documenting correlation, these anthropologists avoided ecological generalization. Instead they adopted the position of "environmental possibilism"--the view that environment places broad constraining boundaries on sociocultural phenomena, but has little influence on the features that develop within those boundaries.

Dissatisfaction with the particularist orientation produced more general theoretical approaches to anthropological subjects during the 1930s and 1940s. One major orientation was functionalism. Functionalism focuses on the role that recurrent social activities play in maintaining the social structure and viability of the community (Radcliffe-Brown 1935, 1956). A second approach, the materialist or ecological orientation, developed principally in the work of Julian Steward (1955). Steward sought systematic ways of studying the relationship between sociocultural life and the environment. He emphasized the intervening variables - technology, material culture, and economic relations - linking particular aspects of sociocultural life to the local environment. Steward paid careful attention to unique aspects of local habitats, to the distribution of plants and animals, and to comparative studies of the adaptive histories of local groups, technologies, and economies. Perhaps most importantly, he viewed the environment as a creative, rather than a limiting factor (Jochim 1981: 7; Murphy 1970: 155).

Recently, cultural ecologists have discovered that to offer ecological explanations for differences in cultural systems, they must be able to compare variations in environment. Therefore, the generation and testing of hypotheses concerning ecological adaptions are not aided by gross environmental descriptions, no matter how elaborate, nor by efforts to label environments with a word or a phrase

(Schalk 1977: 208). Anthropologists have begun to look at environmental factors in more detail and begun to look for spatial and temporal variations in resources. Single species studies, like this one, have played an important role in this research.

DESCRIPTION

The Rocky Mountain Bighorn is a short, deep bodied animal, ranging from brown to tan in color, depending on subspecies and season, with a white rump patch. A ram stands about 40 inches tall at the shoulders, and is about five feet in length (Idaho Department of Fish and Game 1950: 3). The most striking physical characteristic is the curling horn, which in older males usually make more than a full curl. The horns are used during the rut, when males butt heads to drive off competitors for females.

Mountain sheep can be described as "extremely diverse, large-horned, successful glacier followers with narrow food habits and landscape preference, but great adaptability to climatic conditions" (Geist 1971: 9). In general, they are not found in areas of high precipitation, either rain or snow, and therefore, are usually confined to dry mountain ranges. Mountain sheep live in an open terrain, usually close to cliffs. The plant communities are usually climax communities with few tall shrubs and trees, but an abundance of low growing shrubs, herbs, and grasses (Geist 1971: 15). Temperatures and availability of water vary

greatly. Desert Bighorn may live in mountains where temperatures reach 120 F (49 C) in the shade and go for days without water (Welles and Welles 1961), while Dall's sheep survive in the darkness and cold above the Arctic Circle.

Behaviorally, sheep can not be equated with deer or any of the other artiodactyls (Geist 1970: 47). Their home range patterns are entirely different from those of deer; they are highly gregarious and maintain tradition; and they adjust their response to humans on the basis of past experience with them and do not have an "innate" response to humans. Organisms with an adaptive strategy like the mountain sheep are called "conserver" species. They are characterized by a strategy of adaption in which the population maintains itself by great individual longevity, low reproductive rates, slow maturation, and social mechanisms that transmit home ranges and migratory patterns from generation to generation. When dispersal does occur, it occurs through the budding off of segments of the population, rather than through expulsion of juveniles from the population (Geist 1975: 80).

Evolutionarily, mountain sheep have been a very successful group. Part of this success is due to their unique digestive system, which allows them to exploit a hard, abrasive, dry forage of poor quality, the type typically found in mountain and glacial environments. During the Pleistocene, they spread around the Northern Hemisphere to most of the mountain ranges of Europe, North

America, Asia, and North America. Sheep, as a genus, still have a distribution unequaled by any living bovid (Geist 1971: 3). They remain abundant in Canada and Eurasia and were one of man's first domesticated animals. They survive into our times despite the presence of man, while many late Pleistocene mammals became extinct (See Wright and Martin 1967).

TAXONOMY

Despite some taxonomical bickering, most zoologists recognize six species of mountain sheep worldwide. Following Cowen (1970) they are:

> Ovis musimon (mouflons) - originally confined to Corsica and Sardinia, now widely introduced on the mainland of Europe
>
> O. orientalis (urials) - the primitive sheep from Cyprus, Asia Minor, Persia, Pakistan, Afghanistan, northern India, and southern U.S.S.R.
>
> O. ammon (argalis) - the giant sheep from the Karatau, Pamir, Tien Shan, Himalaya, and Altai Mountains, and the Gobi Desert of Mongolia and China
>
> O. nivicola (snow sheep) - thinhorn sheep from Siberia
>
> O. dalli (thinhorn sheep) - American sheep found in Alaska, the Yukon, Northwest Territories, and northern British Columbia
>
> O. canadensis (bighorn sheep) - American sheep whose center of evolution lay in the mountains of western United States

The two species of American mountain sheep can be broken down into a number of subspecies. The northern thinhorn sheep can be reduced to three races or subspecies: O. dalli dalli, the white common Dall's sheep; O. dalli

kenaiensis, the white Kenai Pennisula Dall's sheep, differing mainly in cranial features from the common Dall's sheep; and O. dalli stonei, the black thinhorn sheep or Stone's sheep from northern British Columbia and the Yukon. The thinhorn sheep are remarkable among the sheep for their color. Whereas dalli and kenaiensis are pure white and carry amber colored horns; stonei varies from gray to glossy black in color with a white rump patch, belly and leg trimmings. Also, like the snow sheep, they are unique for living far north of the Arctic Circle.

The bighorn sheep are formed from seven living races plus the extinct badlands or Audubon's Bighorn (auduboni): O. canadensis canadensis, the Rocky Mountain Bighorn, the main subject of this thesis; O. canadensis california, the Lavabed or California Bighorn; and five races collectively called Desert Bighorn: O. c. nelsoni, O. c. mexicana, O. c. texiana, O. c. cremnobates, and O. c. weemsi. Of these canadensis is the largest, most northern in range and the most abundant. The smallest, most primitive, and dalli-like in cranial and horn characteristics is nelsoni. It also has the distinction of living in the hottest region of North America, Death Valley, California. The southernmost bighorn is weemsi, which live in the lower Baja pennisula of Mexico. Desert Bighorn are smaller in size than the other bighorn, but they have larger ears and longer tooth rows.

EVOLUTION

The history of the mountain sheep begins somewhere in the early Pleistocene of Eurasia, but we know only a little of it. Their immediate ancestor is unknown, but like the other caprids ( ), they appear to be an offshoot of the Rupicaprini, the goat - antelope (Thenius and Hofer 1960), which are short horned, light skulled, generally hairy bovids of small size (the North American Mountain Goat [Oreamnos sp.] belongs to this group). The fossil record is poor, because not only are the conditions for fossil formation unfavorable in the mountains, but recurring glaciers have ground over much of the terrain inhabited by sheep. When they first appear in the early Villafranchian faunal populations, sheep are already ox-size giants like Megalovis in Europe and central Asia (Kurten 1968). True sheep (Ovis sp.) are found first in the late Villafranchian of Europe and Asia and from then on appear sporatically in the Pleistocene fossil record (Thenius and Hofer 1960). The fossil record is not too revealing, but it does tell us that sheep arose about 2.5 million years ago, and that they were part of the large mammalian fauna that flooded into Europe and Asia during the Villafranchian, presumably from south of the Himalayas (Geist 1971: 1). Sheep remains in Alaska and the southern United States indicate that sheep reached North America during the late Pleistocene, as part of the faunal exchange across the Bering Land Bridge.

There are two theories regarding the establishment of mountain sheep populations in North America. According to

McCann (1953: 41-42), the time of the first occupation by thinhorn sheep (O. dalli) appears to be much more recent than the time of the first occupation by Bighorn sheep (O. canadensis). McCann theorizes that an Asian form similar to O. ammon entered North America across one of the earlier land bridges and moved southward during the following interglacial period, to be cut off by the succeeding ice invasion, and developed into O. canadensis. An O. nivicola type then entered North America by a later land bridge, perhaps even the most recent, and now as O. dalli is limited to regions near its first establishment on this continent.

A second theory was proposed by Cowen (1940). He is of the opinion that O. nivicola of eastern U.S.S.R., or a form common to both it and O. dalli, is ancestral to all North American sheep forms. It is Cowen's contention that as this form moved southward in North America, into new environments, various new forms gradually evolved. The rather sharp, present day specific differences between O. dalli in the north and the more southern O. canadensis is explained on the basis of ice invasions. The ice sheets, covering the mountainous areas roughly between the United States - Canadian border and central Alaska, separated the sheep into two groups. The group ancestral to O. canadensis was trapped in the area of the present day continental United States, while the population ancestral to O. dalli was isolated above the ice sheet in Northern Alaska. When separated, the two groups developed

morphological and behavioral variations, so when they were reunited, they exhibited differences great enough to be recognized as two distinct species. Much of the recent paleontological evidence seems to support this single migration theory (Stock and Stokes 1969).

It has been suggested (Clark 1940) that during the early Holocene, mountain sheep were even more abundant than the precontact estimates suggest. Right after the retreat of the glaciers, much of western North America was covered by vast prairies, much of which has been subsequently covered by forest. This grassland would have been prime bighorn territory, and would have produced a population boom. From the early Holocene to the time of European contact, the bighorn population was slowly decreasing as the forest gradually encroached upon their territory and split up ranges.

DISTRIBUTION

Prior to widespread contact with Europeans, Bighorn sheep inhabited much of the mountain and desert west. Sheep populations were found from the Badlands of North and South Dakota to the Sierra Nevada and Cascade Mountains of California, Oregon, and Washington. The northern limit was the Peace River in british Columbia and Alberta and they stretched south to the Lower Baja Pennisula of Mexico (Fig. 1).

It has been estimated that at this time there were 1.5 to 2 million bighorn in the western United States. It

Figure 1 map showing pre contact range of *Ovis canadensis*

is currently estimated that the present sheep population is 35,000 to 40,000 (Trefethen 1975), less than three percent of the original population figure. Much of this population reduction is attributed to disease such as scabies, livestock competition, winter range restriction, and indiscriminate hunting by settlers. Even areas that are relatively undisturbed have experience drastic population reductions. Seton (1929) quotes a M. W. Miner, who in 1897 wrote:

> It is estimated there are between 2,000 and 2,500 Mountain Sheep, now inhabiting the slopes and the mountains of the Middle Fork of the Salmon River [now included in the River of No Return Wilderness Area of central Idaho], mostly in the vicinity of the upper end of the Grand Canyon....Two trappers who wintered in that country last winter told me...it was almost a daily occurrence to see bands of 60 to 100 feeding on the bare hillsides.

The geographic limits of this area are unclear, but there are no more than a few hundred sheep wintering on the same range today.

Historically, mountain sheep also inhabited a wider range of habitats. Grinnell (1928) felt that "(i)n the old times the wild sheep were not confined to what we call mountains but in many parts of their range lived...near buttes, rough badlands or low rock hills." Because of competition from livestock and other factors, bighorn are now restricted to the roughest, most isolated portions of their previous ranges (Fig. 2).

This population reduction is probably one of the main factors in why mountain sheep have been ignored in

Figure 2 map showing present range of *Ovis canadensis*

subsistence studies. The population reduction occurred prior to most natural history studies, and several generations before ethnographies were done. The population drop made hunting by aboriginal groups uneconomical. So by the time studies were made, the sheep had disappeared and much of the information about them and their procurement had been forgotten by aboriginal informants.

Chapter 2

MOUNTAIN SHEEP BIOLOGY: ANATOMY

The aboriginal inhabitants of the western United States had an intimate knowledge of bighorn sheep anatomy. This knowledge was obtained from the killing of the animal, the butchering of the kill, procuring the most desirable portions of the animal, and extracting the most calories from the kill. Anthropologists interested in understanding Native American subsistance patterns should have a comparable knowledge of anatomy, if they are to detect and understand intra- and intercultural variations in the utilization of big-game.

This chapter looks at various physical characteristics of mountain sheep and how people utilizing sheep may have viewed them. The chapter begins by attempting to determine how much food value a mountain sheep may have and how this varies by sex and season. It then examines some of the non-food values of sheep, in particular, uses of the hide and horns. Reports on the various senses of the mountain sheep are then presented. These senses influence the selection of hunting techniques described in later chapters. Finally, sheep forage and reproduction are examined. Examining forage is important because it is a primary determinate of where the animals are found and what kind of physical condition they are in. Reproductive rates are a determinate in how well a population will withstand hunting pressures.

FOOD YIELD

The first step in determining how much food each mountain sheep represents is to establish how much an individual weighs and how much muscle and fat tissue it carries. The weight of bighorn sheep varies drastically by sex, season, subspecies, and age.

Rams are generally larger than ewes. A good trophy Rocky Mountain Bighorn ram will weigh about 300 pounds (136 kg) (Smith 1951: 37; McCann 1953: 7; Baille-Grohman 1882: 162). Two hundred and fifty pounds (114 kg) is closer to the average weight for Rocky Mountain Bighorn males (Idaho Department of Fish and Game 1950: 3). Ewes weigh about half as much as a trophy ram, averaging about 150 pounds (68 kg) (Honess and Frost 1942).

During the early spring, mountain sheep generally weigh less than during the summer and fall. This is especially true for rams. Full grown bighorn rams, seven years of age or older from southern Alberta weigh an average of only 225 pounds in the spring, compared to the 250 pound average in the summer and fall (Geist 1973:).

There is also weight variation due to subspecies. Ovis canadensis auduboni seems to have been the largest subspecies (in terms of body size). Audubon gave the weight of a ram he collected as 344 pounds (156 kg) (Clark 1964: 10). O. c. canadensis are just slightly smaller, with large rams weighing about 300 pounds (136 kg). The Nelson's

Bighorn (O. c. nelsoni) is reputed to be the smallest of the bighorn sheep. The average weight for 12 captured rams was 164 pounds (74 kg). For 15 females, the average weight was 96 pounds (43 kg) (Aldous and others 1958).

Finally, there is weight variation due to age. Rocky Mountain Bighorn rams do not complete growth until they are approximately seven years of age; ewes complete growth when they are four (Blood and others 1970). Prior to this time the animals have a lower body weight.

Spiess (1979) estimates that for caribou about 55% of the carcass is edible meat and about 25% is bone. There are no comparable calculations for mountain sheep, but if we can apply Spiess' figures, the a 250 pound ram would yield 137.5 pounds (62.5 kg) of meat.

Fresh, lean meat is about 21% protein by weight and, for animal protein, the net utilization value is about 66% (Net utilization is the "percent of amino acids ingested as protein that are retained in the body and incorporated into cellular proteins" [Scrimshaw and Young 1976: 33].). Scimshaw and Young (1976) report the minimum protein requirement for a young adult to be 40 grams of protein a day. The formula for determining the amount of meat needed to provide this protein is:

$$M = P / (W \times U)$$

M = weight of meat needed
P = amount of protein needed
W = percentage of protein in the meat
U = net utilization percentage

or in this example:

M = 40 grams / (.21 x .66)

M = 290 grams or .29 kilograms of meat

Thus a figure of .25 kilograms (.5 pounds) of meat can be used as an average person-day requirement. Any protein intake over that amount will be converted into energy yielding 4000 calories per kilogram of protein or 800 - 1000 calories per kilogram of fresh lean meat. On a pure meat diet, .25 kilogram of meat per day would be needed for protein requirements, and three kilograms would be needed to fulfill the caloric requirements. So 3.25 kilograms represents the requirements for one man person-day on a pure meat diet (Spiess 1979: 27). Any addition of plant food would reduce the amount of meat needed daily (Speth and Spielmann 1983:).

The fat content of the carcass varies considerably with sex and season in mountain sheep (Fig. 3). Male ungulates may lose up to 10 or 15% of their body weight during the fall rut due to high energy expenditure and reduced forage intake. As a consequence, they often enter winter in comparatively poor condition. If nutritional shortages occur during winter, their body-fat reserves begin to be depleted and their overall condition declines through late winter into spring. Females often enter winter with more more reserves than males; their condition, therefore, may be somewhat better in early spring. Later in the spring, however, pregnant or lactating females decline in condition to a level below that of males. Thus both sexes

Figure 3 Graph showing variation in weight in different seasons of year

are in poorest condition in the spring, and both may have become severely fat depleted (Speth and Spielmann 1983: 3). In rams, fat reserves, which may have been as high as 25% of the body weight in the fall, drop as low as 1% in March (Speth and Spielmann 1983: 10). Ewes usually make it through the winter with 10% body fat, but this reserve is often depleted by the late stages of pregnancy and lacation, so that by June, they too are down to 1 - 5% fat.

When animal fat is ingested, it is broken down into its component fatty acids by the digestive track. The fatty acids are eventually converted to energy by being processed through the Krebs Cycle in the liver. Fat metabolism yields 9000 calories per kilogram. Fat supplies nine times the calories by weight that lean meat does. These different caloric potentials of meat and fat mean the food value of an animal will fluctuate over the course of a year and that it will be differentially attractive to human hunters.

For example, if a 120 kilogram (265 pound) ram was killed in early November, before the rut, about 24 kilograms (20% of the body weight) is fat. Of the remaining 96 kilograms, 53 kilograms (55%) is edible meat. This animal provides 9000 calories per kilogram times 24 kilograms of fat or 216,000 calories, divided by 3000 calories per person-day, or 72 person days of fat supplied calories. In these 72 person-days, some 72 times .25 kilograms or 18 kilograms of meat would be eaten to satisfy protein requirements, leaving 35 kilograms. That 35 kilograms of

meat, used at the rate of 3.25 kilograms per day represents another 10 person-days of food (It makes no difference to the calculation whether fat is eaten first, leaving just meat for the last 10 days, or whether more meat and less fat is eaten each day and some of the meat is converted into calories throughout the whole time.). Thus a 120 kilogram ram in the late fall yields about 82 person-days of food.

That same ram in late February or early March, having depleted its fat reserves down to 2% would weigh 100 kilograms and yield 2 kilograms of fat and 53 kilograms of meat. The fat would yield only six person-days of food and the meat would supply 16 person-days of calories and protein requirements. Thus, this same ram, in late winter, provides only 22 person-days of food, approximately one quarter of what it supplied a few months earlier.

A 70 kilogram ewe killed in February has a theoretical 10% fat content (7 kilograms) and yields 63 kilograms times 55%, or 35 kilograms of meat. Seven kilograms of fat last 21 person-days using five kilograms of meat at the same time for protein requirements. The remaining 30 kilograms of meat represent nine person-days of food at 3.25 kilograms per day. So, a 70 kilogram female in late winter represents 30 person-days of food, over a third more than a much larger ram killed at the same time.

The amount of food obtained from each carcass may be stretched by the retention and utilization of the viscera and stomach contents. This practice may be necessary to

reduce the deletorious effects of a high protein - low fat and carbohydrate diet during the late winter and spring. It would also provide much needed vitamins and minerals during this period of stress.

One final source of calories that was often utilized was bone marrow. Long bones were broken open and this fatty substance was dug out with a stick or piece of bone. Bone fragments were often placed in boiling water so any remaining marrow would float to the surface in the form of grease and could be scooped off and consumed. Binford (1978:) reports that discarded bones from previous seasons and years were scavenged and processed in this way.

Numerous examples of hunters being aware of the deletorious effects of a lean meat diet are present in the ethnographic literature. Hunters would often abandon lean animals on the chance that they might encounter fatter ones, even when they were short of food (Speth and Spielmann 1983: 3-5). The data given above would suggest that there would be selection by sex during different seasons. Ewes were probably more attractive to hunters than rams during the winter. However, in the summer and fall, a hunter hoping to maximize his food yield would concentrate on rams.

PELAGE

Occassionally, mountain sheep were hunted primarily for their hides. Baille-Grohmann (1882: 175) reported, "(t)he Indians will kill a whole band for their skins." The hide of a bighorn sheep is covered with two types of hair

(Smith 1951: 41). There is a dense outer layer of coarse, rather stiff fibers comparable to that of deer or elk. These outer hairs are hollow, each hair being a tube with dead air inside for insulation. Beneath these hairs is a loose inner layer of very fine, woolly fibers known as the inner coat. The fur varies in thickness from one to four inches (Russell 1973: 19). Both sets of hair are, of course, at their longest and fullest during the winter. Winter pelage is generally too thick to sew into comfortable clothing, but it may be used as bedding or robes. By the end of winter, the hairs of the outer coat are very brittle and break off very easily, making the hide unsuitable for most uses.

Beginning in March, the sheep begin to shed their coat. Both the inner and outer coats are shed. Females and young animals appear to shed later than the rams. The molt continues into the summer, usually not being complete until July (Geist 1971: 276). The hair comes off in matted bunches and may hang like towels around the sheep. These matts are often found on branches and rock outcrops, where the sheep have rubbed to remove the dead hair. None of the cervids (deer or elk) appear to molt in this manner. The shedding and summer coats make poor clothing.

At the end of summer, both the inner and outer coats begin to grow again. The best time to take bighorn sheep skins for clothing, therfore, is in the fall (September, October), when the fur has grown out, but is not yet too

thick.

The Tekudeka of the Northern Rocky Mountains were well known as furriers for their use of mountain sheep hides (Liljeblad 1977: 157). Depending on the use, the fur could be removed or left on. The hides were tanned by rubbing brains into them. There are numerous examples of sheepskin clothing manufactured for both sexes. Liljeblad (1977: 157) reports that it took two hides to produce a women's dress. At Lemhi Reservation, Lowie (1909: 179-180) observed bighorn hide robes and a men's shirt of mid-thigh length that was fringed along the bottom. A mummy excavated from Mummy Cave, in northwest Wyoming, wore a parka-like coat of tanned mountain sheep hide with the hair on the inside, next to the body (McCracken 1978: 13). Some of the tufts of mountain sheep hair recovered from Mummy Cave had been dyed red (Husted 1978: 60), suggesting that some of the hide clothing may have been decorated.

In many ethnographic accounts ( ), it is claimed that mountain sheep hides were not used for footwear because they were too cold. However, at Mummy Cave, a pair of skin boots were found in a cache beneath a grinding stone. The boots were dated to 1230 + 100 BP and described as being:

> ... made of mountain sheep hide with the hair intact. The foot portion was made of four pieces of hide sewn longitudinally with a running stitch. Seams ran along both edges and down the center of the sole and body. The edge and sole seams were sewn first, on the interior side. The longitudinal body seam was sewn from the outside. The legging portion consists of pieces of hide folded so that hair is present on both inner and

> outer surfaces. Pieces were joined with a overhand stitch. The upper edge is represented by a fold on one side, but the other side is considerably higher. This side deteriorated and the actual height is undetermined. This appears to be a winter boot for use in snow and served the same purpose as the Eskimo mukluk. Grass liners may have been used (McCracken 1978: 59).

In addition to clothing and footwear, bighorn hides may have been used for shelters. Dominick (1964: 163) tells of a site in the Absaroka Mountains of Wyoming with conical structures of aspen poles five to eight feet high and six to nine feet in diameter that were probably covered with hides

A good estimate would be that each family member would require six to eight hides for winter clothes; two to four hides for winter clothes; two hides for moccasins and boots; plus another two to three hides to make bags and rawhide line (for snowshoe lacing and nets). In addition, the family as a whole would require eight to twelve hides as a covering for their lodge. Thus a six member family would require something on the order of 90 skins. Many of these hides would have to be replaced annually. However it should be noted that the hides of other large ungulates (i.e. deer, elk, and antelope) or small game (rabbits, marmots, mink, etc.) would function just as well as mountain sheep hides in many cases.

HORN

The horns of the mountain sheep are permanent structures with a bony core surrounded by an outer sheath which becomes deciduous only after death. The annual growth

increment is added at the base of the horn only (Smith 1951: 38). In rams, the horn keeps growing through out the life of the animal. In ewes, growth appears to slow down drastically after age four. The presence of so called growth rings on the horn may be caused by the cessation of horn growth during the breeding season or winter.

In older rams, the horns characteristically form a spiral, often making considerably more than a complete turn. The horns are extremely heavy at their bases and are roughly triangular in cross-section. The anterior face is broad while the posterior face forms a sharp angle (McCann 1953: 10).

The horns of females are much smaller than those of the rams and are suggestive of the horns of the goat. The horns of a female sheep are small in girth, form a simple, short curve, and have a small amount of taper from base to tip.

The external sheath of a mountain sheep horn can be made pliable by heating. This plasticity made sheep horn a valuable material and allowed to be was utilized in the manufacture of many objects. Bowls and spoon were manufactured out of the natural curve of the horn or were shaped on molds of wood (Teit 1930: 43; Lowie). Mountain sheep horn was also used as the handle for root diggers (Teit 1930: 240), snowshoe frames (Dominick 1964: 152), and atlatls (Cressman 1977: 106).

Mountain sheep horn was commonly used in the

manufacture of bows, because it was strong, yet flexible. Strips of horn could be attached to a wooden bow with fish glue to make the bow stronger and more powerful (Forde 1934: 38) or the bow could be made entirely out of horn.

> The bows were made from the thick ridge on the upper side of the ram's horn. The horn was heated over coals to soften it and then the naturally curling horn was straightened. Unwanted portions of horn were whittled away, and the remaining solid piece was 18 to 24 inches long and one inch thick at the butt. Heat was again applied, making the horn semi-plastic, and it was smoothed and shaped by pounding with a round stone. The end result was a very smooth and evenly tapered piece which was oval-shaped in cross-section. A duplicate of this was made from the ram's other horn and the two pieces were beveled at their butt ends and fitted together. A separate piece of horn, about five inches long and as wide as the butt ends, was placed at their junction. Wet rawhide was then wrapped around the three pieces. When it dried it made a very firm joint. Sinew strips which came from the neck and back of large animals were glued to the back of the bow to give it added strength. The glue was made by placing shavings from the hoof and small bits of thick neck-skin or back-skin in boiling water, and then as a thick scum formed, it was skimmed off (Dominick 1964: 155).

It took two months for a skilled specialist to produce a bow. Horn bows were highly prized in the Northern Rocky Mountains and the Columbia Plateau and were often highly decorated. Osbourne Russell reported, "the bows were beautifully wrought from Sheep, Buffaloe (sic) and Elk horns secured with deer and elk sinews and ornamented with porcupine quills" (Russell 1955: 26-27). A well made bow would trade for five to ten good ponies (Dominick 1964: 155).

Mountain sheep horn also played an important part in

Native American ceremonialism and beliefs. There are a number of locations where sheep horns have been found embedded in a tree (Morgan 1968: 46). These were apparently placed there by Indians to mark a location with strong medicine. Mange (1926: 253) tells of a village in Arizona with a pile of 100,000 sheep skulls and horns in the center, probably collected for ceremonial purposes.

BONE

The bones of the mountain sheep are not structurally different from the bones of the deer or antelope. The types of tools made from mountain sheep bone are practically identical to those made from other ungulate bone.

SENSES

The sensory equipment of mountain sheep has not been well investigated (Geist 1971: 12). Their eyesight is marveled at by hunters, and there is a popular myth that sheep vision is equal to that of a man aided by eight-power binoculars. Smith (1951: 44) reports that sheep seem to be able to detect moving objects at distances up to one mile, but their ability to detect stationary objects is questionable. Geist (1971: 12) noted sheep would pay attention to coyotes at a distance of 1000 yards. However, if an animal was further than 400 yards away, the sheep would usually look at it for 10 to 20 seconds before returning to feed, even if it was another sheep, as though

they had problems identifying objects at that distance. Actually, the evolution of highly magnified sight would have very little survival value; because of the uneven terrain that sheep inhabit, preditors would still be able to approach to within striking distance of the sheep (Sugden 1961: 18)

Sheep can probably distinguish colors just like their close relative, the goat (Backhause 1959) and they do have some capacity to distinguish shapes. Domestic sheep can distinguish a circle from a square, but not from a hexagon (Seitz 1951). Like other ruminants, sheep probably have astigmatism and can see vertical lines better than horizontal ones. They can disconcern detail less well than we do (Backhause 1959). In general, mountain sheep's vision and ability to recognize appears to be very different from that of humans. Sheep are much better at spotting moving objects in obscuring terrain, but not very good in resolving lines or shapes.

Mountain sheep are not noted for their scenting ability; compared to other animals this facility seems to be somewhat dull. The sense of smell is well enough developed to scent a man at about 350 yards, under very favorable conditions (Geist 1971: 13). Bighorns do, occassionally, make use of olfactory forms of communication. During the rut, rams frequently smell the urine of females to determine if they are in estrus.

Very little is definitely known about about mountain

sheep's hearing. Sheep are frequently startled by distant landslides; but like their sense of smell, sheep's hearing does not appear to be particularly strong.

FORAGE

It is generally held that wild sheep are primarily grass eaters or grazers. The data given in Table 1 indicates that this is generally true for bighorn, but there is considerable variation from the norm. Considerable amounts of browse and forbs are found in the contents of sheep stomachs, and bighorn are often observed feeding on them even where grass is plentiful. Generally, bluebunch wheatgrass (Agropyron spicatum) in the north and little gilleta (Hillaria jamesii) in the south are the preferred grass species. Browse seems to become an important factor in the diet during periods of stress, such as winter, when the grasses and forbs may be unavailable. The body of data indicates that the bighorn are to some degree opportunistic and adaptable feeders. They eat whatever is on hand, depending on the locality and season they are in.

Analysis of the diet at the level of season as shown on Table 1 may be somewhat misleading. There appear to be significant differences in the diet for each month of a season (Oldemeyer 1967: 67; Woolf 1968: 77) and there are even dietary differences between different parts of the month (Davis 1938: 90). These differences are probably due to the fact that, though bighorn sheep are capable of

TABLE 1

DIET OF BIGHORN SHEEP

LOCATION	YEAR ROUND	SUMMER	FALL	WINTER	SPRING	NOT
Salmon River Mountains, Idaho	Grass & Forbs 70% Browse 27% Moss & Lichen 3%	Grass & Forbs 86% Browse 14% Moss & Lichen 0%	Grass & Forbs 66% Browse 25% Moss & Lichen 9%	Grass & Forbs 56% Browse 39% Moss & Lichen 5%	Grass & Forbs 77% Browse 22% Moss & Lichen 1%	Wheat gra and Balsa most popu Mahogony, and Rabbi most popu
Sun River, Montana	------	------	------	Browse 43% Grass 36% Forbs 21%	------	
Teton Range, Wyoming	------	Grass 22.7% Forbs 13.0% Shrubs 64.2%	------	Grass 29.1% Forbs 32.4% Shrubs 38.5%	------	
Yellowstone National Park, Wyoming	------	------	------	Grass 61.4% Forbs 17.2% Browse 21.5%	------	Most popu is Bluebu grass (Ag spicatum) ular brow Chrysotha diflorus, lanata.
Yellowstone National Park, Wyoming	------	Grass 72.3% Forbs 27.6%	------	------	------	Most comm Carex hep spicata, diversifo Saxifraga
Mount Washburn, Yellowstone National Park, Wyoming	------	Graze 95% Browse 5%	------	------	------	

TABLE 1 (concluded)

DIET OF BIGHORN SHEEP

LOCATION	YEAR ROUND		SUMMER	FALL	WINTER		SPRING	NOT
Glacier National Park, Montana	------		------	------	Grass Forbs Shrubs Lichen	71% 11% 11% 5%	------	Preferred Carex ger Agropyron
Painted Desert Utah	Grass Browse Forbs	38% 45% 17%	------	------	------		------	Preferred galleta (Indian ri (Oryzopsi black bru ramosissi
Desert Wildlife Range, Nevada	Grass Browse Forbs Unident.	71% 13% 5% 11%	------	------	------		------	

digesting dry, mature grasses (Geist 1971:), they seem to prefer succulent vegetation and ignore the older, dried out material (Woolf 1968: 77). The sheep generally concentrate on the species that is sprouting at that time, and is, thus, the moistest.

In addition to eating only the most succulent species of vegetation, mountain sheep usually eat the tenderest parts. Unlike domestic sheep, when grazing mountain sheep do not bite off the grass blades so much as pull them out. This allows them to get the most nutritous portions of the plant, the new blades. The tougher stems seem to be the least preferred portion of the plant (Geist 1971: 268). Similarly, unlike domestic sheep, which feed almost continuously, mountain sheep are more sporadic in their feeding; taking a few bites, moving to a new area, taking a few more bites (Capp 1968: 13).

In addition to this seasonal variation, there is good reason to suspect that even among the different age classes of sheep feeding at the same location there are considerable differences in the selection of forage (Geist 1971:). Young female sheep may be feeding on different material than old rams, but no study has yet described these differences.

REPRODUCTION

North American Bighorn sheep have a fall rutting period and are relatively sexually inactive at other times of the year. A ewe will accept the ram only during the

"heat" period of her estrus cycle. The further south and the lower the elevation that the bighorn are found on the North American continent, the earlier and longer is the rutting season. This probably relates to the need for lambing in the most optimal time of the year in the more rigorous northern climates. Welles and Welles (1961: 103) state that the rutting period for Desert Bighorn in Death Valley "begins in late June, increases in intensity rather sharply through July, maintains a fairly high level through September and October, and gradually declines through November to subsidence some time in December." While in Alberta, the rutting season is restricted to late November and December (Geist 1971: 184).

The gestation period is about 175 - 180 days. About ten days to two weeks before they are due, pregnant ewes leave the band to move to lambing grounds and become solitary. Traditional lambing areas are chosen on the basis of isolation, shelter, and an unobstructed view. In the northern subspecies, lambing occurs in late May and June (Idaho Department of Fish and Game 1950: 9). The Desert Bighorn lambs from January through March (Turner and Hansen 1980: 148). Ewes give birth to a single lamb, twinning, while it occurs, is very rare.

The ratio of the number of lambs per 100 ewes is suggestive of the percentage of productive ewes in a population. Nearly all fertile ewes lamb each year, but other ewes are too old or too young to mate. Productive

ewes are very difficult to differentiate from non-breeding females, or even yearling and two year old males, especially in aerial counts. Another portion of the variability in lamb : ewe ratios is caused by early post-natal mortality. The early survival of lambs is probably a factor of maternal nutrition and weather (Geist 1971: 285). Lamb mortality is often raised after a hard winter when the female (and thus the fetus) is in a poor nutritional state. Mortality is also higher when there is cold, wet weather during the lambing period, which often can lower the body tempature of a newly born lamb to a dangerous level. If the lamb survives the first few days, it has a good chance of surviving the summer as lamb mortality is low over that period.

Winter is the time of year when mortality for all sheep is the highest. Winter is especially hard on lambs that were born the spring before. This is due to the fact that lambs have a high surface area to body mass ratio and thus are not as efficent as adults in maintaining body heat. Also, since most of their energy intake goes toward growth, they have smaller fat reserves to utilize when forage gets scarce. As the data in Table 2 shows, winter survival of lambs varies greatly from region to region and year to year. Factors that determine the percentage of lambs that survive the first winter are density, weather, and the age of the mothers (Geist 1971: 282-284). Density influences the amount of winter forage that is available for the lambs; the

TABLE 2

LAMBS AND YEARLINGS IN BIGHORN SHEEP HERDS

LOCATION AND DATE	LAMBS PER 100 EWES	YEARLINGS PER 100 EWES	SOURCE
Waterton, Alberta 1970	34	21	Stelfox 1976
Banff, Alberta 1970	45	22	Stelfox 1976
Jasper, Alberta 1970	36	18	Stelfox 1976
Wild Horse Island, Montana, no date	90	-*	Woodgerd 1964
Panther Creek, Idaho 1974	81	11	Hickey 1974
Morgan Creek, Idaho 1967	8	10	Morgan 1968
Morgan Creek, Idaho 1968	36	8	Morgan 1969
Big Creek, Idaho 1967	10	14	Morgan 1968
Big Creek, Idaho 1971	38	-	Hickey 1972
Big Creek, Idaho 1972	37	5	Hickey 1973
East Fork, Salmon River, Idaho 1967	20	30	Morgan 1968
East Fork, Salmon River, Idaho 1968	21	9	Morgan 1969
Middle Fork, Salmon River, Idaho, no date	75	30	Smith 1954
Middle Fork, Salmon River, Idaho 1949-50	41	24	Hickey 1974
Middle Fork, Salmon River, Idaho 1950-51	70	38	Hickey 1974
Middle Fork, Salmon River, Idaho 1951-52	52	30	Hickey 1974
Middle Fork, Salmon River, Idaho 1967	21	30	Morgan 1968
Middle Fork, Salmon River and Big Creek, Idaho 1968	13	13	Morgan 1969
Middle Fork, Salmon River, Idaho 1971	25	-	Hickey 1972
Middle Fork, Salmon River, Idaho 1972	55	43	Hickey 1973
Middle Fork, Salmon River, Idaho 1973	55	9	Hickey 1974
Middle Fork, Salmon River, Idaho 1974	54	9	Hickey 1974
Middle Fork, Salmon River, Idaho 1975	53	21	Hickey 1976
Middle Fork, Salmon River, Idaho 1976	48	44	Hickey 1976

higher the density of sheep, the smaller the amount of food that is available for a young sheep. The milder the winter weather, the higher the lamb survival rate. Finally, in general, the older the mother, the better care she takes of her young, so they have a better chance of surviving.

Sheep that survive to yearling stage have a high probability of a long life, so this is a good figure to use as the recruitment factor (the number of sheep added to the poulation annually). Adult sheep from a stable population reach a mean age at death of ten years. Ewes become sexually mature at two and a half years of age, but often do not breed until a year or two later, when they achieve full adult size (Bunnell and Olsen 1981: 380). Rams may be sexually mature as early as eighteen months, but usually do not breed until much later because of exclusion by older males.

As an example of how the replacement factor can be used we can look at the Middle Fork of the Salmon River herd of central Idaho. This herd was censused on consecutive years between 1971 and 1976. Over this period, the mean yearling to 100 ewe ratio was 21. If we make the assumptions that the sex ratio was approximately 1 to 1 and that the herd size was approximately 300 then we can determine the effect hunting pressure would have on the herd.

CHAPTER 3

MOUNTAIN SHEEP BIOLOGY: BEHAVIOR

In addition to knowing about their anatomy, the aboriginal inhabitants of the Northern Rocky Mountains had an intimate knowledge of mountain sheep behavior. This knowledge came from locating herds of the sheep during various times of the year and tracking them during the hunt. Mountain sheep behavior was a major influence on the timing and method of the hunt. Specific behaviors made several unique hunting techniques possible. The composition of the kill was also effected by the behavior of the sheep. Anthropologists interested in big game hunting, and big horn sheep in particular, must have a knowledge of mountain sheep to understand the rationale behind a hunt and to interpret the results. The practice of reconstructing the behavior of mountain sheep during prehistoric periods from the behavior of modern populations may have some problems. Modern mountain sheep populations have adapted to severely restricted ranges and competition with introduced species, which may have resulted in behavioral changes. Care must be used, and information should be compared with data from early natural histories.

This chapter looks at various behavioral characteristics of the bighorn sheep. The chapter begins by describing their seasonal round. The various ranges are examined as well as the timing of movements between ranges and how the seasonal round develops for an individual. Next

the structure of the different groups of sheep found through the year is examined. The size of the group and its composition are considered. Then the daily behavior of a group of mountain sheep is reported. This includes the amounts of time spent in various activities and small scale movements. Next the escape patterns of big horn sheep are presented. Mountain sheep are very predictable in their reactions when startled. This figures highly in the selection of hunting methods as will be seen in later chapters. Finally, the reaction of mountain sheep to man is considered. Unlike many species, sheep do not seem to be instinctively afraid of man, and do not always flee immediately when one is spotted. All of these facets of bighorn sheep behavior were understood and exploited by the Indians in their search for food.

SEASONAL ROUND

It is commonly assumed that mountain sheep make two major movements a year; one to the wintering area and one to the summer range. This is actually a half truth, the real situation is much more complicated.

Ewes tend to live in "home range groups" in which a band shares a range and generally moves en mass from range to range. A ewe group may have a winter home range, a spring range, a lambing range, and a summer range. For rams, the concept of a home range group is less useful (Geist 1971: 63).

The yearly migratory cycle of rams can be described

as follows. Sometime in late September, rams appear on their fall, or pre-rut, home ranges. They gather in large bands, stay two to five weeks, then disband and disperse to different rutting grounds, where they remain till the end of December. Thereafter, some rams return to winter on their pre-rut home ranges, other rams move to a distinct midwinter home range, while most young rams and some older ones remain with the females on the rutting area, this being a wintering area for the ewes. When the snow cover grows hard in late winter, from mid-March on, the rams not already on the former fall concentration area begin to return. Almost all of the rams which use the concentration area in the fall return in the spring. After the usually massive spring concentration, rams disperse to their summer ranges, but may also move first to a salt lick and remain there for a few weeks (Geist 1971: 63). Therefore, a ram may have at the most (many rams do not have all of these ranges) six ranges utilized at different times of the year; a pre-rut range, a rutting range, a mid-winter range, a late winter/ spring range, a salt lick range, and a summer range.

There are five major periods in a year when mountain sheep may move a considerable distance: 1) late September, early October - rams and ewes move to wintering area (pre-rut range for the rams); 2) last week in October, first week in November - rams move to rutting grounds; 3) last half of December, first week of January - rams move to winter range from rutting ground; 4) late March, April - rams and ewes

move to late winter/ spring home ranges; 5) late May, June, July - females move to lambing ground, rams move to salt lick, then rams , barren ewes, and juveniles move to summer range (Geist 1971: 63-64).

Whether mountain sheep actually migrate or not is a point of contention among some ethologists. What some workers consider a true migration, others call a seasonal drift or an extension of the winter range during the summer months (Woolf 1968: 49). Some mountain sheep herds move from a well defined winter range to a well defined summer one. The ranges of other herds appear to be spread out, yet remain continuous. Also, the migrations are not always complete. Groups of ewes with lambs often use the winter range through out the summer. Some rams may remain on the windswept alpine tundra through out the winter (Whitfield 1983: 85). Smith (1954: 46) notes that up to a quarter of the population may not migrate. Large portions of the population do not move from one range to another as with the caribou; movements are made by scattered group of a few individuals. It appears that some transplanted herds do not shift ranges at all (Bear). This is probably due to a lack of knowledge about their immediate environment.

Whether it is a true migration or not, mountain sheep typically wander great distances between their seasonal home ranges, but are very predictable in their movements and are most loyal to their home ranges. In southern Alberta, Geist (1971: 79) counted a 77.5% return rate to winter range. Of

all the individuals noted on a range, 77.5% of them would be on the same range the next year. Taking mortality into account this is an 87.1% fidelity rate. Sheldon (1911) says "the sheep cling so tenaciously to their ranges that a destructive enemy like man usually exterminates them before they will leave. If driven off temporarily, most of them will return."

For many sheep, one seasonal home range is only one valley removed from the next, but there are many exceptions. Some sheep have been noted to move as far as 40 miles between ranges. Rams, on their way to their rutting ground, may have to pass several suitable areas to reach it and ignore several groups of females. Rams evidentally do not establish home ranges to serve expediency; rather they appear to inherit them from older rams they happen to follow in their younger years. Once a ram forms the habit of moving at a specific season to a specific locality, he sticks to it.

Young rams desert the maternal "home range group" of females sometime after their second year and join ram bands. Young rams generally follow the largest horned ram in the group (Geist 1971: 112). By following various large rams during the yearly cycle, the young ram establishes an individual pattern of home ranges. When rams mature and become more independent, they are followed by younger rams and passively pass on their habits to them. The seasonal home range pattern of ram appears to be fixed when he

reaches four and a half years of age (Geist 1971: 98).

While rams follow the largest horned ram in the band, females usually follow some older, generally lamb-leading ewe. Ewes usually inherit their home range pattern from the ewe band in which they were born and raised (Geist 1971: 64). However, in the formation of home ranges, there is a critical period between one and two years of age, in which a young ewe may switch to another female band if they meet one, or follow a ram and join the ewes at his next range (Geist 1971: 98).

For home range traditions to exist there must be a continuous association between donors and receivers. Almost all information about the seasonal round is passed on from one generation to the next. There is very little independent exploration among mountain sheep. Wandering two year old rams may stray into areas uninhabitated by sheep. However, they will not return unless they are accompanied by other sheep, no matter how rich the environment. Apparently, a habitate without companions is not a suitable place to live (Geist 1967b: 25).

Weather conditions are usually seen as the events that precipitates the various migrations between ranges. The Tarryall herd of Colorado is the only reported exception (Spencer 1943). These sheep are reported to always migrate at the same time each year regardless of the weather conditions.

Snowfall generally gets the sheep started on their

fall migration. They usually descend very rapidly to the wintering ground. The migration in the spring is usually much more leisurely, following the greening of the plants (Smith 1954: 45-46). Frequently, the sheep would be forced to return rapidly to the wintering area by a spring snow storm (Geist 1971: 70).

Winter range is usually found at low elevations, often near the bottom of river canyons. Bighorns prefer south and southwest facing slopes in steep rocky terrain or ridge tops. The south facing slopes receive more sun and are usually warmer than other aspects. This results in less snow on the ground and easier forage for the sheep. In snow deeper than 18 inches, sheep have difficulty foraging,and when it is over 30 inches forage is impossible.

Riggs (1977: 41) found that 41-60% slopes were utilized the most often; followed in descending order by 21-40%, 61-80%, 0-20%, and 81-100% slopes. Sheep tend to begin the day low on the winter range and gradually work their way up, so by late afternoon, they are generally in the higher elevations of the winter range (Riggs 1977:45). On the winter range most sheep occupy grassland within 100 yards of rocky, escape terrain (Oldemeyer 1966: 70).

Bighorn summer at higher elevations, usually in open, subalpine meadows just below the tree line (Woolf 1968: 70) or on the tundra above tree line (Geist 1971: 16). Similar to the winter range, cliffs or rocky slopes are usually nearby to provide an avenue for escape. Rams tend to summer

at higher elevations than ewes and in more rugged terrain. The typical summer range is two to three square miles in area (Woolf 1968: 58).

GROUP STRUCTURE

Mountain sheep are highly gregarious. Unlike most other ungulates, such as deer or elk, that are solitary most of the year and then for a few weeks form large groups, bighorn normally stay in small herds almost year round. The number in a herd stays fairly constant through out the year, averaging six to twelve animals. As the data in Table 3 shows, the tendency to seek company seems to be a stronger urge in ewes and their young than it is in rams. Rams are more commonly found solitary and ewe bands are consistantly larger than ram bands.

Through out most of the year, these small herds are made up of a single sex. These groups make a distinct effort to remain separate on the range, even though they may be in close proximity (Morgantini and Hudson 1981: 69; Woolf 1968: 52). It is only during the rutting season that rams and ewes intermingle regularly (McCann 1953: 77). The Desert bighorn from Cabez Prieta appear to be an exception to this pattern. According to the table, they are found primarily in mixed groups year round. However, this pattern is caused by the mingling of ram and ewe groups at water holes, where most observations were made during the dry season. Simmons (1969) states that desert bighorn typically

TABLE 3

AVERAGE SIZE OF MOUNTAIN SHEEP BANDS OF VARYING COMPOSITION*

LOCATION	GROUP COMPOSITION	YEAR AVERAGE	MONTH AVERAGE J	F	M	A	M	J	J	A	S	O	N	D	SOURCE
Banff, Alberta	Male		5.2	5.2			8.2	8.2			5.5	5.5			
	Female		9.5	9.5			11.5	11.5			9.0	9.0			Geist 1971
	Mixed												6.6	6.6	
	Male		7	7	6	10	11	8	7	10	7	2	2	3	
	Female		7	10	7	9	8	21	18	15	14	5	3	7	Blood 1969
	Mixed		19	13								8	14	12	
	All Groups	9.3													
	Male	2.8	2.4	2.4	2.4	1.9	1.9	1.9	3.1	2.9	3.1	3.1	3.1	2.4	
Teton Range,	Female	4.9	6.0	6.0	6.0	3.4	3.4	3.4	4.7	5.8	4.8	4.8	4.8	6.0	Whitfield 1983
Wyoming	Mixed	9.4	8.2	8.2	8.2	0	0	0	4.0	10.5	12.4	12.4	12.4	8.2	
	All Groups	4.6	5.4	5.4	5.4	2.6	2.6	2.6	4.1	4.9	5.3	5.3	5.3	5.4	
Yellowstone	Male								5.7	5.7	5.7				
National Park,	Female								8.0	8.0	8.0				Woolf 1968
Wyoming	All Groups								7.4	7.4	7.4				
Yellowstone National Park, Wyoming	All Groups		8.7	8.7	8.7									8.7	Oldemeyer 1966
	Male		1.9	1.9	1.9	1.4	1.0	1.0	1.0	1.0	1.0	1.3	1.9	1.9	
Cabeza Prieta,	Female		2.6	2.9	2.9	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	Hansen 1980
Nevada	Mixed		4.5	4.0	4.0	4.5	5.0	5.0	4.5	4.0	4.0	4.5	5.0	5.0	
Middle Fork of Salmon River, Idaho	All Groups	6.7													Smith 1951

* Several studies gave the group size only by season. In these cases the value given was placed under all months for the season.

"separate into ram and ewe groups shortly before and during the lambing season, and mingling rams and ewes in the late summer and fall for rutting activity."

Table 4 shows that mountain sheep spend most of the year in a large number of small bands. However, during the late fall and early winter, they congregate into a few large groups. For example, the number of different bands observed in the Tetons ranged from 68 in August down to just 10 in December and January. This congregation is due to the sheep's tendency to group during the rut, plus snow cover restricts the area available for grazing so bands are forced into close proximity, making it difficult for the researcher to differentiate them.

The reasons for this type of group composition have been discussed by Geist (1968). He stated that mountain sheep can be ranked by outward appearance from the adult ram to the lamb, and that sheep at the opposite ends of this smooth cline segregate into separate bands: ram bands and "nursery" bands. The sexually mature rams associate with all sheep, though they prefer to interact with rams of equal horn size and with adult ewes. Females and juveniles, however, interact almost exclusively with sheep of equal or smaller horn and body size. Estrous ewes change their regular behavior patterns and associate with adult rams, while anestrous ewes withdraw from interactions with adult rams.

Occassionally groups of mountain sheep much larger

TABLE 4

NUMBER OF EACH TYPE OF GROUP OBSERVED BY MONTH

LOCATION	GROUP COMPOSITION	NUMBER OF BANDS OBSERVED IN A MONTH J	F	M	A	M	J	J	A	S	O	N	D	SOURCE
Banff, Alberta	Male	57	58			79	80			69	69			Geist 1971
	Female	24	24			18	18			16	17			
	Mixed											73	74	
Teton Range, Wyoming	Male	3	3	5	5	5	5	21	25	8	8	8	3	Whitfield 1983
	Female	4	4	6	6	5	5	39	29	7	7	7	4	
	Mixed	3	3	3	0	0	0	3	4	3	3	3	3	

than the averages presented in Table 3 are reported (for example Geist [1973: 28] reports a mixed group of 52 sheep, a male group of 49, and a ewe group of 41; Oldemeyer [1966: 85] saw a group of 38; and Woolf [1968: 55] reports a ewe group of 61). These large groups are probably, in reality, a number of different herds that are occupying the same range and were forced into close proximity.

It is interesting to note that Baille-Grohman (1882: 163) in the 1830s reports that mountain sheep herds average six to ten or twelve animals in size. This value fits very closely with modern averages. This suggests that the numerical abundance of the prehistoric and early historic sheep population resulted, perhaps not so much from larger numbers in each individual band, as from the fact that there were many more bands and that they were more broadly distributed than they are today (McCann 1953: 44).

During the winter months, snow reduces the amount of available range and the various herds are brought into much closer proximity. This is reflected in a greater density. The density of sheep on the wintering area near Banff, Alberta, in early winter, was four to six individuals per square mile (Geist 1971: 31). Along Big Creek in the Salmon River Mountains of Idaho, the density during winter was sheep per square mile of range (Akenson and Akenson). During the summer months this density drops to less than one sheep per square mile.

DAILY BEHAVIOR

Mountain sheep tend to be basically diurnal animals, especially when compared to deer and elk, who are most active near dusk and dawn. During the summer months the sheep alternately feed and bed. They often start feeding before dawn, graze until the middle of the morning, and then bed down until noon. In the afternoon feeding most often occurs right after noon and in the early evening, with a period of rest in between. Grazing usually continues until dusk (Davis 1938: 88). When mountain sheep bed down during the day, they do not seek shade, but, sun themselves in the open. Generally, they spend their time dozing or "chewing their cud" (McCann 1953: 67). There is considerable individual variation within these patterns. While most sheep are bedded down, some individuals may be grazing in the immediate vicinity.

Toward dusk, the herds move to bedgrounds. The bighorn continue feeding after dark (Woolf 1968:61). They do bed down, but are probably up and feeding at intervals through the night. However, their movements are limited to the immediate vicinity of the bedgrounds.

Daytime bedding may occur where ever the herd is at. The only requirement is a good view of the surrounding country side, so they may search for potential preditors. Over night bedding sites are usually more established locations, usually located on top of a ridge or in some cliffs. These sites also have good views. Often the bighorn have scratched shallow depressions to lay in.

During the winter, mountain sheep become totally diurnal, absolutely minimizing nocturnal activities (Geist 1971: 261-262). As food is less abundant, all waking hours are spent feeding or searching for food.

During the warmer months, most weather does not seem to effect the feeding/bedding behavior (Smith 1951: 65). Herds have been observed in storms with 30 mile-per-hour winds and sleet, following their normal foraging behavior.

Each local herd appears to have a number of regular feeding routes, each terminating at a familiar bedground. The sheep travel these routes with great regularity throughout the seasons (Allen 1939:254).

The data in Table 5 shows some variability in the distance a herd of sheep travel in a day. Average daily movement (ADM) is a figure that attempts to measure how far a individual or herd will move in a day. ADM is determined by establishing a study unit, be it a herd or individual, and plotting its location on a daily basis. Then the distance between the plots is measured and averaged. A great deal of the variability seen in Table 5 is probably due to differences in study technique and frequency of observation. When ADM is viewed in an intra-study context some regularities arise; specificly, sheep travel less than the other ungulates studied. Simmons (1961) was the only study that set out to examine daily activities and movements (The other figures are based observations made while studying other aspects of mountain sheep behavior), so his figure of

daily movement will be accepted as the best estimation of

TABLE 3

AVERAGE DAILY MOVEMENT

Species	Location	Average Daily Movement	Source
Mountain Sheep	1	.75 miles	Davis 1938
Mountain Sheep	1	.25-.5 miles	Woolf 1968
Mountain Sheep	1	.25-.5 miles	Woolf and others 1970
Mountain Sheep	2	.473 miles	Simmons 1961
Mountain Sheep	1	.06 miles	Skinner
Buffalo	1	.125 miles	Skinner
Antelope	1	.125 miles	Skinner
Mule Deer	1	.125 miles	Skinner
Elk	1	.5 miles	Rush
Elk	3	.5 miles	Rush

* 1 = Yellowstone, Wyoming
  2 = Poudre River, Colorado
  3 = Sun River, Montana

how far a herd of sheep moves over a 24 hour period. Skinner's ( ) estimates of ADM for all species seem to be much lower than the figures from other studies. However, if the figures for the various species within the study are examined, then they are consistant with the other studies, mountain sheep are less mobile than the other big game species studied.

Simmons (1961: 55) notes that the herds that he observed near the Poudre River in Colorado had an average pace of 164 yards per hour. Half the time the sheep moved at a slow walk and one quarter of the time they were at a

fat walk. The remaining quarter was split between running and meandering, with 20% spent at a meander and 5% at a run. Most of the time the groups of sheep meandered while feeding and then walked short linear distances to a new feeding locality (Simmons 1961: 67).

ESCAPE BEHAVIOR

Through millenia of interaction with preditors and natural selection, mountain sheep have developed successful behavior patterns for the avoidance of preditors. This adaption involves grazing and bedding near escape terrain, either cliffs or steep rocky slopes (Oldermeyer 1966: 70); a tendency to bunch up when startled or paniced (Smith 1954: 49, Woolf 1968: 61);and a quick flight into cliffs or rocky areas for protection (McCann 1953: 66).

As a result of this adaption, bighorn can not only negotiate rugged cliff terrain, but also have the ability to climb ordinary steep slopes with greater facility than their pursuers. However, on the flat, mountain sheep are not particularly fleet animals. According to Grinnell (1928), mountain sheep are readily overtaken on horseback in open country. This can not be readily done in the case of deer or antelope. Those that have hunted sheep with dogs say that sheep are rather easily caught by dogs in open country, where speed and endurance would be the only attributes involved. Bighorn seem to be capable of short bursts of speed, but sustained flight at high speed does not appear to

be part of their physical qualities. Desert bighorn have been clocked at 30 miles per hour over a short distance (Cottam and Williams 1943).

Perhaps because of their lack of speed, mountain sheep tend to react very quickly to a threat. "There never seems to be any confusion on the approach of danger. Their flight is always immediate and direct. The closest cliffy ledges are invariably the objective" (McCann 1953: 62-63). Geist (1971: 100) suggests a general rule applicable to sheep when they are startled - run first, look later.

Mountain sheep are particularly frightened by odd or uncommon actions by their own herd members. Commonly, it is not the rifle report that frightens the sheep as much as the sight of a rolling, kicking companion in its death throes (Geist 1971: 44).

When bighorn sheep reach ledges and cliffs in their escape terrain, they seem to assume they are safe and frequently stop to examine the danger. In the upper Yukon, Sheldon (1911) found that even after several members of a band of Dall sheep had been shot, the rest of the of the sheep would stop and look at him, at times long enough to photograph.

The direction in which mountain sheep will flee when startled is usually quite predictable. Whenever they are startled, sheep will flee uphill, a majority of the time they will flee toward the tallest, most prominent cliffs in the area. One of the early sheep hunters at Estes Park,

Colorado recognized the predictability of mountain sheep escape behavior. He stated that "Sheep Rock was the cause of the mountain sheep being exterminated in the Park. When we saw a flock of sheep within a mile or two of Sheep Rock, we had a trained dog we set on them and they would strike straight for Sheep Rock, then we would get the whole flock" (Packard 1942: 12).

The escape strategy utilized by sheep is very successful against natural preditors. The major sheep preditor appears to be the wolf, but they take mountain sheep only infrequently. Coyotes, grizzlies, wolverines, and lynx may take an occassional sick or incapacitated sheep, while the mountain lion may take a healthy one now and then. These carnivores appear to play only a very minor role in mountain sheep mortality (Geist 1971: 14). Bighorn's strategy for avoiding preditors is less successful when confronted with human preditors (Leonhardy and Kohler 1985, Campbell 1974). This lack of success can probably be attributed to the human abilities to coordinate group efforts, predict the behavior of the prey, and kill while at a considerable distance from the prey.

REACTION TO MAN

Unlike deer, mountain sheep do not appear to have an instinctual fear of man. Smith (1954: 50) and Couey (1950: 33) report that sheep are one of the most easily approached big game species. The mountain sheep herd at Banff even learned to follow Valerius Geist (1971:) after he gave

them food. Activity by backpackers in sheep range did not disturb daily movements, feeding patterns, or use of the range (Hicks and Elder 1979).

However, when hunting is introduced, the reaction of mountain sheep to man may be totally different. Woolf (1968: 69) noted that the sheep's tolerance of human activities in his study area was unpredictable. In Colorado, ewes and young animals tended to be rather tolerant. Some of the rams however, were extremely apprehensive and would take off at a run the moment they saw anyone (McCann 1953: 60).

Mountain sheep may be "some of the finest learning machines on four legs" (Geist 1975: 81). Thus they can be expected to learn very rapidly to avoid human contact if they are hunted. Rams, in populations that are hunted today, avoid open meadows where the best graze is found and remain in or near cliffy escape terrain (Geist 1975). They also learn to avoid humans, running long distances when one is spotted (Whitfield 1983: 145).

It is unknown what kind of effect aboriginal, non-trophy, both sex, hunting would have on sheep behavior. Many early explorers found the bighorn unafraid and often curious ( ). Grinnell (1928: 3) reported that the Indians found the mountain sheep "unsuspicious" and more easily secured than any other of the large game animals. It may have been with the larger sheep populations, wider range, and more bands, hunting pressure was very light or

infrequent and thus had very little effect on sheep behavior.

CHAPTER 4

MOUNTAIN SHEEP AND MAN: ETHNOGRAPHY

Humans have been interacting with mountain sheep in the western United States for thousands of years. The types of interaction were numerous and complex. A partial listing of the types of interactions between Native Americans and mountain sheep would include hunting, butchering, and the inclusion of mountain sheep figures in ceremonies and rituals.

This chapter attempts to look at these interactions between people and mountain sheep as they are portrayed in ethnographic and historic accounts. The chapter begins with a brief consideration of some of the theoretical considerations of trying to apply ethnographic concepts of hunting to archeological situations. Next there is a description of ethnographic sheep hunting techniques from western North America. Then these hunting techniques are summarized. Common, everyday, subsistence activities like butchering rarely get discussed in ethnographies, so the section on the butchering is rather short. Finally, Native Americans incorporated salient parts of their environment into their religion and rituals. The use of mountain sheep in ceremonies is discussed in the last portion of this chapter. It should be noted that because of the paucity of ethnographic and historical data from the Northern Rocky Mountains, many of the examples in this chapter come from other regions of western North America. The Great Basin, in particular, provides a number of examples. The behavior of

the Desert Bighorn from the Basin is at times radically different from the behaviors presented in Chapter 3. Thus, a number of the techniques (both practical and religious) utilized in the Great Basin may not be applicable on mountain sheep from the Northern Rocky Mountains, so it is likely that not all of the techniques and ceremonies presented in this chapter were utilized in the Northern Rockies.

HUNTING

The actual interface between human and mountain sheep behavior occurs when human beings hunt mountain sheep. The actual hunting technique used follows choices made by the hunters. These choices depend on a knowledge of previously used techniques; the availability of the technology; the size of the human group and its intended use of the kill; bighorn group size, composition, and behavior; and the geography and weather at the time and place of the hunt (Spiess 1979: 103).

Archaeological recovery of mountain sheep kill sites is rare, so archaeological investigation of the human adaptions involved in mountain sheep hunting must be based on the recovery of associated settlement patterns - structure, size and form; material culture; floral and faunal species other than mountain sheep; as well as mountain sheep numbers, age and sex - plus some inferences on the length of the stay and the size of the human group involved. A kill of 25 sheep in a two day period represents a different adaptation than the

kill of 25 sheep over a three month season. Also, mountain sheep herds vary in composition and behavior with geography and season (Chapter 3). Thus, some hints of the hunting adaption in the archaeological context can be had by comparing environmental data, and the size and composition of the kill, with generalizations from the ethnographic record.

The following discussion will summarize ethnographic descriptions of human - mountain sheep hunting adaptions. The quality of these descriptions varies, but more often than not, the detailed data necessary for archaeological comparability are scanty. The ethnographic descriptions are presented by geographical culture regions. The end of this section contains generalizations that can be made from the ethnographic data.

Survey of Hunting Techniques

Northern Rocky Mountains

Many of the aboriginal groups that inhabited the Northern Rocky Mountains utilized mountain sheep. Their techniques ranged from stalking single animals to mass drives.

Irving (1843: 169) gives an early description of Lemhi Shoshone mountain sheep hunting. "...[L]arge flocks of the ahsahta or bighorn, the mountain sheep were to be seen bounding among the precipices. These simple animals were easily circumvented and destroyed. A few hunters may

surround a flock and kill as many as they please." Lowie (1909: 185) adds that the Lemhi also occassionally stalk the sheep disguised in a mountain sheep skin. However, the customary way was to pursue them with dogs, until the sheep were driven to a high rock where they could be easily shot.

Among the Tekudika of Central Idaho, the preferred method of hunting mountain sheep was for a party of hunters, along with their dogs, to drive the sheep toward favorite jumping off ledges or inclines.

> Mountain sheep [are] best hunted by a group of men usually three in number. They moved on until they got near. When the dog "feels it" he will run before and chase the sheep to a rock or a side of the canyon. The sheep will stay there. The mountain sheep when coming up there, will jump down the cliff and kill themselves or the dog will kill them. A stick with poison was placed at a place where the sheep was expected to jump down from a higher point. Such a stick was of "the grey willow" which is harder than the common willow. There was grass tied on to the stick so that it looked like a large grass. It was a little longer than the front legs of the animal for giving a chance to hit it. The poison sticks were put at places where the sheep usually had their way and where they had to jump. Often there was a stick placed on each side of an obstacle, always in an angle so that the stick pointed in the direction from where the animal had to jump off. These sticks were about as thick as an ordinary arrow shaft. They could easily break. There was a poisoned black stone point fixed to it like an arrowhead [Liljeblad field notes, quoted in Miller 1972: 80).

In jumping, the sheep would "impale" themselves on the shafts and, sickened by the poison, could be driven and encircled by the hunters and their dogs, who took advantage of their weakness and confusion. Often the poison would take days to effectively slow the sheep and necessitated a

long track by the men and dogs.

The Tekudika would also use the dogs to drive the sheep past concealed hunters. One informant claimed his father had a dog that drove sheep in a circle around him (Dominik 1964: 153). The dogs would occassionally be used to kill the mountain sheep themselves or to force them off cliffs (Lowie 1909).

Another method was to attract the sheep during the rutting season by knocking two logs together in imitation of the impact of the ram's horns during a challenge fight (Miller 1972: 81). The Tekudika would also kill sheep with the bow from behind circular roofless brush enclosures built near frequent watering places (Lowie 1909). The use of poison tipped arrows by northern Shoshone (including the Tekudika) was documented by Lowie (1924).

Occassionally, herds of sheep were driven into brush corrals in narrow canyons, or stone corrals across high altitude ridge trails. Inside the corral, they were forced to circle until exhausted and then dispatched with clubs, thrusting spears, or arrows (Miller 1972: 82).

The Okanagon conducted communial mountain sheep hunts during the winter, in the Ashnola district of northeastern Washington. The best hunters were stationed in depressions in the talus at the top of the slope. The remaining men along with the women and children of the tribe then located a herd of sheep and drove them upward. Dogs were often used to keep the mountain sheep moving and bunched together. As

the bighorn ran by the concealed hunters, they would shoot at them with bows and arrows (Teit 1930: 244). The Okanagon and Similkameen hunted mountain sheep year round, but had a preference for gender by season. "In the winter sheep hunt, mostly ewes were killed and rams were let go. The later were hunted on their summering grounds, when fat, by small parties in the late summer or early fall" (Teit 1930: 243).

The Flathead of western Montana, only hunted mountain sheep in the fall, not starting until late August. The hunting was mainly individual, mostly stalking with very few organized drives. The only collective hunting method utilized by the Flathead was to station hunters in appropriate areas and drive the animals past them. Apparently, they did not use corrals or surrounds. (Turney-High 1937: 112-113).

The Blackfeet of Montana also usually hunted sheep by stalking involving single hunters. Occassionally, mountain sheep were driven into natural defiles where hunters were waiting in ambush (Ewers 1958: 84).

Great Basin

Mountain sheep were a common prey of the hunters from Great Basin bands. The hunting methods varied from a single hunter stalking a herd of sheep to communial drives of herds of sheep into stone or brush corrals. From the ethnographic sources it appears that the Great Basin groups placed more emphasis on communial methods, though it may be that the ethnographies on Great Basin tribes were conducted at

earlier dates, so more rememberances of the communial hunts remained. Studies of the various groups of Paiute contain the best examples of mountain sheep hunting, but it is assumed that the other Basin Shoshone groups utilized similar methods.

Gilmore (1953: 149) describes a drive by the Northern Paiutes in Nevada. He states the prey is goats, but the technique seems to be much more appropriate for mountain sheep (also mountain goats are not found that far south).

> The Medicine Man announced that a goat [sheep?] drive was to be held, setting aside a day ahead for the drive in order for his followers to be prepared. A dance was held the day preceeding the drive and continued all night until near the break of day when a big feast took place. The drive started at day break. Most people spread out over a wide area, closing in gradually as they moved toward the corral with its long, quarter mile wings which served as a chute. After driving the goats [sheep?] into the chute, which became narrower as the corral was approached, it was a simple matter to force them into the enclosure. The Medicine Man stood at the gate and selected which animals were to be killed. Not all animals were killed, some were released to produce young for years to come. The animals were dressed at the corral, the meat being wrapped up in hides to be transported home.

Single animals were also taken by the Northern Paiute. Individual hunters often used disguises and decoys. Gilmore (1953: 150) noted that noises often provide an important part of the disguise.

Among the Southern Paiute of the Kaibob plateau (Lowie 1924, Kelly 1964) mountain sheep were hunted year round. Hunting in parties, the men commonly flushed the animals towards hunters waiting in ambush along the trails. When hunting alone, the Kaiparowits Paiute would stalk the sheep

while imitating their call. When hunting in groups, the methods used running the animals into a cleft in the rocks or out onto a ledge where fire was used to cut off their escape; occassionally, they would be deliberately driven over a precipice. Wetherill (1954) describes a wing trap corral, on Skeleton Mesa, built by the Southern Paiute in 1890, where the last herd of mountain sheep in the area was trapped and killed.

The Death Valley Paiute built blinds along the bighorn's ridgetop runways. The blinds were usually semicircular walls of stone. "When all preparations were complete, [the Indians] posted their best marksmen in the blinds while the others chased the sheep up to the slaughter" (Spears 1892: 73).

The Paiute hunted for mountain sheep in the Sierra Nevada Mountains of California in every season. John Muir (1894: 320-321) stated they would often drive the sheep uphill into an ambush. In addition,

> on some particular spot, favorably situated with reference to the well-known trails of the sheep, they built a high walled corral, with long guiding wings diverging from the gateway and into this inclosure they sometimes succeeded in driving the noble game. Great numbers of Indians were required,...they were compelled to build rows of dummy hunters out of stone along the ridgetops which they wished to prevent the sheep from crossing (Muir 1894: 321-322).

Among the Owens Valley Paiute, Forde (1934: 38) states that mountain sheep and deer, although sometimes driven into pounds or rounded up by burning grass, were more usually

hunted by individuals and small parties in the higher ranges. In addition, the Owens Valley Paiute also utilized the often cited, drive uphill into ambush from "hiding places of piled stone."

Southwest

Most of the tribes of the southwestern United States occassionally hunted mountain sheep. Many of these tribes practiced agriculture, which lead to decreased emphasis on hunting. A majority of the tribes only practiced individual stalking.

The Apache and Zuni would ambush the mountain sheep at their mountain watering holes. The only tribe that seems to have practiced communial hunting methods was the Hopi (Tyler 1975: 120). These hunts were led by the "Cougar Man" and involved trapping the game in pits.

> Pits for game can still be seen in a narrow trail on a promontory east of Bland above Canado de Cochiti. The pits were located where the mesa top reduced to a narrow trail, with very high and steep walls on either side. Traps in the trail were covered with grass matting and dust and hunters drove the deer and sheep onto the mesa and into the pits (Tylor 1975: 121).

These animals were then shot with arrows or choked to death.

Human Hunting Techniques

The previous sections have presented accounts of various techniques of hunting mountain sheep. Some of these methods are quite unique; such as attracting rams by banging logs together, or driving the sheep into pits and choking them to death. However, the number of parallels in the use of similar techniques under similar circumstances is even

more remarkable. The technique of driving mountain sheep uphill past concealed hunters is particularly widespread. The use of stone or brush corrals and, on a smaller scale, the use of dogs to drive sheep and disguises in stalking sheep are also common.

This diversity of hunting techniques: wing corrals, human surrounds, drives into ambush, drives onto isolated ledges or over precipices, stalking, and decoying, can be roughly divided into two groups. Corrals, human surrounds, and ambushes are for mass killing, they attempt to take all or a large portion of a band of mountain sheep. The other techniques take individuals or very small numbers. Mass killing techniques vary in scope and efficency from an impromptu human surround to a corral constructed with four foot tall stone walls and quarter mile long guiding walls. In general, the choice to attempt mass killing techniques is made with a) a reasonable expectation or knowledge of the availability of moderate or large bands of mountain sheep; b) a high percentage dependence on mountain sheep compared with other species for the season in question; and c) the availability of a moderate sized human group (10-25 people) to operate the mass killing technique and the necessity to provide meat or skins for that many people (Spiess 1979: 135).

Thus, the larger and more "efficent" mass killing techniques were used in areas of high mountain sheep population density or along migration paths where bands

would be more predictably encountered. Mass killing techniques would not be expected or would be at the small end of the range in areas with very diverse faunas and more scattered mountain sheep populations.

These mass killing techniques would tend to focus on the larger population aggregations such as ram herds before the rut and ewe herds during the winter. However, small scale drives would be possible almost year round due to the aggregation habits of the sheep. These methods are often nonselective on the basis of age or sex from the attacked band (though the sheep herd is usually selective from the whole or "natural population") and would take from two or three to twenty-five individuals at a time.

Any of the individual killing techniques can be used by a solitary hunter from a band that uses mass killing techniques, but in general, they will be used a greater percentage of the time by hunters from bands to small, at least seasonally, to efficently utilize the mass killing techniques or groups only incidentally using mountain sheep (Spiess 1979: 136). Stalking, running down with dogs, and decoying cover a myriad of techniques, which are not limited by seasonality or human group size. Of course, the detection of the use of these techniques may be swamped in the archeological record by the remains from mass killing techniques. Stalking, running down and decoying can be selective for age and sex. Most often, they will take only one or two individuals at a time.

Composition of the kill

As noted previously, mass killing techniques, such as the corral, are often nonselective for age and sex from the attacked group. As sheep tend to form characteristic herds, each type of band taken should produce distinct remains.

If ram bands are hunted, more than 90% of the animals killed will be males of more than 36 months of age. Mixed bands will yield approximately equal numbers of rams and ewes, with a smaller percentage of lambs and yearlings. The mixed bands are only available during and right after the rut. Ewe bands should yield almost all females, with some lambs and a few young rams (Wright and Miller 1976: 297). However, these results may be distorted by individual hunting techniques, which can be selective for age and sex. Similarly, the patterns from individual techniques can be swamped by remains from mass killing techniques. In addition, the occupation of a site through several drives may mix the remains of several bands and obscure any patterns.

BUTCHERING

Unlike hunting, where there are numerous ethnographic examples of technique from all over the west, common everyday activities like butchering of a kill do not receive much attention by ethnographers. Only two ethnographic examples of the butchering of a mountain sheep have been reported. One of these examples comes from the Northern Rocky

Mountains, while the other is from the Great Basin.

The Northern Rocky example is taken from Sven Liljeblad's field notes (cited in Miller 1972: 47). His informant was A.J., whose father was Bannock and mother Shoeshone. He was born around 1860 in central Idaho and lived among the Tekudika.

> They used to go three together. They divided the animal right on the place [where it was killed]. The man who kills the sheep will have the hide and the rump. The hide must always go to the killer. They used to cut the two hind legs off at the joints. Of the insides, the killer will have the main part, most of it, the guts. The other two [hunters] will divid the fat, the fine fat that goes over and around the guts. The head was thrown away. One of them will have one front arm and one side of the ribs. He will also have one of the hind legs. The third man in the party will have the same as this one. But the killer will have the hide and the backbone which was cut separately in one piece, and he will have both hips with the rump.

It is interesting that A.J. states that head was thrown away while it has been noted that the brains were used for tanning hides and the horns had many uses (Chapter 2). It may be due to the fact that by the time A.J. had learned how a sheep should be butchered, European trade goods had taken the place of many traditional items, so the brain and horns were no longer needed.

Kelly (1964) gives a brief account of the butchering of mountain sheep among the Paiute. The method varied with the distance necessary to transport the carcass to camp. At the kill, the meat and hide was divided between the participants, if the hunt was a cooperative effort. When

the hunter was alone and the animal was too heavy or, if he managed to kill more than one individual, the sheep were quartered and part of the meat was cached in a tree to be retrieved later. Whenever possible, the entire animal was carried back to camp. Among the Paiute, the head was saved and baked in an earthoven overnight. Fat meat and rib meat were preferred and eaten immediately; all meat was either boiled, roasted, or baked or stripped and air dried. Entrails and internal organs were roasted or boiled. Knee and ankle joints were sometimes pounded into a pemmican-like mass, boiled and eaten. Marrow was always recovered and brains were saved for hide tanning.

These two accounts have a number of similarities including division of meat at the kill site and utilization of the entrails. The major difference is in the retention and consumption of the head by the Paiute. It can not be determined if the similarities are caused by cultural relationships or if they are a case of covergent development to fit similar needs.

CEREMONY

The large scale hunting of big game is usually associated with a great deal of ceremony and ritual to aid the hunters and placate the spirts of the hunted ( ). Unfortunately, much of the ceremonies associated with the hunting of bighorn sheep has disappeared since sheep became too rare to hunt regularly. Once again because of a lack of ethnographic data from the Northern Rockies, other

portions of the western United States provide some of the examples presented here.

The primary figure in a communial hunt was the game shaman. He organized the hunt, selected the location, and directed the participants. In addition, the game shaman was thought to have supernatural control over the animals so he could direct them to the kill site. The shaman also lead prayers, so the game would be willing to be killed and that its spirit would return again and again in game form. For example, when the Okanogan of eastern Washington conducted mountain sheep drives, as the hunters neared the place where they were going to drive, the hunting shaman took off his hat made of the skin of a ewe's head, and, waving it towards the cliffs where the sheep were, prayed to them as follows: "Please sheep, go your usual way, and follow each other,so that we may eat your flesh and thus increase or lengthen our breath (life)! Pity us and be driven easily to the place where we shall shoot you" (Teit 1930: 243-244).

Prior to these prayers there was probably a great deal of religious ceremony. Gilmore (1953) notes that a dance was held the day before the drive that continued almost all night. Near daybreak of the day of the drive a big feast was held. These ceremonies were probably used to ritually purify the participants in the hunt and to appease the spirits of the animals that were being hunted so they would return again in animal form.

Because of the large number of mountain sheep motifs in

the rock art of the Indians of the western United States and the importance of mountain sheep in the diet of many groups in that area, Grant (1980) suggests that a Bighorn hunting cult may have developed over much of this area. Many Indian tribes hold certain creatures in special reverence. In the Northwest, the salmon was believed to be immortal, ascending the streams to provide food for the people and returning to life the following year to be harvested again (Clark 1953). In other areas, similar beliefs were held for buffalo and deer (Powers 1975). These important animal dieties had to be continually honored and good relations maintained with them, lest they disappear or diminish in numbers. The shamans communicated with these supernatural animal beings through recitations, trances, and ceremonial dances. There is evidence that supports the idea that the mountain sheep became a venerated animal diety in parts of the Great Basin and Rocky Mountains (Grant 1980: 25) and rituals were developed in its honor to insure its continued abundance. Apparently, an important part of this hunting magic was the drawing of sheep motifs near the hunting location.

In some portions of the west, mountain sheep also appeared in ceremonies not directly associated with their hunting or continued abundance. There is evidence from southwestern Arizona and northwestern Sonora that the bones and horns of the bighorn were utilized ritually by the Piman Sand Papagos. These Indians were centered near Sonoyta, but ranged widely to the Gulf of California. In 1774 Juan

Bautista de Anza traveled across their territory. On 1 February, he reached the Cabeza Prieta Tanks (watering hole) and recorded in his diary:

> These horns the Indians are careful not to waste. Indeed, whenever they kill the sheep they carry the horns to the neighborhood of the water holes, where they go piling them up to prevent the Air from leaving the place. Those who, like ourselves, do not practice or do not know of this superstition, they warn not to take one from its place, because that element would come out to molest everybody and cause them to experience greater troubles [Bolton 1930].

Fontana (1962) reports that at the Cabeza Prieta Tanks there were piles of sheep horns, the remains of which were still visible in 1970 (Grant 1980: 30). Horns have also been seen near Heart Tank in the Sierra Pinta to the east. At Papago Tanks in the lava fields of Sierra Pinacate, Julian Hayden observed horn piles similar to those seen by De Anza (Grant 1980: 30). Historically, Mange (1926: 253) reported a pile of more than 100,000 horns at an aboriginal village near present day Florence, Arizona in 1697.

In a similar custom, the Pueblo Indians brought the bones of butchered mountain sheep back to the village with them. The bones were painted red with ochre and placed in a special shrine (Tylor 1975: 122).

In addition, the Hopi had a mountain sheep kachina, called Panwu or Pang. Two different versions of the mountain sheep kachina appear. The heads of the two kachina are identical, the mask being surmounted with two imitation ram's horns in black with a green zigzag lightning mark

along their sides. The head is black with squash blossoms for ears. There is a protuberant visor from which hang turkey tail feathers. The short snout has teeth painted on. One version is dressed in a buckskin shirt with a white kilt striped with red and black. The second version of Pang is completely naked and seems to be a phallic sprite, derived from the ram's promiscuous nature. His back and limbs are painted blue or green, while his ventral side is painted white. Both versions have a semicircular framework with attached feathers that they carry on their back (Fewkes 1903: 102, Washburn 1980: 146). According to Colton (1949), these sheep kachinas appear in bands during ordinary kachina dances, where they have power over rain - being associated with the mountains - and spasms - as they often appear to convulse after collisions during the rut. The Acoma Indians were, at one time, reported to also have a bighorn kachina named Kac-ko.

At one time there was a mountain sheep clan, now extinct, among the Hopi from First Mesa (Tyler 1975: 123). The mountain sheep motif is also present in the Hopi Flute Ceremony, where it appears as a hero.

At Zuni Pueblo, the clowns are called Halliliku, which is also the Zuni name for mountain sheep. They preform while climbing from house to house, impersonating sheep (Tyler 1975: 127).

The Navaho Yei, Ganaskidi, the Humpback God, has many characteristics of the mountain sheep (Reichard 1950: 23).

Ganaskidi is very similar to the Hopi Kachina Pang, in that he has horns growing from his head and a hump on his back (the hump is a feathered bag bearing seeds of all vegetation). If the Humpback God is not actually the mountain sheep, "he at least has supernatural control over it" (Reichard 1950: 23).

The mountain sheep also play a major role in Navaho mythology and ritual. In the Night Chant, a healing ceremony, the bighorn are sent by Ganaskidi to provide food for the stricken heros, the twins (Reichard 1950: 443).

The interactions between humans and mountain sheep are numerous and varied. Sheep provided a major meat source for a number of groups in the western United States. The sheep were hunted in many ways, ranging from stalking individuals to complex drives, that attempted to take whole herds of sheep. Small scale, individual, hunting techniques were found in almost all groups, but were most common in groups not specializing in hunting sheep, or too small to utilize large scale methods. Large scale drives were found only among populations located where there is a high density of sheep or along pathways where sheep can be predictably encountered.

Fewer ethnographic examples of butchering technique are available. Possible cross-cultural similarities are the division of the body at the location of the kill and the use of entrails.

Several rituals are closely associated with the

hunting of mountain sheep. Large scale drives are often proceeded by ritual feasting and dancing. Bighorn also appear as an important figure in the mythology and ceremony of several tribes.

CHAPTER 5

MOUTAIN SHEEP AND MAN: ARCHEOLOGY

Many of the types of interactions between mountain sheep and man that were reported in the previous chapter have great temporal depth. The archeological record shows that humans have been hunting and butchering bighorn for at least 10,000 years. Because of a number of factors, including cultural and natural phenomena, archeological remains often do not reveal a clear a picture of cultural activities as ethnographic reports, but a study of archeological sites can add information to these reports and even turn up cultural activities that have not been reported ethnographically.

Faunal Remains

Over one hundred archeological sites have yielded evidence of prehistoric mountain sheep (Fig. 4, Table 6). Numerous isolated or unprovenienced finds and bone artifacts (Heizer 1951) have not been tabulated. Much of the most recent archeological work has been reported in contract reports which have limited distributions and are often difficult to procure. Many of the earlier site reports (pre-1970) merely gave a list of the species represented in the faunal remains from the site. Recently, faunal remains have received more detailed reporting, including body elements recovered and number of elements per stratia. However, it is still not uncommon for the faunal remains to be totally ignored or written off by a single paragraph.

Figure 4 Distribution of sites containing mountain sheep remains

TABLE 6
MOUNTAIN SHEEP REMAINS FOUND IN ARCHEOLOGICAL SITES
IN THE WESTERN UNITED STATES

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	NISP	COMMENTS
		GREAT BASIN			
1	Catlow Cave No. 1 (Cressman 1942)	Site AD 850-1150	38*	121*	Most Common Species
2	Roaring Spring Cave (Cressman 1942)		Present		Number not given
3	Paisley Five-Mile Point Cave No. 3 (Cressman 1942)	Below Mazama Ash	Present		Number not given
4	Bare Cave (Schultz and Simmons 1973)	Site 2000 BC - AD 1200	Present		"Several Individuals"
5	Surprise Valley Sites (O'Connell and Hayward 1972)		Present		Number not given
6	Karlo Site (Schultz and Simmons 1973)	Site 2000 BC - AD 1900	Present		Number not given
7	Tommy Tucker Cave (Schultz and Simmons 1973)	Site AD 1000 - 1800		11	
8	Chilcoot Rock Shelter (Schultz and Simmons 1973)	Site AD 1400 - 1850		1	
9	Loyalton Rock Shelter (Schultz and Simmons 1973)	Site AD 1000 - 1800	9		
10	Hobo Hot Springs (Elasser 1960)		Present		Number not given
11	Rose Spring (Krantz 1963)	Cottonwood AD 1300 - 1840	2		Most common large mammal, rabbit most common in all layers
		Late Rosespring AD 500 - 1300	1		
		Middle Rosespring 500 BC - AD 500	3		
		Early Rosespring 1500 - 500 BC	1		
12	Stahl Site (Harrington 1957)		Present		Number not given

TABLE 6 (continued)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	SHEEP REMAINS NISP	COMMENTS
13	Little Smokey Site (Thomas 1970)			20*	
14	Smokey Creek Cave (Thomas 1970)			36*	
15	Silent Snake Springs (Thomas 1970)			47*	
16	26-Wa-1502 (Thomas 1970)			7*	
17	Lovelock Cave (Grosscup 1960)				
18	Humbolt Cave (Heizer and Kreiger 1956, Brooks 1956)	Site 100 BC - AD 1500	5*	20*	
19	Wagon Jack Shelter (Heizer and Baumhoff 1961)	Early layers 1150 -750 BC		39*	
		Late layers AD 1350 - 1500		45*	
		Undated		46*	
		Site 1150 BC - AD 1500		130*	
20	Skull Creek North (Pastron 1972)	Site AD 600 - 1800	Present		Infrequent
21	South Fork Shelter (Heizer and others 1968)	Site 2400 BC - AD 600		81*	
22	Bronco Charlie Cave (Casjens 1973)	Site 1500 BC - AD 500			
23	Newark Cave (Fowler 1968)	Level 6 AD 750 - 1400	1		
		Level 4 400 BC - AD 250	1		
24	Deer Creek Cave (Ziegler 1963)	Stratum 2 AD 1100 - 1350		16*	
		Stratum 3 AD 350 - 550		23*	
		Stratum 6 800 - 500 BC		33*	
		Stratum 15 8400 - 7420 BC		9	
		Site 8000 BC - AD 1400		157*	
25	Scott Site (Fowler and others 1973)	Site AD 850 - 1100		4	

TABLE 6 (continued)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	SHEEP REMAINS NISP	COMMENTS
26	O'Malley Shelter (Fowler and others 1973)	Level 5 AD 1000 - 1200	1		
		Level 3 1950 - 1600 BC	1		
		Level 2 2150 - 1800 BC	2		
		Level 1 5350 - 2500 BC	1		
27	Conaway Shelter (Fowler and others 1973)	Level 1 AD 1600 - 1800		6*	
		Level 4 AD 800 - 1000		29	
		Level 5 AD 900 - 1100		26	
		Level 6 200 BC - AD 1		1	
		Level 7 250 - 100BC		2	
28	Warshield Rockshelter (Shutler 1961)	Site AD 500 - 700	Present		Number not given
29	Chuckawalla Cave (Shutler 1961)	Site AD 500 - 1150		1	Horn Fragment
30	Boulder Rockshelter (Shutler 1961)	Site AD 500 - 1150	Present		Number not given
31	Lost City (Shutler 1961)	Site AD 700 - 1100	Present		Number not given
32	Median Village (Dalley 1970)	Site AD 800 - 1200	24		
33	Bonaza Dune (Aikens 1965)	Site AD 1000 - 1200		141	Third behind rabbit and deer
34	Coombs Village (Lister and Lister 1961)	Site AD 1100 - 1275	Present		Second to deer
35	Old Woman Site (Taylor 1957)	Site AD 700 - 1100		16	Most common large mammal, less than rabbit and prairie dog
36	Pharo Village (Marwitt 1968)	Site AD 1100 - 1350		86	
37	Snake Rock Village (Aikens 1967)	Site AD 1075 - 1275		584*	

TABLE 6 (continued)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	SHEEP REMAINS NISP	COMMENTS
38	Nephi Site (Sharrock and Marwitt 1967)	Site AD 600 - 1000		93	Third behind deer and rabbit
39	Spotten Cave (Mock 1971)		Present		Number not given
40	Sandwich Shelter (Marwitt and others 1967)	Level 1 Fremont		15	
		Level 5 5400 - 4800 BC		5	
41	Danger Cave (Jennings 1957)	Level 5 3400 BC - AD 250	Present		Second to antelope; number not given
		Level 4 2100 - 1700 BC	Present		Number not given
		Level 2 8450 - 6650 BC	Present		Number not given
		Level 1 9800 - 7600 BC	Present		Number not given
42	Hogup Cave (Aikens 1970)	Level 14 AD 650 - 1400	3		
		Level 12 1050 BC - AD 500	1		
		Level 8 2750 - 1050 BC	1		
		Level 7 4400 - 4050 BC	1		
		Level 6 4550 - 4350 BC	3		
43	Black Rock Cave (Steward 1937)		Present		Number not given
44	Promontory Point Cave No. 2 (Steward 1937)		Present		Number not given
45	Injun Creek (Aikens 1966)	Site AD 1450 - 1700		37	
46	Bear River No. 2 (Aikens 1967)	Site AD 850 - 1100		7	
47	Bear River No. 1 (Aikens 1966)	Site AD 750 - 1000		5	
48	Rock Creek Shelter (Green 1972)	Site AD 1 - 1700		3	
49	Weston Canyon Rock Shelter (Miller 1972)	Site 6000 BC - AD 1000	300*		
50	Malad Hill (Swanson and Dayley 1968)	Level 5 5400 - 4250 BC	Present		Number not given

TABLE 6 (continued)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	NISP	COMMENTS
51	Sudden Shelter (Lucius and Colville 1980)	Sudden Shelter III 1750 - 550 BC	8		
		Sudden Shelter II 4350 - 1850 BC	7		
		Sudden Shelter I 6450 - 4400 BC	7		
52	Amy's Shelter (Miller 1979)	Site 3000 BC - AD 400	49*		
		Level BIII AD 300 - 500	8*		
		Level B V 1000 - 800 BC	10*		
		Level B VII 1900 - 1700 BC	3*		
		Level B IX 2600 - 2500 BC	1		
53	Kachina Cave (Miller 1979)	Site 3000BC - AD 1800	29*		
54	Smith Creek Cave (Miller 1979)	Mt Moriah 11,000 - 9,000 BC	Most Common		Number not given due to disturbances
		Late Occupation 250 - 100 BC	Most Common		Number not given due to disturbances
55	Council Hall Cave (Bryan 1979)		6*		Cache of horns
56	Death Valley Area (Hunt 1960)			?	"large numbers of sheep bones found at the winter camp sites in the sand dunes"
57	Bull Creek (Jennings and Sammons-Lohse 1981)	Site 1150 - 1250 AD	Present		Number not given
58	Cowboy Cave (Jennings 1980)	Site 10,000 BC - AD 500	10		
		Unit Va AD 400 - 500	1		
		Unit Vc AD 300 - 400	2		
		Unit IVc 1700 - 1600 BC	1		
59	Juke Box Cave (Jennings 1957)	Site 7000 BC - AD 1000	Present		Number not given; second to antelope
60	Gypsum Cave (Harrington 1933)	Recent AD 500 - 1200	Present		Number not given
		? 10,000 - 8,000 BC	Most common*		"greatest number of bones"

TABLE 6 (continued)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	NISP	COMMENTS
		NORTHERN ROCKY MOUTAINS			
61	Hells Canyon Creek Rock Shelter (Pavesic 1971)	Occupation 2 5500 - 4500 BC	2*		Pre-mazama
		Occupation 3 5500 - 4500 BC	3*		Pre-mazama
		Occupation 5 4500 - 1500 BC	1		
		Occupation 6 4500 - 1500 BC	12*		
		Occupation 8 500BC - 1500 AD	16*		
		Occupation 9 AD 1500 - 1800	1		
		Site 5500 BC - 1800 AD	35*	71*	
62	10-CR-60 (Miss and Anderson 1984)		2*	7*	
63	Bighorn Shelter (Ranere 1971)	Site 5200 BC - AD 1650	most common*		Number not given
64	Polly's Place (Ranere 1971)	Site 750 BC - AD 1650	most common*		Number not given
65	Veratic Rock Shelter (Ranere 1971, Swanson 1972)	Site 9000 BC - AD 1850	58	251	Second to Bison
66	Bison Rock Shelter (Ranere 1971, Swanson 1972)	Site 9000 BC - AD 1850	31	81	Second to Bison
67	Jaguar Cave (Sadek-Kooros 1972, Wright and others)	Site 9600 - 2000 BC	+200*		Exact number not given
68	10-VY-31 (Leonhardy and Thomas 1985)				
69	Big Creek Cave (Manion 1982)				
70	Corn Creek (Holmer and Ross)				
71	Taylor Ranch Rock Shelter (Leonhardy and Thomas 1985)				
72	Shoop Rock Shelters (Swanson and				

TABLE 6 (continued)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	NISP	COMMENTS
73	Bernard Creek Rock Shelter (Randolf and Dahlstrom 1977)	Site 7350 - 6700 BC	Present		Numbers not given. Sheep and deer were the predominate meat resource.
74	Chief Joseph Reservior Area (Leeds and others 1971)		7	8	From seven sites in the reservior
75	Myers-Hindman Site (Lahren 1975)	Site 7000 BC - AD 1200	27*		Tied with bison
76	LAURD Area (Roll 1979)		Present		Found at eight sites, less frequent than deer, beaver and elk.
77	Crystalsin Cave (Oliver and Bonnichsen 1981)	AD 1 - 100	6*		
78	Shield Trap (Oliver and Bonnichsen 1981)		Present		Numbers not given
79	Bobcat Shelter (Bonnichsen and Young 1978)		Present		Numbers not given
80	Corwin Springs (Davis 1980a)	Site 3000 - 400 BC	Present		Numbers not given
81	Metzal Site (Davis 1980b)	ca. 6800 BC	Present		Numbers not given
		ca. 3400 BC	Present		Numbers not given
82	Birdshead Cave (Bliss 1950)	Level IV AD 1500 - 1800	Present		Numbers not given
		Level V Historic	Present		Numbers not given
		Level VI Historic	Present		Numbers not given
83	Spring Creek Cave (Frison 1965)	Site AD 1 - 400	Present		Less frequent than bison, antelope, and elk.
84	Wedding of the Waters Cave (Frison 1962)	Level 2 AD 150 - 500	Present		Numbers not given

TABLE 6 (continued)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	NISP	COMMENTS
85	Daugherty Cave (Frison 1968)	Level 1 late prehistoric	Present		Numbers not given
		Level 2 ca. AD 250	3*		Tied with bison
86	Eagle Shelter (Chomko 1982)	Site 7000 BC - AD 1700	Present		Numbers not given
87	Wortham Shelter (Greer 1978)	Site ca. AD 700	1	8	Less frequent than bison, deer, and antelope.
88	Bottleneck Cave (Husted 1969)	Site 4400 BC - AD 50		45	Most common large mammal, rabbit more frequent.
89	Dead Indian Creek Site (Frison 1978)	Site 2450 - 1850 BC	Present		Second to deer
90	Medicine Lodge Creek Site (Frison 1978)	Site 7350 - 6800 BC	Present		Second to deer
91	Deadman Wash Site (Mackey and others 1982)	Site 1050 - 50 BC	2	62	
92	Pine Spring Site (Sharrock 1966)	Occupation 1 8000 - 7500 BC		236*	
		Occupation 2 1750 - 1600 BC		1366*	
		Occupation 3 AD 950 - 1200		754*	
		Site 8000 BC - AD 1200		2426*	
93	Mummy Cave (Harris 1978)	Level 3 ca. AD 734	25*		
		Level 5 ca. 87 BC	2*		
		Level 7 ca. 856 BC	2*		Tied with deer
		Level 9 ca. 2455 BC	17*		
		Level 11	5*		
		Level 12 ca 3290 BC	1		
		Level 13	1		
		Level 15	3*		
		Level 16 ca. 3425 BC	1		
		Level 18 ca. 3660 BC	1		
		Level 19 ca. 3850 BC	1		
		Level 20	1		
		Site 4000 BC - AD 1000	87*		

TABLE 6 (continued)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	SHEEP REMAINS NISP	COMMENTS
94	South Fork of Salmon (Carley				
		SOUTHWEST			
95	Glen Canyon Area (Woodbury 1965)	AD 1000 - 1300		1135*	Remains from fifteen sites in region
96	Grasshopper Ruin (Kelly 1974)			4	
97	Aztec Ruin (Richert 1964)		Present		Numbers not given
98	Cummings Mesa (Ambler and others 1964)		Present		Numbers not given
99	Kin Kletso (Vivian and Mathews 1965)	Site AD 1000 - 1300	Present		Numbers not given
100	Point of Pines Area (Stein 1964)		Present		Numbers not given
101	Broken K Publeo (Hill 1970)		Present		Numbers not given
102	Snaketown (Gladwin and others 1937)	Site 350 BC - AD 1000	Present		Numbers not given
103	Ventana Cave (Haury and others 1950)	Site 6000 - 5000 BC	Present		Numbers not given
		PLATEAU			
104	Knap Coulee (Gunkel 1961)	Orando Subphase I AD 500 - 1400		1	
		Orando Subphase II AD 1400 - 1900		5*	Tied with Marmot
105	Entait Site (Gunkel 1961)	Orando Subphase I AD 500 - 1400		5*	
		Orando Subphase II AD 1400 - 1900		1	

TABLE 6 (concluded)

MAP NO.	SITE	COMPONENT AND DATES	SHEEP REMAINS MNI	NISP	COMMENTS
106	Orando Rock Shelter (Gunkel 1961)	Orando Subphase I AD 500 - 1400		1	
		Orando Subphase II AD 1400 - 1900		1	
107	Riparia (Miss and Cochran 1982)	6000 - 500 BC	1	4	
108	45-CH-57 (Schalk and Mirendorf 1983)	1000 BC - AD 1800	1	2	
109	45-CH-254 (Schalk and Mirendorf 1983)	AD 750 - 950	1	3	
110	45-DO-408 (Schalk and Mirendorf 1983)	AD 450 - 600	4*	57*	
111	45-DO-409 (Schalk and Mirendorf 1983)	1000 BC - AD 1	1	4	
112	45-DO-407 (Schalk and Mirendorf 1983)	Component I AD 500 - 700	3*	20*	
113	Umatilla Site (Schalk 1980)	450 BC - AD 1550		9	
114	Hell's Gate Site (Sappington 1986)	Tucannon & Harder Phases 2000 BC - AD 1		3	
115	Lydle Gulch (Sappington 1981)	Upper Component AD 760 - 1140		1	
116	Red Elk Rockshelter (Sappington 1984)	AD 1665 - 1800		11	

Many reports list bone fragment frequencies or number of identified specimens (NISP), while others report the minimum number of individuals (MNI). Both methods have advantages and drawbacks (Greyson 1983).

Mountain sheep first appear in the human diet between 9,000 and 10,000 BC. Sites with evidence from this early date include Danger Cave, Smith Creek Cave, Jaguar Cave, Veratic Rockshelter and Bison Rockshelter. These sites cluster in the mountainous area at the northern edge of the Great Basin. It appears that the large scale hunting of sheep began in this locality and it retained its importance as a the cluster remains present through time.

In the Great Basin the hunting of sheep appears to be a fairly late phenomena. Eighty percent (out of) of the sites from the Great Basin where sheep is the most common animal fall into the Late Prehistoric (after 1000 BC). This pattern is confirmed by Pippin (1979) who sees an increase in the number of sites containing sheep remains in the late Prehistoric period. He interpretes this pattern as the result of increased utilization of mountain sheep. It appears that from 9,000 to 1,000 BC mountain sheep hunting was only a minor portion of the subsistence round. After 1,000 BC it became much more important.

This pattern does not hold for the Northern Rocky Mountains. Only 50% of the sites or stratia where sheep is the most commmon animal date to the last 3,000 years. The large number of early sites where bighorn is dominate

indicate that in this region mountain sheep hunting has played an important role in the subsistence round since 9,000 BC. The Plateau and Southwest contain too small of a sample of dated sites to make any comparisons, but it appears, just from the number of sites, that mountain sheep hunting was not as important in these regions as it was in the Great Basin and Rocky Mountains.

Even during periods when the hunting of mountain sheep appears to be important, there is considerable variability in the composition of the faunal remains from different sites. For example, at the date AD 1000 in the Great Basin; South Fork Shelter faunal remains contain 30% mountain sheep; Sandwich Shelter has 26% sheep; Deer Creek Cave contains 15% bighorn; and O'Malley Shelter has only 8% mountain sheep (Pippin 1979: 349). Besides the taphonemic processes there are a number of cultural features that may cause these differences. The variation may be due to the fact that the sites were occupied during different portions of the seasonal round, and hunting mountain sheep was a seasonal activity. The sites may have served different functions during the same season: thus a site occupied by a party of sheep hunters contains a high percentage of sheep remains, while a site occupied by a party of gatherers at the very same time would contain very few sheep remains. Finally, the sites may have been occupied by different social groups, some of which utilized a large amount of mountain sheep, while others emphasized other resources.

Many ethnographers describe the hunting of mountain sheep as occassional and haphazard ( ). Archeological data from some regions, favor an interpretation which contrasts with these ethnographic reports. While the hunting of mountain sheep may have been of secondary importance at some prehistoric sites in the Rocky Mountains, others such as Weston Rockshelter and Mummy Cave, obviously reflect activities that are not commonly reported ethnographically. The amount of remains at these sites indicates that at certain locations and times mountain sheep hunting was a major subsistence activity.