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We are submitting herewith a dissertation written by Lynn M. Snyder entitled "Assessing the Role of the Domestic Dog as a Native American Food Resource in the Middle Missouri Subarea AD 1000 - 1840". We have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

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ASSESSING THE ROLE OF THE DOMESTIC DOG AS A NATIVE AMERICAN FOOD RESOURCE IN THE MIDDLE MISSOURI SUBAREA A.D. 1000-1840

A Dissertation

Presented for the

Doctor of Philosophy

Degree

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Lynn M. Snyder

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ABSTRACT

The journals of early European explorers and fur traders, as well as ethnographic records, document the integral part domestic dogs played in the village life and economy of the Plains Villagers in the Middle Missouri Subarea. Early travelers on the plains also remarked on the consumption of dog meat in association with certain rituals and ceremonies, and noted the use of dogs as an emergency food resource.

This study focuses on nearly 7000 large canid skeletal elements from six Plains Village sites in the Middle Missouri Subarea dating from approximately A.D. 1000 to 1840. Two indicators of the continued importance of domestic dogs in Native American economy are explored. They are the use of dogs for traction, and the use of dogs as food.

Osteoarthritic changes to joint structures, particularly those of the shoulder and vertebral column - areas most directly subject to stress during load bearing or pulling, are identified in the canid assemblages. Further evidence of travois pulling is the multiple instances, in at least six Middle Missouri assemblages, of distortion and apparent stress fracturing of the cranial portion of the scapular blade, with at least partial healing and remodeling of the area of fracture. The duel role of these animals in village economy is illustrated by cutmarks indicative of

disarticulation and filleting which appear on many of the affected scapulae.

At least three butchering operations or goals are indictated by cutmarks inflicted on the large canid skeletal materials. These include skinning, disarticulation, and filleting. Observed indicators of changing emphasis through time on dogs as a food resource include 1) a general increase in the frequency of cutmarks on skeletal elements, and 2) increases in the frequency of filleting marks, particularly those on the scapular blade and vertebrae. In the two early sites, cutmarks occur on approximately 15% of all large canid skeletal elements. In three Post Contact Coalescent sites, cutmarks frequencies, particularly filleting marks, increase to approximately 30%. In the Historic assemblage, cutmarks occur on approximately 40% of canid skeletal materials.

Cutmarks on canid bones from earlier Initial Middle Missouri assemblages indicate that dogs were regularly used as food throughout the Plains Village Period. Increases in cutmark frequencies on large canid skeletal remains through time in the Middle Missouri assemblages support a model of more intensive exploitation of large canids as a food resource during the Coalescent and Historic Periods.

During the Coalescent and Historic periods populations of native game animals were reduced or displaced due to the hunting pressures of the fur and hide trade, and traditional

Native American subsistence patterns were disrupted by increased intertribal conflict and repeated waves of epidemic diseases which devastated Native American populations. In these later periods, domestic dogs became increasingly important as a food resource, as evidenced by patterns of greater cutmark frequencies, and increased filleting marks on canid bones.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

CHAPTER I

INTRODUCTION

This study investigates the changing role of the domestic dog as a food resource for the Plains Villagers living in the Middle Missouri subarea, that portion of the Missouri River valley which flows through present day North and South Dakota (Lehmer 1971:28), from the prehistoric Initial Middle Missouri (ca. A.D. 1000) through the fully historic (ca. A.D. 1840) time periods. A number of previous archaeological studies have concentrated on description and taxonomic separation of canid skeletal remains (cf. Allen 1920; Bozell 1988; Haag 1948; Morey 1986; Olsen 1974, 1985; Walker and Frison 1982). There have also been detailed "butchering" studies of large ungulate species (Binford 1981; Davis and Fisher 1990; Lyman 1987; Morlan 1994; Wheat 1979; White 1952b, 1953, 1954, 1955).

A number of studies have considered the use of dogs as food (Parmalee 1965, 1979; Wing 1978, 1984). However, with the exception of two brief studies by T.E. White (1955) on the dog bones from the Buffalo Pasture (39ST6) and Rock Village (32ME15) sites, little specific attention has been focused on archaeological evidence for the use of dogs as a food resource. The present study focuses on the large canid assemblages from a group of Plains Village sites in the

Middle Missouri subarea, and modification of skeletal elements in the form of cutmarks, chopmarks, and burning, which are interpreted as indicators of the use of dogs as food.

The Use of Dogs on the Northern Plains

Throughout the North American Plains, before horses became common in the 19th century, large domestic dogs were the only draught animals used by Native Americans. Most commonly they either drew loads of up to 100 pounds, on a pole and platform travois, or bore smaller loads on their backs. Following the introduction of the horse, and the shift to mounted hunting and travel, the role of dogs in Native American economy inevitably changed. However, even into historic times, village dogs were still used for traction, particularly around the earthlodge villages, where they transported loads of wood and other materials for the village women (Wilson 1924).

During the eighteenth and nineteenth centuries dogs were still an important and highly visible component of the village life and economy of the Arikara, Mandan, and Hidatsa who inhabited the Middle Missouri subarea of present day North and South Dakota. As European and American explorers and fur traders made contact with Native American villagers, they took note of the large numbers of dogs in the villages, their importance as draft animals and, at times, as food

(Snyder 1991). Dog feasts were a traditional part of Native American ceremonies such as the grass dance (Driver and Massey 1957:182, Map 6; Wilson 1924:230). Dog meat was also commonly served as part of pipe smoking or greeting ceremonies (De Smet 1905:212).

However, with the growth of the Euroamerican fur trade in the 19th century, native game animals were dispersed and depleted by the great demands of the fur and hide trade. This was also a time of increased hostilities between Native American groups, which were often competing for dwindling animal resources and trade relations with American and Canadian traders. During this period, ethnohistoric sources indicate a changing role for village dogs. They were increasingly exploited as, if not a staple, a readily available emergency food source (Bradbury 1904:135, 180; Maximilian 1906:90).

Archaeological Evidence for the Use of Dogs as Food in the Middle Missouri

As a result of the massive archaeological salvage program of the River Basin Surveys (RBS) begun following World War II, hundreds of archaeological sites were investigated along the Missouri River in the Middle Missouri subarea of the Northern Plains (Lehmer 1971). Extensive excavations were carried out in Plains Village sites ranging in age from the prehistoric Initial Middle Missouri to the

Post-Contact Coalescent and Historic periods. This study concentrates on the large canid remains from six sites excavated during this program. In chronological order they are the Initial Middle Missouri Sommers site (39ST56); the two component, Initial Middle Missouri and Initial Coalescent Crow Creek site (39BF11); three Post Contact Coalescent sites, Bamble (39CA6), Spiry-Eklo (39WW3), and Larson (39WW2); and the Historic period Leavenworth site (39CO9). All are earthlodge villages located along the mainstem of the Missouri River in what is now South Dakota (Figure 1). They were excavated under the auspices of the RBS Missouri Basin Project by the Smithsonian Institution (Sommers, Larson), the Nebraska State Historical Society (Crow Creek), the University of Wisconsin (Bamble, Spiry-Eklo) and the University of Kansas (Leavenworth). However, because excavations were carried out under the well developed methodological field program of the RBS, field excavation techniques and recovery of faunal materials were largely consistent for all six sites. The size of the large canid assemblages recovered varies from 628 specimens (Leavenworth) to 2613 specimens (Larson); coyote remains (Canis latrans) are not considered in the present study.

The excavation goals and field methodologies of the RBS program were developed as part of a massive archaeological salvage program of unprecedented scale (Jennings 1985; Lehmer 1971). This program was also undertaken at a time,

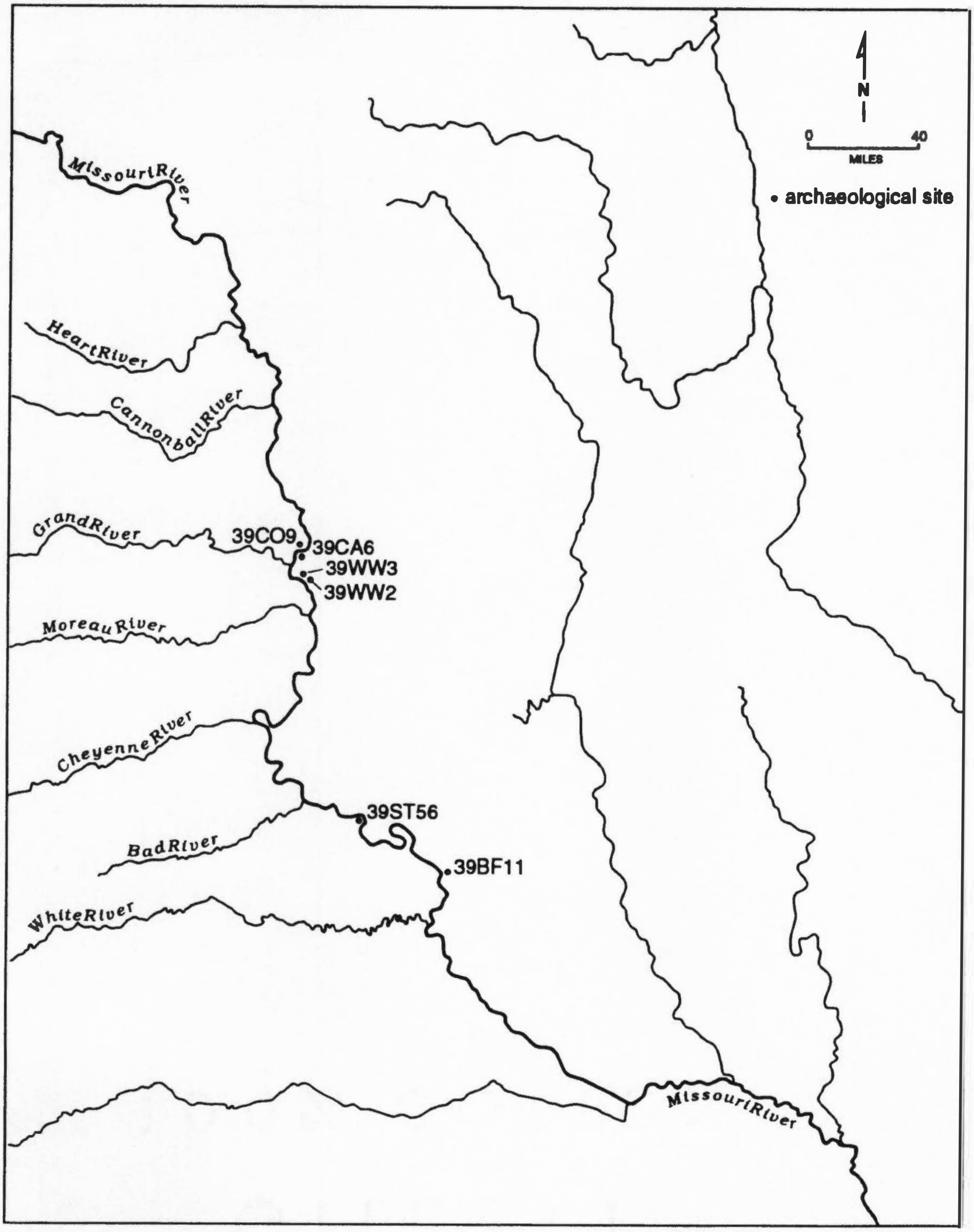


Figure 1. Map of the Middle Missouri Subarea, South Dakota, showing the locations of archaeological sites considered in the present analysis.

beginning in the 1940s and 1950s, when archaeological faunal studies received little serious attention in the North American Plains or elsewhere in the United States (Binford 1981; Falk 1977). It was during this time that Theodore E. White, a Harvard paleontologist who joined the RBS program in 1947, first became interested in the faunal materials being recovered from archaeological excavations. Through his continuing interest and subsequent publications (White 1953, 1954, 1955, 1956), T.E. White was instrumental in formulating the goals and methodology of faunal analysis during this period. White's personal interests in archaeological faunas and the excavation methodology of the RBS program also had a very direct effect on the recovery and retention of archaeological faunal assemblages in the Plains (Falk 1977). The effects of these practices and policies on the potentials and limitations of the canid assemblages considered in this study will therefore be assessed as their analysis is presented.

The focus of this study is analysis of evidence of butchering which occurs in these assemblages of large canid bones. The patterns of cutmark location on individual elements will be considered as evidence of processing of the animal carcass, including skinning or hide removal, dismemberment or disarticulation, and defleshing - filleting or flesh removal. Variation in the frequency of occurrence of marks is considered as a potential indicator of butchering intensity, or the thoroughness with which an animal carcass was utilized or exploited.

Finally, possible variations in the patterned location of cutmarks or cutmark frequencies between sites will be used to investigate possible changes in the intensity with which domestic dogs were exploited as a food source, through time, in the Middle Missouri subarea.

Organization of the Study

This study is presented in eight chapters. Following this Introduction, Chapter II presents the natural environment of the Middle Missouri subarea, a brief culture history, and the traditional subsistence patterns of the Plains Villagers who lived along the Missouri River. It also explores the development of the Euroamerican fur trade, Native American participation in that trade, and the drastic changes in Native American life and subsistence brought about by the European fur trade, introduced epidemic diseases, and increased intertribal competition for rapidly disappearing native territories and resources.

Chapter III considers ethnohistoric, ethnographic and nutritional evidence for the use of dogs as food on the Plains. Chapter IV discusses the history of the River Basin Survey program, and T.E. White's participation in that program, including the effects both had on the recovery and study of archaeological faunal assemblages. Chapter V provides descriptions of the six sites considered, their excavation, and the canid assemblages recovered.

Chapter VI describes the methodology developed for this analysis. Chapter VII presents the analysis of cutmark data, as well as possible skeletal evidence for the use of the dog travois. Chapter VIII discusses the results of the analyses, and concludes with a brief review of the study.

CHAPTER II

THE MIDDLE MISSOURI ENVIRONMENT AND CULTURES

Physiography of the Middle Missouri Region

The Middle Missouri region is part of the Great Plains of North America, which lie between the foothills of the Rocky Mountains to the west and the Central Lowlands to the east (Fenneman 1931:11). The Missouri River flows through the Northern Plains, across the Missouri Plateau in a generally northwest to southeast direction, and now empties into the Mississippi River. Prior to the Wisconsin glaciation, the Missouri flowed north into the Souris River drainage and into Hudson Bay. With the growth of the Wisconsinan ice sheet, these north flowing streams were blocked and redirected southward along the southern edge of the ice, capturing the eastward flowing streams which still flow across the western portions of the Dakotas (Flint 1971:232-235). From south to north these rivers are the White, Bad, Cheyenne, Moreau, Grand, Cannonball, Heart, Knife and Little Missouri.

The Middle Missouri subarea lies within the mixed grass temperate grasslands of the Great Plains, and corresponds to that portion of the Missouri River trench within the present states of North and South Dakota. West of the river, prior to modern ranching and stock grazing, mixed and short grasses predominated; to the east, the transition between mixed and tall grasses occurs along a broad ecotone roughly corresponding to the 97th meridian and 20" rainfall gradient (Gilbert 1980:8; Shelford 1963:334; Weaver and Albertson 1956:5).

The region immediately to the east of the Missouri River trench, the "Coteau du Missouri", lying between the trenches of the Missouri and the James River, is a glaciated plateau of glacial drift and heavy clay till above a bedrock of Pierre shale. Its topography is generally smoother, flatter and less deeply dissected than lands west of the Missouri (Flint 1955:14-15).

West of the trench, the Missouri Plateau reaches from North Dakota southward into Nebraska and westward into Montana and Wyoming. It is largely unglaciated, and cut by a series of eastward trending streams, emptying into the Missouri, which occupy trenches 200-300 feet deep, fed by well developed tributary systems (Flint 1955:15-16). Prior to inundation, on it's western banks, the river floodplain was edged by steep dissected bluffs from 300 to more than 600 feet high, and in younger portions of the trench the "breaks" or dissected ravine system extended up to several miles back from the trench (Flint 1955:14). Between and beyond these stream systems are the expanses of mixed grass upland grasslands which cover the eastern portion of the Great Plains.

The Missouri River trench itself is relatively deep, narrow and steep. The floor of the trench prior to modern inundation averaged less than one mile in width; where it occupied portions of earlier drainage systems it widened to as much as 10 miles. In the wider portions of the trench the river developed a meander belt up to four miles wide. The bed of the river developed point bars and subsidiary channels, and two large loops or "bends", Big Bend between Pierre and Chamberlain, and Little Bend at the Cheyenne River juncture, which are apparently remnants of small river valleys incorporated into the Missouri River trench during glacial rerouting.

The terrace system of the Middle Missouri consists of lower and upper terraces, which rise in some areas up to 500 m, to meet the upland plains (Hedges 1972:20-29). These terraces are primarily grass covered, with some timber development where cut by stream ravines and gullies.

The contrast in geographic and physical features between the glaciated east bank and unglaciated west bank of the river is reflected in modern land usage. The lands to the east of the trench are heavily utilized as farmland; to the west of the trench population density is lower and the mixed grasslands are used primarily for grazing (Lehmer 1971:53, 54).

Lehmer (1971:53) notes that the majority of Native American village sites (>60%) were also located on the west bank of the Missouri, primarily on the terraces overlooking the river floodplain, a location which would have maximized access to both floodplain and upland resources.

Climate

The climatic regime in the Middle Missouri subarea is continental and subject to strong seasonal extremes. The modern mean annual temperature, recorded at Pierre, South Dakota, is 46.3 F. The average January temperature is 15.1 F; in July the average temperature is 75.1 F. Average annual precipitation, also recorded at Pierre, is 45.5 cm, 80% of which falls during April through September. Average annual snowfall is 73.7 cm (Borchers 1980:82-83; Borchert 1950). Mean temperatures and length of the growing season increase within the trench from north to south, while mean precipitation increases from west to east (Burgess et al. 1973:23). This conjunction of temperature and moisture gradients made the low lying terraces and floodplains of the Missouri River trench an ideal setting for Native American village agriculture (Richtsmeier 1980).

Plant Communities

The Missouri River floodplain provided locations for Native American gardens and a variety of native plant and animal resources. In the 19th century, the Hidatsa (Wilson 1916) utilized stands of cottonwood as firewood, building materials for earthlodge superstructures, drying racks for meat, and village fortification palisades. In addition, cottonwood bark was gathered for horse fodder in winter (Wilson 1924:175, and references therein). Peachtree willow branches were used for basket and bullboat frames; other willow species were used in earth lodge roofing and woven mats. Wild fruits and berries gathered in the floodplain included chokecherry, Juneberry, currant, gooseberry and plum. Above the floodplain, terrace forests provided ash for mortars and pestles, elm wood for bows, and boxelder bark for baskets (Wilson 1916), as well as grassland grazing for horses.

The vast upland grasslands above the terraces also provided winter fodder for horses and wild plant foods such as prairie turnips and wild onions. The major grass species in these mixed grasslands included blue grama, western wheat grass, buffalo grass, and needle-and-thread grass. Prior to modern grazing, side oats gramma, Junegrass, green needle grass, and little bluestem were also present in varying percentages (Shelford 1963:334; Weaver and Albertson 1956:326).

Animal Resources

The conjunction of physiographic biomes in the Middle Missouri provide habitat for both open land and forest species. Jones et al. (1983:17) list the species most often found in the mixed grass uplands of the plains:

> The following kinds of mammals are typical of the mixed-grass prairie communities: black-tailed jack-rabbit, desert cottontail, spotted ground squirrel, thirteen-lined ground squirrel, black-tailed prairie dog, silky pocket mouse, hispid pocket mouse, Ord's kangaroo rat, plains harvest mouse, northern grass-hopper mouse, swift fox, black-footed ferret, badger, pronghorn and bison.

Species more common to the stands of eastern deciduous forests within the floodplain forest of the Missouri and its tributary rivers include opossum, eastern cottontail, fox squirrel, white-footed mouse, eastern woodrat, raccoon, red fox, and white-tailed deer. Species with broad habitat tolerance, primarily omnivores or carnivores, include deer mouse, coyote, long-tailed weasel, and striped skunk (Jones et al. 1983:17-18). Other animals living in the river floodplain itself included bear, otter, beaver, raccoon, and gray wolf (Canis lupus) (Weitzner 1979:194-197).

The Missouri River itself provided fish, turtles and aquatic birds. Fish taken from the Missouri River included catfish, walleye, sturgeon, goldeye, and buffalo (Weitzner 1979:196-210).

Cultural Historical Setting

The cultural historical sequence in the Middle Missouri, as elsewhere on the Plains, is commonly divided into Paleoindian (10,000-6000 B.C.), Archaic (6000 B.C.-A.D. 1), Woodland (A.D. 1-900) and Plains Village (A.D. 900-1862) (Lehmer 1971:29-33; Toom 1989:28).

Perhaps because the evidence has been either destroyed or deeply buried by erosional and depositional cycles in the trench, few Paleoindian sites are currently recognized in the Middle Missouri subarea. Evidence of nomadic Archaic foraging and hunting groups is also scarce (Toom 1989:29). Sites of the Plains Woodland period are much more numerous (Neuman 1975). It is during the latter portion of this period that horticulture may have begun in the Middle Missouri (Neuman 1975:89; Wedel 1961:284-285).

The Plains Village Period

The Plains Village period is one of great population expansion in the Middle Missouri, resulting in the prominent earthlodge villages of the Middle Missouri and Coalescent traditions. The origins of these groups, whether an indigenous development among resident Woodland populations or the result of a westward migration of new groups from the eastern woodlands, has been the subject of numerous investigations and much speculation (Alex 1981; Lehmer 1971; Tiffany 1983; Toom 1992a, 1992b; Wood 1967). Whatever their origins, for a period of nearly 800 years these groups of hunter-gatherer horticulturalists lived a semi-sedentary life in the Middle Missouri subarea and ultimately gave rise to the known historic tribes of the Missouri River, the Mandan, Hidatsa and Arikara.

Within the Plains Village period, Lehmer defined a chronological cultural historic sequence based on archaeological manifestations such as house outlines and ceramic seriation, and temporal indicators such as site stratigraphy, radiocarbon dating, and the presence of Euroamerican trade goods.

The major components within this period are the earlier "Initial Middle Missouri" (IMM) and the later "Coalescent" traditions (Lehmer 1971:27-33). Although subject to later minor modifications based on local archaeological sequences (e.g. Ahler 1993; Toom 1992a, 1992b), this chronology (Table 1) has continued to form the basic culture historic framework in the Middle Missouri subarea (cf. Johnson 1994).

Around A.D. 1000 groups of semi-sedentary village hunter/horticulturalists began to appear in the Missouri Valley and elsewhere in the eastern Plains (Wedel 1983). The first village groups in the Middle Missouri area appear to have had their origins farther to the east, perhaps among the Great Oasis or Mill Creek cultures of western Iowa and southwestern Minnesota (Henning 1970; Lehmer 1971:98; Tiffany 1983; Toom 1992a). These people, labeled archaeologically the Initial Middle Missouri (IMM) tradition, lived in sometimes extensive, fortified or unfortified villages of long-rectangular semi-subterranean earth covered houses, located primarily on the terraces overlooking the Missouri River floodplains or its tributaries (Lehmer 1971:66).

Table 1. General Cultural-Historic Sequence for the Plains Village Tradition in the Middle Missouri Subarea.

Sub-Tradition	Variant	Estimated Time Range
	Lehmer 1971	
Middle Missouri	Initial	900-1400
	Extended	1100-1550
	Terminal	1550-1675
Coalescent	Initial	1400-1550
	Extended	1550-1675
	Post-Contact	1675-1780
	Disorganized	1780-1862
	Toom 1993	
Middle Missouri	Initial	A.D. 1000-1300
	Extended	A.D. 1050-1500
	Terminal	A.D. 1500-1650
Coalescent	Initial	A.D. 1300-1500
	Extended	A.D. 1500-1650
	Post-Contact	A.D. 1650-1850

Their subsistence revolved around the hunting of large ungulates, principally bison, gathering of some wild foodstuffs, fishing, and gardening in the floodplains (Lehmer 1954; Wood 1967:121). Archaeologically recovered plant remains from Initial Middle Missouri sites include charred remnants of maize, squash, bean, *Chenopodium* (goosefoot or lambsquarter), and wild fruits or berries such as chokecherry and wild plum (Nickel 1977). Based on archaeological faunal assemblages, bison comprised the major meat portion of their diets (cf. Chomko 1976); other species taken included elk, pronghorn, deer, beaver, and large canids (see also data in Semken and Falk 1987).

The earliest Initial Middle Missouri villages were located along the Missouri River trench from the White to the Cheyenne rivers. As the "Extended Middle Missouri" (ca. A.D. 1000-1500), these villages expanded into the northern portion of the trench above the Grand River as far north as the Knife River. The final manifestation of the Middle Missouri variant, the "Terminal Middle Missouri" (ca. A.D. 1550-1650) includes villages in a restricted portion of the Middle Missouri subarea between the Cannonball and Knife rivers in present day North Dakota (Lehmer 1971).

Subsistence and settlement patterns show no major shifts between the Initial Middle Missouri and the later Extended and Terminal variants. These designations are based primarily on shifts in geographic location and chronological age (Lehmer 1971:65).

The Initial Coalescent variant (IC), first occurring in the southern portions of the subarea around A.D. 1300, appears to represent an influx of new people or groups from the Central Plains to the south. House form differs from that of the Middle Missouri; most common is an almost square outline with rounded corners and four large center support posts, developing in the later Extended Coalescent (EC) period (ca. A.D. 1500-1650) into the large circular earthlodge structures known from the historic period. Coalescent peoples initially settled in the lower reaches of the Middle Missouri subarea and, like the earlier IMM groups, were village horticulturalists and hunters (Lehmer 1971).

Historic Middle Missouri Groups

It is from the peoples of the Post-Contact Coalescent (PCC) variant (ca. A.D. 1650-1850) in the southern portion of the subarea, and the Coalescent remnants of the Initial Middle Missouri groups in the northern portion of the trench, that the historically known tribal groups, the Arikara, Mandan, and Hidatsa arose.

The Arikara occupied the southern portion of the region in the area of present day South Dakota, in the region of the "Big Bend" of the Missouri between the White and Bad rivers (Lehmer and Jones 1968). In the northern portion of the subarea, Coalescent and Terminal Middle Missouri peoples became the historic Mandan and Hidatsa (Ahler et al. 1991; Wood 1967).

This phase of Plains Village history is often broken into the "protohistoric" and "historic" periods. The protohistoric is so named to signify the final prehistoric period in which initial Native American-Euroamerican contacts had been made to the east and north. However, a majority of Plains groups still had only indirect contact, usually through middlemen Indian traders, with Europeans and European manufactured goods. The historic period, as the name implies, is the period of direct contact between Europeans and Native Americans and the beginning of written documentation of that contact by European explorers and traders.

During this approximately 200 year period, development of the European and later Canadian and American fur trade (Wishart 1979; Wood and Thiessen 1985) produced fundamental and irreversible changes in Native American social, economic, and cultural lifeways.

Of the six sites considered in this analysis, the earliest is the Initial Middle Missouri (IMM), Sommers site (39ST56); a second early site is the mixed component, IMM and Initial Coalescent (IC) Crow Creek site (39BF11). Next are three Post-Contact Coalescent (PCC) sites: Bamble (39CA6), Spiry-Eklo (39WW3), and Larson (39WW2). The sixth site is the historic PCC Leavenworth site (39CO9). The three PCC sites are probably ancestral to the Arikara; the Leavenworth site represents the last two semi-autonomous Arikara villages.

Middle Missouri Subsistence

Before their lives were forever changed by the effects of the fur trade, the villagers of the Middle Missouri subarea practiced an extensive garden horticulture in the Missouri River floodplain and conducted local and extended seasonal hunts, sometimes over long distances, on the upland plains to the west of the trench. This mixed hunting-horticultural subsistence was augmented by an aboriginal trading system in which the Missouri River villagers traded horticultural products from their gardens for meat and hides procured by the more nomadic tribes to their west. This subsistence economy was remarkably successful and stable, persisting in the Northern Plains for nearly 1000 years (Wood 1974).

Plant resources of the Middle Missouri villagers included both native and domesticated species. There are abundant ethnohistoric and ethnographic accounts of the success and importance of maize horticulture in Middle Missouri subsistence (e.g. Will and Hyde 1917, and references therein). Squash and beans were also important garden products (Nickel 1977; Will and Hyde 1917:59-76).

Other possible cultigens included *Chenopodium* and *Helianthus* (sunflower)(Nickel 1977, 1988). Wild fruits and berries commonly gathered included wild plum, chokecherry, wild grape, and buffaloberry (Nickel 1977, 1988; Gilmore 1977).

The staple meat source for Plains Villagers throughout this period was the bison (Chomko 1976; Gilbert 1969). Faunal assemblages from both the Middle Missouri and Coalescent traditions are invariably dominated by bison bone, although they also provide evidence for exploitation of other mammal, bird and fish resources taken from the rich upland plains and Missouri River trench (Falk et al. 1980, 1984, and references therein; Falk and Ahler 1988; Parmalee 1977, 1979; Toom et al. 1989:578). More pertinent to the present study, throughout the Plains Village period in the Middle Missouri subarea, large canids (domestic dog and/or wolf) are frequently the second most commonly represented taxon (Semken and Falk 1987; White 1955, and references cited above).

Middle Missouri Villagers and the Fur Trade

Long before European traders reached North America, the Mandan, Hidatsa, and Arikara participated in a wide spread network of trading relations (Ewers 1954, 1968; Wood 1972, 1974, 1980) which brought such "exotic" goods as *Anculosa* shell beads from the Tennessee Valley, *Dentalium* from the Pacific coast, and *Busycon*, *Marginella*, and *Olivella* from the Atlantic and Gulf coasts (Lehmer 1954). The Missouri River villages formed the heart of an eastern trading system, in which the Arikara acted as "middlemen" in a larger continent-wide trading network (Wood 1980:100-101). Part of this network involved the trade of horticultural products from the sedentary village gardens for meat and hides from the more nomadic western tribes.

In the early historic period, the developing Euroamerican fur trade at first fit easily into this established trading pattern (Rogers 1990). The Mandan, Hidatsa, and Arikara were able to continue their middleman roles, now also trading Euroamerican goods to tribal groups farther up the Missouri, groups initially beyond the geographic reach of Euroamerican traders (Orser 1984; Ray 1978; Toom 1979). However the acquisition of European goods, weaponry, and alcohol, the insatiable European demand for furs and hides, and the epidemic diseases which following direct contact with Euroamericans led inevitably to devastating Native American population losses and the demise of their traditional lifeways (Gilman and Schneider 1987; Rogers 1990; Weston 1993).

In a recent study focusing on the effects of the fur trade on the material and cultural worlds of the Arikara, Rogers (1990) divided the protohistoric and historic into six periods. Period I (A.D. 1500-1681) was one of indirect involvement with European trade goods. The Arikara occupied as many as 32 villages along the Missouri (Beauregard 1912:28, 29, cited in Rogers 1990). Even in this period, however, the first epidemic diseases may have already reached the Middle Missouri area, far in advance of any direct contact with Euroamericans (Ramenofsky 1987).

During Periods II and III (A.D. 1681-1775) the Arikara participated first indirectly in the Euroamerican fur trade, receiving horses from the Southwest around 1738 and guns by 1750. Later in this period, trading directly with Europeans, they acted as middlemen traders for other up-river groups, and according to Rogers, maintained good relations with white traders despite increasing social and economic stress due to epidemic disease (Trimble 1979, 1994) and conflicts with the nomadic Sioux.

During Periods IV and V (A.D. 1776-1835) the traditional lifeways of the Arikara were drastically altered as they became increasingly dependent on European and American manufactured metal goods (Weston 1993) and weaponry. During this period continuing waves of epidemic disease led to severe population decline and the physical amalgamation of previously autonomous groups into fewer and fewer villages.

The Arikara occupied only seven known villages in 1785. By 1814 they were reduced to only two semi-autonomous villages at what would become known as the Leavenworth site (39CO9). Here they suffered continuing attacks by the

Sioux, their sometimes trading partners. In 1823 they were shelled by the American troops of Col. Henry Leavenworth in retaliation for increased hostilities against white fur trappers and traders, now passing beyond the Arikara to trade directly with the villagers of the Upper Missouri (Rogers 1990:86-87; see also Krause 1972:14-15, and references therein). The Arikara temporarily abandoned the Leavenworth villages in 1824, then returned in 1825 and remained until 1833. Finally, in 1837, the Arikara moved to a single combined village (Like-A-Fishhook) in North Dakota with the remnant populations of the Mandan and Hidatsa (Gilman and Schneider 1987; Nichols 1982; Rogers 1990:87-88).

The Euroamerican fur and hide trade developed an enormous demand for pelts of native fur bearers and ungulate hides, and by 1815 the demand for bison hides had outstripped that for fur pelts. A partial record of returns from the Missouri River region in 1834-1835 lists 36,000 buffalo robes from four trading posts, plus over 800 "salted buffalo tongues", 3500 pounds of "powdered buffalo" and 3000 pounds of "dried buffalo meat" (Wishart 1979:58-59, Table 3). Over 160,000 bison hides were received at the Upper Missouri and Sioux stations of the American Fur Company between 1835 and 1839 (Johnson 1969).

The drastic population declines resulting from epidemic diseases, and increasingly hostile relations with both

American military and civilian forces and the nomadic tribes to the west, particularly the Sioux, put additional pressures on the Missouri River villages. This led the last Arikara, Mandan and Hidatsa first to Like-A-Fishhook village, and later to the town of Independence on the Fort Berthold Reservation in North Dakota.

CHAPTER III

DOMESTIC DOGS IN PLAINS VILLAGE LIFE

Dogs were a prominent part of Plains Village life, as noted by early European explorers and fur traders, where they were used as beasts of burden and often eaten ceremonially. Before the horse became the primary beast of burden on the Plains, dog travois were used for transport. Dog meat was also often included in ceremonial feasting and dance rituals such as the grass dance ceremony. With the advent of the Euroamerican fur and hide trade, and the disruption of traditional subsistence and economic systems, the dog took on an increasingly important role as an alternative or emergency food source for Plains Villagers and at times for European and American visitors as well.

Use of the Dog as Food

Driver and Coffin (1975) listed 55 Native American groups who included dog feasts in their ceremonies. Plains groups include the Crow, Cheyenne, Mandan, Teton, Arikara, Assiniboin, Blackfoot, Blood, Hidatsa, Omaha, and Pawnee (see also Driver and Massey 1957, Map 6).

There were, however, some groups who rarely ate dogs, or adopted them as food only as part of acquired ceremonies. De Smet (1905:104) noted that the Snake did not eat dogs, and Maximilian (1906:109) made the same observation of the Blackfeet. Buffalo-Bird-Woman, a Hidatsa informant, told Gilbert Wilson that the Hidatsa normally did not eat dog meat until they acquired rights to the grass dance ceremony from the Sioux:

> Ordinarily, dogs were not eaten, partly because the dog was a sacred animal, and again because the flesh was not good, for dogs fed on carrion and human ordure. Our people did not eat dog until about 40 years ago, when we learned the custom from other tribes, I think the Santee Sioux, who gave us the grass dance (Wilson 1924:230).

The taste of dog meat was likened to that of pork, or mutton. De Smet, who was often served dog meat as part of greeting ceremonies, in describing his meeting with the Cheyenne in the Black Hills in 1840 wrote, "Do not wonder when I tell you that this is their great feast, and that the flesh of the wild dog is very delicate and extremely good; it much resembles a young pig" (De Smet 1905:212). Fremont in 1845 described dog meat as "very glutinous, with something of the flavor and appearance of mutton" (Allen 1920:468).

Dogs chosen for feasting were often noted for their fatness. De Smet describes the portion he received at a feast associated with a council meeting in 1851:

> I was invited to several of these banquets, a great chief in particular wished to give me a mark of his friendship and respect for me. He had filled his kettle with little fat dogs, skin and all. He presented me on a wooden platter the fattest well boiled (De Smet 1905:682).

Preparation Techniques

Dogs were most commonly cooked by boiling in pots. One of the most detailed accounts of preparation and cooking of dog is that of Melvin Gilmore who observed the preparation of a dog feast in association with the ceremonies of "Holy Grandmother Cedar Tree" in July 1926 (Gilmore 1934). After killing, the dog carcass was placed upon a fire to singe off the hair. The carcass was then washed and eviscerated. According to Gilmore, in this instance the head and tail were also cut off and discarded. The carcass was then "divided into portions in accordance with a well-established tradition."

> These portions are the two forequarters, the two hind-quarters, the two sets of ribs, the cervical and dorsal vertebrae with adjacent bones and muscles between the shoulders, and the lumbar vertebrae with the bones and muscles which form the pelvic girdle (Gilmore 1934:37-38).

Gilmore notes that the carcass was cooked with skin still attached because, according to his Hidatsa informant, "The skin is too rich to lose" (Gilmore 1934:38). The carcass sections were then further reduced to fit into the cooking pot and boiled until done.

The Gilmore account is supported by De Smet's observation that the young dog presented to him was served "skin and all." He also reported that at the Cheyenne feast in 1840 the portion served to him "was large, the two thighs and paws, with five or six ribs" (De Smet 1905:210-212).

These accounts indicate that a common method of cooking was pot boiling of carcass segments with bones included, and that the skin was most often left intact. Disarticulation marks would therefore be commonly inflicted as the carcass was cut into "potsize" portions (cf. Oliver 1993). Because the portions served at meals were smaller body segments which still contained bones, additional "disarticulation" or "filleting" cutmarks might have been inflicted as these segments were further disarticulated and meat was cut from the bones by the diners.

The Changing Importance of Dogs as Food Through Time

The preparation of dogs for consumption with skin intact, and in bone-in segments, would have preserved all subcutaneous, intramuscular and mesenteric fats. Cooking by pot boiling would also have insured that these fats became part of the cooking broth rather than dripping out and being lost over an open fire during roasting. This preparation technique which preserved all available nutrients, particularly fats, may have become increasingly important following the vast changes in Native American economy and subsistence brought about by the European and American fur and hide trade.

The disruption of traditional subsistence and trading patterns was brought on, initially, not by wholesale destruction of native game animals but by the effects of epidemic diseases on Plains Village populations and disruption of their formerly successful trading relationships with nomadic plains groups such as the Sioux (Hyde 1952; Orser 1984; Rogers 1990:80-88). As the competition for favorable trading relations with European and American companies increased, so too did intertribal hostilities. These increasing tensions were magnified by the recurring waves of epidemic diseases which drastically reduced population numbers, particularly among the sedentary villagers who were in direct contact with white traders (Trimble 1979, 1994).

Although the Arikara had formerly maintained good trading relations with the Sioux, with whom they exchanged horticultural products for meat and hides, Abel (1939:131) noted that by the beginning of the 19th century the Sioux were stealing horses from the Arikara villages and disrupting their bison hunts.

By the early to mid-nineteenth century, the traditional hunting activities of the Missouri River villagers were severely curtailed due both to the activities of the Sioux and extreme population decline. In June 1810, Bradbury (1904:135) reported that the Arikara villages on the Grand River were low on stores because their underground caches had been spoiled "by excessive rains." When he returned to Ft. Mandan in May of 1811, he found the Indians "starving" because their stores were exhausted and the threat of the Sioux kept them from leaving their villages to hunt

(Bradbury 1904:180). At that time more than two-thirds of the village dogs had been slaughtered for food.

Visiting Ft. Pierre, on the Missouri, in spring of 1834, Maximilian described the Indians who were living around the fort as "half-starved" and noted that Indian dogs were scarce. While visiting the Sioux who were camped near the fort, Maximilian's party was served a meal of dog meat. When they returned to the fort from this visit, they found that the fort was also low on stores, and dogs were to be served for dinner there as well:

> For his own table of ten or twelve persons, Mr Laidlow had generally bought dogs of the Indians, but these were now scarce, and consequently very dear; twelve dollars were paid for the dogs destined for our repast today (Maximilian 1906:90).

In summary, ethnohistoric and ethnographic accounts emphasize cooking preparation techniques by which the nutrients in dog meat, particularly fats, were retained by cooking the divided carcass, with skin still attached, by boiling in pots. This method would have resulted in serving portions which had been disarticulated into potsize pieces, but still often consisted of meat on bone. Disarticulation marks should therefore be common, and additional marks might have been inflicted by individual diners as they further disarticulated sections or cut meat from the bone.

The exploitation of dogs as a food resource appears to have changed in emphasis over time. Initially used primarily in ceremonial feasting, dogs became an increasingly important food resource in the nineteenth century as subsistence patterns changed and later Post Contact groups such as the Arikara were restricted in movement by increased hostilites with the Sioux. Under such circumstances domestic dogs, readily available in the villages in large numbers, would have become a valuable food resource. The intensity with which they were utilized should be reflected in the archaeological record by a greater concentration of butchering evidence on skeletal materials.

CHAPTER IV

THE RIVER BASIN SURVEY PROGRAM AND THEODORE E. WHITE

The excavation techniques developed during the massive River Basin Salvage program begun in 1945 were influential in the development of archaeological field practices in North American archaeology. In addition, this vast program of archaeological "salvage and recovery" played an important part in the development of conservation archaeology.

Theodore E. White first became involved in Plains archaeology during the RBS program, initially as an RBS paleontologist and later as a "specialist" in mammal bone identification. His willingness to identify the masses of vertebrate remains being recovered from archaeological excavations, and his association with RBS archaeologists such as Donald Lehmer, evolved into his own interest in the analysis of archaeological faunas. This led to a series of articles on "butchering practices" based on his analyses of a number of faunal assemblages from the Middle Missouri subarea. In addition, his suggestions on recovery and retention of unmodified faunal materials had definite consequences for the resultant RBS faunal collections, still curated by the Smithsonian and Institutions throughout the Plains, including the large canid collections considered in the present analysis.

History of the River Basin Survey Program 1946-1969

Enacted near the end of World War II, the Flood Control Act of 1944 called for the construction of dams and reservoirs on river systems throughout the United States by the Bureau of Reclamation and the U.S. Army Corps of Engineers for the production of hydroelectric power, irrigation, improved river navigation, and flood control. When this plan became public, concern for the fate of archaeological sites and resources, often concentrated along major streams and their tributaries, led scientific groups such as the American Council of Learned Societies, the Society for American Archaeology, the American Anthropological Association and archaeologists, including Julian Steward, Frank H.H. Roberts (Smithsonian Institution), and William Duncan Strong (Columbia University) to establish the Committee for the Recovery of Archaeological Remains (Jennings 1985; Lehmer 1971:2). The committee was to serve as an advisory and support body for the subsequent archaeological salvage operations throughout the reservoir construction period.

Archaeological survey and excavation became the responsibility of the National Park Service under the Historic Sites Act of 1935 for the preservation of archaeological and paleontological resources, under which the Park Service became responsible for surveying recreational, archaeological, and paleontological resources within the proposed reservoir areas. To undertake this enormous project, a Memorandum of Understanding in 1945 (revised 1961, 1965) between the National Park Service and the Smithsonian Institution led to the creation of the River Basin Surveys division of the Bureau of American Ethnology (later Division of Anthropology) within the Smithsonian. This entity, as part of the governmental Inter-Agency Salvage Archaeological and Paleontological Program, then took primary responsibility for archaeological survey, testing, and salvage excavation in advance of dam and reservoir construction. After 1949, field work under this program was also supplemented by a National Park Service contract program which allowed museums, historical societies, and universities to participate in fieldwork and archaeological survey and salvage projects.

Frank H.H. Roberts became the first head of the RBS (River Basin Surveys division) in 1945. From 1946 through 1968 the Inter-Agency Archaeological Salvage Program of the River Basin Surveys conducted surveys in more than 500 proposed reservoir basins and recorded nearly 20,000 site locations (Brew 1968:3).

The process of dam construction in the Missouri River basin was begun in 1946 under the Pick Sloan plan which called for the construction of a series of four dams in South Dakota (Gavins Point, Fort Randall, Big Bend, and Oahe) and one in North Dakota (Garrison) which would eventually inundate 621 of the 756 river miles (more than 81%) of the Missouri River floodplain in North and South Dakota (Lehmer 1971:19, Table 1).

Because of the potential extent of proposed reservoir flooding and the already documented intensity of Native American prehistoric and historic settlement along the Middle Missouri, the Missouri Basin Project, headed by Waldo R. Wedel (then Associate Curator of Archaeology at the United States National Museum) was created in 1946 with headquarters in Lincoln, Nebraska. Until the transfer of responsibility to the National Park Service, Midwest Archaeological Center in 1969, this office directed all archaeological and paleontological research in the Middle Missouri subarea under the direction of Waldo W. Wedel (1946-1949), Paul L. Cooper (1949-1952), Robert L. Stephenson (1953-1963) and Warren W. Caldwell (1964-1969).

From 1946 through 1971 over 800 archaeological sites were recorded in the Middle Missouri portion of the Missouri River Valley (Lehmer 1971:10). Over 700 of these sites were located in South Dakota in the areas of the Oahe (299), Big Bend (182) and Fort Randall (235) reservoirs (Helgevold 1981:56). Survey of proposed reservoir flood pools began in 1946, and large scale excavations were begun in 1950. In his summary of the operation and initial results of the Interagency Archaeological Salvage Program in the Middle Missouri subarea, Lehmer noted that by 1969 excavations had been carried out at more than 200 sites in North and South Dakota. "Major excavations" (by Lehmer's definition those operations for which the cost of field work was greater than $2500) had been conducted at 92 sites (Lehmer 1971: 20, 193-200). All sites considered in the present analysis were initially excavated during this time as part of the Missouri Basin Project.

Excavation and Laboratory Techniques

Although excavation techniques varied somewhat among RBS field directors and contracting institutions, field methods were largely oriented toward rapid, maximum data recovery in a vast salvage operation. To this end, earthmoving equipment was routinely used to remove overburden in archaeological excavation:

> Excavation methods have involved adapting standard archaeological techniques to the exigencies of salvage archaeology. There has been a general feeling that it was justifiable to foreswear some technical niceties in the interest of obtaining maximum information under shortages of time and funds. This attitude has been expressed by limited screening and the use of heavy earth-moving machinery [Wedel 1951]. Bulldozers, road patrols, draglines, and other types of equipment have been used, and used to great advantage. The Missouri Basin was, so far as I am aware, the first archeological area in which the extensive use of heavy equipment came to be an acceptable technique. In this respect, the salvage program made a valuable contribution to archeological technology (Lehmer 1971:14).

In the interest of collection of cultural historical information, excavations of village sites concentrated on exposure and mapping of a limited number of earth lodge house floors (usually 1 to 6), and limited testing of midden areas and fortification ditches. Archaeological materials were recovered primarily by hand from shovel and trowel excavation of house floors, interior and exterior cache pits and other features, and test units. There was no consistent screening program, and while some features at individual sites might be dry screened, the amount of matrix screened was rarely recorded, and at many sites no screening was conducted (for further details of excavation procedures see individual site descriptions in Chapter V).

Those classes of materials which might bear on cultural historical and/or chronological project goals, such as pottery, lithic artifacts and modified bone were collected and segregated, usually by numbered feature, although the term "feature" was used to designate a variety of units in the field:

> In conformance with standard River Basin Surveys usage, the term "Feature" was applied to anything which we wished to specify within the site. A house, a cache pit, a test trench, etc., were all designated as a "Feature" and distinguished by an Arabic numeral. At the beginning of the season the writer was rather dubious about this practice. At the end of the season he was completely converted to it. The use of the single term precluded the confusion which arises when something which was originally called a cache pit develops into a full sized earth lodge (Lehmer 1954:6).

In the field all excavated features and test units were described on standardized record forms, and standard photographic record sheets were also used. In the laboratory, recovered pottery rim sherds and "nonpottery artifacts" were assigned catalog numbers, and these numbers were inked onto the objects themselves. Pottery body sherds and unmodified animal bone, however, were generally cataloged by lot, with one number being assigned to all materials from a single feature. Following laboratory processing and cataloging in Lincoln, site assemblages were variously stored at the Lincoln offices or at participating institutions, or were sent to the United States National Museum/National Museum of Natural History in Washington, D.C., the Smithsonian.

Three complete sets of field and laboratory records were theoretically produced for each site investigated, two copies were maintained at the River Basin Surveys offices in Lincoln and a third set was stored at the University of Nebraska, Lincoln campus.

Site Reports and Publications

Due to the size of the River Basin Surveys salvage program and its emphasis on field work and the recovery of archaeological resources prior to their inundation, publication of site reports and syntheses fell well behind field work (Jennings 1985; Lehmer 1965; Wedel 1967).

The River Basin Survey Papers series, published in the *Bulletin of American Ethnology* between 1953 and 1966, included 38 papers or site reports. From 1966 to 1969, the River Basin Surveys program also published a series of 13

Publications in Salvage Archaeology, which consisted of individual site reports and regional syntheses of salvage archaeology. Number 10 in this series (Petsche 1968), A Bibliography of Salvage Archeology in the United States, listed nearly 2600 publications related to archaeological salvage projects in the United States, including those of the River Basin Surveys.

The first major synthesis of work in the Middle Missouri subarea, An Introduction to Middle Missouri Archaeology, was produced by Donald J. Lehmer in 1971, and is still a standard reference for archaeologists working in the Middle Missouri subarea or with River Basin Salvage materials. In 1977 a festschrift in honor of Lehmer (Wood 1977) presented summary papers on many aspects of Middle Missouri archaeology, based almost entirely on data produced during the Missouri Basin Salvage program.

Nevertheless, much of the original River Basin Surveys field work in the Middle Missouri subarea never resulted in published reports, and analyses of the results of individual site excavations are still being completed under the continuing contract program of the National Park Service.

Distribution of Site Assemblages and Excavation Records

After cataloging in the Missouri Basin Project laboratory in Lincoln, recovered assemblages were variously distributed, initially to storage facilities in Lincoln, at the University of Nebraska, or at institutions participating in contracted excavations. Other assemblages were transferred directly to the United States National Museum, later the National Museum of Natural History and Man of the Smithsonian Institution. Eventually, following the transfer of responsibilities of the Lincoln, Nebraska, River Basin Surveys office to the National Park Service, the artifactual collections still stored in Lincoln were also transferred to the Museum of Natural History in Washington, D.C., where they are currently curated by the Anthropology Division of the Museum. However, the unmodified bone assemblages from many of these sites still remain in storage in Nebraska, at the University of Nebraska State Museum.

In July 1969 the River Basin Surveys program was formally concluded and its remaining responsibilities transferred to the National Park Service, Lincoln office. At this time, at least one of the three duplicate sets of records of the Missouri Basin project was placed in the National Anthropological Archives (NAA) of the Smithsonian Institution. In addition, records of the Washington offices of the RBS were also transferred to the NAA. By agreement, the National Park Service - Midwest Archaeological Center in Lincoln retained a library of publications and manuscripts relating to Middle Missouri and Plains archaeology which is still maintained and made available to researchers in Lincoln.

Original site records, files, maps, specimen catalogs, and field and laboratory print negatives and slides from the Lincoln region offices are presently curated by the National Anthropological Archives. These materials are currently being sorted, organized and cataloged, and all are available to researchers. In many instances, T.E. White's original identification sheets are contained in individual site files; for as yet unstudied and unpublished collections, these are apparently the only documentation of White's work.

The Influence of T.E. White on Collection, Retention, and Analysis of Plains Archaeological Faunal Remains

In the Middle Missouri subarea, as elsewhere in North America, unmodified faunal materials recovered from archaeological excavations received little consistent attention prior to the 1960s (but see Hargrave 1938; Gilmore 1946). However, with the inception of IAS-RBS operations, the coincidence of archaeological and paleontological investigations in the same program and reservoir basins, particularly the Middle Missouri subarea, provided further impetus for the study of faunal materials recovered from archaeological contexts (cf. Falk 1977:152).

Donald J. Lehmer, in an article entitled "Animal Bone and Plains Archaeology" (Lehmer 1952), proved to be an early advocate for the analysis of faunal materials from archaeological contexts:

> Animal bone is found in enormous quantities in most of the archeological sites in the Great Plains. So far, archaeologists have made almost no use of this potential source of information. Studies of butchering techniques such as the one prepared by Theodore White and read by George Metcalf at the 8th Plains Conference must necessarily remain primarily within the field of the specialist in vertebrate osteology. Similarly, the identification of the different species represented in a collection is usually in the specialists's province. However, if the archeologist has kept reasonably complete samples of the animal bone found, has made adequate records of provenience, and has been able to arrange for identification by a specialist, he has equipped himself with a potentially valuable body of data (Lehmer 1952:53).

In the same article Lehmer went on to discuss the faunal assemblage collected from the Dodd site (39ST30) and the types of information to be gained from its analysis, including the volume of bones recovered from the components of a multi-component site, the proportional representation of major subsistence species (based on number of identified specimens), and the percentage of immature animals (bison) represented in each cultural component. From this information Lehmer concluded that:

> The decrease in the relative amount of animal bone in the late horizon might be due either to a change in butchering techniques by which less bone was brought into the village, or to an actual decrease in the amount of hunting in late times. (Lehmer 1952:54).

He also noted a drop in the percentage of bison relative to antelope through time and speculated that this drop is "presumably culturally significant: "

> Except in rare instances, bison hunting must have been a group affair, while hunting deer and small game animals was presumably an individual matter. It would thus appear that those aspects of the social organization which were directed toward the communal bison hunt were less strongly developed by the people of the Stanley Focus than by those of the Anderson and Monroe Foci. (Lehmer 1952:54-55).

Finally, he noted that the proportion of immature bison remains consistent through time, "indicating that none of the groups made an attempt to concentrate on the younger animals for tender meat." Lehmer ended the paper by stating:

> Data such as these seem to be a material addition to the total body of information about the cultural complexes represented at the Dodd site, and it seems likely that similar treatment of the animal bones from other sites could be equally valuable (Lehmer 1952:55).

In a footnote to the paper he states, "It is very pleasant to be able to take this opportunity to express my appreciation to Dr. Theodore White, MRBS Paleontologist, for this identification of the Dodd site animal bone" (Lehmer 1952:54).

Dr. Theodore E. White, the "specialist" to whom Lehmer referred in his footnote, was a Harvard University paleontologist who joined the River Basin Surveys in 1947. Subsequently, no single individual had a greater influence on the collection, analysis, curation, and ultimate disposition of unmodified faunal materials from Plains archaeological sites during the River Basin Surveys period than Theodore E. White.

White's official association with the River Basin Surveys began as a paleontologist in April 1947, when he was authorized by Frank H.H. Roberts to proceed from Washington, D.C. to Lincoln, Nebraska "for official travel in Nebraska, Kansas, South Dakota, North Dakota, Montana, Wyoming and Colorado in association with the Missouri Basin Archeological and Paleontological surveys." For this survey of paleontological locations he was to receive a maximum of $800 in expenses, plus a per diem of $6 per day for a period not to exceed six months (memo from Frank H.H. Roberts, April 22, 1947, SI Authorization No. 48).

In March of 1948 Roberts wrote to White requesting identification of bones excavated by Joe Ben Wheat at Addicks Reservoir and on March 31 White sent Roberts the list of identifications. Several similar exchanges took place between Roberts and White during the same year. On October 11, 1948 White wrote to Roberts concerning bones excavated by Wheeler at Park River:

> I agree with you that further study of the bison bone will probably be most useful to archaeology as well as Pleistocene and recent stratigraphy. From my own causal observations I feel morally certain that the deer will be just as useful after a similar study is made and we should preserve at least the dentitions and horns so that such a study will be possible. It seems reasonable to assume that this same axiom can be extended to most of the food animals of the Indians. I also feel that the problem is important enough to warrant the addition of a combined Pleistocene stratigrapher and paleontologist to the staff of the division of archeology in our larger museums and universities. However, I don't expect to live long enough to see this happen.

Authorization No. 156, June 27, 1949/May 8, 1950 enabled White to proceed with paleontological work in the Missouri River Basin at a per diem of $8.00. He spent the summer of 1950 in the Garrison Reservoir, North Dakota. On Nov. 13, White sent the following memo to Roberts from Lincoln, Nebraska:

> During the identification of the bone from a couple of sites in Angostura Reservoir, the distribution of the various elements aroused my curiosity concerning the parts of the animal used and how they went about it to get a meal off of a carcass. A more thorough examination of the material resulted in some reasonably good guesses concerning their methods of handling a carcass. George Metcalf has agreed to read it at the Plains Conference with the table shown as a slide. I turned the title over to Bob Cumming so it should be on the program. It also occurred to me that you might want to publish it as a note in Antiquity or some other outlet. I am not a member of any of the archeological societies, so it will be necessary for some one to communicate it for me. On the other hand I am a member of the Washington Academy, but if it is worth publishing it will reach more people through an archeological journal.

This memo clearly indicates White's interest in archeological faunas and Native American subsistence. The paper "Observations on the butchering techniques of some aboriginal people" was read at the 8th Plains Conference in 1951, and later was published as part of a series of articles by White on prehistoric butchering patterns which appeared in <u>American Antiquity</u> (White 1952b:337-338).

White continued to be involved with RBS archaeologists, and his developing interests in zooarchaeological analysis led to an expansion of his RBS role, beyond that of paleontologist, to a specialization within archaeology. In December, 1951 Frank H.H. Roberts requested a "Position description:"

> At your convenience, with the accompanying instructions as a guide, will you please prepare a description of your job as you see it. The Personnel Office is anxious to have new job descriptions for all of our people. In your case you certainly know better than we what you do and how it has to be done.

In 1953 White transferred to the National Park Service's Dinosaur National Monument, Vernal, Utah, where he remained as museum geologist and paleontologist until shortly before his death in September 1977. However, his participation in archaeological faunal analysis did not cease with his move to Dinosaur. In the years 1954-1961, Robert L. Stephenson repeatedly requested the detail of White from Dinosaur to the Missouri Basin Project for short periods during the spring, for identification and analysis of faunal materials. In December 1956 Stephenson wrote:

> Our purpose in wishing to have Dr. White detailed to us is that we have a considerable quantity of bone material, recovered from archeological sites in the Missouri Basin over the past years. Dr. White has been very proficient in quickly running through such material for us in the past and making identifications and analyses of these materials. It would greatly facilitate our work here in writing the archeological reports if we could again have him for a short time, in order to work up the backlog of such material.

To White, he wrote in February, 1957:

> We will plan on seeing you about the end of March. Meanwhile, the bones are piling up now that everybody has gotten wise to the fact

> that you are going to be with us for a short time this spring. They are all wanting to send their bones in to us. So far, I have accepted all comers. Alan Woolworth has a couple of bones from North Dakota; Gus Kivett has some, then of course we have the big mass of stuff from Dave Baerreis' dig last summer, plus our own. Almost all of this stuff, however, is in large lots and shouldn't take a terrific amount of time to run through.

In some cases, White's identifications were acknowledged and included, at least in summary, in published or unpublished faunal reports (cf. Kivett and Jensen 1976, Appendix D, pp. 94-96; Miller 1964, Appendix 2, pp. 233-237). In other instances, White's identification sheets are contained in RBS site files, but have never been reported.

Recovery and Retention of Faunal Materials

It became RBS practice, promoted by White, to discard, either in the field or following analysis, bones considered to be "unidentifiable" or not useful for analysis. In a paper entitled "Studying Osteological Material", first published in the Plains Anthropological Conference News Letter (White 1953; see also White 1956:401-404), White, in addition to suggesting a methodology for identification and analysis of faunal materials, made the following comment:

> Many archaeologists, because they have not given the problem much thought, do not know which elements are identifiable and which are not, and in order to play safe they bring everything in. Others, because they lack the moral courage to make a decision, bring in everything and justify their action by boasting of the capabilities of the physical anthropologist. They forget

> that physical anthropologists deal with minute differences of only a single species while paleontologists and zoologists deal with only slightly greater differences in several hundred species. They also forget that certain elements of the human skeleton, such as ribs, have no more utility for the physical anthropologist than animal ribs do for the zoologists.
>
> Since all terrestrial vertebrates are constructed on the same fundamental plan, a course in elementary physical anthropology or comparative anatomy should furnish an adequate background for separating the identifiable and unidentifiable material. Such a separation can be made in the field when the materials is being packed for shipment or in the laboratory when it is being washed to recheck for use as an implement. The discarding of the unidentifiable material will save at least 50 percent of identification time. (White 1953:9).

White then listed those elements or element portions which he considered "Identifiable Material", including:

> Skull fragments, jaws, hyoid, vertebra with most of the neural arch, glenoid portion of the scapula, pelvis if nearly complete, limb bones if one end is complete, foot bones, metapodials if one end is complete and phalanges.

"Unidentifiable Material" included ribs, "fragments of the shafts of limb bones," scapula fragments, vertebral centra and dorsal spines, and "immature limbs without the epiphyses." In a letter to Don Hartle (January 16, 1952) concerning faunal remains from Rock Village (32ME15) White voiced a somewhat different stance:

> Lehmer assured me that he brought in all bone with one good end. Even at that his unidentifiable scrap was between 30 and 40 percent while yours ran around 80 percent (by the numbers). However, it is nothing to loose sleep over--you're erring on the right side. "When in doubt bring it in" is a pretty good rule to follow.

In some instances, White himself discarded bone fragments following identification (memo to Field Director, MRBS, March 28, 1952):

> Enclosed are the bone identification sheets for the 22 boxes of animal bones sent in last month. According to instructions from Dr. Roberts the unidentifiable scrap has been discarded. The bird bone and dog bones from 39CH7 has been segregated and placed in a separate box. That from the other sites has been segregated but placed in the original box with the other bone. The small carnivores and rodents have been turned over to the Division of Mammals. The other materials will be returned to you in the near future.

The effects of these practices on resultant vertebrate and more specifically canid collections retained by the River Basin Surveys program, and later transferred to the National Museum of Natural History, are discussed in Chapter VI.

Butchering Analyses of Plains Faunal Materials

It is widely recognized by zooarchaeologists (cf. Binford 1981; Falk 1977) that White's studies of Native American butchering techniques were enormously influential in the development of analysis of vertebrate faunal remains in North America. Falk noted (1977:152), "As the first individual to systematically consider animal bones from Plains sites, White played a key role in defining and shaping research problems which have been the focus of investigative effort for a quarter century." Binford (1981:89) noted "Most of the research oriented toward the 'reconstruction' of prehistoric butchering practice stems directly from the seminal work of Theodore E. White".

White defined a series of research problems which might be addressed through the analysis of vertebrate faunal remains, and suggested a methodology for their analysis. These included analysis of the age at which animals were killed, based on tooth eruption and wear and epiphyseal fusion, indicating selective hunting; and relative abundance of skeletal elements for individual species, which could be used to infer portions of a carcass left at a kill site or brought back to the camp or village. He also noted that bone breakage patterns might be defined. Analysis of relative representation of left/right and front/hind elements within a species, White suggested, might indicate differential distribution of carcass elements to family units and/or lodges, and thus aid in identification of village social organization.

He suggested a methodology for determination of minimum number of individuals based on maximum numbers of left and right elements, and in his initial publication in the Plains Conference Newsletter (White 1953:62-66) provided a table of average meat yields for commonly recovered species of mammals and birds, based on average live weights and generalized percentages of "edible meat."

In a series of articles concerning "The Butchering Techniques of Some Aboriginal Peoples" (White 1952b, 1953, 1954, 1955) he employed these techniques in analysis of bison, deer, antelope, elk, and canid bones from a series of sites in North and South Dakota.

Analysis of Canid Materials

With widescale excavation of Middle Missouri village sites, the quantities of large canid skeletal material in Plains archaeological assemblages drew attention to the role of domestic dogs in Native American life. In November, 1957 R. L. Stephenson wrote to White:

> I wrote to Dr. Olaus Murie about the dog material, and just now had a very delightful letter from him in response. He doesn't feel that at this time he can tackle the proposition for us, but assures me that he has a continued interest in dogs, and will be interested in what we will be able to come up with, one way or another, from our collections.

White himself became interested in the large canids from the Middle Missouri villages, and in 1957 wrote a short article entitled "The Large Dogs of the Earth Lodge Peoples" (White 1960).

The collection and segregation of large canid bones from Plains archaeological excavations continued, as noted by Stephenson in a letter (March 23, 1961) to Frank M. Setzler, Curator at the Department of Anthropology, National Museum of Natural History:

> We have again borrowed the services of Ted White for a few weeks here in this office to sort through and identify the accumulated mammal bones from the archeological sites in the Missouri Basin. In the course of his identifications he will be sorting out various kinds of bone for special treatment, and I am hoping that we

may count on you, as in the past, for some of that special treatment in detailed identifications.

The point that particularly comes to my mind is the matter of dog bones. I know you have been interested in the various kinds of dog bones we have been getting in the various sites over the years. About three years ago you were interested in the very large dogs that we had found. At that time we transferred all our dog bone on hand to the Division of Archeology with the understanding that when and if you were interested, and could find time, Waldo Wedel would transfer it down to you for further study. I gather that nothing further has been done with this material. I am wondering now what we should do with the material we have in the present batch that Ted is identifying. Would you, in the reasonably foreseeable future, have time to make any study of these dog bones? If so, I can ask Waldo to transfer the 9 cartons that he already has on hand down to your division and I can send the several cartons in the current batch directly to you early in the summer. On the other hand, if you don't feel you have the time or the inclination to work with this material, I think perhaps the best thing for us to do would be to keep it here in the hopes that later on you might be able to do something with it.

The canid materials discussed in the above letter were never transferred or studied. They remained in the uncataloged collections of the Smithsonian Institution, Division of Archaeology, later the Department of Anthropology, where they were stored in the "attics" of the Natural History Museum building on the Mall. They were "rediscovered" by Melinda Zeder and Darcy Morey in the 1980s. At that time they were removed from the attics, decontaminated, and formally transferred to the Department of Anthropology. A portion of these materials forms the basis for the present analysis. Further details concerning the sites represented are presented in Chapters V and VI.

CHAPTER V

THE SITES AND FAUNAL ASSEMBLAGES

Site Descriptions and Excavation History

The Sommers Site (39ST56)

Site Description and Excavation History. The Sommers site (39ST56) is one of the earliest Plains Village sites in the Middle Missouri subarea. It is an Initial Middle Missouri village located on a high terrace above the east bank of the Missouri River in Stanley County, approximately 24 miles southeast of Pierre, South Dakota. The site consists of more than 100 shallow house depressions. A fortification ditch encircles a portion of the village. The site covers approximately 27 acres, and the terrace on which it is located falls steeply 100 feet to the original river floodplain below. Several ephemeral stream channels pass near the site, only one of which still carried water at the time of excavation (Steinacher 1990:39).

Limited archaeological testing was done at the Sommers site in 1947-1949 by the University of South Dakota Museum and the South Dakota Archaeological Commission under the direction of Elmer E. Meleen. Meleen excavated parts of two long rectangular house floors and a number of cache pits located within the fortification ditch which he presumed to be the oldest portion of the village. The house floors occurred at depths of five to seven feet below surface.

In 1963, in conjunction with the River Basin Surveys program in the area of the Big Bend Reservoir, test excavations were conducted by a Smithsonian Institution crew under the direction of J. J. Hoffman. Major excavations by the Smithsonian/RBS were conducted under the supervision of Richard E. Jensen in 1964-1965. Five earth lodge floors and portions of three others were excavated. Six test units were placed in midden areas, across the fortification ditch, and between observed lodge depressions (Jensen 1965; Steinacher 1990:43; Stephenson 1964:97-99; Missouri Basin Project Weekly Reports - Field Party No. 5, 1964-1965).

After removal of 2 to 2.5 feet of overburden by power equipment in test areas, exposed house depression fill was further reduced by machine stripping to approximately one foot above the house floor. The house fill was then excavated by shovel, but was not screened. Recovered cultural materials and faunal remains were segregated by general fill (occurring in fill more than one foot above the house floor), house floor (occurring in the one foot immediately above the house floor), associated nearby midden areas and features, backdirt, and surface finds.

Excavated houses were long-rectangular in outline, ranging in size from 39 to 47 feet long, and 21 to 25 feet wide. The outer walls were supported by lines of wall posts, with additional support and/or partition posts along and adjacent to the center line of the structure. Multiple shallow basin-shaped fire pits and undercut subterranean storage pits were also encountered on or beneath the house floor. A total of 1176 features and/or test units was excavated; over 700 of these were postmolds associated with house floors.

A series of early dendrochronological dates and two radiocarbon dates from the Sommers site range from A.D. 977 to 1631 (Steinacher 1990:80). The majority of these dates were initially used to place the Sommers site in the late prehistoric Plains Village period. However, the wide range of dates, and an apparent contradiction between dendro and radiocarbon dates was noted (Johnson 1977:209-210). Subsequently, six additional samples were submitted for analysis to Beta-Analytic, in association with detailed analyses of the Sommers site materials by the University of Nebraska, Division of Archaeological Research. These dates, at one standard deviation, ranged in age from A.D. 400 to 1150. The wide range of dates obtained from this apparently single component Initial Middle Missouri village has been frequently noted (Caldwell and Snyder 1983; Johnson 1977; Steinacher 1990:78-89; Toom 1992b) but is as yet unresolved. However, based on site stratigraphy, house architectural design, and ceramic seriation, Steinacher posits a rather long period of continuous occupation at the Sommers site by prehistoric Initial Middle Missouri peoples, with a gradual reduction in village size into an area in the midst of the village which was then encircled by a fortification ditch (Steinacher 1990:87-89, 220-236). Johnson (1994:307) places occupation of Sommers at the beginning of the Initial Middle Missouri period, from approximately A.D. 1000 to 1100.

Faunal Materials Reported. The Smithsonian/RBS investigations at the Sommers site did not result in a published report. A detailed reanalysis of the Sommers materials is currently being completed (Falk, Steinacher and Johnson, n.d.). A summary of taxa present in the Sommers faunal assemblage (Semken and Falk 1987:289-290) indicates that a range of small mammals including rabbit, ground squirrel, prairie dog, pocket gopher, beaver, muskrat, swift fox, weasel, badger, and striped skunk are represented in the site assemblage, along with large canids, bison, elk, deer, and antelope.

The Crow Creek Site (39BF11)

Site Description and Excavation History. The Crow Creek site is a two-component fortified earthlodge village located on the east bank of the Missouri River in Buffalo County, approximately 11 miles north of Chamberlain, South Dakota (see Figure 1). The high, triangular terrace point on which the village is located is cut by two small creeks, Crow Creek to the south and Wolf Creek to the west.

Remnants of two fortification ditch/bastion lines cross the remaining side of the terrace point. The site covers approximately 18 acres, and in 1954 contained 48 still visible earth lodge depressions. Archaeological site 39BF4, also named Crow Creek, lies immediately to the north of the main village area.

Excavations at the Crow Creek site were conducted by the Nebraska State Historical Society under the field direction of Marvin Kivett (Kivett and Jensen 1976). Five square to rectangular Initial Coalescent house floors and one long rectangular Initial Middle Missouri house depression were completely or partially excavated. Test excavations were placed in areas of village midden deposits and across both the outer and inner fortification ditches. Test excavations were 10 foot units excavated by shovel and trowel in arbitrary six inch levels. When a house feature was encountered and delimited, power equipment was used to remove remaining overburden from the area. The remaining fill was then hand excavated. The matrix from storage pits, one house excavation (House 5) and "dense midden deposits" was dry-screened through 1/4" mesh (Kivett and Jensen 1976).

Two major occupational components were recognized at the Crow Creek site. The earlier component, labeled the "Crow Creek" occupation by the excavators, occurred at a depth of 48 to 60 inches below the modern surface, with a maximum thickness of 41 inches, and represents an Initial Middle Missouri component. The later "Wolf Creek" occupation zone occurred at approximately 31 to 40 inches below surface, and varied in thickness from 1 to 12 inches. This upper zone contained the remains of square to rectangular Initial Coalescent house floors.

Six house floors were completely excavated, Houses I through V (Initial Coalescent) were square to slightly rectangular, from 19.5 to 41 feet on a side, with exterior entrance passages oriented toward the southwest, central fire hearths, four central support posts, and one or more internal subterranean storage pits. House VI was rectangular in outline, 58 feet by 25 feet, with post holes concentrated along the side walls, hearths and larger post molds along the center line, and subterranean storage pits. House VI is assigned to the earlier Initial Middle Missouri component of the site. A total of 223 features was identified and excavated within and beyond the house floors, and included hearths or fire pits, underground storage pits, shallow depressions or pits, and midden areas (Kivett and Jensen 1976: 30-37).

There are two radiocarbon dates from the Crow Creek site (Kivett and Jensen 1976:65-67). A charred post from House IV (Initial Coalescent) was dated 560±150 BP (A.D. 1390, uncorrected) (University of Michigan No. M-1079a). A charcoal sample from a preserved post in House VI (Initial

Middle Missouri) produced a date of 900±200 BP (A.D. 1050, uncorrected). Johnson (1994:309, 320) places the Initial Middle Missouri component at Crow Creek at around A.D. 1000-1150. The Initial Coalescent component at the site, ca. A.D. 1300-1400 culminated in the massacre of village inhabitants by another Native American group, sometime in this 100 year period.

In 1966 the Crow Creek site was designated a National Historic Landmark and entered into the National Register of Historic Places. At the western margin of the outer fortification ditch, along the margins of Wolf Creek, human skeletal materials were discovered in 1978, exposed by the continued erosion of the fortification ditch. Subsequent archaeological excavations in this area, conducted by the University of South Dakota under the direction of Larry Zimmerman and Thomas Emerson, recovered the commingled skeletal remains of a minimum of 486 Initial Coalescent individuals, the victims of a raid and massacre at Crow Creek. Analysis of the recovered human skeletal material by John B. Gregg and P. Willey indicated that the remains were probably those of a Caddoan speaking, Initial Coalescent group who show osteometric affinities to the Central Plains St. Helena focus and later historic Arikara groups (Willey 1982, 1990; Zimmerman and Bradley 1993; Zimmerman et al. 1981). Numerous examples of cut marks, fractures, and tooth evulsion were noted on the Crow Creek cranial materials, and postcranial elements exhibited cut marks on limb bones as well.

After the attack in which the Crow Creek villagers were killed, their remains lay exposed on the ground surface for a relatively short period, perhaps several months, before being collected and deposited in a cone-shaped pile in the village fortification ditch. Following laboratory analysis in 1979, all human skeletal materials were returned to the Crow Creek Sioux Reservation, where they were reburied in August 1981 within the village perimeter.

Ethnohistoric Documentation. Lewis and Clark apparently visited the vicinity of the Crow Creek site in September 1804, although they make no mention of observing the abandoned village. Their journal entry for September 19 states:

> Set out early, a cool morning verry clear the wind from the S.E. a Bluff on the L.S. here commences a Butifull Countrey on both Sides of the Missouri, passed a large Island called Prospect Island opposit this Isd. the 3 rivers Coms in, passing thro a butifull Plain, here I walked on Short & Killed a fat Cow & Sent her to the boat and proceeded on to the first of the 3 rivers, good deel of water. I walked up this river 2 miles & cross, the bottom is high and rich Some timber, I crossed & returned to the mouth, & proceeded up one mile to the 2nd. river Wolf Creek which is Small 12 yards wide, and on it but little timber, on this Creek the Sioux has frequently camped, as appears by the Signs, but lands between those two Creeks is a perpendicular bluff on about 80 feet with a butifull Plain & gentle assent back (Thwaites 1904:156).

Faunal Materials Reported. Faunal materials from the site were briefly discussed by Kivett and Jensen in an

Appendix to their site report (Kivett and Jensen 1976). In this Appendix they note:

> Because of the enormous quantity of bones recovered, certain pieces were discarded in the field. The discarded materials consisted of ribs and bone fragments which would be difficult or impossible to identify. Of course, any bone showing evidence of use or of having been cut or purposefully broken was saved (Kivett and Jensen 1976:94).

T. E. White identified the mammal materials from Crow Creek, J. P. E. Morrison identified mollusks, and David H. Dunkel identified the fish remains. Bird remains had not yet been identified in 1976. Identified taxa included "twenty-three different mammals, eleven mollusks, two turtles, two fish, and one "snake", however, no table of identified species, or number of identified specimens (NISP) was presented. Kivett and Jensen noted that bison were the taxon most consistently represented, followed by deer and antelope. Bones of elk and black bear were identified; other "more common" small animals included prairie dog, cottontail rabbit, beaver, and skunk. Swift fox, red fox, jackrabbit, plains pocket gopher, muskrat, badger, mink, least weasel, woodchuck, thirteen-lined ground squirrel, painted turtle, snapping turtle, snake, catfish, and sucker were also identified.

Large canid remains were also noted:

> Dog (<u>Canis familiaris</u>) bones were found in 38 percent of the features from both components, and coyote (<u>Canis latrans</u>) was found in 41 percent of the Crow Creek features assigned to the Wolf Creek occupation. Detailed studies concerning the types or breeds of dogs have not been made, nor is there

any definite evidence to suggest that these animals were used as food (Kivett and Jensen 1976:95).

The Bamble Site (39CA6)

Site Description and Excavation History. The Bamble site is a fortified Post Contact Coalescent period village located on a high terrace on the east bank of the Missouri River in Chambers County, approximately six miles north of Mobridge, South Dakota. The site covered approximately 6.5 acres and was surrounded on three sides by a fortification ditch, with 29 house depressions visible within and 12 outside the fortification system. A seasonal stream passes nearby (Baerreis and Dallman 1961:107).

Fieldwork conducted at the site in 1956 by the University of Wisconsin, under a contract with the Interagency Salvage Office of the National Park Service, included excavation of three house depressions, one within and two outside the fortification ditch, plus test units placed in midden areas and across the fortification system. If excavation techniques were similar to those employed at the nearby Spiry-Eklo site, also excavated by the University of Wisconsin during the same field season, test units were 10 foot squares, dug in arbitrary six inch levels. Midden fill above house depressions was removed as a single unit to a level six inches above the house floor. The six inches of matrix immediately above the floor was then hand excavated as a single unit. Houses were circular in outline with elongated entryways and internal storage pits and hearths.

Based on the presence of Euroamerican trade materials and the analysis of the ceramic and bone tool assemblages recovered, Baerries and Dallman concluded that Bamble had been occupied by several succeeding Le Beau phase groups, who were related to the historic Arikara. In at least two instances house floors were superimposed on earlier earthlodge floors. In one instance the earlier floor was separated from the later by "4 inches of sterile midden" with the later house reusing posts from the former. The earlier house showed evidence of burning. Despite this evidence of continued occupation of the site, the excavators noted "relatively little change" in the artifact assemblage through time, with trade goods, scapula hoes modified by metal tools, and bone handles for metal blades present in all excavated areas of the site. Johnson (1994:337, 342) places the initial occupation of the Bamble site at approximately A.D. 1650. By around A.D. 1750 it had probably been abandoned.

In 1963 Alfred W. Bowers visited the site, while conducting excavations at the Larson site (39WW2), and conducted a surface collection in the village area.

Faunal Materials Reported. Analysis of the faunal materials from the University of Wisconsin excavations was not completed at the time of publication of the Bamble site report. The authors of the report noted, however:

> A considerable amount of bone refuse was also collected which was sent to the River Basin Laboratory at Lincoln, Nebraska, together with materials from 39WW3 and 39WW10. Information has not been received at the time this report was written (Baerries and Dallman 1961:114).

The Spiry-Eklo Site (39WW3)

Site Description and Excavation History. The Spiry-Eklo site is a fortified earthlodge village located on a low terrace on the east bank of the Missouri River, approximately one mile south of the town of Mobridge, South Dakota. The site covered approximately 10 acres, extending some 900 feet east to west and 600 feet north to south along a narrow ridge ten feet above the lower river terrace.

The site was investigated by Baerreis and Dahlman, University of Wisconsin, during the same excavation season in which the Bamble site was excavated. Excavations included testing of midden areas and complete excavation of two house floors. Test units were begun as 10 foot squares, excavated in arbitrary six inch levels. In the excavation of house depressions, the overburden was removed as a single unit to within six inches of the house floor. The remaining six inches of matrix was then removed by hand and shovel as a single unit. Excavated houses were circular in outline, with short extended entryways, central fire hearths, and internal subterranean storage pits (Baerreis and Dallman 1961). Two apparent fortification ditches were also identified and tested.

The excavators note "a lack of pronounced ceramic trends" in the excavated portions of the Spiry-Eklo site. They do, however, note some change through time in the number and type of bone tools present. On the basis of this information excavated features were divided into early, middle, and late components, although Euroamerican trade materials were present in all features. In their final analysis, the site is grouped with the Bamble site (39CA6) as a Le Beau focus occupation, probably related to the historic Arikara. Johnson (1994:340, 344) places the initial occupation of Spiry-Eklo after the abandonment of both Bamble and Larson, around A.D. 1700 to 1750. He suggests it was abandoned by 1785, some 50 years later, possibly as a result of a 1780-1781 smallpox epidemic.

Faunal Materials Reported. Faunal materials from the Spiry-Eklo site were sent, along with the assemblage from Bamble (39CA6), to the River Basin Survey laboratory in Lincoln, Nebraska, for analysis. However, Baerries and Dahlman noted that results were not available to them at the time of their 1961 publication (Baerreis and Dahlman 1961:114).

The Larson Site (39WW2)

Site Description and Excavation History. The Larson site is a Post Contact Coalescent village of 20 to 25 house depressions surrounded by a double fortification system, located on the east bank of the Missouri River in Walworth County, approximately two miles south of Mobridge, South Dakota. The site is located on a high terrace well above the Missouri River floodplain, near a spring-fed creek.

Smithsonian Institution, River Basin Surveys excavations were conducted at the site in the summers of 1963-1966, under the direction of Alfred W. Bowers (1963-1964) and Jake J. Hoffman (1966). During the 1963 and 1964 seasons three house depressions were excavated and an additional 10 were tested (Current Research 1965, Missouri Basin Project Weekly Reports, Party No. 12, 1963, Party No. 13, 1964). In 1966 Johnson supervised the excavation of a single five foot wide, 150 foot long test trench from the outer limits of the fortification ditch, westward through two fortifications and two house depressions (Current Research 1965, Missouri Basin Project Weekly Reports, 1966).

During Bowers' investigations four house floors were completely excavated; test units were excavated in an additional 10, and across portions of two fortification ditches. In some instances, soil matrix was dry-screened through one-half inch wire mesh; however, the field records do not note which samples were so treated (Falk and Johnson n.d.). Excavated house floors were circular structures, from 25 to 40 feet in diameter, with projecting entranceways, and contained internal fire hearths and subterranean storage pits.

Extensive excavations were also undertaken in nearby cemetery areas located approximately 300 feet to the north of the village, on a series of low hills, by the University of Kansas under the direction of Dr. William M. Bass (1966-1968). Sponsored by the National Science Foundation and the National Geographic Society, these excavations resulted in the recovery of the skeletal remains of over 600 individuals (Owsley and Bass 1979). In addition, within the village itself the skeletal remains of at least 71 individuals were recovered from within earthlodges and subterranean storage pits. The majority of these remains were found in three earth lodges, resting on the lodge floors. The skeletal materials showed evidence of burning and cut marks. Other premortem and perimortem injuries indicated that they represent individuals who died during an attack on the village. After death their bodies remained where they fell and were subsequently covered by the burning and collapse of the lodges (Owsley, Berryman, and Bass 1977).

Ceramic analysis and Euroamerican trade goods recovered in the village excavations indicate that the Larson village was continuously occupied by one or more Post-Contact Coalescent groups from around A.D. 1680-1730 (Falk and Johnson n.d.).

<u>Faunal Materials Reported</u>. No excavation report was completed for the Larson site; however, a detailed analysis of faunal materials is currently being undertaken (Falk and

Johnson n.d.). Several of the more complete canid crania from the site were assessed by Morey (1986) in his craniometric analysis of large canids from the Northern Plains.

The Leavenworth Site (39CO9)

Site Description and Excavation History. The Leavenworth site is located on the west bank of the Missouri River in Corson County, South Dakota, approximately five miles above the confluence of the Grand River with the Missouri. The site consists of two adjacent earth lodge villages located on the first Missouri River terrace about 70 meters above the original river floodplain. The two village locations were separated by Cottonwood Creek, a small seasonal stream which entered the Missouri River floodplain immediately in front of the village area. Each village consisted of from 60 to 80 lodges located along the terrace edge for approximately 450 yards; these circular earthlodges ranged from 25 to 60 feet in diameter. Both villages were surrounded by a fortification ditch and palisade system.

Burial complexes located on nearby hills to the north of the villages were partially excavated by Stirling and Over in 1924 (Wedel 1955), and later by the University of Kansas under the direction of William M. Bass (Bass, Evans and Jantz 1971).

In 1932 W. D. Strong excavated a series of test trenches and four earth lodge depressions at Leavenworth (Strong 1940). Under a contract with the National Park Service, the University of Nebraska conducted excavations at the Leavenworth villages in the summers of 1960-1962 under the direction of Preston Holder. The University of Nebraska investigations included the excavation of portions of 4 midden areas, 7 house depressions, 34 external storage pits, and test units within the village areas and across supposed fortification ditches. The overburden above earth lodge depressions was removed to a level approximately 1/2 foot above the lodge floor. Below this level all matrix was removed by hand and all observed features were "excavated, mapped, recorded, and photographed" (Krause 1972:22). There is no indication in the published site report that excavated matrix was screened.

Excavated earth lodges were rounded structures supported by four centrally located support posts placed around one or more central fire hearths. Analysis of house form and ceramics supports ethnohistoric data which indicate that both villages at the Leavenworth site were occupied by the historic Arikara.

<u>Ethnohistoric Documentation</u>. The Grand River Arikara villages are among the best documented in the ethnohistoric literature. By 1804, following repeated occurrences of epidemic disease, a much diminished Arikara population had

moved down the Missouri River from areas in North Dakota where they had formerly lived near the Mandan, to establish three fortified villages near the Grand River. In 1804 Pierre Antoine Tabeau noted that the Arikara were living in two west bank villages near the Grand, plus a third village on an island a league below the first two. He also noted extensive gardens on the river island and along the floodplains adjacent to the villages (Abel 1939:149-150).

Lewis and Clark observed the villages on their way up and down the Missouri in 1804 and 1805, and reported that the village inhabitants were growing gardens of maize, beans, and squash on the island site (Thwaites 1904:186-187).

Bradbury and Brackenridge both stopped at the Grand River villages in 1811, and found the river island village abandoned. They noted that the villages were located near bison spring/fall migrations routes (Bradbury 1904:140-141). They estimated the population of the villages to be approximately 2000 (Brackenridge 1904:11).

In 1823 the villagers took part in an armed dispute over trading rights with fur traders who were under the command of General H. L. Ashley. As a result of this encounter, Col. Henry Leavenworth and troops of the U.S. Army 6th regiment, aided by irregulars from the Missouri Fur Company and approximately 500 Sioux mercenaries, attacked and shelled the villages but were unable to overrun them

(Morgan 1953:69, 1964:27). Nevertheless, the Arikara temporarily abandoned the villages, again moving north to the vicinity of the Mandan villages in North Dakota. Soon after their departure the villages were burned. The following year, in 1824, the Arikara returned to the Grand River villages, and it was at these villages that they signed the Atkinson-O'Fallon peace treaty in 1825 (Reid and Gannon 1929:7-8).

In 1823 George Catlin passed the Leavenworth villages on his way up the Missouri and both sketched and described them:

> Plate 80 gives a view of the Riccares village, which is beautifully situated on the west bank of the river 200 miles below the Mandans; and build very much in the same manner being constituted of 150 earth-covered lodges surrounded in part by an imperfect and open barrier of pirquets set firmly in the ground and of 10 to 12 feet in height (Bushnell 1922:173).

However, when Maximilian passed the villages in the spring of 1833 he found them deserted and the fortifications partially fallen down (Maximilian 1906:335-336). The villages were thus probably occupied for no more than 30 years, from 1804 to 1833.

<u>Faunal Materials Reported</u>. Faunal materials from the Leavenworth site were not examined by T.E. White. They are mentioned only briefly in Krause's 1972 report:

> Our faunal sample consists of those bone definitely associated with lodge floor and cache pit debris. No attempt was made to save all bone encountered in the village refuse mantle, and our sample is thus far from complete. For economy of presentation, we decided

> to compute the number of individuals of a given kind of animal per cubic foot of debris.
>
> The faunal remains were identified by students at the University of Nebraska who compared the archeological specimens with an identified type collection. Since we lacked personnel familiar with the intricacies of making the observations and fine discriminations necessary for specie and genus distinctions, we decided to present the identifications by common name only, i.e. bison, deer, elk, rabbit, etc (Krause 1972:86).

A footnote states that the determination of MNI "was based upon a recorded volume of 127,767 cubic feet of debris moved during excavation". The results, presented in a graph (Krause 1972:87), indicate that bison bones were the most frequently recovered taxa, apparently occurring with a frequency of approximately 1.06 MNI per cubic feet of debris (matrix?). Other taxa identified, in descending order of abundance are: deer, dog, bird, antelope, fish, horse, turtle, elk, beaver, badger and cat (Krause 1972:86-87). Although these graphed data are difficult to interpret, it would appear to translate into MNI's of approximately 135 bison, 74 deer and 71 dogs. Thus deer and dog skeletal materials were apparently recovered in approximately equal numbers, while bison bones were nearly twice as common as either of the former.

Canid Skeletal Materials Considered in the Present Analysis

The Sommers Site (39ST56)

A total of 1161 large canid elements was recovered from the Sommers site (39ST56). These specimens were recovered from stratigraphic excavations in arbitrary 0.5 foot levels above observable earthlodge depressions (259 specimens, 22.3% of the assemblage), subsurface pit features (162 specimens, 13.9% of the assemblage), and house fill matrix from directly above and upon the earthlodge floors (379 specimens, 32.6% of the assemblage). An additional 238 specimens (20.5% of the assemblage) came from post hole features, a large exploratory test, and miscellaneous contexts. Eighty-three additional specimens are from unknown contexts.

Approximately 42% of recovered elements were cranial or axial (vertebrae, sacra, ribs) elements (493 specimens); 370 elements (31.9%) were from the upper front (scapula, humerus, radius, ulna) and hind (innominate, femur, tibia, fibula) limb, and 290 specimens (25.0%) were those of the foot (carpals, tarsals, and phalanges) (Table 2). A minimum of 35 animals are represented, including one nearly complete juvenile or puppy skeleton recovered from Excavation Unit 17.

A total of 189 elements from the assemblage (16.3%) exhibits cut or chop marks, and four elements are partially burned. Seventy-nine elements were gnawed by carnivores and one element was rodent gnawed.

Table 2. Frequency of Large Canid Skeletal Portions from Six Sites in the Middle Missouri Subarea.

Skeletal Portion					
39ST56	39BF11	39CA6	39WW2	39WW3	39CO9
Crania					
32/3.1%	58/6.2%	49/7.8%	152/6.1%	45/4.9%	45/7.8%
Mandible					
68/6.6%	42/4.5%	127/20.3%	215/8.6%	57/6.4%	51/8.8%
Vertebrae					
268/26.1%	174/18.6%	94/15.0%	656/26.2%	172/19.2%	143/24.7%
Upper Front Limb					
215/20/9%	186/19.9%	177/28.3%	419/16.7%	191/10.2%	150/25.9%
Upper Hind Limb					
155/15.1%	130/13.9%	114/18.2%	313/12.5%	139/15.5%	112/19.4%
Feet					
290/28.2%	345/36.9%	65/10.4%	748/29.9%	290/32.4%	77/13.3%

The Crow Creek Site (39BF11)

A total of 1024 large canid elements was recovered from the Crow Creek site. Based on provenience and cultural historic designations provided in the published site report (Kivett and Jensen 1976), 381 canid elements (37.2%) are from the earlier Intital Middle Missouri or "Crow Creek" occupation and approximately 44% of the assemblage (453 specimens) were recovered from the later "Wolf Creek" or Initial Coalescent occupation. The remaining 190 specimens (18.5%) were recovered from mixed or unassigned contexts.

Canid materials were recovered from midden deposits (108 specimens, 10.5%), external underground storage pits in midden areas (409 specimens, 39.9%), and house fill and interior storage features (367 specimens, 35.8%). An additional 118 specimens were recovered from test units; 22 specimens came from excavation units placed across the ditch and pallisade fortification system.

In the complete site assemblage, 111 of 1024 elements (10.8%) exhibit cut or chop marks, five elements showed clear evidence of partial burning, and 81 specimens were carnivore gnawed. In the Initial Middle Missouri canid assemblage of 381 elements, 39 elements (10.3%) were cut. Thirty-nine of the 453 Initial Coalescent component (8.6%) elements also bore cut marks.

Recovered elements were about evenly distributed by body segment. Three hundred and sixty-three elements

(35.4%) were from the head and axial skeleton, 316 elements (30.9%) were upper limb elements, and 345 elements (33.7%) were from the feet. A minimum of 20 animals are indicated in the site assemblage, including at least five partial skeletons of very young animals or puppies. A minimum of eight individuals are represented in the earlier Initial Middle Missouri assemblage; at least 11 individuals are indicated in the Initial Coalescent component assemblage.

<u>The Larson Site (39WW2)</u>

A total of 2613 large canid elements was recovered from the Larson site. Approximately 33% of the canid assemblage (876 specimens) was recovered from six lodge excavations; 502 specimens (20.5% of the assemblage) were recovered from storage features within the village midden deposits. Nearly 40% of the canid assemblage (1033 specimens) was from general excavation or test units, and 110 specimens (4.2%) were collected from the site surface. The provenience of 92 specimens could not be determined.

A total of 1114 elements (42.6%) from the Larson site is from the head and axial skeleton. Upper limb bones constitute 28% of the assemblage (732 specimens), while 748 elements (28.6%) are those of the foot.

A minimum of 79 animals are indicated for the site as a whole. If house fill and all below ground features are considered discrete depositional contexts for the purposes of minium numbers calculations (cf. Grayson 1984), at least 138 animals are indicated in this assemblage.

Seven hundred and eighty-seven elements (30.1%) were cut and 18 elements were partially burned. Carnivore gnawing was noted on 206 elements; six elements had been gnawed by rodents, and one element appears to have been eroded by partial digestion.

The Bamble Site (39CA6)

The large canid assemblage from the Bamble site consists of 636 specimens recovered during two site investigations. The University of Wisconsin excavations in 1956 produced 143 specimens (22.5% of the assemblage) from excavated earthlodge depressions and test excavations placed in the area of the fortification ditch.

Approximately 75% of the assemblage (493 specimens) is from the Alfred Bowers 1963 surface collection; collection lots were designated by sequential three digit numbers. During the 1963 summer field season, while working at the Davis Creek and Larson sites, Bowers and his field crew spent three days conducting a surface collection at the Bamble site which had been partially inundated by the rising waters of Lake Oahe.

Bowers' weekly report of 29 June 1963 (Missouri Basin Project, Weekly Field Report, Party 12, # 3) provides a general description of the condition of the site at that time and the collection procedures and objectives:

> Tuesday afternoon I drove up to the Bamble site 39CA6 which was worked by the Wisconsin crew in 1956 and site 39CA4 which Dr. Strong and Dorothy Frazier did some work in about 1936 and I worked between 1957 and 1959 to observe the effects of wave action there. Pothunters had been active along shoreline but there were huge quantities of faunal materials and pottery sherds so I put a half-crew in Bambles on Wednesday picking up and boxing bones and sherds. We even used rakes in shallow areas to recover much pottery.
>
> Hoping that rain would come soon and make following of lodge floors at Davis easier, I put the whole party in the Bamble site on Thursday, continuing to collect according to areas of the village which had been inundated. This site has a new area within a central ditch, and an old area even further out from the center. Pottery was collected and identified by area and statistically we seem to find about what is suspected to have been the type changes through time.
>
> Rygh site being little damaged as yet by wave action but cut up by pot hunters, I put a half crew in each site on Friday. Both sites have now been cleaned of most useful faunal and cultural objects and the salvaged materials are in excess of 80 boxes. In picking up faunal materials, especial care was taken to get bones of the smaller animals and birds as well as the more common species of buffalo, antelope, etc. so that the collection will be truely representative of both species present and their relative proportions.

The spatial dimensions and methodology of Bowers' 1963 surface collection at the Bamble site are unclear. No notes on the size and placement of his collection units are contained in the current site files. It is unclear whether materials were collected in a lineal series of units along the rising lake margin, or across some portion of the site still exposed above the lake waters. Therefore, this assemblage is considered for the purposes of this analysis, as a single surface collection.

The Bamble assemblage is strongly dominated by cranial and axial elements (270 specimens, 42.4% of the assemblage), and upper limb elements (291 specimens, 45.7%). Foot bones (carpals, tarsals, metapodials and phalanges) comprise less than 12% of the recovered assemblage (75 specimens, 11.8%).

A minimum of 55 animals are represented in the combined site assemblage, based on left mandibles and mandible segments. Bowers' surface collection alone represents a minimum of 45 animals based on right mandibles and mandible segments. The high proportion of mandibles in the Bowers collection (109 of 493 specimens, 22.1%) suggests that work crews were especially careful to collect all observed mandibles and mandible segments, perhaps due to their perceived diagnostic and analytic potential. In contrast, a minimum of 22 animals are indicated by appendicular elements, based on right radii.

In the canid assemblage recovered during University of Wisconsin field work, from one to five animals are represented per feature.

A total of 273 of 636 specimens from the Bamble site (43.1%) show cut or chop marks and three elements are partially burned. Sixty-seven elements are carnivore gnawed and two elements are rodent gnawed.

<u>The Spiry-Eklo Site (39WW3)</u>

A total of 894 large canid specimens was recovered during University of Wisconsin archaeological testing and excavations at the Spiry-Eklo site in 1956.

Approximately 30% of the assemblage (267 specimens, 29.9%) was recovered from the excavation of two circular earthlodge depressions and three interior underground storage features. One hundred and twenty-six specimens (14.1% of the assemblage) were recovered from exterior subsurface pit features. The remaining specimens are from excavation and test units in midden areas. Seventy-two specimens are from excavations placed across the fortification ditches, and 11 specimens are from unknown or undefined contexts.

Skeletal elements are about evenly divided by body portion. Approximately 30% of recovered elements (274 specimens, 30.6%) are from the crania and axial skeleton; 330 upper limb elements (36.9%) were recovered, and 290 specimens (32.4%) are from the feet or paws.

A minimum of 29 animals are represented in the site assemblage as a whole. If minimum numbers are calculated by feature and earthlodge excavation, a minimum of 43 animals are indicated for the site.

A total of 272 elements (30.4% of the assemblage) exhibit cut or chop marks and 13 elements are partially burned. One hundred and fifty-one bones had been carnivore gnawed; four had been partially digested by stomach acids.

The Leavenworth Site (39CO9)

A total of 628 large canid bones or bone segments was recovered from the Leavenworth site during excavation and testing by the University of Nebraska in 1960-1962. A reference grid of 500 foot squares was used during excavation, with an existing section line and four permanent grid markers as reference points (Krause 1962:65). All cultural features, tests, and collection units were mapped and numbered with reference to this grid.

Faunal materials were recovered from excavation of house depressions, within structure and exterior features and storage pits, and in midden areas. However, since no provenience information is recorded on specimen storage bags or on individually numbered elements, this collection is therefore considered in this analysis as a single unit.

Cranial material and mandibles make up approximately 18% of the Leavenworth large canid assemblage; vertebrae constitute approximately 25% of recovered materials. Upper front limb elements comprise 25.9% of the assemblage. Upper hind limb elements are 19.4% of the assemblage; elements of the foot or paw represent 13.3% of recovered specimens.

A minimum of 16 animals are indicated in the site assemblage, based on left tibiae. A total of 257 specimens (40.9%) have cutmarks; seven elements are partially burned. Seventy-one elements have been gnawed by carnivores, and three have been partially digested by stomach acids.

CHAPTER VI

MATERIALS AND METHODS

Materials

The excavation, storage, and curation history of the large canid assemblages considered in this analysis is a complex one. It reflects upon and was directly affected by the interests and active involvement of T. E. White in the River Basin Survey program and his analysis of recovered faunal collections. This history is also a result of the interests and goals of site excavators and administrative personnel of the River Basin Survey Program.

The more general history of storage, curation, and ultimate disposition of archaeological faunal assemblages produced by the RBS salvage program to participating institutions, as well as national repositories such as the Smithsonian Institution, has also affected the collections considered in this analysis.

White's interest in archaeologically recovered faunal materials, and more particularly large canid specimens, has been discussed elsewhere (Chapter III). His interest in the large domestic dogs in the Plains led, in some instances, to the separation of their remains from the larger faunal assemblages. These materials, still unstudied, were eventually stored as uncataloged collections in the Anthropology Division at the Smithsonian Institution Natural History Museum. The paper trail for these official or semi-official transfers from RBS field offices to museum storage is murky at best and largely nonexistent.

The canid collections included in the present analysis were formally transferred to the Anthropology Division of the Smithsonian Institution in 1989, and were initially examined during the course of a predoctoral fellowship which forms the basis for this dissertation, conducted at the Smithsonian Institution Natural History Museum from May through December 1992. A summary of additional sites represented in these large canid collections and the number of specimens per site is presented in Appendix Table 1.

Additional canid materials were found in the collections of the University of Nebraska State Museum (UNSM) in Lincoln, Nebraska, during a trip to Lincoln for that purpose in October 1992. Canid materials from the Bamble site (39CA6), the Spiry-Eklo site (39WW3), the Leavenworth site (39CO9), and the Hosterman site (39PO7) were segregated and temporarily transferred to the Smithsonian Institution Natural History Museum to be included in the present analysis.

During the visit to Lincoln, all storage boxes were carefully checked for large canid remains. These materials were removed from storage boxes and field bags and placed in new plastic bags, with all available site and provenience information transferred to the new bags. An inventory of these materials was then submitted to the UNSM with a request for temporary transfer to the Smithsonian Institution for analysis. Upon completion of the analysis these materials will be returned to Nebraska and reincorporated with the larger site faunal assemblage.

In two cases, canid assemblages curated at the Smithsonian were augmented by materials from the UNSM. For the Bamble site (39CA6) 40 large canid specimens, recovered by Baerreis and Dahlman (University of Wisconsin, 1968), were stored at the Smithsonian. An additional 581 specimens, recovered by A.E. Bowers in a surface collection were found in the UNSM collections. Seventy additional specimens from the Bamble site (39CA6), also recovered during the University of Wisconsin investigations, were located in the UNSM collections. The Leavenworth (39CO9) canid assemblage is also in the UNSM collections.

Because many of the canid assemblages curated at the Smithsonian were very small, ranging from a less than 10 to a few hundred elements (see Appendix Table 1), a decision was made to limit the present analysis to collections of more than 500 elements.

From the eight sites with collections of more than 500 specimens, two were rejected on the basis of other criteria. Although the Hosterman site (39PO7) produced a relatively large assemblage of nearly 600 specimens (NISP = 598), a great many of these specimens appeared to be remains of coyote (*Canis latrans*) rather than the larger domestic dog (*Canis familiaris*) and/or wolf (*Canis lupus*). The assemblage from the Sully site (39SL4, NISP = 823) was also excluded from analysis because of the large number of coyote elements, its complex occupational history, and the lack of published or unpublished stratigraphic data (Johnson 1994:149).

The exclusion of these two sites is particularly unfortunate, since it leaves a large gap in the cultural historic sequence of available sites. As a result, of the six sites included in the final analyses, two are very early in the sequence, 39ST56 (Initial Middle Missouri) and 39BF11 (Initial Middle Missouri and Initial Coalescent). Three sites (39WW2, 39WW3 and 39CA6) are identified as Post Contact Coalescent, all dating to around A.D. 1700 to 1800. The final site, Leavenworth (39CO9), was occupied for a relatively short period in the fully historic period (A.D. 1804 to 1832).

Once gathered in Washington the assemblages from all six sites were cleaned, as necessary, using either soft dry brushes or brushes and clear water. They were then identified as to element, side and portion, and data pertinent to the present analysis (e.g. cutmarks, chop-marks, burning, etc.) were gathered.

Methods

Identification

The problem of defining identifiable specimens (sensu Binford 1981) is negligible to non-existent in these assemblages. There were no unidentifiable specimens in the traditional sense. Field recovery techniques (hand picking of excavated matrix) and instructions for the recovery of faunal remains during RBS excavations (cf. Falk 1977; White 1956) emphasized the selective recovery of those "diagnostic" elements and element segments with "at least one good articular end" (White 1956:402). Some of the faunal assemblages may have undergone a further selection process during White's identifications. There are no unidentifiable bone fragments, or long bone shaft segments in any of the assemblages. If a limb bone is less than complete, it has at least one articular end, or is the nearly complete diaphysis of a very young animal, from fetal/neonate to juvenile.

It is also obvious, from inspection of the canid collections curated at the Smithsonian, that White had specifically segregated only two "large canids" (domestic dog (*Canis familiaris*) and wolf(*Canis lupus*) for potential future analysis, excluding bones of the coyote (*Canis latrans*).

Preservation

As with many faunal assemblages from the Middle Missouri subarea, specimen preservation is excellent. In only one site assemblage, 39BF11 (Crow Creek), was there an appreciable number of eroded or weathered specimens. Even in this assemblage, only a relatively small percentage of specimens exhibited evidence of surface erosion severe enough to potentially obscure or obliterate evidence of cut marks or burning.

Cutmarks, chopmarks

In the following descriptions and analyses the marks made on bones by humans using metal or stone tools for skinning, dismemberment, defleshing, or other manipulation of the vertebrate skeleton are referred to as cutmarks, chopmarks, or scrapemarks (cf. Fisher 1995:48).

The examination for evidence of tool marks and burning, as well as marks produced by carnivore or rodent chewing, was conducted in a standardized manner for all specimens. The surface area of each specimen was examined under strong, directional, artificial light from an adjustable goose neck table lamp.

During this initial examination all portions of the element surface were examined, without regard for the likelihood, based on anatomical position, of cut marks occurring in a particular location. Each element was also examined from a variety of angles or perspectives. It soon became evident that, depending on the angle at which a specimen was held and therefore the direction and angle at which the light struck it, light or fine cut marks were invisible at one angle but readily noticeable at another. Each element was therefore turned repeatedly during inspection, while the direction and angle of the primary light source remained steady.

For example, a long bone such as a femur was first inspected along the length of all four aspects (anterior, posterior, medial and lateral) while being held in an "upright" position (e.g. proximal end toward the light). It was then reversed, and the same four aspects scanned with the distal end toward the light. Both epiphyses were then scanned more closely, again manipulating the element to alter the angle of direct light and shadow on anatomical features. This method proved particularly useful in detecting the fine, light cut marks often resulting from the use of a metal tool. This was especially true of marks made when the angle at which the tool edge had struck the bone surface was shallow, causing a thin layer of cortical bone to be "lifted" away from the bone surface, but not completely detached. Binford (1981:105) describes such marks as resulting in "an overlapping small 'shelf' of bone that remains in place", often produced by metal tools with "straight or single-plane cutting edges."

A second factor which proved critical to the detection of the finer cutmarks was the regular use of a hand held magnifier. Rather than a jewelers lens, a Bausch & Lomb "Sight Savers" hand held reading magnifier (2X), with a rectangular viewing lens of approximately 4 X 10 cm, was used. This allowed a larger area of bone to be scanned, from a greater (eye to object) distance, and greatly relieved eye and back strain.

To confirm the thoroughness of cutmark detection with the hand lens, several hundred elements were also inspected under varying magnification using a free standing binocular microscope with an independent light source. After repeated tests it became apparent that careful scanning with the hand lens, under strong directional light, detected virtually all cutmarks and duplication of this process with the binocular microscope was time consuming and largely unnecessary. Thereafter, the hand lens was used consistently with the binocular microscope used only to confirm or reject questionable marks.

The assemblages studied were recovered from archeological contexts of high "integrity" (sensu Binford 1981:19). It is presumed, in these village settings, that a single agent (human) was responsible for the disposition of canid bones in village midden and features. Evidence of non-human involvement with the assemblages is minimal, consisting primarily of the relatively infrequent occurrence of carnivore gnawing marks, presumed to be the result of chewing by village dogs of discarded or scavenged food debris. As Binford (1981:19) noted, "historical integrity" and "relative resolution" do not necessarily covary:

> Resolution of assemblages may vary independently of the degree of integrity. For instance, we might have a deposit with high integrity in that all the included materials are referable to a single agent-hominids. Yet the events and activities that the hominids participated in might span a considerable period of time and represent a wide range of different behaviors, which have in common only the fact that they occurred in the same place.

These assemblages, however, appear to have a high degree of resolution in the sense that they are primarily the result of human consumption and discard behavior within a village setting over a relatively brief span of chronological time. Thus they constitute the discard products of final butchery and consumption, what Lyman (1994:300-301) terms "consumption waste" or "debitage resulting from producing, typically, a meal".

Recording and Quantification of Cutmarks

As cutmarks were identified, they were recorded both descriptively as to anatomical position, and graphically on individual skeletal element outline drawings. These outline drawings show all four aspects (anterior, posterior, medial and lateral) of long bones, plus superior, inferior, anterior and lateral aspects of the skull and vertebrae.

Initially, for ease in recording, both left and right element outlines were used. However, for all subsequent quantifications and analyses, cutmarks on left and right elements were combined on composite left element outlines.

A two step method was devised for defining the locations at which cutmarks occur and recording their frequency of occurrence (see also below, Specimen Coding). As each specimen was examined, it was compared to a set of element outline drawings in which the elements were divided into eight linear segments of equal length. The portion of the element represented was then recorded. By tallying the number of times each one eighth segment of a particular element occurred in an assemblage, the total number of that segment which might have been cut could be estimated. This proved much more sensitive to variation in cutmark location than simple freqencies of cut specimens.

Each observed cutmark was also reproduced graphically in individual drawings or skeletal element outlines. Prior to analysis, a second set of skeletal outlines was produced, with the potential locations of cutmarks demarcated as "zones". The definition of these coding "zones" or bone portions was based on the structure of the element, plus reference to published information such as Binford's 1981 study of butchering, to determine those surfaces or locations which might be likely to incur patterned cutmarks.

The resultant zones were numbered logically and sequentially, beginning with the proximal end of the element, and proceeding to the distal epiphysis. All four aspects of long bones were so divided, and all other flat and irregular skeletal elements, crania, vertebra, etc. were also systematically and logically divided. A set of these coding outlines is included in the Appendix, and all references to "CM" numbers in the following analyses refer to these outlines.

Specimen Coding

All specimen information was recorded in a coding system designed specifically for this analysis, and entered into a DBASE 3+ database, later transferred to PARADOX for analysis. Variable fields and attributes used are presented in Table 3. Variable definitions, descriptions, conditions of observation and recording are described in greater detail below.

Fields 1-7 Provenience Information

SITENO: The alphanumeric designation given to the site at the time of investigation followed the Smithsonian Institution - nationwide system of alphanumeric coding; first the state, in alphabetical order (e.g. 39 = South Dakota), a two letter county designation (e.g. CA = Campbell County), and consecutively assigned site specific numbers

Table 3. Coding System for Canid Specimens, DBase 3+ and Paradox.

FIELD		Description
	Attribute	Description
SITENO		Site Number
	39BF4	
	39BF11	
	39CA6	
	39CO9	
	39PO7	
	39SL4	
	39ST56	
	39WW2	
	39WW3	
SITENAME		Site Name
	Bamble (39CA6)	
	Crow Creek (39BF11)	
	Crow Creek I (39BF4)	
	Hosterman (39PO7)	
	Larson (39WW2)	
	Leavenworth (39CO9)	
	Sommers (39ST56)	
	Spiry-Eklo (39WW3)	
	Sully (39SL4)	
TIMEPERIOD		Culture/Historic
	IMM	Initial Middle Missouri
	IC	Initial Coalescent
	EC	Extended Coalescent
	PCC	Post Contact Coalescent
	HIS	Historic
	MIX	Mixed
PROVEN		Field location
	Various	
FEATURE		Cache pit, House, etc.
	Various	

Table 3. (cont.)

FIELD / Attribute	Description
LEVEL	Vertical location
Various	
LOT	Lot number, assigned by SI-RBS
Various	
SPECNUMOLD	Specimen number, assigned by SI-RBS
Various	
SPECNUMNEW	Specimen number, present analysis
Sequential	
ELEMENT	Skeletal element represented
SKUL	skull, complete or portion
MAXI	maxilla
PMAX	premaxilla
MAND	mandible
TOTH	isolated tooth
ATLS	atlas, 1st cervical vertebra
AXIS	axis, 2nd cervical vertebra
3CVT	3rd cervical vertebra
4CVT	4th cervical vertebra
5CVT	5th cervical vertebra
6CVT	6th cervical vertebra
7CVT	7th cervical vertebra
CVVT	indeterminate cervical vertebra
1TVT	1st thoracic vertebra
2TVT	2nd thoracic vertebra
3TVT	3rd thoracic vertebra
4TVT	4th thoracic vertebra
5TVT	5th thoracic vertebra
6TVT	6th thoracic vertebra
7TVT	7th thoracic vertebra

Table 3. (cont.)

FIELD Attribute	Description
8TVT	8th thoracic vertebra
9TVT	9th thoracic vertebra
10TV	10th thoracic vertebra
11TV	11th thoracic vertebra
12TV	12th thoracic vertebra
13TV	13th thoracic vertebra
THVT	indeterminate thoracic vertebra
1LVT	1st lumbar vertebra
2LVT	2nd lumbar vertebra
3LVT	3rd lumbar vertebra
4LVT	4th lumbar vertebra
5LVT	5th lumbar vertebra
6LVT	6th lumbar vertebra
7LVT	7th lumbar vertebra
LMVT	indeterminate lumbar vertebra
CDVT	caudal vertebra
VERT	indeterminate vertebra fragment
RIB	rib
RIBS	multiple ribs/rib fragments
SACR	sacrum
STER	sternebra segment
BACU	baculum
SCAP	scapula
HUMR	humerus
RADI	radius
ULNA	ulna
RCRP	radial carpal
UCRP	ulnar carpal
2CRP	II carpal
3CRP	III carpal
4CRP	IV carpal
ACRP	accessory carpal
1MTC	I metacarpal
2MTC	II metacarpal
3MTC	III metacarpal
4MTC	IV metacarpal
5MTC	V metacarpal
METC	indeterminate metacarpal fragment
INOM	innominate/os coxae
FEMR	femur

Table 3. (cont.)

FIELD Attribute	Description Description
TIBI	tibia
FIBU	fibula
CALC	calcaneum/fibular tarsal
ASTR	astragalus/tibial tarsal
CTRS	central tarsal
3TRS	III tarsal
4TRS	IV tarsal
1MTT	I metatarsal
2MTT	II metatarsal
3MTT	III metatarsal
4MTT	IV metatarsal
5MTT	V metatarsal
METT	indeterminate metatarsal fragment
METP	indeterminate metapodial fragment
PATL	patella
SESM	sesamoid
1PHL	1st/proximal phalange
2PHL	2nd/middle phalange
3PHL	3rd/distal phalange
SIDE	side
LEFT	left
RGHT	right
AXIL	axial
U	unsided
PORTION	portion
ACET	acetabulum
ACET+	acetabulum & portion of ilial/ ischial/pubic necks
ANTERIOR	anterior
BODY	body of vertebra
CAUDAL	caudal portion of scapula
COMPLETE	complete element
DIAPHYSIS	diaphysis
DIST DIAPH	distal portion of diaphysis
DIST EPIP	distal portion of diaphysis
DIST/MED	distal/medial
DISTAL	distal
FRONTAL	frontal portion of skull

Table 3. (cont.)

FIELD Attribute	Description Description
HR	horizontal ramus of mandible
ILIUM	ilial portion of innominate
INFERIOR	inferior portion of skull
ISCHIUM	ischial portion of innominate
LATERAL	lateral
M2	2nd molar
OCCIPITAL	occipital portion of skull
PALATE	palatal portion of skull
PARIETAL	parietal portion of skull
POSTERIOR	posterior
PROX DIAPH	proximal diaphysis
PROX EPIP	proximal epiphysis
PROXIMAL	proximal
PUB SYMPH	pubic symphysis of innominate
SEGMENT	segment of sternebra
SHAFT	shaft of rib
SPHENOID	sphenoid portion of skull
SPINE	spine of the scapula
SUPERIOR	superior
TEMPORAL	temporal portion of skull
VR	vertical ramus
ZYGOMATIC	zygomatic portion of skull
c	isolated canine tooth
m1	isolated molar tooth
PFUSION	proximal fusion
F	fused
U	unfused
P	partially fused
DFUSION	distal fusion
F	fused
U	unfused
P	
RELATVEAGE	relative chronological age
FETL/NEON	fetal/neonate, unborn-ca. 6 wks
JUVENILE	ca. 6 wks - 6 months, "pup"
IMMATURE	subadult, less than fully developed

Table 3. (cont.)

FIELD / Attribute	Description
ARTICUNIT	articular unit
Various	
TYPE ALT	type of modification
BURN	burning, charring
CVGN	carnivore gnawing
EROD	eroded
HEAT	heated?, but unburned
RDGN	rodent gnawing
RECT	recent breakage
SCAT	scatalogical, partially digested
WEAT	weathered, exposed on surface
CUTMARK	cutmarks
Y	yes, cut marks present
N	no, no cut marks observed
COMMENTS	descriptive comments, teeth present, pathologies, etc.
Various	
MEAS	measurements
LBMEAS TL	greatest length of long bone
LBMEAS BP	greatest breadth of the proximal epiphysis
LBMEAS DP	greatest depth of the proximal epiphysis

Table 3. (cont.)

FIELD Attribute	Description
LBMEAS BD	greatest depth of the distal epiphysis
LBMEAS DD	greatest depth of the distal epiphysis
LBMEAS DMC	depth of the medial condyle, humerus, femur
SCPMEA HS	height of the scapula
SCPMEA GLP	greatest length of the glenoid cavity
SCPMEA BG	breadth of the glenoid cavity
ULMEAS SDO	smallest depth of the olecranon
ULMEAS DPA	depth across the Processus anconaeus
ULMEAS BPC	greatest breadth across the coranoid process
CTMEAS GL	greatest length, calcaneum & astragalus
CTMEAS GB	greatest breadth, calcaneum
CTMEAS WT	width of the trochlea, astragalus
MANMEAS 1	total length, from condylar process
MANMEAS 2	total length, from angular process

Table 3. (cont.)

FIELD / Attribute	Description
MANMEAS 7	posterior alveolus of canine to anterior alveolus of m3
MANMEAS 8	length of cheektooth row, p1-m3, along alveolus
MANMEAS 9	length of cheektooth row, p2-m3, along alveolus
MANMEAS 13L	length of carnassial, at cingulum
MANMEAS 13B	breadth of carnassial, at cingulum
MANMEAS 18	height of vertical ramus
MANMEAS 19	height of mandible behind m1
MANMEAS 20	height of mandible between p2-p3
SKLMEAS 13	median palatal length
SKLMEAS 15	length of cheektooth row, p2-m2, along alveolus
SKLMEAS 23	greatest breadth of mastoid
SKLMEAS 25	greatest breadth of occipital condyles
SKLMEAS 27	greatest breadth of foramen magnum
SKLMEAS 28	greatest height of foramen magnum
SKLMEAS 34	greatest palatal breadth, from outer alveoli of M1

Table 3. (concluded)

FIELD Attribute	Description
SKLMEAS 36	palatal breadth, at outer alveoli of C
SKLMEAS 40	height of occipital triangle
SKLMEAS P4L	length of P4
SKLMEAS	greatest breadth of P4

(e.g. 6 = sixth site identified within a particular county).

SITENAME: Assigned site names such as Bamble, Crow Creek, etc.

TIMEPERIOD: The site or site components position within the general culture historic chronology developed for the Middle Missouri subarea, as assigned by the site excavators, or through later analysis. All designations are in agreement with Lehmer 1971.

PROVEN: Where provided, this variable gives the location of a specimen or object within the site, as for instance a grid location number for a surface collection.

FEATURE: The context of a specimen or object, as noted in the field catalogs (e.g. cache pit, house floor, midden, etc.).

LEVEL: The vertical location of the specimen or object within a feature or excavation unit.

LOT: Designation by the excavator or laboratory personnel of a common lot number for a group of objects, or lot of bones, sometimes recorded as SPECNUOLD.

Fields 8-9 Specimen Numbering

SPECNUMOLD: Numbers assigned to a group of objects or lot of bones at the time of excavation or initial laboratory processing. In the specimen catalogs, lot or specimen numbers were routinely followed by locational data, as provided by the field excavators. During analyses, these numbers were found either on the original brown paper specimen bags, or in some cases on the individual bones themselves.

SPECNUMNEW: Numbers assigned sequentially to each specimen examined in the present analysis, and used only for the purposes of this analysis. These numbers were not recorded on the bones themselves.

Fields 10-17 Element Information

ELEMENT: A four letter or alphanumeric code designating skeletal element represented (SKUL, MAND, etc.)

SIDE: Left, right, axial, or unsided for elements such as phalanges.

PORTION: This variable was used to indicate more precisely what part of an element was present, or that the element was complete. Initially, a very simple descriptive code was applied. The skull was divided by element or complex (ex. frontal, occipital, posterior, occipital complex, etc.). The mandible was coded as complete, horizontal ramus (HR), vertical ramus (VR), anterior or posterior. More specific details of teeth present, and state of eruption and/or wear were included in the comments field. The innominate was noted as complete, acetabulum, acetabulum plus ilial neck, etc.

Long bones were coded as complete, diaphysis, proximal, distal, proximal or distal diaphysis, and proximal or distal epiphysis for unfused epiphyses. Later this simple coding scheme was found to be inadequate for the effective calculation of cut mark frequencies per bone portion represented by long bone specimens, and a new coding scheme was devised. This format divided each hypothetically complete element into eight equal portions (diaphysis plus epiphyses). Each specimen was coded to the nearest eighth present, beginning with the distal end. Thus, the distal 1/2 of a femur, for instance, would be coded as D4. Long bone diaphyses were coded as DI plus the portion present (ex. DI5-7 for the central portion of a diaphysis). Unfused epiphyses remained proximal or distal epiphysis. A complete diaphysis with unfused epiphyses not present was coded DI.5-7.5.

An exception to this general format was the scapula in which the glenoid fossa was designated proximal and blade distal. Thus the glenoid plus one half blade would be coded P4. The innominate was coded from posterior to anterior; an acetabulum plus ilium would thus be A4.

A single set of life size element outline masters was measured and each element divided into eight segments of equal length. Each archaeological specimen was then compared to these masters, and an estimate of portion present to the nearest eighth was made. Spiral breaks were coded at their greatest length. Although still somewhat arbitrary, this method provided a much more precise estimate of the number of element portions actually present and these figures were used in all subsequent cutmark analyses.

PFUSION, DFUSION: Where detectable, the state of epiphyseal fusion was noted for all limb bones and proximal or distal limb bone segments. Recorded stages included fully fused, or unfused - whether or not the epiphysis was present. An element was coded as partially fused when the epiphysis was firmly attached to the diaphysis, but the area of contact, or ephyseal fusion line, was still visible along some portion of the contact face.

RELATIVE AGE: This category was devised to separate individual specimens into relative age groups. Categories included fetal or newborn (less than six weeks old), and juvenile or "pup" (ca. six weeks to six months) for elements of less than full length, with unfused epiphyses. Immature was used to describe those elements which appeared to have reached full or nearly full size, with epiphyses unfused or partially fused, on which some portion of the cortical bone surface was still somewhat porous or incompletely ossified.

These designations, despite the criteria outlined above, proved very arbitrary in assignment, and ultimately proved unsuitable for analysis.

ARTIC UNIT: In some cases, articular units, either axial or appendicular, could be reconstructed with some degree of certainty. This was most obvious where some characteristic of a group of anatomically related bones (e.g. partial puppy skeletons, adult limb elements similar in size and shape) suggested that they were part of the same individual in life. For example, the vertebrae and associated hindlimb bones of an aged individual from the Sommers site (39ST56) which exhibited arthritic remodeling and lipping of vertebral bodies and epiphyseal margins were coded as an articular unit.

This was done by noting the specimen number of the first element coded and adding a "+" (e.g. atlas, 1683+). This designation was then repeated in the coding of all associated elements in the articular unit. Such reconstructions were relatively easy for those sites in which specimens were stored by provenience designation. They were somewhat more difficult in those collections where specimens had been segregated by element rather than provenience. In the latter cases, the co-occurrence of a single set of adult left front limb elements (for instance a left scapula, humerus, radius and ulna) in a discrete provenience location such as a storage pit, was taken as possible indication of an articular unit. No attempt was made, however, to make maximum articular matches by laying out whole assemblages and checking all possible articulations.

Fields 18-19 Description of Alterations

TYPEALT: This generalized category includes all observed alterations to a specimen, with the exception of cut or chop marks which were recorded separately. The following types of modification were recorded: BURN - observable burning or charring, indicated by visible discoloration of the bone, from dark brown/black through blue-black, to white (calcined) or "vitrified" (Brain 1981; Lyman 1994:384-391; White 1992:156-160). Relatively few canid specimens exhibited clear and unambiguous signs of complete or partial burning; only 44 specimens of 6956 elements recorded for the six sites were coded as burned. HEAT - This category included those elements which exhibited some slight discoloration and/or dryness and cracking which impressionistically appeared to be the result of heating, but without direct exposure to open fire for long enough to produce charring or calcining. This category, without extensive actualistic study to develop more objective criteria, proved to be arbitrary and was not consistently recorded or used in later analyses. CVGN- Carnivore gnawing was identified by the characteristic damage patterns noted in actualistic research (Binford 1981; Burgett 1990; Fisher 1995:36-40; Haynes 1982, 1983; Lyman 1994:204-216). This included punctures, pitting, furrowing or crenelation of bone margins, and scooping out of cancellous tissue near epiphyses. RDGN - The distinctive, multiple, closely spaced grooves produced by rodent gnawing (Fisher 1995:40-41; Lyman 1994:194-1961) were also noted and recorded. RECT - Recent breakage, e.g. post recovery, was recorded where noted, and was distinguished primarily by the color differentiation on freshly broken surfaces. EROD/WEAT - These variables indicate damage to the bone surface which appears to be due either to subareal surface exposure (weathering) or taphonomic chemical processes within the burial context (erosion). SCAT - Although rare (17 specimens), probably due in large part to the collection criteria during excavation which emphasized recovery of diagnostic or identifiable specimens, some instances of elements or element fragments which appeared to have been eroded or smoothed by stomach acids (Klippel et al. 1987:158-159; Lyman 1994:204-205) were noted and recorded.

CUTMARKS: This variable was coded simply as yes or no (present or absent) for each element or element portion. A more detailed locational treatment of cut marks was also developed (see above) and this more specific locational information was used in analysis.

Fields 20-21 Additional Comments and Measurements

COMMENTS: This field, of variable length, was used to record further observations on individual specimens such as presence/absence of specific teeth in mandibles or maxillae, tooth eruptions stages, anomalies and pathologies, etc.

MEASUREMENTS: All well developed, mature limb bones, crania, mandibles or portions thereof were measured using measurment points recommended by von den Driesch (1976). Measurements were taken to the nearest 1/10 mm, using a hand held Mitutoyo model CD-6" Digimatic calliper. Repeated measurements on selected specimens indicated that small variations, due to slight changes in instrument placement, were persistent, and most pervasive for those measurements noted by von den Driesch (1976:6) as (-) "difficult to take" (1976:6).

CHAPTER VII

SKELETAL EVIDENCE AND ANALYSES

In the following analysis the large canid assemblage from the Post-Contact Coalescent Larson site (39WW2) will be considered first. This large (NISP = 2613) assemblage will be examined in detail; all observed cutmarks will be described, and their probable origin will be investigated with reference to related anatomical features such as muscles, tendons, and joint capsules and ligaments. From this information, a partial model of butchering methods and sequence will be developed.

The early Initial Middle Missouri Sommers site (39ST56) assemblage will then be considered. Patterning in the placement and relative intensity of cutmarks on the elements from this assemblage will then be compared to the later Larson materials, and variations in patterning which might be due to changes in butchering goals or methods will be discussed.

These two site assemblages will also be compared to the remaining four sites considered in this analysis; the Initial Middle Missouri and Initial Coalescent Crow Creek site (39BF11); the two Post-Contact Coalescent sites, Bamble (39CA6) and Spiry-Eklo (39WW3); and the late Post-Contact Coalescent historic site, Leavenworth (39CO9).

Variations in butchering goals and strategies recognized in these analyses will be further discussed in Chapter VIII, and changes through time in the intensity with which large canids were used as food by Plains Village peoples in the Middle Missouri subarea will be considered.

References to cutmark locations "CM 1, CM 2," etc. refer to the zonal coding developed in the course of this analysis and are presented on a reference set of element outlines in the Appendix. Quantification of element portions present and cutmark frequencies for all skeletal elements is presented in Appendix Table 2.

Cutmark Analysis, The Larson Site (39WW2)

Head

Of 152 skulls and skull fragments, 43 specimens (28.3%) have cutmarks (Table 4). Cutmarks occur most commonly in areas indicative of carcass dismemberment. On the posterior portion of the skull (Figures 2, 3) cutmarks cluster around the occipital condyles. Nearly 25% of occipital condyles have cutmarks on their inferior or posterior surfaces (CM 10). These marks are short, often multiple, parallel to subparallel, and sometimes deep. They are analogous to Binford's cutmark S-1 (Binford 1981: Table 4.04, Figure 4.11-b) and those noted by Guilday et al. (1962:67 and Figure 2). On the inferior portion of the skull closely associated marks, undoubtedly also inflicted

Table 4. Frequency of Cutmarks by Skeletal Element, from Sommers (39ST56) and Larson (39WW2).

Skeletal Element	39ST56 NISP/#CM's	39ST56 %CM's	39WW2 NISP/#CM's	39WW2 %CM's
Skull	32/4	12.5	153/43	28.3
Mandible	68/7	10.3	215/105	48.8
Cranial	100/11	9.1	367/148	40.3
Atlas	21/6	28.6	56/39	69.6
Axis	24/3	12.5	43/5	11.6
Cervical V.	62/4	6.4	156/28	17.9
Thoracic V.	94/11	11.7	162/82	50.6
Lumbar V.	51/3	5.9	164/54	32.9
Caudal V.	9/-	-	41/4	9.7
Indet. V.	1/-	-	20/-	-
Sacrum	6/-	-	14/3	21.4
Vertebrae	268/27	10.1	656/15	32.8
Ribs	125/50	40.0	91/32	35.2
Scapula	35/5	14.3	117/67	57.3
Humerus	67/27	40.3	77/35	45.4
Radius	49/9	19.1	106/35	33.0
Ulna	66/12	18.2	119/62	52.1
U. Front L.	215/53	24.6	419/199	47.5
Innominate	23/9	39.1	116/67	57.8
Femur	56/16	28.6	63/20	31.7

Table 4. (concluded)

Skeletal Element	39ST56 NISP/#CM's	39ST56 %CM's	39WW2 NISP/#CM's	39WW2 %CM's
Tibia	56/13	23.2	106/41	38.7
Fibula	20/1	5.0	28/10	35.7
U. Hind L.	155/39	25.2	313/138	44.1
Astragalus	13/2	15.4	14/4	28.6
Calcaneum	15/3	20.0	33/12	36.4
Tarsals	12/-	-	3/-	-
Carpals	4/-	-	14/1	7.1
Metacarpals	87/2	2.3	232/20	8.6
Metatarsals	100/1	1.0	178/9	5.1
Metapodials	-	-	46/1	2.2
1st Phal.	46/1	2.2	159/7	4.4
2nd Phal.	9/-	-	55/-	-
3rd Phal.	4/-	-	14/-	-
Feet	290/9	3.1	748/54	7.2
Other	8/-		19/1	
TOTAL	1161/189	16.3	2613/787	30.1

39WW2

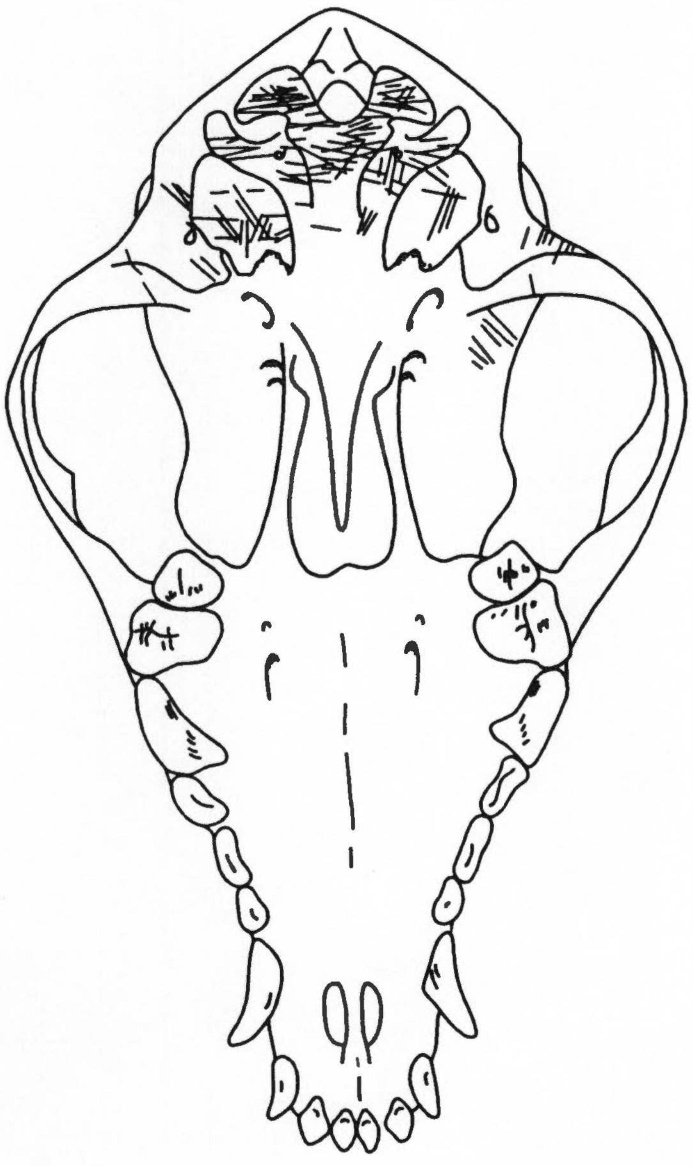


Figure 2. Composite of cutmarks on large canid crania from the Larson Site (39WW2), inferior view.

39WW2

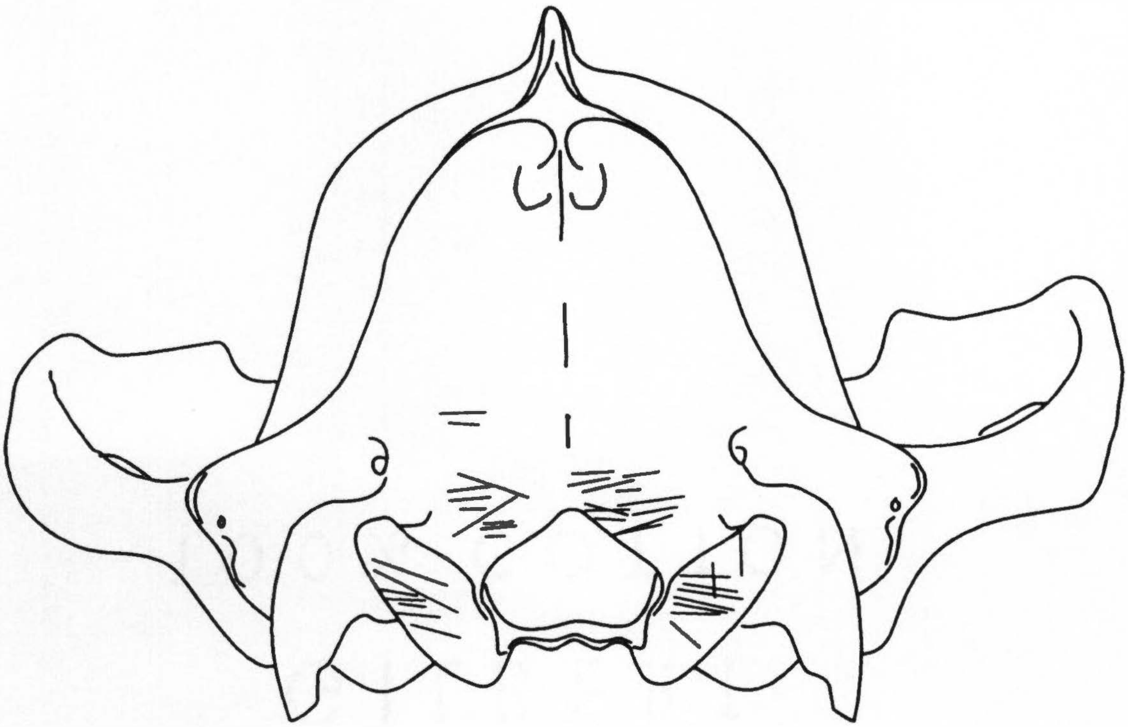


Figure 3. Composite of cutmarks on large canid crania from the Larson Site (39WW2), posterior view.

while separating the head from the body, occur on the rounded bodies of the occipital condyles. These marks are also short, often multiple and parallel, and oriented at right angles to the length of the condyles.

Cutmarks were also frequently inflicted on the projecting jugular processes (CM 11) and the bulbous tympanic bullae (CM 7). These marks are for the most part oriented similarly to those on the occipital condyles and were probably also inflicted during disarticulation of the head. Because the external portion of the bullae are very thin, they were partially or completely broken away on virtually all recovered skulls and occipital fragments. When preserved, however, cutmarks were extremely frequent in these locations. This suggests that these slightly flattened but projecting features were often hit by tool blade edges as the encompassing joint capsule and multiple ligaments of the atlanto-occipital articulation was severed (Miller 1979:232, Figure 5-2).

On the posterior portion of the skull, cutmarks associated with disarticulation of the skull from the vertebral column were also commonly inflicted on the supraoccipital, directly above the foramen magnum (CM 9). These marks probably occurred as first the ventral muscles of the vertebral column, the rectus capitis ventralis and lateralis (Miller 1979:315, Figure 6-31), then the atlanto-occipital joint capsule and the lateral atlanto-occipital ligament were severed.

Disarticulation marks were clustered around the temporal portion of the zygomatic arch (Figure 4, CM 15). These marks occur on five of 16 specimens (31.5%) on the posterior/inferior portion of the zygomatic arch and on the convex ventral surface of the curved retroarticular process. They are most likely associated with severing of the neck muscles and atlanto-occipital joint during removal of the head, or possibly with disarticulation of the mandible from the skull.

Disarticulation marks are also frequent on the superior/inner portion of the posterior zygomatic process (Figure 5, CM 4). Three of 16 preserved zygomatic processes (10.7%) exhibit such cutmarks. Similar marks also occur on the lateral surfaces of the zygomatic processes on both the posterior (temporal) and anterior (rostral) portions. These marks are the most commonly occurring marks on the skull (seven of 16 specimens, 43.7%). They, and associated marks on the ascending ramus of the mandible, are undoubtedly associated with removal of the mandible. They would occur during severing of the superficial layer of the masseter muscle, the strong muscle which arises from the anterior/ventral border of the zygomatic process (Miller 1979:291, Figure 6-13), and the temporalis, "the largest and strongest muscle of the head" which originates largely on the parietal bone, curves upward and forward toward the eye

39WW2

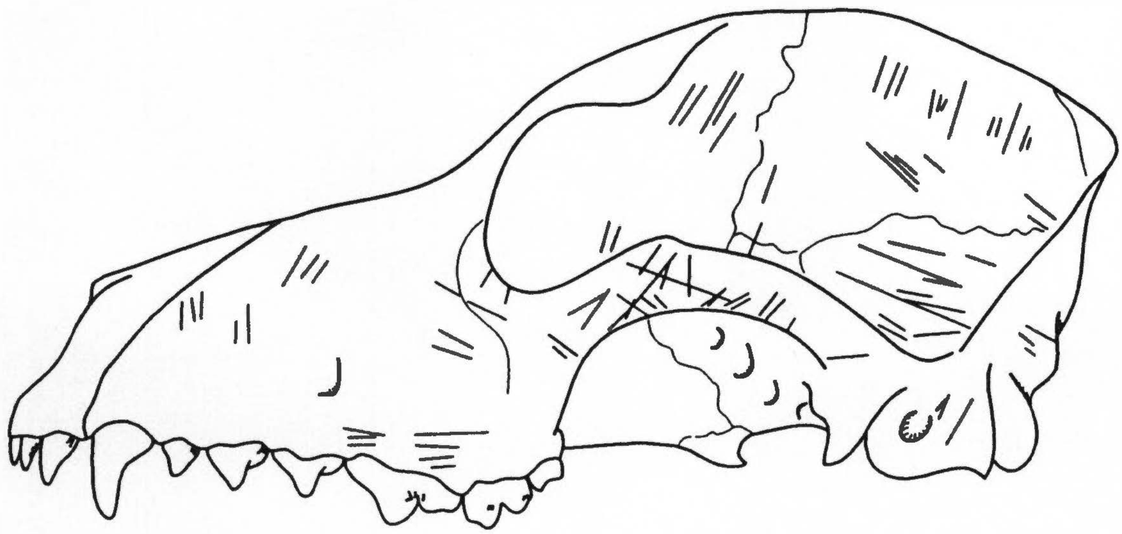


Figure 4. Composite of cutmarks on large canid crania from the Larson Site (39WW2), lateral view.

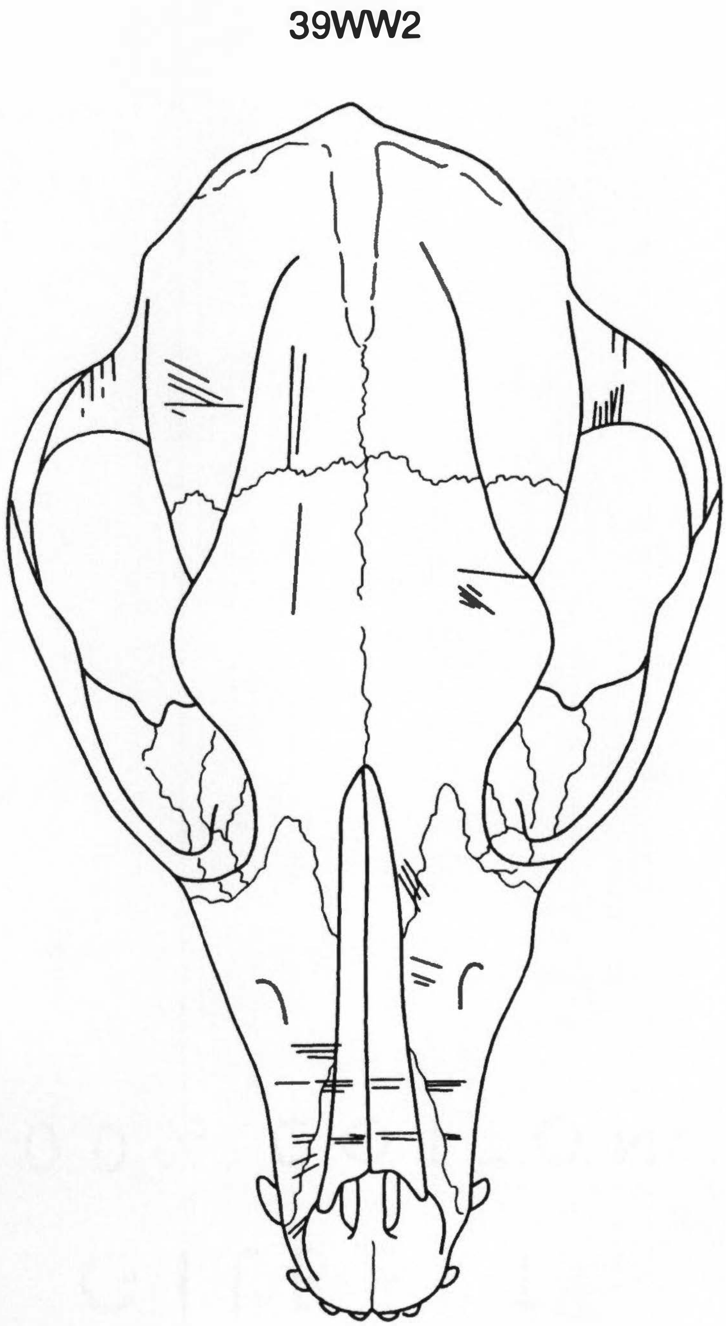


Figure 5. Composite of cutmarks on large canid crania from the Larson Site (39WW2), superior view.

orbit, then downward beneath the zygomatic to insert on the anterior margin of the coronoid process (ascending ramus) of the mandible (Miller 1979:293, Figures 6-13 and 6-14).

Cutmarks on the lower portions of the lateral surfaces of the frontal, parietal, and temporal (CM 1), just above or posterior to the zygomatic processes, are probably also associated with the severing of the temporalis muscle which covers the entire surface of the skull in this area (Miller 1979: Figures 6-14 and 6-15C).

In contrast to disarticulation marks, the short, parallel, nearly vertical cut marks located on the upper portions of the frontal and parietal are more likely associated with skinning of the head, as are the longer marks on the superior portions of these bones (Figure 4). Additional skinning marks occur on the maxilla and nasals of one specimen (Figure 5, CM 3) as a series of short, parallel marks which cross the superior portions of the maxilla and nasals in two parallel rows. Similar marks, more randomly distributed but still occurring in parallel sets, are found on the upper surfaces of the maxilla just above the molars (Figure 4). These marks were probably made as the skin was pulled forward towards the nose, and small cuts were made to separate it from the underlying muscle tissue.

Mandible

Nearly one-half (N = 105, 48.8%) of 215 mandibles or mandible segments from 39WW2 have cutmarks (Figure 6). Marks are most common on the lateral surface of the ascending ramus where they are concentrated on the coronoid crest, the anterior portion of the coronoid process, and on the lateral surface of the condyloid process. These marks are clearly associated with disarticulation of the mandible from the skull. Marks inflicted on the anterior edge of the ascending ramus (CM 1), and in the large concave mandibular notch immediately behind the anterior border (CM 2), would be produced during cutting away the large, multilayered masseter muscle which passes over the ramus of the mandible to insert on the ventrolateral and ventromedial surfaces of angular process of the mandible (Miller 1979:291-292, Figures 6-13, 6-15). These marks are similar to those identified by Guilday et al. (1962:67, Figures 2-3) and by Binford as M-2, associated with disarticulating of the mandible. A second large muscle, the temporalis, inserts directly on the anterior border of the ascending ramus after passing over the apex of the ramus (Miller 1979, Figure 6-14). Cuts on the superior portion of the coronoid process may have been made while cutting away this heavy muscle.

Cutmarks on the angular process (CM 4) and the inferior border of the mandible body (CM 16) are in the area of the insertion points for both the masseter and temporalis muscles and were probably also inflicted while cutting away these two heavy muscles. The most commonly cut area on the

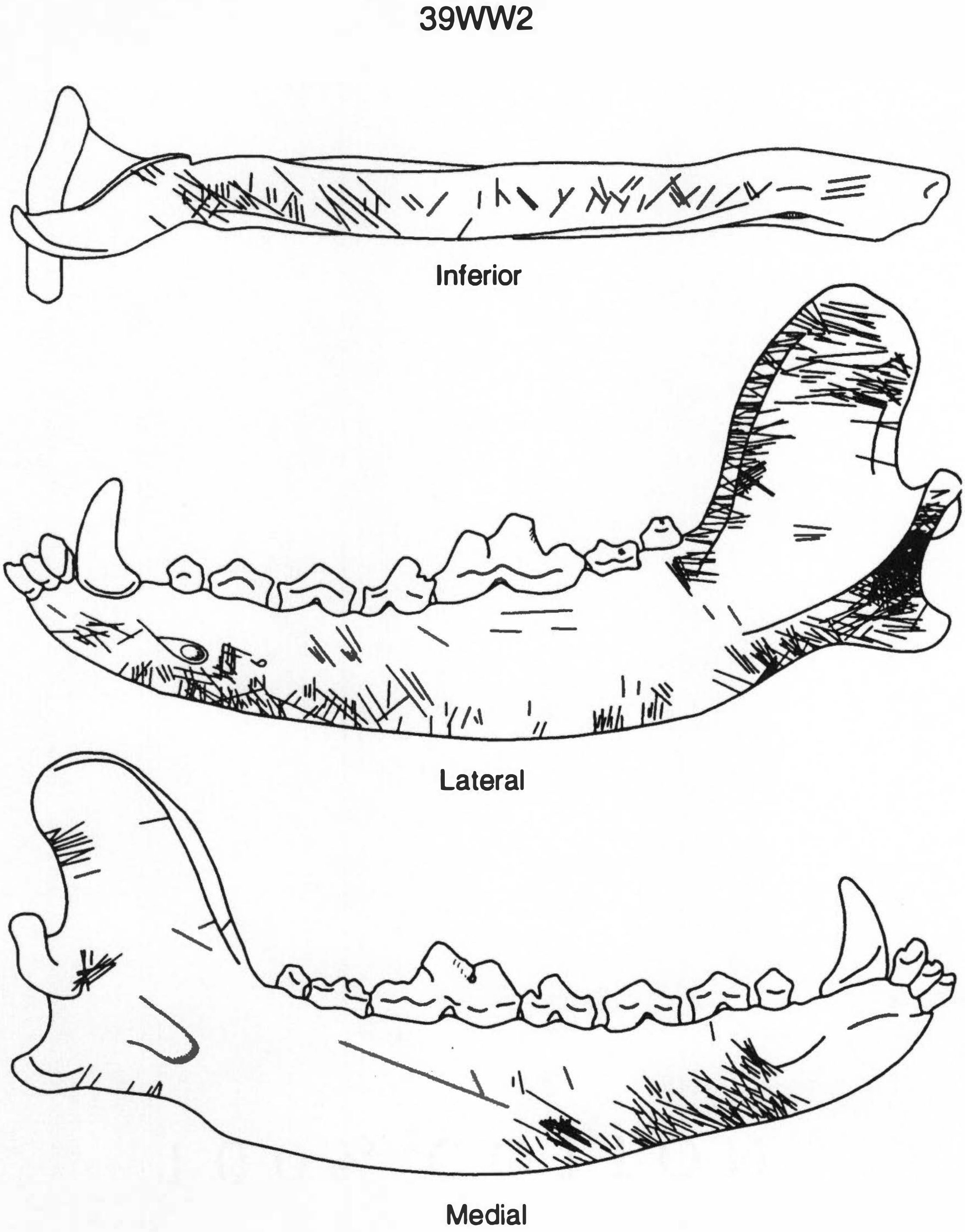


Figure 6. Composite of cutmarks on large canid mandibles from the Larson Site (39WW2).

mandible is the lateral surface of the condylar process (CM 3); 38 of 166 specimens (22.9%) are cut. This is the area of attachment of the lateral ligament (Miller 1979, Figure 5-1) which serves to strengthen the temporomandibular joint and would be a natural point of attack in the disarticulation of the mandible from the skull. These points of disarticulation are also identified by Guilday et al. (1962, Figure 3,2B) in association with severing of the masseter.

The anterior/lateral or buccal portion of the mandible (CMs 7,6,5) also shows multiple short, primarily vertical cut marks. These are often parallel and multiple. They are probably skinning marks inflicted while peeling the pelt forward towards the mandibular symphysis. The anterior most (CM 7) marks are identified as " 'chin' cuts" by Guilday et al. (1962:65, Figure 1). They are also similar in placement and orientation to those illustrated by Wheat (1979, Figure 33-C). Similar marks on the inferior border of the mandibular body (CMs 14,15) could also have be inflicted during skinning (see also Binford 1981, Table 4.04, M-5).

Cut marks on the medial or lingual surface of the mandibular body, or horizontal ramus, are closely clustered on the anterior portion of the ramus (Cms 8,9). This is the area of insertion for two sets of broad, sheetlike muscles, the gleniohyoideus and glenioglossus, the first of which lies below the tongue and runs along the length of the mandible to attach to the hyoid apparatus (Miller 1979, Figure 6-12). The glenioglossus covers the anterior intermandibular space and attaches to the entire length of the tongue (Miller 1979, Figure 6-16). Marks in this location are some of the most commonly occurring on the Larson mandibles (CM 8, 28 of 164 specimens, 17.1%) and are clearly associated with removal of the tongue from the mandible (see also Binford 1981, Table 4-04, M-3).

Vertebral Column

Atlas & Axis. In the Larson assemblage, cutmarks were more common on the first cervical vertebra (atlas) than on any other bone in the canid skeleton. Nearly 50% of recovered specimens (105 of 215 specimens, 48.8%) were cut. These cutmarks (Figure 7) are clustered predominately on the inferior (ventral) body across the ventral surface of the anterior articular processes, the two cuplike processes which receive the occipital condyles of the skull. This articulation is covered ventrally by the atlanto-occipital joint capsule (Miller 1979, Figure 5-2). This is also the area across which the ventral muscles of the vertebral column, including the rectus capitis ventralis and lateralis, connect with the inferior surfaces of the skull, and with the inferior surface of the atlas. The rectus capatis lateralis also passes over this region, from the base of the skull to the inferior transverse processes of

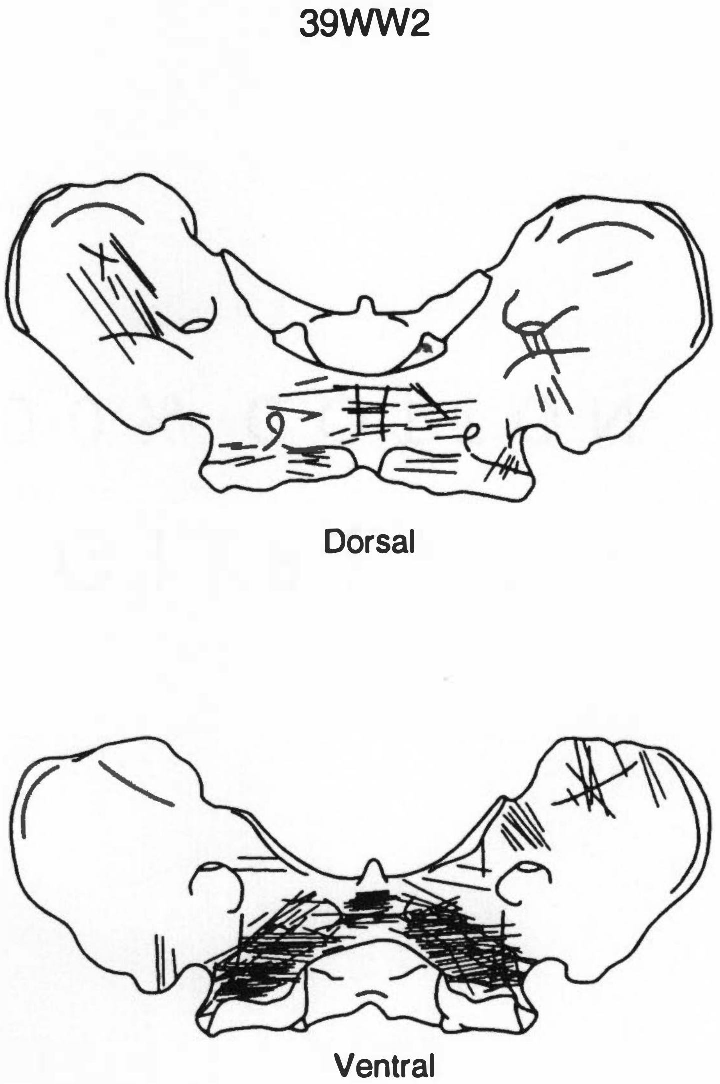


Figure 7. Composite of cutmarks on large canid 1st cervical (atlas) vertebrae from the Larson Site (39WW2).

the succeeding cervical vertebrae (Miller 1979, Figure 6-31). These marks, which were uniformly short, often multiple and oriented transversely to the body of the atlas, are analogous to those illustrated by Guilday et al. (1962, Figure 3, #4) and Binford (Figure 4.20, CV-1 and Cv-2). They were probably inflicted during the separation of the skull from the vertebral column.

Similar short, transverse cutmarks, far less common, occur on the superior body of the atlas (Cms 1,8,11), indicating that while this surface also might be cut as the superior neck muscles such as the splenius and longissimus complex were severed, the primary focus during dismemberment was the underside or ventral surface of the head and neck. This pattern may also be due in part to the relatively open nature of the ventral portion of the atlanto-occipital articulation and joint capsule (Miller 1979, Figure 5-3), as opposed to the close association of occipital condyles with the cupping articular processes on the superior aspect of the atlas, and the associated atlanto-occipital and atlanto-axial ligaments (Miller 1979, Figure 5-2).

Additional cutmarks occur on both the superior (dorsal) and inferior (ventral) surfaces of the flaring wings of the atlas (Cms 7,10). In contrast to those described above, these marks, while also short and often multiple, were oriented parallel to the body of the atlas. These marks may be associated with disarticulation of the skull, or they may have been inflicted while cutting neck muscles away from the vertebral column.

Cutmarks were relatively rare on the second cervical vertebra (axis). Only five of 43 recovered elements (11.6%) have cutmarks. These marks (not illustrated) were generally short, transverse marks on the superior (Appendix Table 2, CMs 1,3 4) and inferior (CMs 2,8) surfaces of the vertebral body and transverse processes.

Cervical Vertebrae 3-7. Cutmarks on the remaining cervical vertebrae (Appendix Table 2, CMs 1-7) were more evenly distributed across the inferior (CM 2), superior (CM 1) and lateral (CM 4) aspects of the vertebral bodies. Like those on the axis, these marks were primarily short, multiple, and transversely oriented to the vertebral body. On the lateral face, most are concentrated at or near the articular processes. This placement, plus the predominately transverse orientation of marks on the superior (dorsal) and inferior (ventral) vertebral body surfaces, suggests that they were inflicted during disarticulation of one vertebra or carcass segment from another.

Thoracic Vertebrae. One half of all recovered thoracic vertebrae (82 of 162 specimens, 50.6%) have one or more cutmarks (Figure 8). These marks are concentrated on the lateral vertebral body (CMs 3,4) and dorsal spinous process (CM 10). The marks are predominately transverse in

39WW2

Lateral

Figure 8. Composite of cutmarks on large canid thoracic vertebrae from the Larson Site (39WW2).

orientation to the vertebral body and spine. Those on the spinous process would appear to be analogous to those identified by Binford (1981, Figure 4.21, TV-2). They were probably inflicted while cutting away the heavy longitudinal longissimus and iliocostalis muscle masses which run laterally along each side of the thoracic and lumbar vertebrae and control movement of the vertebral column and neck (Miller 1979, Figure 6-28). These marks appear to be homologous to the "filleting marks" identified on ungulate vertebrae, which result from the cutting away of the "tenderloin" muscles which lie along both sides of the dorsal spines (Binford 1981, TV-2, TV-5).

Cutmarks on the lateral aspect of the vertebral body (CM 3), the transverse processes (CMs 7, 8), and the costal facets are related to the disarticulation of the ribs from the thoracic vertebrae (see also Binford 1981, Figure 4.21, TV-3, TV-5). The articular capsule of the costovertebral joint consists of four ligaments, the ligament of the rib head, which joins with the disc or vertebral body, the intercapital ligament, which connects pairs of left and right ribs by passing through the associated intervertebral disc, the costotransverse ligament which passes from the tubercle of the proximal rib to the transverse process of the vertebra, and the ligament of the neck which runs from the neck of the rib to the ventral surface of the vertebral transverse processes and body (Miller 1979, Figures 5-5, 5-

6). Transverse cutmarks on the inferior or ventral surface of the vertebral body (CM 2) and vertical cutmarks on the lateral body are probably associated with disarticulation of one vertebra from another. This was accomplished by cutting vertically through the intervertebral disc and the longitudinal and intercapital ligaments, all of which lie between and join the vertebral bodies of the spinal column. The cylindrical form of the vertebral body would likely make it much easier to separate or disarticulate the vertebrae from the ventral side, rather than from the complex and interlocking dorsal or superior surfaces of the vertebral arches and articular processes.

Lumbar Vertebrae. Nearly one third of 164 recovered lumbar vertebrae (54 specimens, 32.9%) bore cutmarks. Marks on the thoracics (not illustrated) were concentrated on the inferior (CM 2) and lateral (CM 3) aspects of the vertebral body, and on the dorsal surface of the arch and spinous process (CM 4). Cutmarks in the latter position are probably a continuation of the removal of the "tenderloin" muscles, the longissimus and iliocostalis muscles masses. Cutmarks on the inferior body, like those on the thoracics, were short transverse strokes and are probably the result of separation of the lumbar portion of the vertebral column into segments.

Cutmarks were much more prevalent on the inferior body of the lumbars (20.1%) than on the thoracics (7.5%), suggesting that the carcass was more often divided in the area of the lumbars, while the thoracic area, or rib cage, was more often left intact.

Sacrum. Three of 14 recovered sacra (21.4%) exhibited cut marks. These marks (not illustrated) occurred on the anterior, inferior and superior surfaces of the anterior sacral wings. They are short, transversely oriented, and lie lengthwise to the anterior/posterior axis of the element. Such marks were probably inflicted while attempting to separate the sacrum from the innominates by cutting through the anterior joint capsule and the ventral and dorsal sacroiliac ligaments which join the 7th lumbar vertebra and the auricular surfaces of the sacro-iliac joint (Miller 1979, Figures 5-22, 5-23).

Ribs

Because ribs were not present in all six site assemblages considered in this analysis, these elements were not coded for portions present or cutmark location. However, observations can be made about the ribs from 39WW2. Slightly more than one third of 91 recovered ribs (32 specimens, 35.2%) bore cutmarks. These marks were concentrated on or immediately below the rib head, tubercle, and neck, oriented transversely to the long axis of the element. These marks are analogous to Binford's marks RS-1 and RS-3 and were probably inflicted either as the ribs or rib segments were cut free from the vertebral column, or while cutting free the vertebral muscle mass or "tenderloin".

Front Limb

Scapula. Over one half of 117 recovered scapulae or scapula segments (67 specimens, 57.3%) bore cutmarks, and the scapula is the third most commonly cut element. Cutmarks on this element provide clear evidence of dismemberment or disarticulation and defleshing.

The front limb has no direct articulation with the axial skeleton, instead it is attached to and supports the trunk by the muscular system only. A powerful series of muscles pass between the neck and trunk and upper portions of the front limb. Once these muscles are cut, the entire front limb can rather easily be cut free of the body by passing a cutting tool between the medial side of the scapular blade and the dorsal surface of the rib cage. Dismembering, or separation of the front limb from the trunk, may therefore be evidenced by numerous but scattered cut marks on the medial face of the scapular blade (Figure 9, CM 9). On the medial scapular blade two large muscles, the serratus ventralis and the subscapularis, attach over the entire surface (Miller 1979, Figure 6-46). The subscapularis lies immediately posterior to the scapular neck and covers approximately two thirds of the medial blade

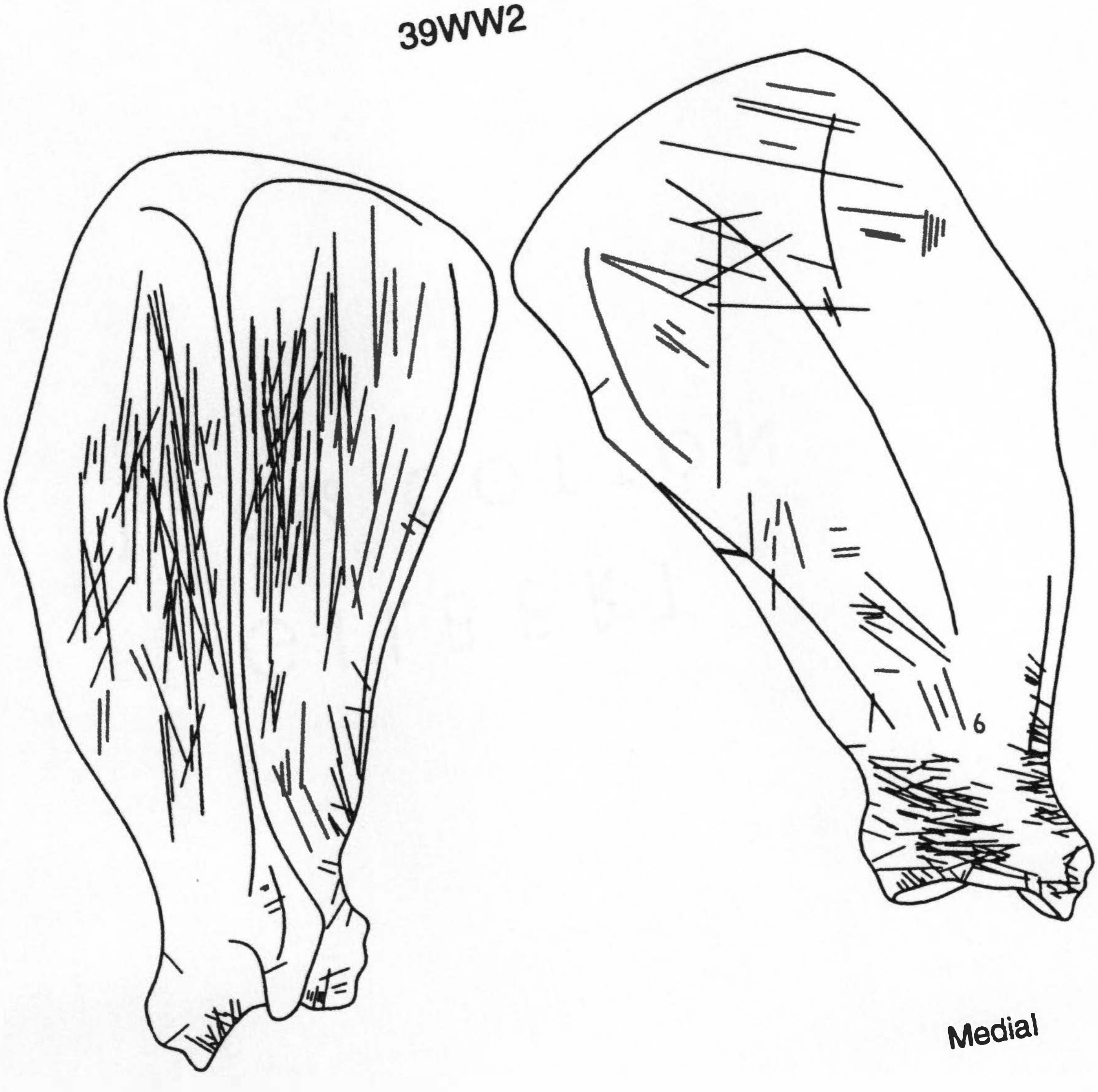


Figure 9. Composite of cutmarks on large canid scapulae from the Larson Site (39WW2).

surface, attaching directly to the proximal humerus. The serratus ventralis, however, which attaches to the remaining one third of the medial surface, attaches cranially to the last five cervical vertebrae and medially to the lower middle shafts of the first seven or eight ribs. The scattered, long, primarily transverse cutmarks on the medial face of the scapular blade are most likely produced as a cutting tool is passed between the scapula and trunk, cutting the serratis ventralis, to free the front limb from the trunk. Binford (1981: Table 4.04, S-4) identified "longitudinal marks up and down the medial face of the scapula" as filleting marks, and it is possible that these marks are made as these relatively thin but broad muscles are cut away from the scapular blade.

Disarticulation marks, inflicted in the separation of the scapula and humerus, were also concentrated on the medial surface of the scapula. Transverse marks clustered on the medial scapular neck (CM 9) are probably associated with severing the heavy supraspinatus, subscapularis, coracobrachialis, and biceps muscle complex which join the scapula and the proximal humerus (Miller 1979, Figure 6-46, 6-51), as well as the medial glenohumeral ligament (Miller 1979, Figure 5-9). These disarticulation marks, concentrated on the medial glenoid and neck, are similar in orientation and placement to those identified by Binford (1981, Figure 4.20) on caribou and Guilday et al. (1962,

Figure 3, #6) on bear scapulae. In both instances, however, the marks occur on the lateral rather than the medial aspect of the scapula. This placement is similar, however, to the placement of cutmarks on the deer scapula from the Eschelman site (Guilday et al. 1962, Figure 8, #5).

On the lateral face of the scapula, the most prevalent cutmarks are the repeated long vertical marks which parallel both sides of the scapular spine. These marks occur on both the supraspinous (CM 5) and infraspinous (CM 6) fossae, and result from cutting away of the large supraspinatus (cranial) and infraspinatus (caudal) muscles (Miller 1979, Figure 6-52). These marks are analogous to the filleting marks illustrated by Binford (1981, Figure 4.06, S-3). They are the most commonly occurring marks on the large canid scapula at 39WW2, present on over 20% of all scapular blades.

Humerus. Approximately one half of the 77 complete humeri or humeri segments recovered (35 specimens, 48.5%) have cutmarks. The humerus is completely and heavily wrapped by the triceps and bracialis muscles, the major muscle complexes of the brachium or upper arm. Although cutmarks were common on the scapular glenoid and neck, no cutmarks occurred on the proximal epiphysis of the humerus, probably reflecting the relative openness of the ball and socket joint of the shoulder. Marks on the upper two thirds of the diaphysis (Figure 10, CMs 2-3,7-8,12-13,17-18) are

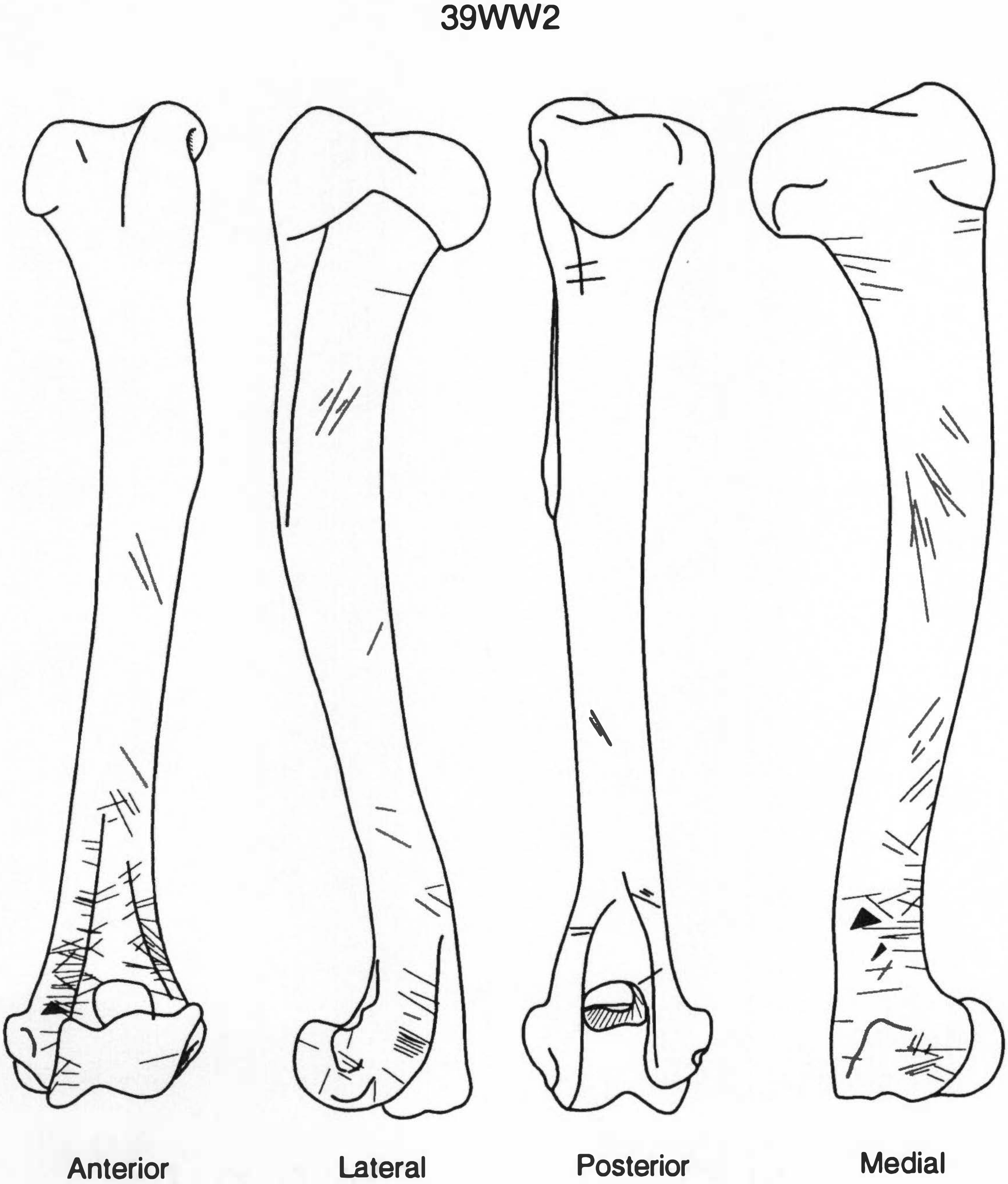


Figure 10. Composite of cutmarks on large canid humerii from the Larson Site (39WW2).

relatively long, transverse to oblique, often multiple, and occur primarily on the medial and lateral aspects of the diaphysis. These areas are crossed by the triceps and branchialis muscles, and the marks were likely inflicted while cutting away these muscle masses. Cutmarks are most common on the lateral diaphysis, just below the humeral head, in the area of the attachment of the brachialis muscle (CM 7, 11.4%) and on the medial aspect (CMs 17,18) in the areas of the triceps, teres, and brachialis muscles.

On the distal portion of the diaphysis cutmarks occur most commonly just above the distal condyles (CM 4B). Short, multiple, transverse or oblique marks are concentrated on the anterior and medial aspects of the distal diaphysis, corresponding to those identified by Binford as filleting marks (1981, Figure 4.39, Hd-6, Hd-7). These are the areas where the cleidobrachialis and pronator teres (medial) and the biceps and brachialis (anterior) muscles wrap around the humeral diaphysis, and marks in these locations are probably associated with cutting through these muscle masses.

Similar marks also occur immediately above the distal epiphysis on the anterior (CM 4A), medial (CM 19A), and lateral (CM 9A) aspects of the diaphysis. These are the most frequently cut areas of the humerus. Binford identified these marks (Figure 4.30, Hd-3, Hd-5, Hd-2) as associated with dismembering of the front limb. Similar marks are also identified by Guilday et al. (1962, Figure 3-8) as associated with disjointing of the "elbow". On the lateral aspect, marks would be inflicted during severing of the anconeus muscle, which passes between the distal portion of the humeral diaphysis and the proximal ulna. On the lateral and medial aspects the medial triceps passes across the distal humerus to insert as a strong tendon on the ulnar olecranon. On the anterior face a number of muscle masses, including the brachialis and biceps, cross (Miller 1979, Figure 6-53). In addition, the oblique ligament of the joint capsule passes from just above the supratrochlear foramen to the proximal/lateral portion of the proximal epiphysis of the radius (Miller 1979, Figure 5-12).

Cutmarks on the distal epiphysis of the humerus occur in about equal frequencies on the medial (CM 2), anterior, (CM 5) and lateral (CM 10) aspects. These marks are clearly attributable to disarticulation of the humerus from the radius and ulna, while cutting through the medial, oblique, and lateral collateral ligaments of the joint capsule (Miller 1979, Figures 5-11, 5-12, 5-13). Such marks are analogous to Binford's Hd-1, Hd-2, and Hd-4 (1981, Figure 4-30).

Radius. One third of the 106 recovered radii or radius segments (35 specimens, 33.0%) have cutmarks. At the proximal end of the element cutmarks are concentrated on the anterior/medial margin of the proximal epiphysis (Figure 11,

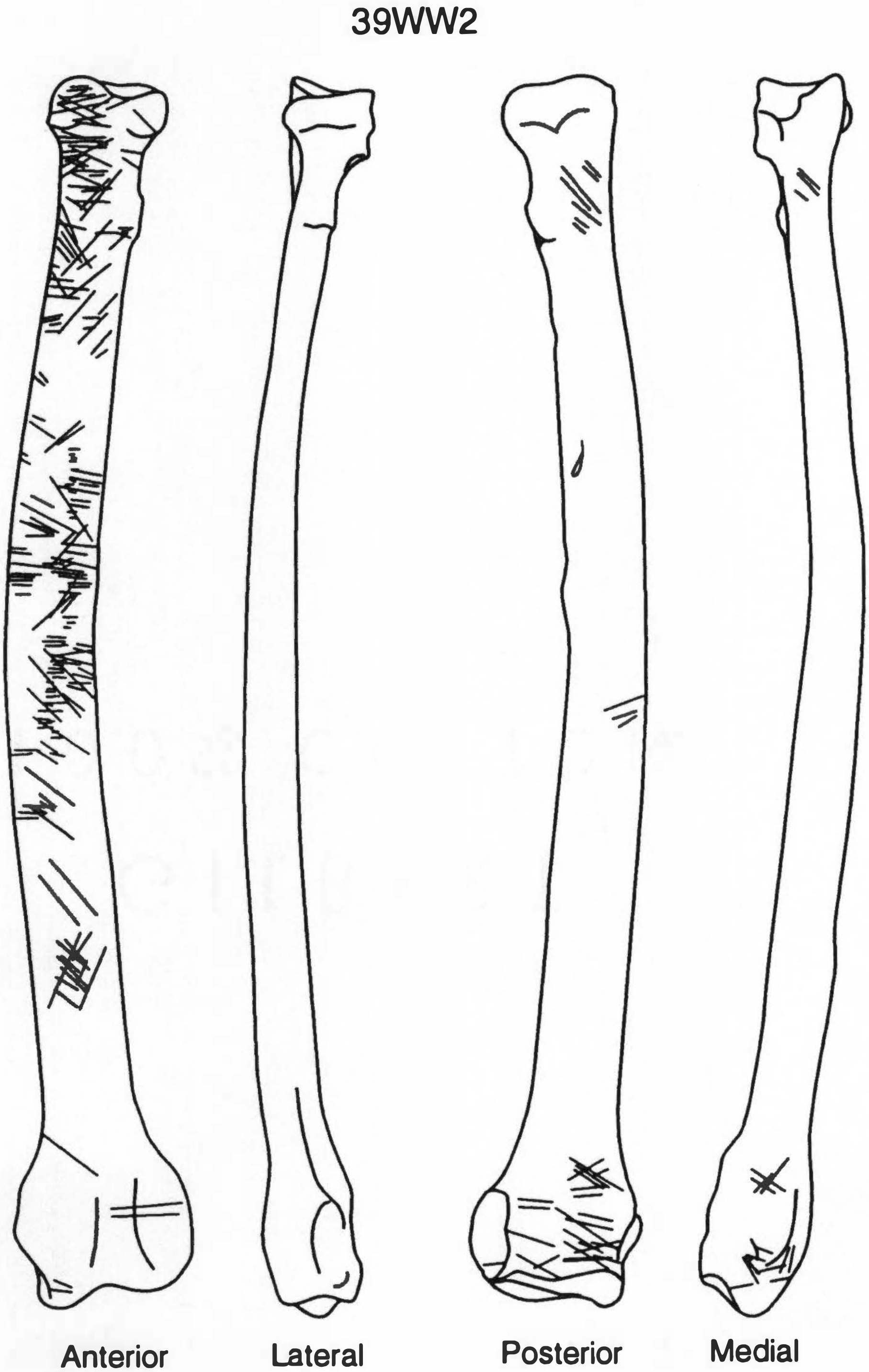


Figure 11. Composite of cutmarks on large canid radii from the Larson Site (39WW2).

CM 1A). Nearly one fourth of all proximal radii (15 of 61 specimens, 24.6%) have one or more short, transverse cutmarks on the medial portion of the epiphysis itself. Cut marks are also common on the proximal/anterior diaphysis directly below the epiphysis (CM 2). This is the area in which several tendons of the humeroradial joint insert, including the medial collateral ligament which joins the medial surface of the humeral distal epiphysis with the proximal radius, and the oblique ligament which passes from the anterior aspect of the distal humerus to the proximal/medial radius. It is at this location, also, that the tendons of the biceps and brachialis muscle masses insert (Miller 1979, Figures 5-11, 5-12, 6-53). These disarticulation marks are analogous to those identified by Binford (1981, Figure 4.32, RCp-5) and Guilday et al. (1962, Figure 8, CM 7). However, the marks on the large canid radii are much more restricted in their distribution, being far more common on the medial portion of the anterior epiphysis (CM 1A, 24.6%) than on the lateral portion (CM 1B, 4.9%).

At the distal end of the radius, cutmarks are most common on the posterior (CM 15) and medial (CM 20) surfaces. In this area, a series of ligaments, including the flexor retinaculum, the radial collateral, and palmar radiocarpal ligaments pass between the distal radioulnar joint and the carpals (Miller 1979, Figure 5-15, 5-19). This is also the area in which the flexor muscle changes to a series of tendinous sheets which articulate with the individual digits of the foot (Miller 1979, Figure 6-63).

The concentration of short, often multiple, but almost randomly oriented marks on the anterior face of the radial diaphysis (CM 3) is not readily attributable to a particular butchering operation, nor is this type of mark noted by either Binford (1981) or Guilday et al. (1962). These marks do, however, mirror similar marks on the posterior aspect of the ulna (see below). Many of these marks are light and appear more like broad scrapes than individually inflicted cut marks. In fact, the middle diaphysis of the radius is essentially bare of substantial muscle coverage (Miller 1979:353, Figure 6-61). It is possible, therefore, that these somewhat randomly oriented marks, which occur over the length of the diaphysis but on relatively few elements (seven of 87 specimens), are the result of the element being held against a flat but irregular surface and moved slightly during the butchering process.

Ulna. Over one half of the 119 ulnae or ulna segments (62 specimens, 52.1%) bore cutmarks (Figure 12). Disarticulation marks on the proximal end of the element are concentrated on the lateral (CM 7A) and anterior (CMs 1A,1B) aspects of the olecranon. On the lateral aspect, they are clustered around the area of the insertion points for the triceps and anconeus muscles and the lateral collateral

Figure 12. Composite of cutmarks on large canid ulnae from the Larson Site (39WW2).

ligament (Miller 1979, Figure 6-56, 5-13). These marks are most closely analogous to Binford's RCp-5 and RCp-2 (Figures 4.31, 4.32), which he identified as dismembering marks. On the anterior aspect, cutmarks are most common on the olecranon surface above the anconeal process, or beak, and inside the trochlear or semilunar notch. These marks are clearly associated with efforts to disarticulate the tightly joined and complicated elbow joint by separating the semilunar notch from the deep olecranon fossa of the distal humerus. The concentration of cutmarks within the semilunar notch is noted by Guilday et al. (1962:67, Figure 2, CM9); 19 of 30 black bear ulnae (63%) had cutmarks "across the semilunar notch". A similar cutmark is illustrated on the deer and/or elk ulnae from the site (Guilday et al. 1962, Figure 8, CM 8). Binford identifies an analogous mark within the medial portion of the notch (1981, Figure 4.32, RCp-4).

On the distal ulna, marks occur most frequently on the lateral (CM 10) and posterior (CM 15) aspects of the styloid process. The posterior aspect of the styloid is the most frequently cut area of the ulna (nine of 31 specimens, 29.0%). This corresponds to the frequency of cutmarks on the distal/posterior radius, and strengthens the scenario that the front paw, when dismembered from the radius and ulna, was attacked from the posterior or palmar surface. Mirroring the frequent mid-shaft marks on the anterior diaphysis of the radius, the posterior face of the ulna shows groups of light, somewhat randomly oriented cutmarks. As on the radius, these marks may be the result of unintentional scraping of the ulna across a stationary surface during butchering. Alternatively, these marks may have been inflicted while cutting or scraping along the long insertions of the pronator quadratus and flexor muscle complexes which insert along the length of the ulnar diaphysis (Miller 1979, Figures 6-63, 6-64).

Metacarpals. Cutmarks appeared on just 20 of 232 metacarpals (8.6%). These marks occurred as short, often parallel, oblique cuts on the anterior, posterior and lateral aspects of metacarpals I, II and V, and clearly seem to be associated with skinning out of the pelt over the front paw. The cuts would have been inflicted as the skin was pulled over the paw and cut free of the underlying tissue.

Hindlimb

Innominate (os coxae). The innominate is the second most frequently cut element in the Larson large canid assemblage. Over one half of the 116 elements (67 specimens, 54.8%) bore cutmarks. The majority of cutmarks on this element are clearly associated with disarticulation of the femur head. They cluster on the lateral surface of the innominate, around the acetabular fossa (Figure 13, CMs

39WW2

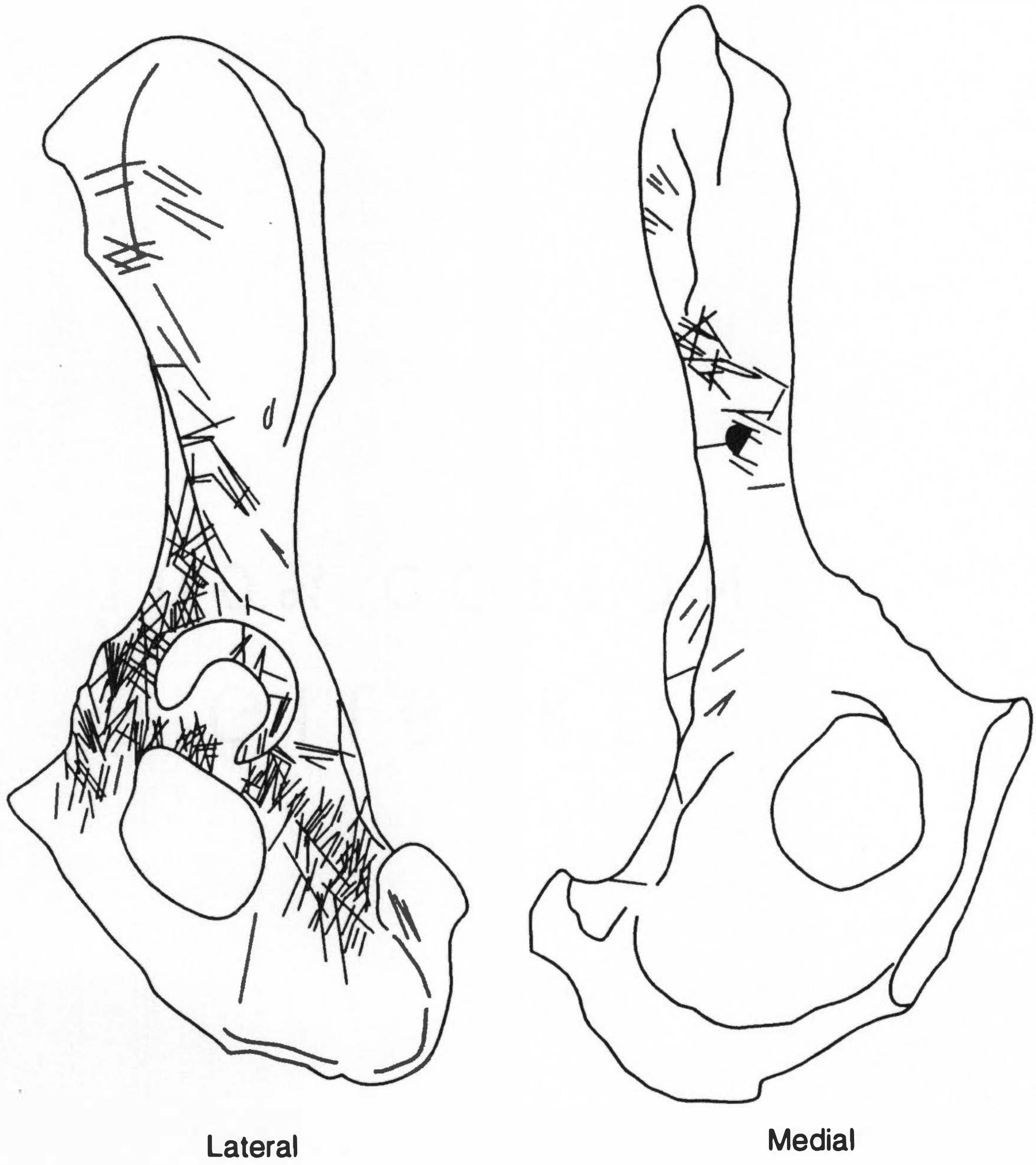


Figure 13. Composite of cutmarks on large canid innominates from the Larson Site (39WW2).

1,2) and in the region of the iliopubic juncture (CM 6) and the bridge-like ridge which runs from the isichiatic tuberosity to the lunate surface of the acetabular fossa. These marks are probably associated with removal of the femoral head from the encircling joint capsule and fibrocartilaginous acetabular lip of the acetabular fossa, and severing the ligament capitis femoris which joins the fovea of the femur head to the inner surface of the fossa (Miller 1979, Figure 5-22). The lateral surfaces of the pubis and ischium are also covered with succeeding layers of the femoral, gluteal, obturator, and other muscle masses of the hindlimb (Miller 1979, Figure 6-73, 6-79 through 6-83). The cutmarks on the ventral aspect of the neck of the ilium (CM 5) and the body of the ischium (CM 3) are probably associated with severing and removal of these succeeding layers of muscle.

On the dorsal surface, cutmarks are again concentrated on the ilial neck and adjacent wing (CM 5) and are probably associated with disarticulation of the vertebral column, by severing the ventral sacroiliac ligament (Miller 1979, Figures 5-22, 5-23). The marks on the large canid innominates are analogous in location to those identified by Binford (1981, Figures 4.22, 4.36), which he associates with both dismembering and filleting (Table 4.04).

Femur. Cutmarks occurred on approximately one third of the 63 femora or femur segments from 39WW2 (20 specimens, 31.7%). Marks on the head of the femur (Figure 14, CM 11A) are clearly associated with disarticulation of the femoral head from the acetabular fossa of the innominate. These marks are analogous to Binford's Fp-2 (1981, Figure 4.25).

The majority of cutmarks on the proximal femur are concentrated on the posterior (CM 11C, 26.1%) and medial (CM 16B, 21.7%) aspects of the femoral neck. On the posterior aspect, the strong tendinous endings of the obturator interus, obturator externus, and gemelli muscles which arise on the dorsal surface of the innominate, insert into the trochanteric fossa (Miller 1979, Figures 6-75, 6-80). Cutmarks in this area are probably made as these muscles are cut away. Binford identifies filleting marks on the posterior and medial neck of the femur (1981, Figure 4.37, Fp-6, Fp-8).

Cutmarks on the posterior, lateral, and anterior aspects of the diaphysis (CMs 3,8,13) are also probably associated with cutting away muscle masses such as the rectus femoris, vastus medialis, and vastus intermedius, which cover the femur diaphysis before passing over the distal femur to attach on the tibial crest (Miller 1979, Figures 6-75, 6-82). Cutmarks occurring just above the distal condyles (CM 14A) are analogous to Binford's Fd-4 (1981, Figure 4.38) and are probably also associated with severing of muscles and the tendinous insertions of the gastrocnemius and pectineus (Miller 1979, Figures 6-75).

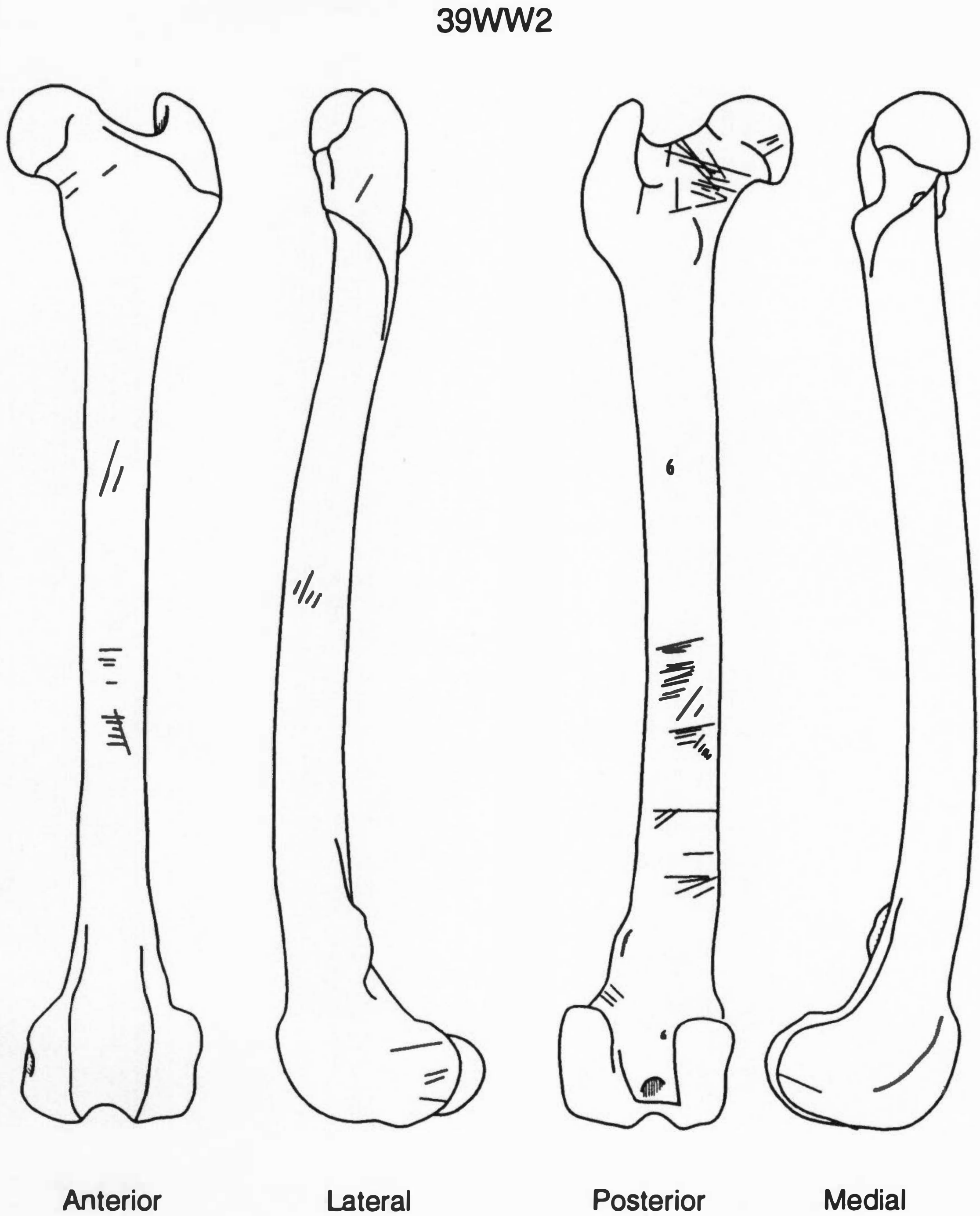


Figure 14. Composite of cutmarks on large canid femora from the Larson Site (39WW2).

Finally, cutmarks on the lateral (CM 10) and medial (CM 20) surfaces of the distal condyles are probably directly associated with disarticulation of the femorotibial joint by severing the lateral and medial collateral ligaments (Miller 1979, Figure 5-26).

Tibia. Nearly 40% of recovered tibiae and tibia segments (41 specimens, 38.7%) bore cut marks. Cutmarks on the proximal articular surface (Figure 15, CMs 1,11,16) are probably associated with disarticulation of the femorotibial joint and probably were inflicted while severing and separating the patellar, cranial, and caudal cruciate ligaments, the medial and lateral meniscus, and the transverse ligament of the joint capsule (Miller 2979, Figure 5-24). These marks are analogous to those noted on black bear tibiae by Guilday et al. (1962, Figures 2 & 3, CM 16), and illustrated by Binford (1981, Figure 4.26, Tp-1, Tp-2).

Marks immediately below the proximal epiphysis on the medial (CM 17A) and lateral (CM 7A) diaphysis are most likely also associated with dismemberment of this joint by severing of the medial and lateral collateral ligaments (Miller 1979, Figures 5-26, 5-27). The proximal portion of the tibia diaphysis, however, is also the point of origin of numerous muscle masses of the crus or shank, including the tibialis cranialis, peroneus longus, and flexor hallucis longus (lateral aspect), popliteus (medial), gastrocnemius,

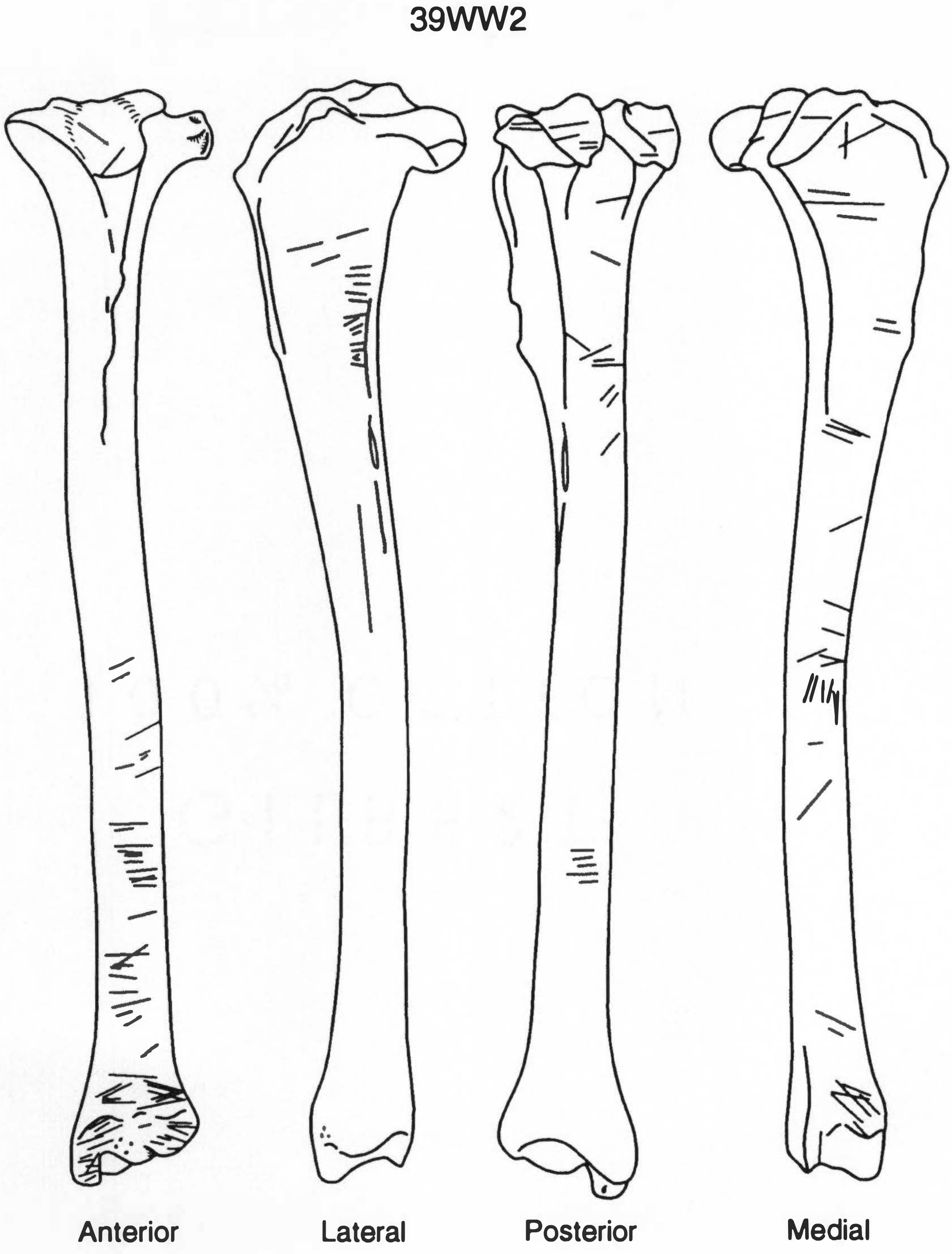


Figure 15. Composite of cutmarks on large canid tibiae from the Larson Site (39WW2).

and flexor muscles (posterior) (Miller 1979, Figures 6-91, 6-92, 6-93). These marks were probably inflicted during defleshing or removal of these muscle masses. Binford identifies similar marks as filleting marks (1981, Figure 4.37, Tp-3, Tp-4, Tp-5).

Likewise, the short, transverse to oblique, often multiple cutmarks on the middle segment of the tibia diaphysis (CMs 3,8,13,18) may also be associated with severing of the muscles which cover this portion of the tibia. These muscles become constricted and tendinous in their distal portions before their eventual insertion on the tarsals and metatarsals (Miller 1979, Figures 6-19, 6-93), and cutmarks on the distal portion of the tibia (CMs 4A/B,9A/B,14A/B,19A/B), are probably associated with these tendons. Cutmarks are especially prevalent on the anterior aspect of the tibia (CM's 4A/B), in the area of the obliquely oriented proximal extensor retinaculum ligament which passes over the tendinous extensions of the tibialis cranialis and extensor digitorum longus (Miller 1979, Figure 6-91A). Similar marks are identified as filleting marks by Binford (1981, Figure 4.38, Td-4).

Short, transverse marks on or directly above the distal epiphysis (CM's 5,10,15,20) are almost surely associated with disarticulation of the tarsals and foot from the tibia, and were inflicted while attempting to cut through this complicated and highly tendinous joint (see also Binford

1981, Figure 4.26, Td-1, Td-3). Cutmarks are concentrated on the anterior aspect (CMs 4A/B), no doubt reflecting the relative accessibility of this aspect, as opposed to the posterior face, which is more shielded by the upward projecting tuber calcanei of the calcaneum. Similar disarticulation marks on the distal tibia are identified by Guilday et al. (1962, Figure 7, CM15).

Fibula. Cutmarks were noted on 10 of 28 fibulae recovered (35.7%). These marks (not illustrated) were about evenly distributed on the proximal (4 specimens), mid-diaphysis (5 specimens) and distal (5 specimens) portions of the element. Because of the close association and sometimes fusion of the fibula with the tibial diaphysis during life, these marks were probably inflicted during the same processes of disarticulation and defleshing noted for the tibia.

Astragalus. Four of 14 astragali (28.6%) have cutmarks (Figure 16). These marks are concentrated on the dorsal aspect of the articular trochlea (CM 1). The anterior surfaces of these trochlea, which articulate with the distal tibia in the anterior (dorsal) portion of the tarsal joint, are at least partially exposed below the distal tibia in normal articulation. If the joint was further stretched or straightened, as it might be during butchering, the trochlea would be further exposed. The proximal extensor retinaculum of the joint capsule passes between these trochlea, as do

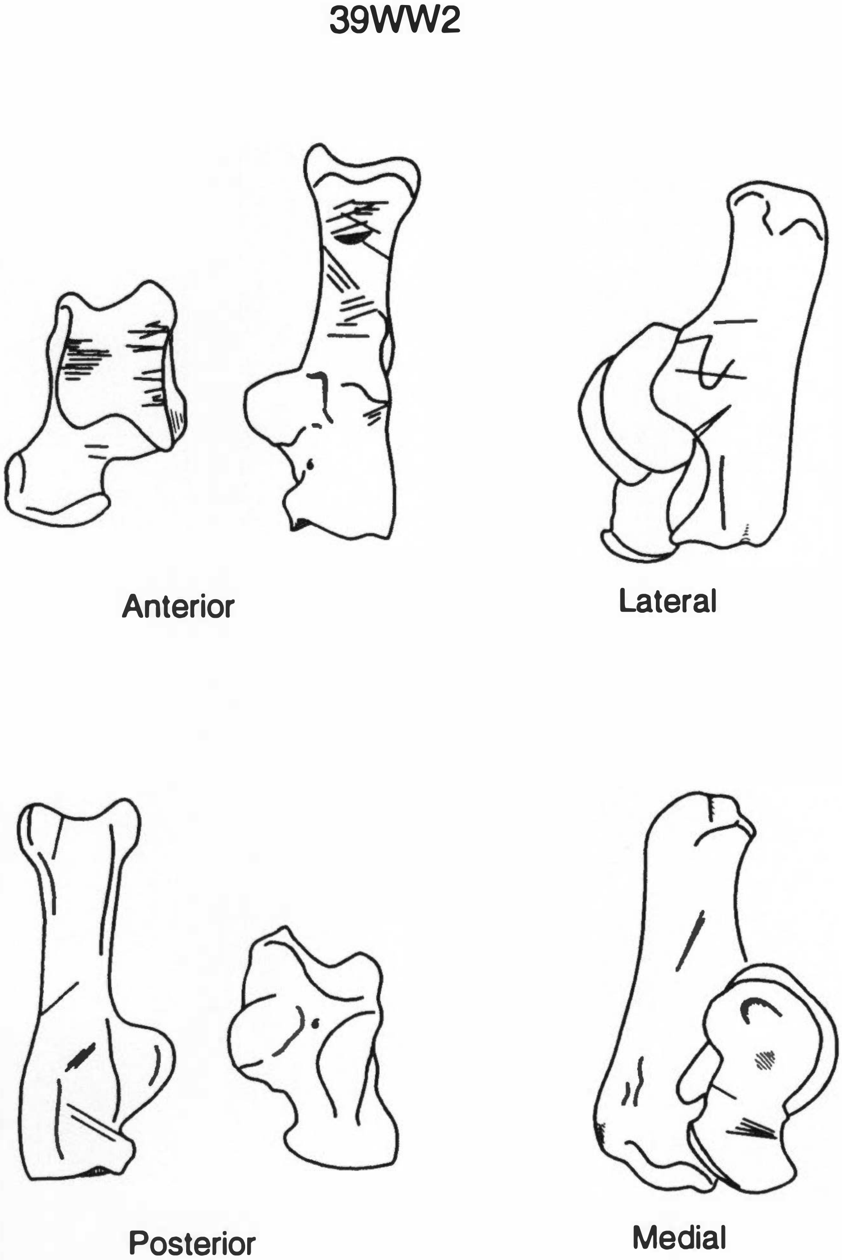


Figure 16. Composite of cutmarks on large canid astragali and calcanea from the Larson Site (39WW2).

the tendinous extensions of the tibialis cranialis and extensor digitorum longus (Miller 1979, Figures 5-31, 6-91). These marks, plus those on the medial (CM 19) and dorsal (CM 4) aspects of the neck of the astragalus were therefore probably produced while severing the collateral and other ligaments of this complicated joint (Miller 1979, Figures 5-31, 5-33).

Although the canid astragalus differs in form and morphology from that of the ungulates, its position and orientation in the joint are much the same, and these marks are analogous to those identified by Binford (1981, Figure 4.27, TA-1, Ta-2). Guilday et al. (1962:74; Figure 8, CM 16) illustrate similar cutmarks and note that 70 of 100 cervid astragali bore such marks on the dorsal, lateral, or medial surfaces.

Calcaneum. Twelve of 33 calcanei (36.4%) showed cutmarks that reflect disarticulation of the talocrucal joint. These marks were concentrated on the anterior or dorsal face of the tuber calcanei, on the superior or proximal half of the element (CM 3). These marks are short, transverse to oblique, often multiple, and probably occurred during severing of the many ligaments of the joint capsule, plus the tendinous distal portions of the tibial muscles such as the flexors which pass over the distal tibia on its posterior surface (Miller 1979, Figures 6-91, 6-92, 6-93). These marks are analogous to Binford's dismemberment marks

TC-3 (1981, Figure 4.27).

Additional cutmarks on the posterior (plantar) aspect of the calcaneum (CMs 11,13,15) are probably associated with severing the heavy tendons of the biceps and gastrocnemius muscles which cover the posterior face of the tibia and attach to the calcaneal tuber. The digital flexor tendons which pass from the posterior aspect of the calcaneum downward to the metatarsal and phalanges also pass over the posterior aspect of the calcaneum (Miller 1979, Figures 6-93, 6-94). Short, transverse to oblique marks on the medial and lateral aspects of the calcaneum are surely the result of joint disarticulation by severing the collateral ligaments of the joint capsule (Miller 1979, Figure 5-33).

Metatarsals. Only nine of 178 metatarsals (5.1%) showed cutmarks. These marks (not illustrated) occurred most often on the dorsal surfaces of the outer (II) and inner (IV) metatarsals. They are most likely skinning marks, inflicted as the pelt was pulled downward over the paw, and cuts were made to free the skin from the underlying tissues.

Cutmark Analysis, The Sommers Site (39ST56)

A total of 1161 large canid elements or element segments was recovered from the Initial Middle Missouri Sommers site (39ST56). Cutmarks occurred on 189 elements, 16.3% of the assemblage. Cutmarks were most common on the humerus (27 of 67 specimens, 40.3%), innominate (9 of 23 specimens, 39.1%) and ribs (50 of 125 elements, 40.0%).

Head

Only four of 32 skulls or skull fragments exhibit cutmarks, and nearly all marks are associated with dismemberment of the skull from the spinal column. Cutmarks are concentrated on the inferior aspect of the occipital condyles, basioccipital, jugular processes, and tympanic bullae (Figure 17). Marks on the lateral aspect (CM 5) of the zygomatic process (Figure 18) on two specimens are probably also disarticulation marks associated with removal of the mandible. Two sets of short, multiple, parallel marks on the posterior portion of the maxilla (CM 3) are oriented obliquely to the long axis of the maxillary tooth row, and were probably inflicted during disarticulation of the mandible.

Mandible

Approximately 10% of the 68 mandibles or mandible segments (seven specimens, 10.3%) show cutmarks. The majority of these appear to be disarticulation marks and are concentrated on the anterior margin of the vertical ramus (CM 1) and the lateral aspect of the condyloid crest (Figure 19). A series of oblique, parallel marks just above the inferior border of the mandibular body, below the molar

39ST56

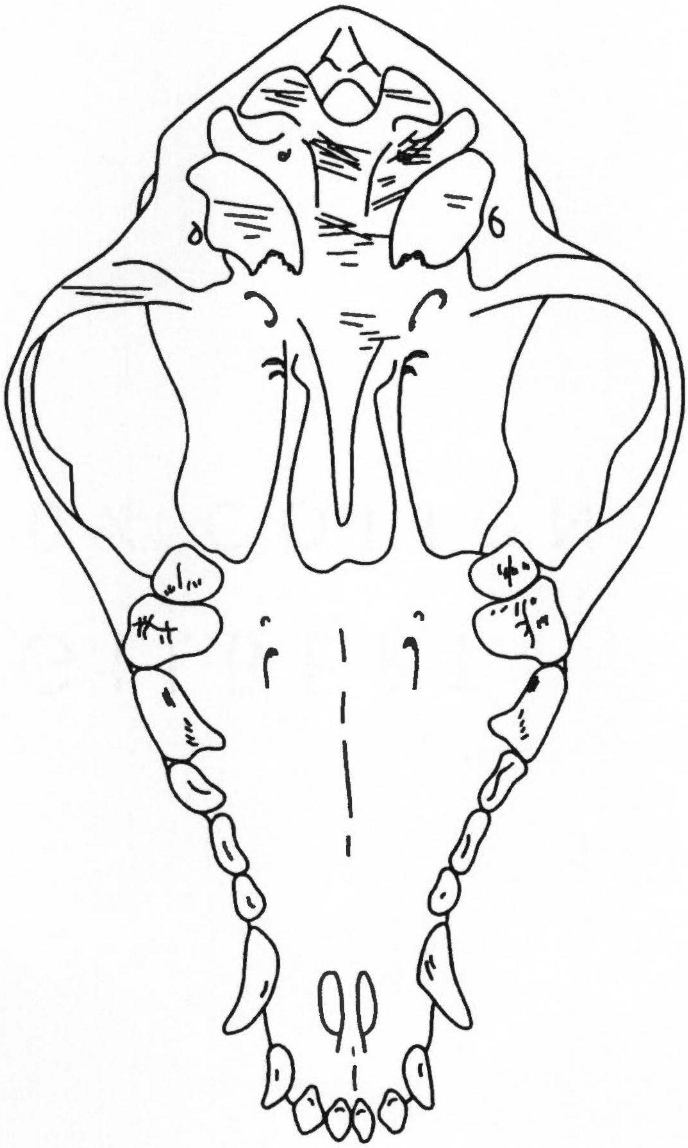


Figure 17. Composite of cutmarks on large canid crania from the Sommers Site (39ST56), inferior view.

39ST56

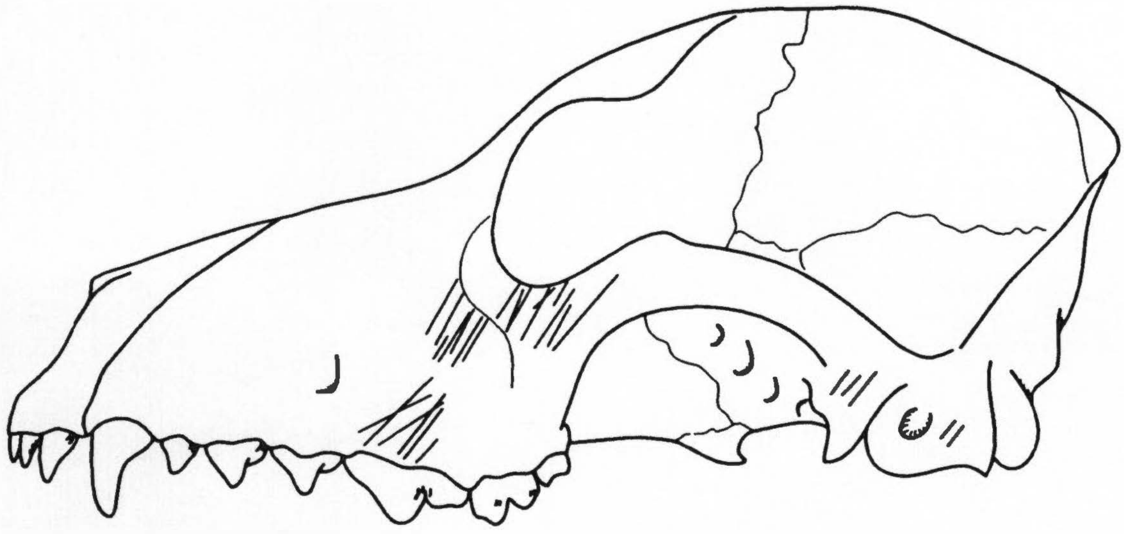


Figure 18. Composite of cutmarks on large canid crania from the Sommers Site (39ST56), lateral view.

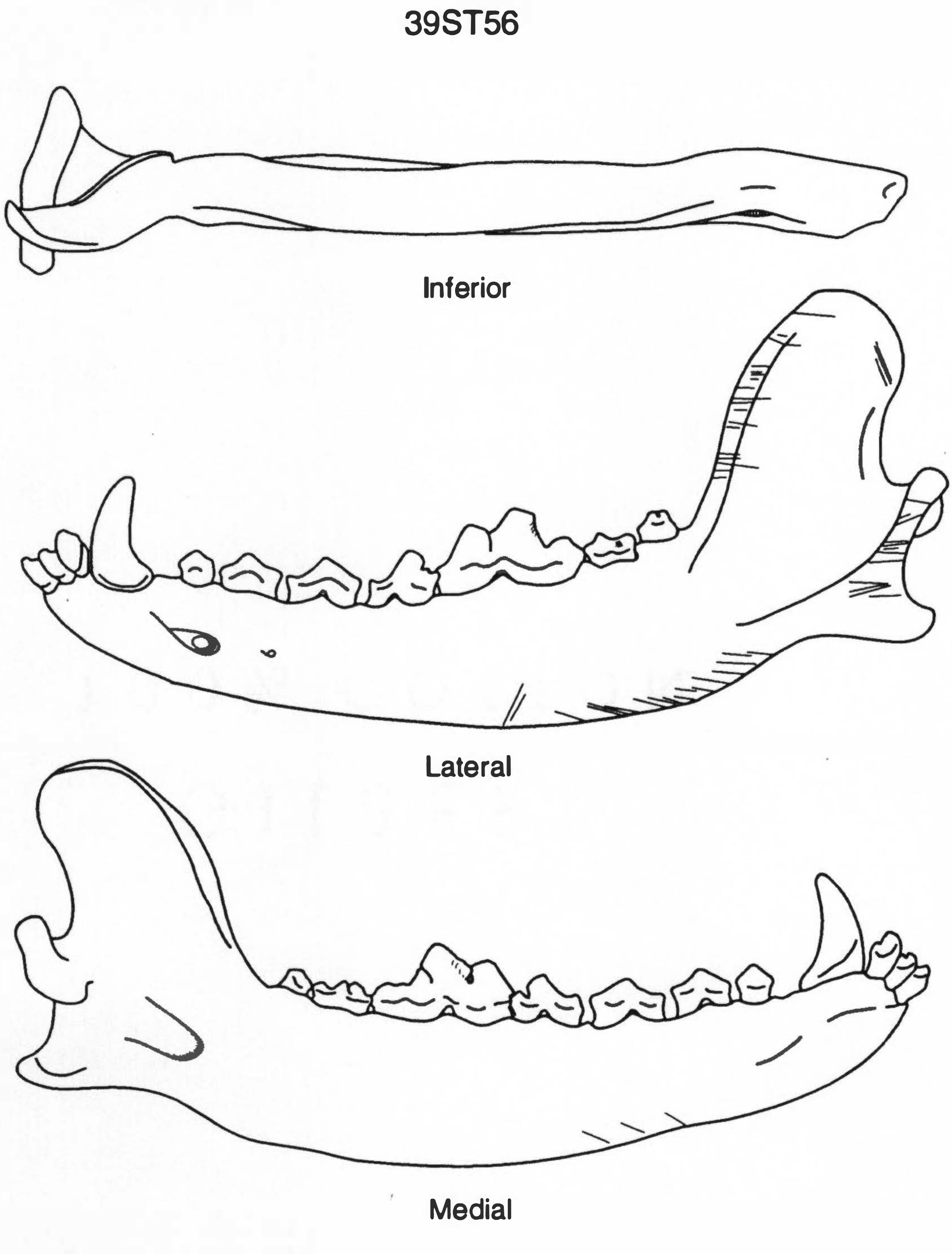


Figure 19. Composite of cutmarks on large canid mandibles from the Sommers Site (39ST56).

tooth row, were probably inflicted while severing the masseter and temporalis muscles, and thus are associated with disarticulation. A single set of three parallel, oblique marks on the lingual aspect of the mandibular body below the third and fourth premolars is probably associated with removal of the tongue. No cutmarks occurred on the anterior/lateral or inferior border of the mandibular body.

Vertebral Column

Atlas & Axis. Nearly 30% (six of 21 specimens, 28.6%) of first cervical vertebrae (atlas) have cutmarks, while marks occur on only three of 34 second cervicals (axis). On the atlas (Figure 20), disarticulation marks are concentrated on the inferior aspect of the cranial articular processes. Cutmarks on the axis are more evenly distributed on the lateral and inferior aspects of the vertebral body.

Cervical Vertebrae 3-7. Only four of 62 cervical vertebrae show cutmarks. Marks occur on the superior surface of the posterior articular process (1 specimen) and on the inferior body and transverse processes (3 specimens).

Thoracic Vertebrae. Eleven of 94 thoracic vertebra (11.7%) have cutmarks. These marks are most common on the inferior vertebral body, the lateral aspect of the vertebral arch (Figure 21, CMs 2,4), and on the spinous process (CM 10). Marks on the vertebral body are probably

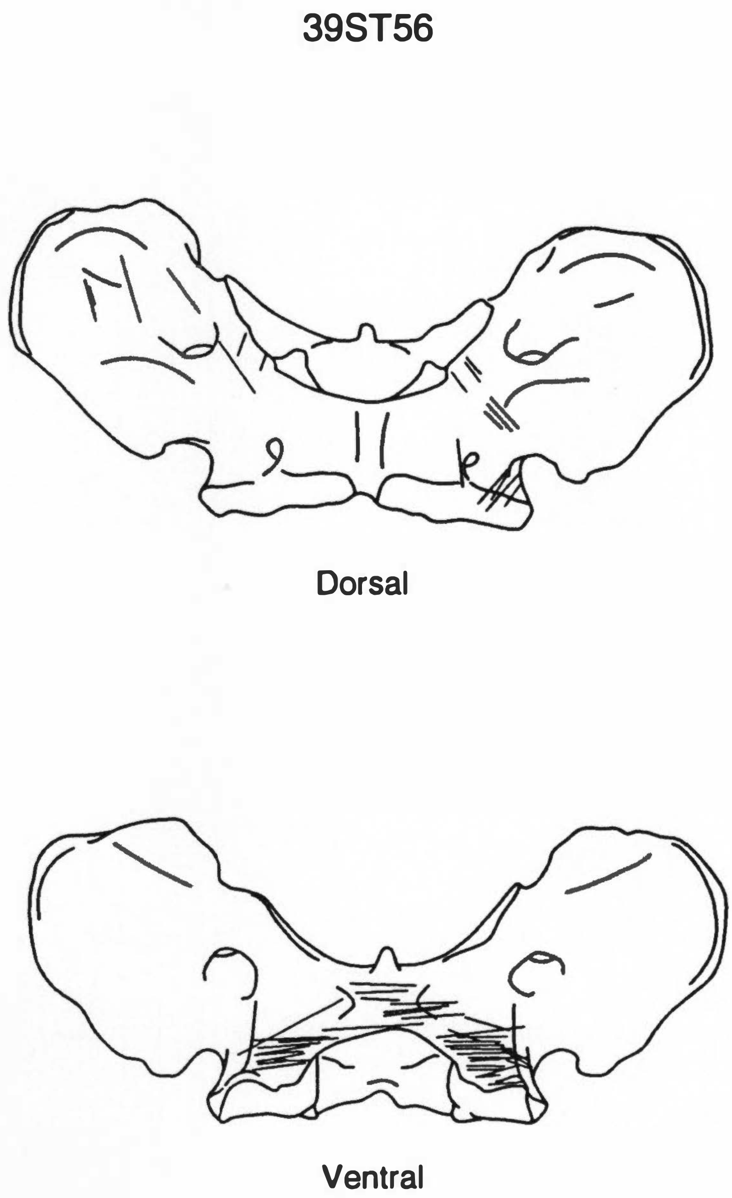
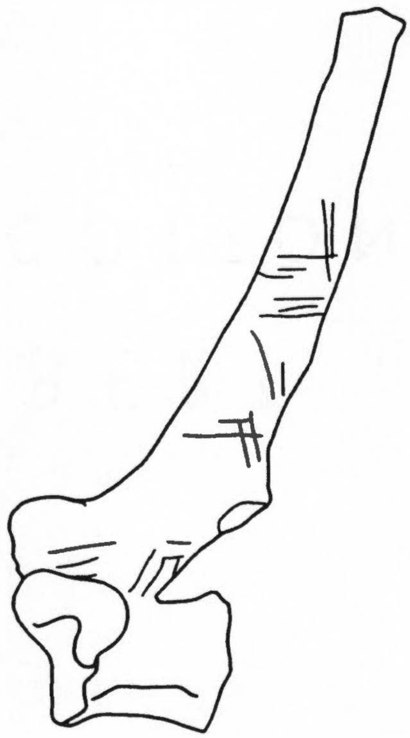


Figure 20. Composite of cutmarks on large canid 1st cervical (atlas) vertebrae from the Sommers Site (39ST56).

39ST56



Lateral

Figure 21. Composite of cutmarks on large canid thoracic vertebrae from the Sommers Site (39ST56).

disarticulation marks, those on the arch and spinous process are probably filleting marks.

Lumbar Vertebrae. Cutmarks occur on three of 51 lumbar vertebra, primarily on the inferior aspect of the vertebral body, indicating disarticulation of the spinal column.

Ribs

Fully 40% of ribs (50 of 125 specimens) from the Sommers site are cut. The cutmarks are concentrated on or just below the rib head. In at least two cases multiple ribs which appear to be from a single individual exhibit cutmarks in similar locations. The marks were probably made either during disarticulation of the ribs from the vertebral column or removal of the "tenderloin" muscle mass which sits atop the ribs, along both sides of the vertebral column.

Front Limb

Scapula. Cutmarks are rare on canid scapula from the Sommers site, occurring on only 5 of 35 elements (14.3%). With one exception, these marks all occur on the medial aspect of the glenoid and neck (CMs 8,9) and are probably associated with disarticulation of the scapula and humerus (Figure 22). There were no longitudinal marks on the lateral blade of the scapula indicative of muscle removal or filleting. A single set of marks on the medial blade of one element was probably inflicted while cutting through the

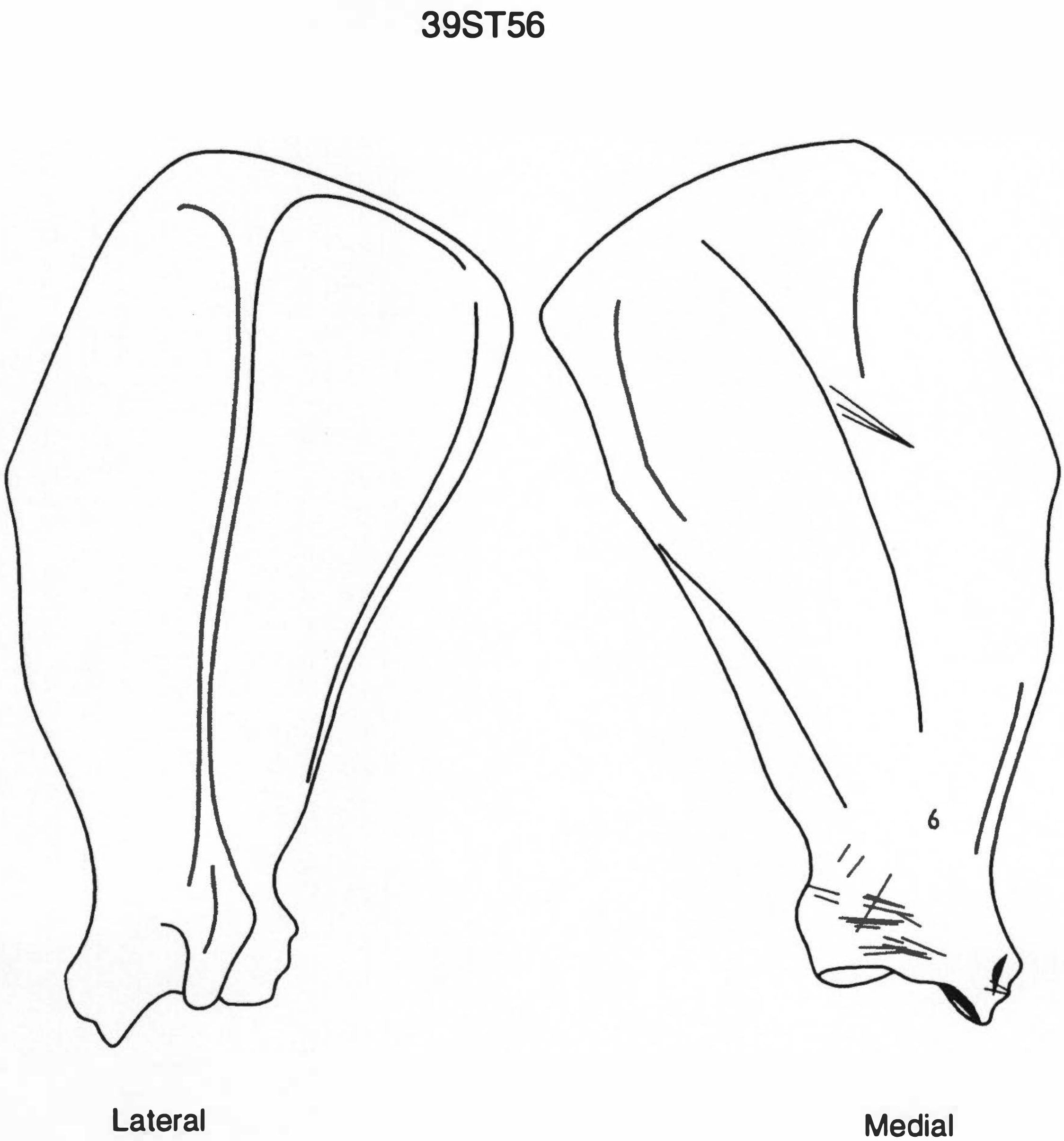


Figure 22. Composite of cutmarks on large canid scapulae from the Sommers Site (39ST56).

serratus muscle to free the front limb from the carcass.

<u>Humerus</u>. The humerus is the most frequently cut element in the Sommers assemblage. Cutmarks occur on just over 40% (27 of 67 specimens, 40.3%) of recovered elements (Figure 23). These marks are concentrated on the anterior and medial aspects of the distal diaphysis just above and on the distal epiphysis (CMs 14A,19A,19B,20). They also occur in lesser numbers on the lateral and posterior aspects of the distal diaphysis and on the posterior and medial proximal diaphysis just below the proximal epiphysis or head. These marks were probably inflicted either during disarticulation of the humerus or in cutting away the heavy muscle masses which surround the humerus.

<u>Radius</u>. Cut marks occur in low frequencies on the proximal and distal epiphyses of the radius (Figure 24) and appear to have been inflicted during disarticulation.

<u>Ulna</u>. As on the radius, cutmarks are relatively rare on the ulna and are concentrated around the proximal articulation (Figure 25), on the anterior aspect of the olecranon, and within the trochlear notch (CMs 1A,1B). These marks are probably associated with disarticulation.

<u>Metacarpals</u>. Only two of 87 metacarpals have cutmarks. These two elements are part of an articulating set of four. The marks occur on the lateral/anterior margins of the II and IV metacarpals and are most likely the result of skinning.

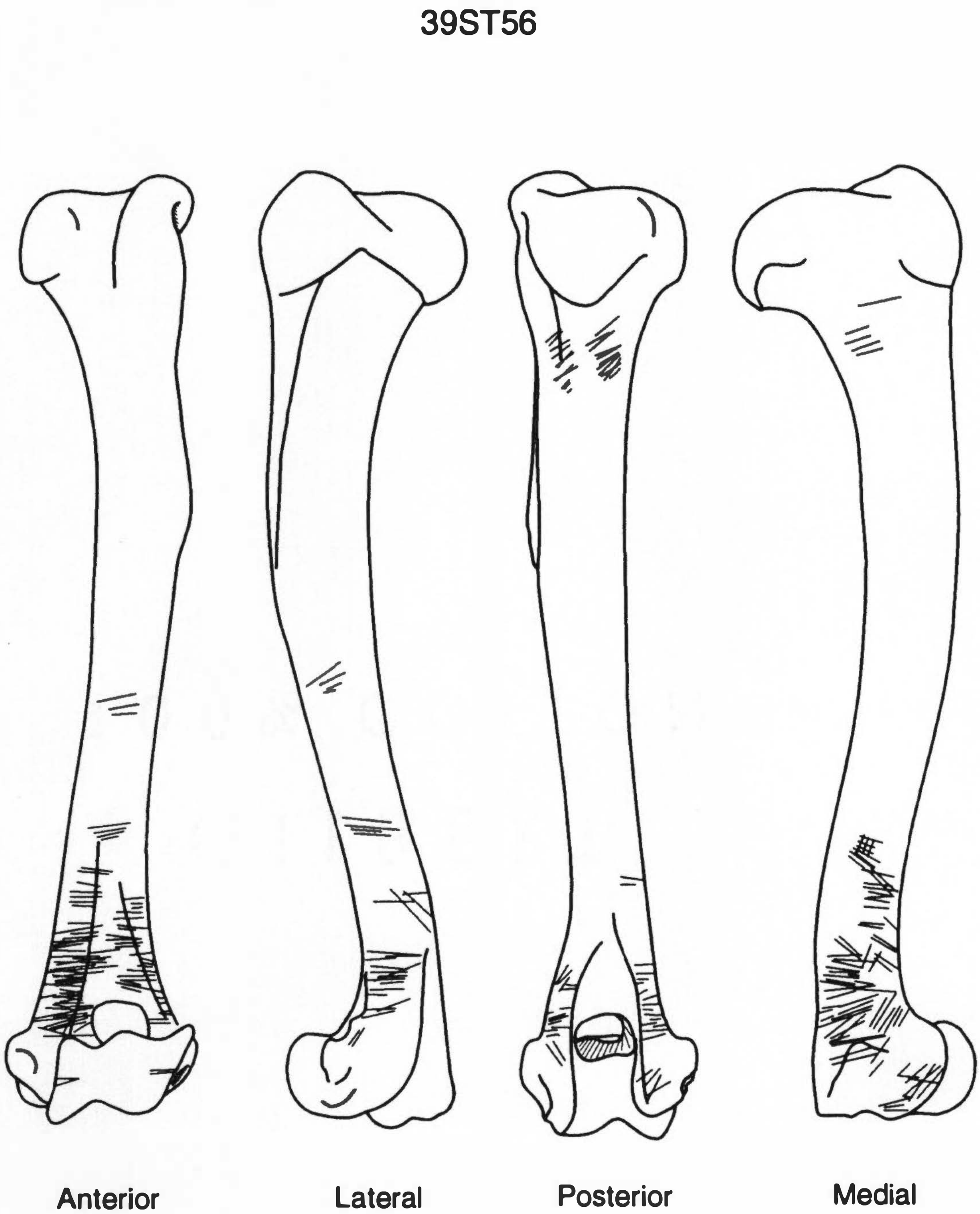


Figure 23. Composite of cutmarks on large canid humeri from the Sommers Site (39ST56).

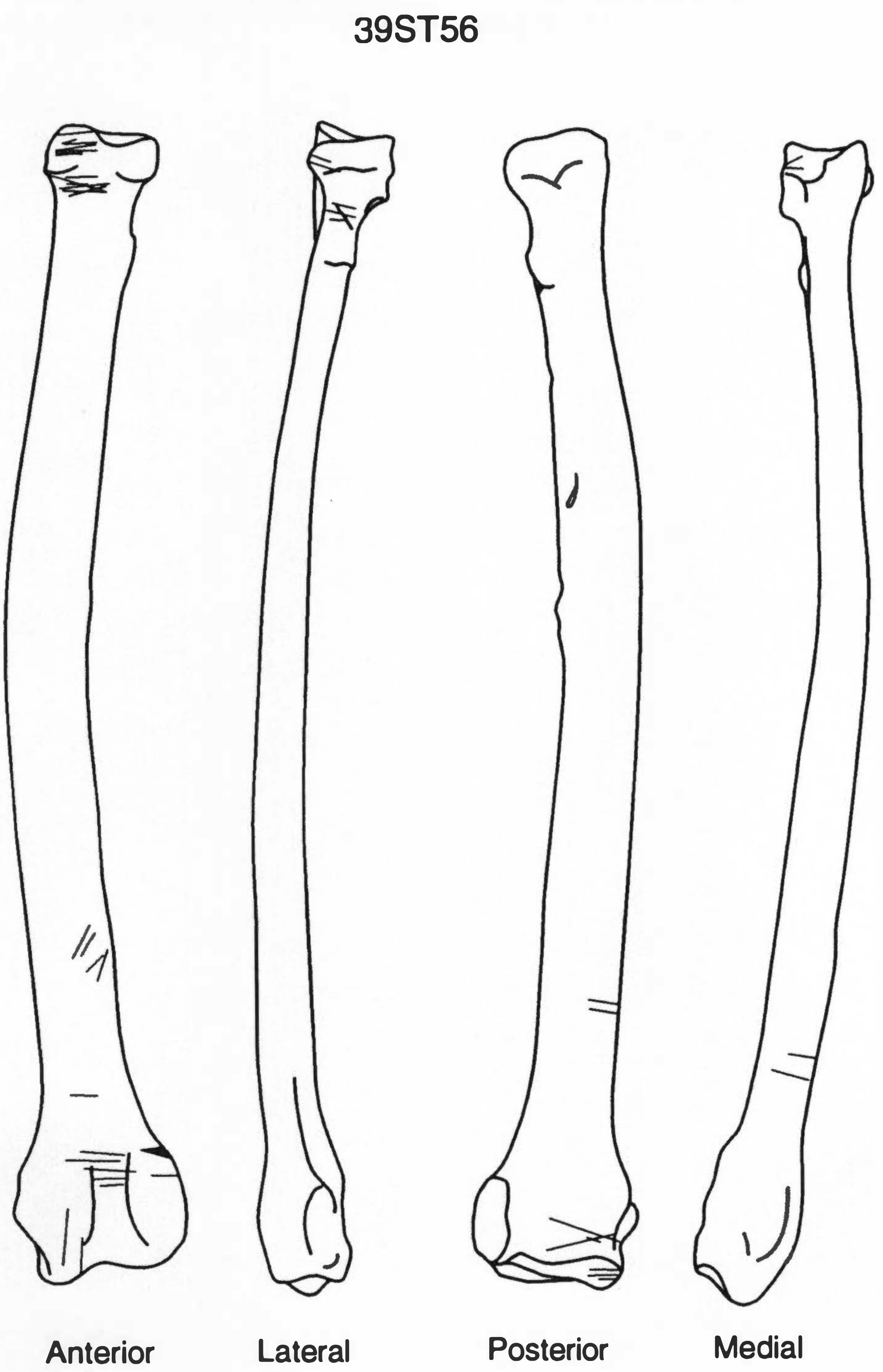


Figure 24. Composite of cutmarks on large canid radii from the Sommers Site (39ST56).

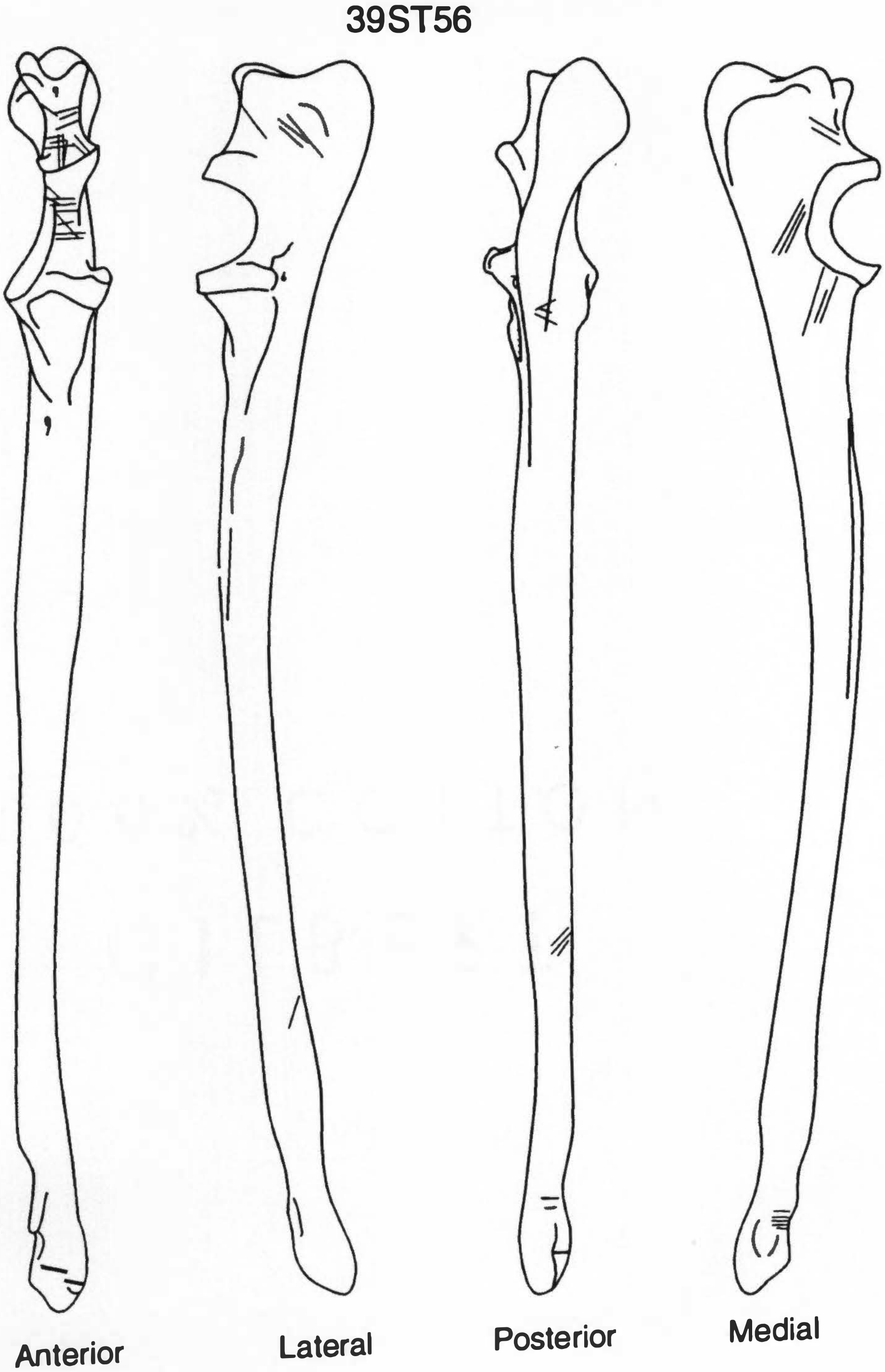


Figure 25. Composite of cutmarks on large canid ulnae from the Sommers Site (39ST56).

Hind Limb

Innominate. The innominate is the second most often cut limb element in the Sommers assemblage (nine of 23 specimens (39.1%). All observed marks were on the inferior aspect of the element (Figure 26), occurring primarily on the ilial neck (CM 5), the lateral border of the ischium (CM 3), and surrounding the acetabulum (CMs 1,2,6). These marks are probably associated with both disarticulation of the femur head and cutting away of the muscle masses of the upper hind limb.

Femur. Sixteen of 56 femora or femur segments (28.6%) are cut (Figure 27). At the proximal end of the element marks are concentrated primarily on the neck, clearly associated with disarticulation of the femur from the innominate. Cutmarks on the distal femur are most common on the posterior and anterior aspects and are probably associated with muscle removal.

Tibia. Thirteen of 56 tibiae (23.3.%) were cut. Cutmarks are rare on the proximal tibia, occurring on only two elements. On the distal tibia (Figure 28), marks are concentrated on and just above the epiphysis, on the anterior and posterior aspects. The majority of these marks are probably associated with disarticulation of the foot.

Fibula. Only one of 20 fibula segments was cut. This element has a cutmark just above the distal epiphysis, probably inflicted during removal of the foot.

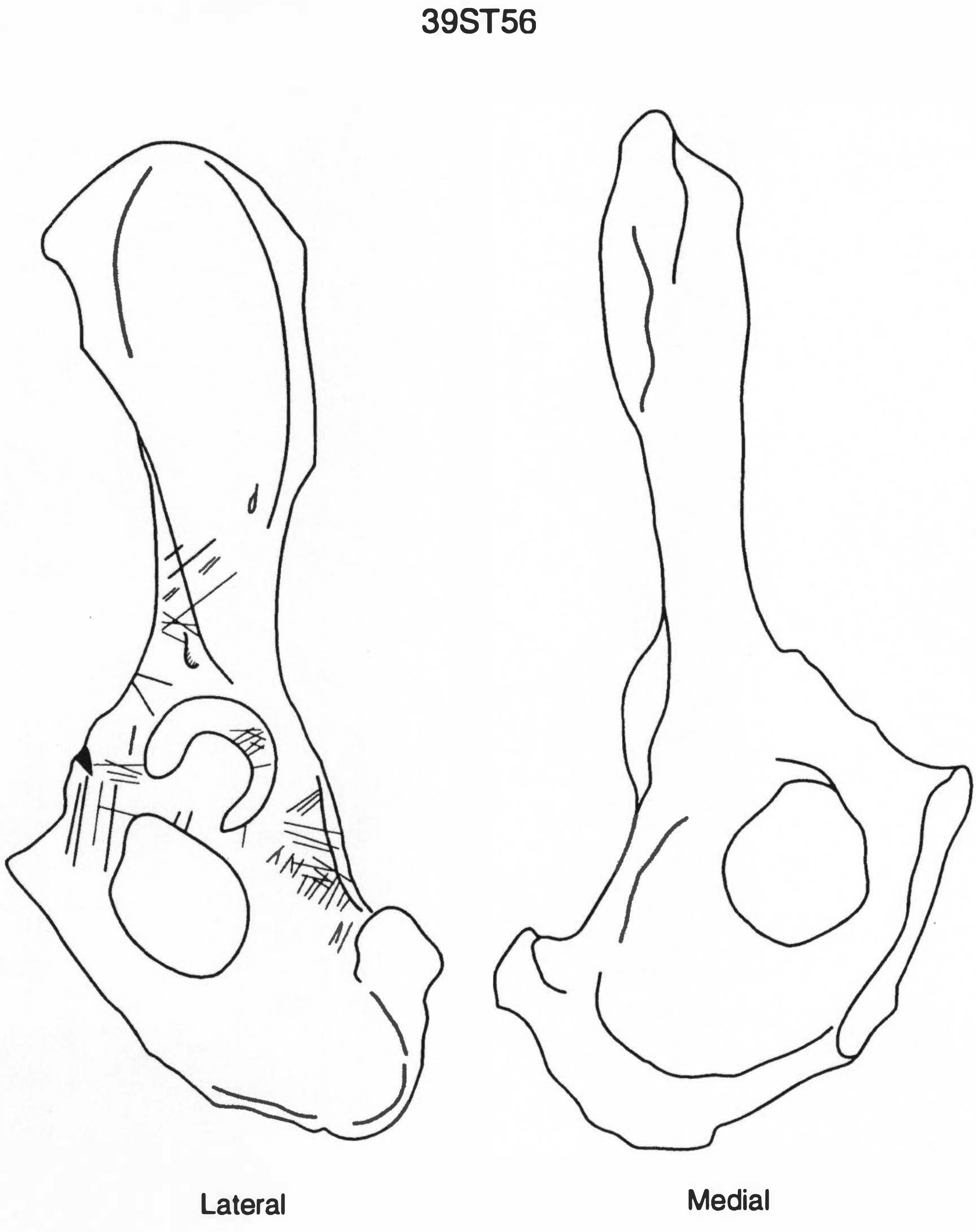


Figure 26. Composite of cutmarks on large canid innominates from the Sommers Site (39ST56).

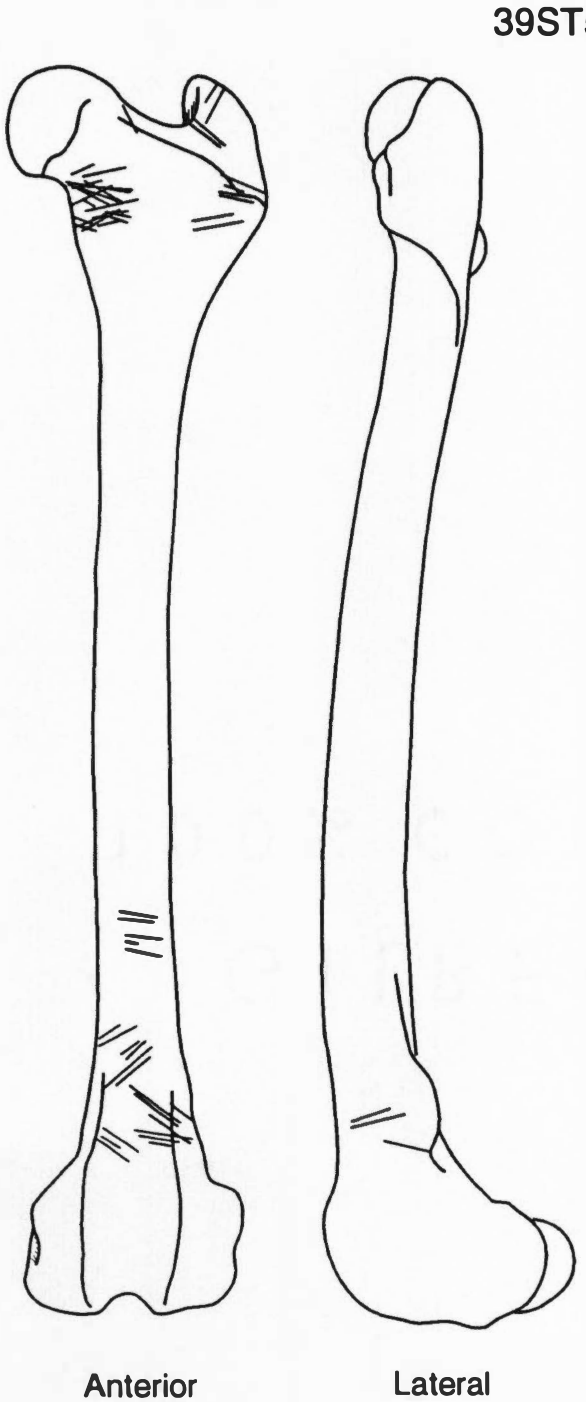


Figure 27. Composite of cutmarks on large canid femora from the Sommers Site (39ST56).

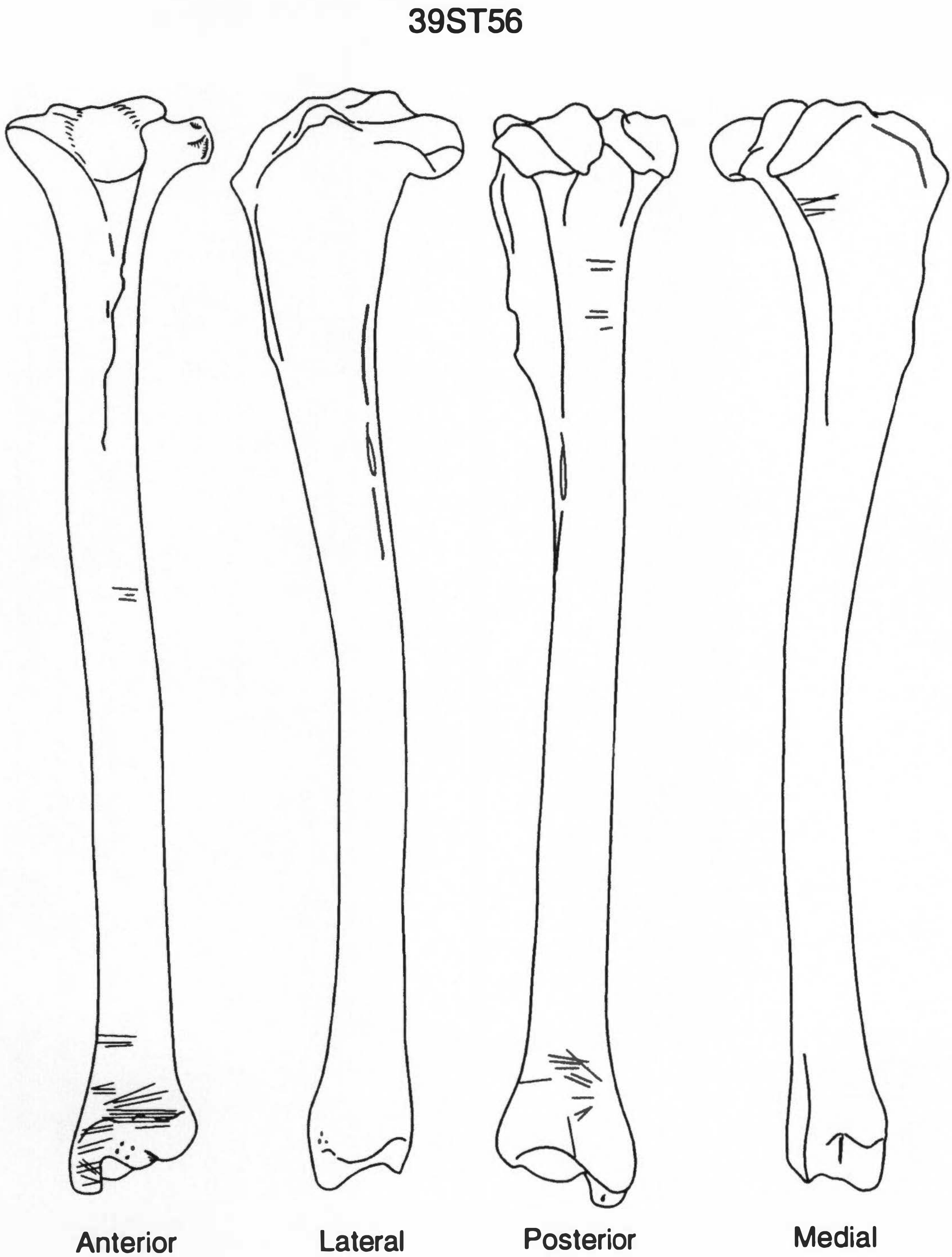


Figure 28. Composite of cutmarks on large canid tibiae from the Sommers Site (39ST56).

Astragalus. Two of 13 astragali have cut marks on the dorsal aspect of the articular trochlea.

Calcaneum. Cutmarks occur on three of 15 calcanea. These marks occur on the anterior and posterior aspects of the projecting tuber calcanei and are most probably the result of severing the ligaments which attach to the calcaneal tuber.

Metatarsals. Only one of 100 metacarpals is cut. The mark on this element, a V metacarpal, is located on the outer or lateral aspect of the diaphysis and was probably inflicted during skinning of the hindlimb.

Changes in Cutmark Patterning Through Time, Six Sites

In the following analysis the frequency and location of cutmarks on the elements from the early Initial Middle Missouri Sommers site (39ST56) and the late Post Contact Coalescent Larson site (39WW2) will be compared. This comparison will then be augmented by comparison with one additional early site, Crow Creek (39BF11); two later Post Contract Coalescent sites, Bamble (39CA6) and Spiry-Eklo (39WW3); and the historic Leavenworth site (39CO9).

Cutmarks occur on only 16.3% (189 of 1161 specimens) of the large canid elements from the Initial Middle Missouri Sommers site. At the Post Contact Coalescent Larson site (39WW2), 30.1% of the assemblage (787 of 2613 specimens) are cut. With the exception of the elements of the lower leg and foot (calcaneum, astragalus, and metapodials), cutmarks are far less common on all major portions of the skeleton in the Sommers assemblage (Figure 29). However, within this dominant pattern, individual element differences can be defined.

Skull

Cutmarks occur on just 9.1% of cranial materials from the Sommers site, but are present on just over 40% of the cranial elements from the Larson site (see Table 4). Disarticulation marks occur in the same locations on the skulls from both sites, clustered around the occipital condyles on the basioccipital, tympanic bullae, and the zygomatic arch. However, these marks are far less common on the Sommers elements. The major variation between the earlier and later site, however, appears on the superior surface of the skull. Probable skinning marks on the maxilla, nasals, frontals, and parietals occur on the skulls from the Larson assemblage (Figure 5). With one possible exception, no such skinning marks were found on the Sommers crania (Figure 18).

This pattern is repeated in the four other site assemblages (Table 5). Probable skinning marks (CMs 1-3) are rare on cranial material from the early sites (39ST56 and 39BF11), while they occur on multiple specimens from the later sites.

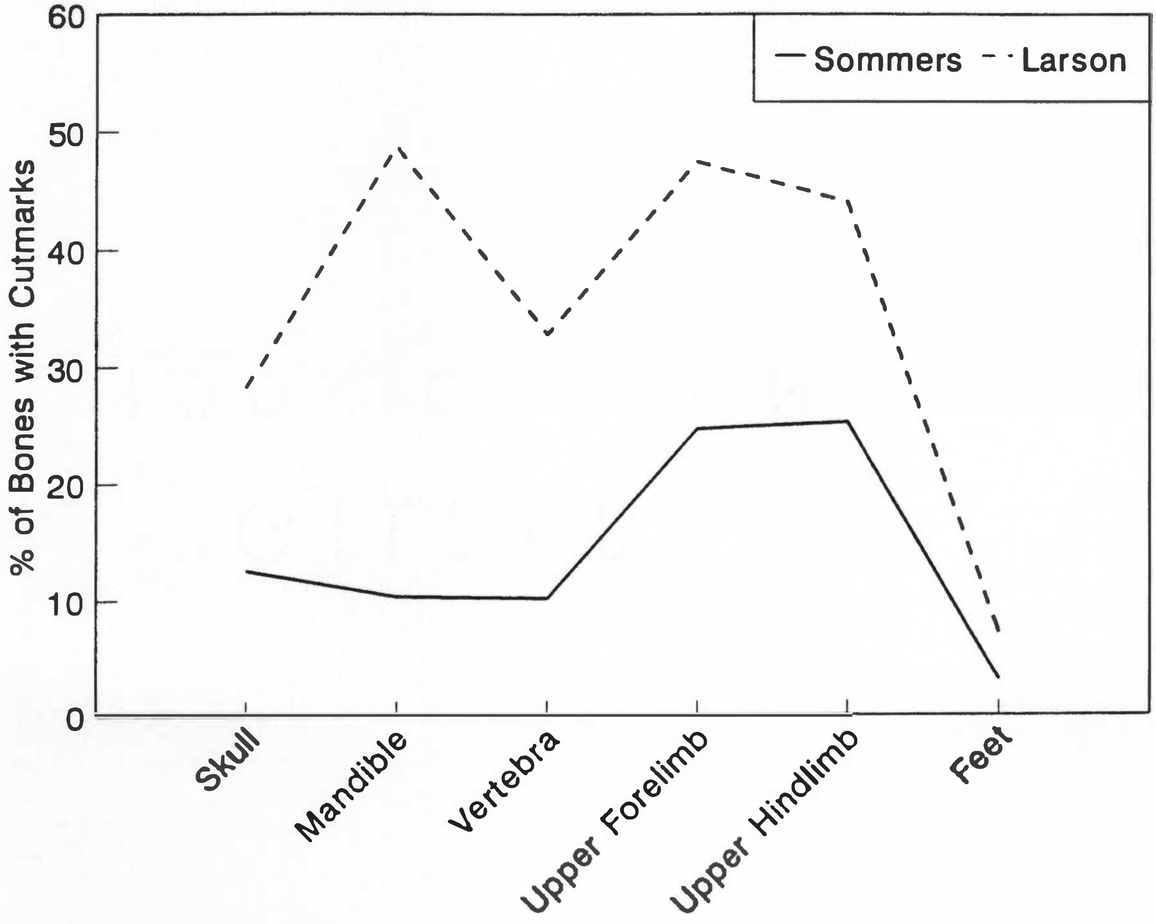


Figure 29. Cutmark frequencies on large canid bones from the Sommers (39ST56) and Larson (39WW2) sites, by generalized body segment.

Table 5. Frequency of Cutmarks by Skeletal Element, from Bamble (39CA6), Spiry-Eklo (39WW3), Larson (39WW2), and Leavenworth (39CO9).

ELEMENT	39BF11		39CA6		39WW3		39CO9	
	NISP/CM	%CM	NISP/CM	%CM	NISP/CM	%CM	NISP/CM	%CM
SKUL	58/8	13.8	49/21	42.9	45/14	31.1	45/13	28.9
MAND	42/10	23.8	127/55	43.3	57/28	49.1	51/26	51.0
CRAN	100/18	18.0	176/76	43.2	102/42	41.2	96/39	40.6
ATLS	12/3	25.0	25/17	68.0	17/9	52.9	15/10	66.7
AXIS	14/0	0.0	4/0	0.0	7/1	14.3	12/2	16.7
CVVT	33/4	12.1	21/11	52.4	38/16	44.4	47/12	25.5
THVT	70/1	1.4	18/9	50.0	36/23	63.9	39/9	23.1
LMVT	37/1	2.7	24/6	25.0	67/24	35.8	25/7	28.0
CDVT	4/0	0.0	-		6/0	0.0	1/0	0.0
VERT	2/0	0.0	-		-		-	
SACR	1/0	0.0	2/0	0.0	1/0	0.0	4/2	50.0
VERTS	179/9	5.2	94/43	45.7	172/73	42.4	143/42	29.4
RIBS	59/3	3.4	-		-		50/17	34.0
SCAP	33/3	9.1	37/25	67.6	52/33	63.5	22/8	36.4
HUMR	59/16	27.1	34/25	73.5	25/11	44.0	41/31	75.6
RADI	42/6	14.3	56/27	48.2	52/11	40.4	44/16	36.4
ULNA	52/9	17.3	50/26	52.0	62/19	30.6	43/21	48.8
U.FRO	186/34	18.3	177/103	58.2	191/84	44.0	150/76	50.7

Table 5. (concluded)

ELEMENT	39BF11		39CA6		39WW3		39CO9	
	NISP/CM	%CM	NISP/CM	%CM	NISP/CM	%CM	NISP/CM	%CM
INOM	23/6	26.1	33/18	54.5	50/27	54.0	28/23	82.1
FEMR	39/10	25.6	21/10	47.6	30/15	50.0	40/23	57.5
TIBI	56/16	28.6	59/20	33.9	47/10	21.3	36/25	69.4
FIBU	12/2	16.7	1/0	0.9	12/2	16.7	8/5	62.5
U.HIN	130/34	26.1	114/48	42.1	139/54	38.8	112/96	67.9
ASTR	8/1	12.5	-		12/5	41.7	5/3	60.0
CALC	21/5	23.8	3/1	33.3	14/3	21.4	14/2	14.3
TRSL	2/0	0.0	-		8/0	0.0	2/0	0.0
CRPL	17/1	5.9	-		3/1	33.3	2/0	0.0
METC	143/4	2.8	31/1	3.2	102/6	5.9	21/0	0.0
METT	94/1	1.1	36/2	5.5	102/1	1.0	22/1	4.5
METP	7/0	0.0	2/0	0.0	7/0	0.0	1/0	0.0
PH1	45/1	2.2	2/0	0.0	39/3	7.7	10/1	10.0
PH2	7/0	0.0	1/0	0.0	-		-	
Ph3	1/0	0.0	-		3/0	0.0	-	
FEET	345/13	3.8	75/4	5.3	290/19	6.5	77/7	9.0
TOTL	1024/111	10.8	636/274	43.1	894/272	30.4	628/257	40.9

Mandible

Cutmarks occur on only 10.3% of the mandibles from Sommers (seven of 67 specimens, 10.3%) while nearly one half of the mandibles from the later Larson site (105 of 215 specimens, 48.8%) were cut. Disarticulation marks occur on the condylar and coronoid processes of the vertical ramus in both assemblages; however, they are much more common on the Larson specimens (Appendix Table 2, CMs 1-4).

The most notable differences are on the mandibular body or horizontal ramus. Only two mandibles from the Sommers site (Figure 19) have cut marks on the mandibular body, one on the lateral (CM 5) and one on the medial (CM 8) aspects. There are no cutmarks on the inferior aspect of mandibles from Sommers. In contrast, marks are prevalent on all three aspects of the Larson horizontal rami (Figure 6). Cutmarks on the anterior portion of the horizontal ramus are probably indicative of skinning, those on the medial aspect indicate tongue removal. There is little or no evidence of these activities on the Sommers mandibles.

This pattern is reinforced in the four additional assemblages. There are no cutmarks on the inferior horizontal ramus of the 32 mandibles from the Crow Creek site; only two elements from this assemblage have cutmarks on the lateral aspect (CMs 6,7); one has cutmarks on the medial aspect (CM 8). In contrast, these marks are frequent on the mandibular bodies of specimens from the later sites. The Leavenworth mandibles are an exception; only one mandible from 39CO9 has cutmarks on the inferior border.

Vertebral Column

The location of cutmarks on vertebrae is similar in both the Sommers and Larson assemblages throughout the vertebral column. On the atlas, marks resulting from disarticulation of the skull are concentrated on the inferior aspect of the cranial articular processes and inferior body (CMs 9,2). Far fewer marks occur on the axis and remaining cervicals.

Disarticulation marks on the thoracics and lumbars occur on the inferior aspect of the vertebral body. Evidence of defleshing or "filleting" of the long muscle masses which lie along each side of the thoracic and lumbar vertebrae are the horizontal to oblique, often multiple and parallel cutmarks which occur on the dorsal spinous processes (CM 10) and lateral aspect of the vertebral arch (CM 4). Marks on the spinous processes of the thoracics are three times more common in the Larson (18.4%) than Sommers assemblage (5.4%).

Again, this pattern is emphasized by the vertebrae from the other four sites. Cutmarks occur on only two of 10 atlas vertebrae from the early Crow Creek site. Two Crow Creek first cervicals have cutmarks on the inferior and superior aspects of the anterior articular processes (CMs 8,9). In contrast, cutmark frequencies on the inferior aspect of the anterior articular processes on first cervicals from the later sites range from 43.7% at Spiry-Eklo (39WW3) to 69.2% at Leavenworth (39CO9).

There are no marks indicative of filleting on either the thoracic or lumbar vertebrae from the Crow Creek site. These marks do occur on thoracics from the later sites, although in lower frequencies than on those from the Larson assemblage.

Front Limb

Scapula. Perhaps the most striking contrast between the early Sommers and later Larson assemblages is that of the scapula. On the scapulae from both sites disarticulation marks are concentrated on the medial aspect of the glenoid fossa and neck (CMs 8,9). However, on the later Larson scapulae, the most commonly occurring marks are the long, straight, and nearly parallel cutmarks on both the supraspinous and infraspinous fossa of the scapular blade (CMs 5,6). These are "filleting" marks, made as the muscle masses which overlie these areas are cut and peeled away. No such marks occur on the Sommers scapulae.

This pattern is mirrored in the Crow Creek (39BF11) assemblage (Figure 30). No filleting marks occur on the lateral aspect of the scapula. In contrast, these marks are

39BF11

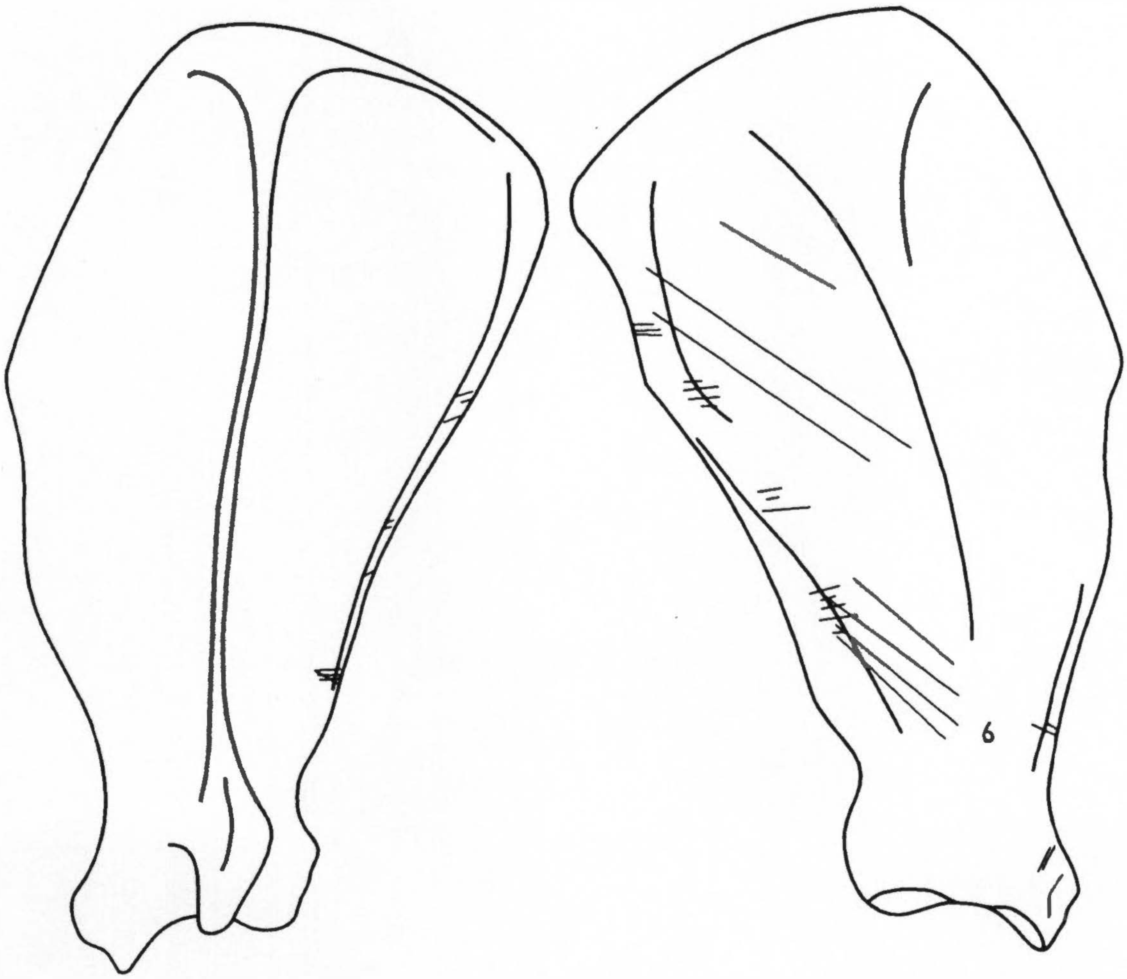


Figure 30. Composite of cutmarks on large canid scapulae from the Crow Creek Site (39BF11).

abundant on the scapulae from both Bamble (Figure 31) and Spiry-Eklo (Figure 32). The absence of filleting marks on the scapula from Leavenworth (Figure 33), is an exception to this pattern, but may be due in part to small sample size (15 specimens).

Humerus. On the humeri from both Sommers and Larson cutmarks occur most often on the anterior and medial aspect of the distal diaphysis (CMs 4A,4B,19A,19B). However, in this instance the predominant pattern of increasing frequency on elements in the later assemblages is reversed. On the Sommers humeri cutmark percentages on the anterior diaphysis (CMs 4A,4B) are 22.5% and 35.3%, respectively. On humeri from the Larson assemblage cutmarks occur on 22.8% and 27.8% of elements, respectively. The same reversal occurs on the medial aspect. There is no immediate behavioral or methodological explanation for this apparently anomalous pattern.

This reversal is not mirrored in the four additional assemblages. Cutmark frequencies on the distal humeri from the Crow Creek assemblage range from 6.2% (CM 4A) to 18.7% (CM 19A). Cutmark frequencies on the anterior aspect of distal humeri from the later sites range from 19.4% (39CO9, CM 4B) to 66.6% (39CA6, CM 4A). In fact, in all cases except for the 19.4% figure from 39CO9, the percentages for the anterior aspect are 40% or above. Frequencies on the medial aspect (CMs 19A,19B) are lower, averaging around 20%.

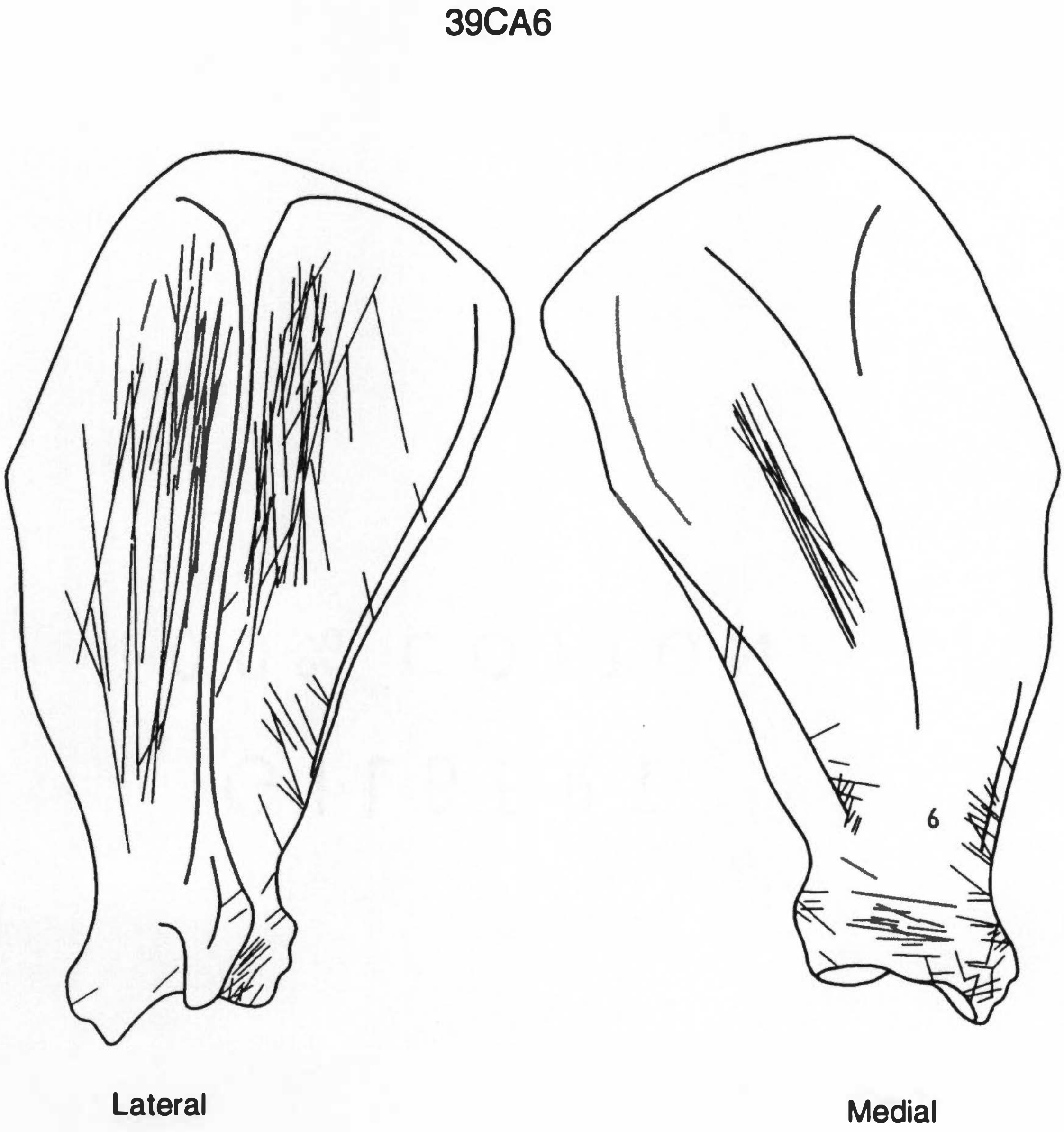


Figure 31. Composite of cutmarks on large canid scapulae from the Bamble Site (39CA6).

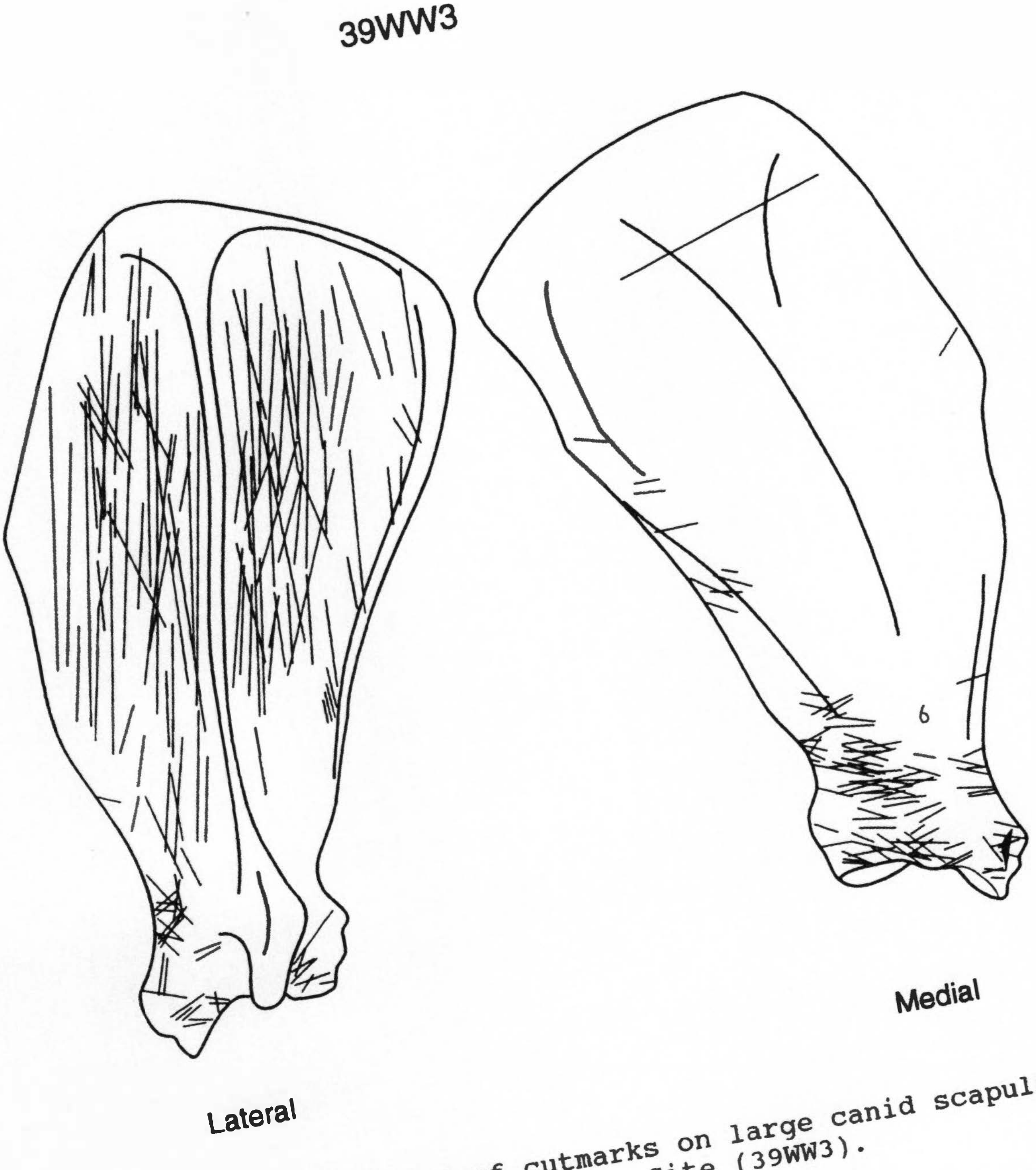


Figure 32. Composite of cutmarks on large canid scapulae from the Spiry-Eklo Site (39WW3).

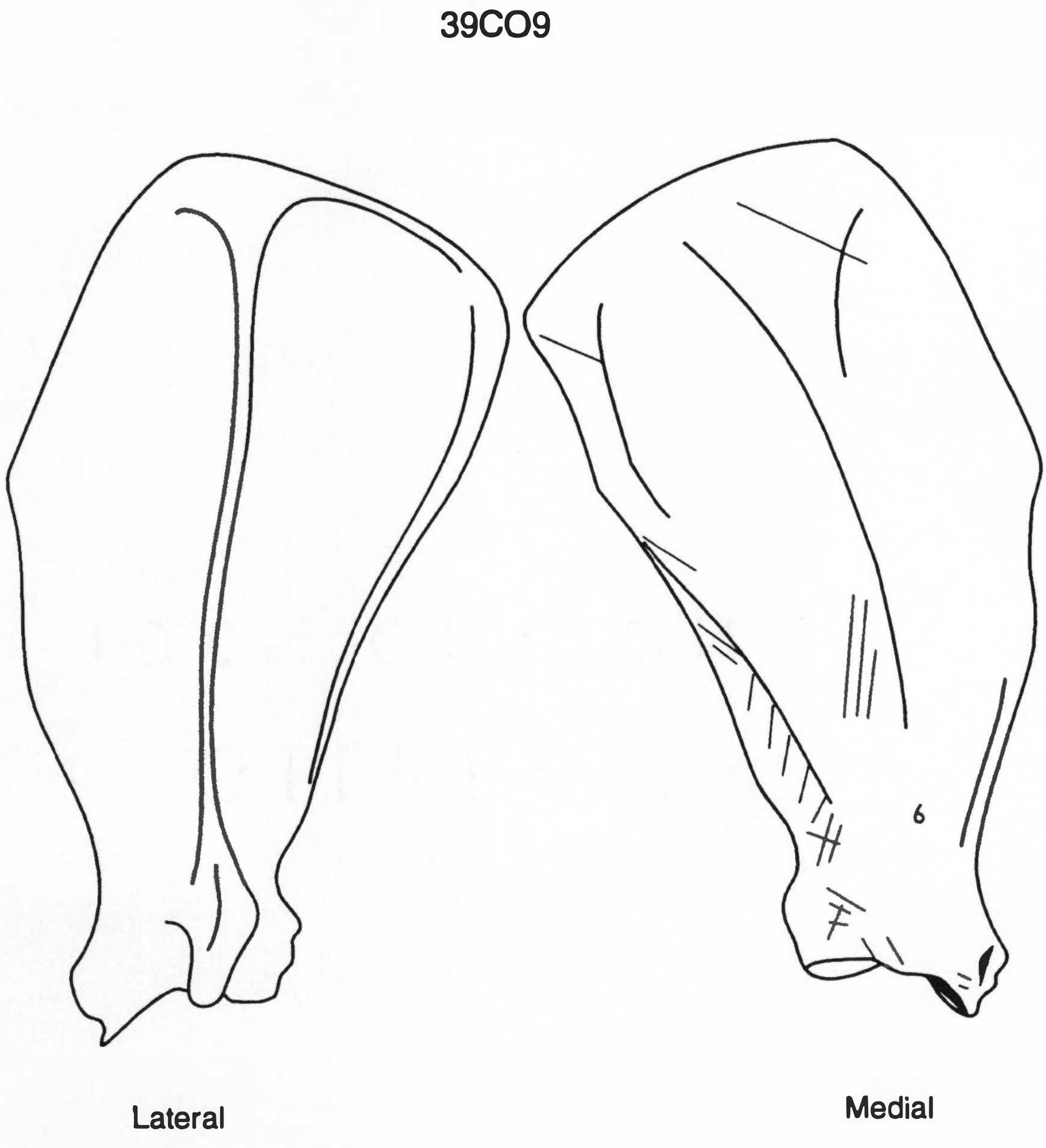


Figure 33. Composite of cutmarks on large canid scapulae from the Leavenworth Site (39CO9).

Radius and Ulna. Cutmarks on the radii and ulnae from Sommers and Larson are similar in location, with disarticulation marks concentrating on the anterior aspects of the proximal radius and ulna and within the trochlear notch of the ulnar olecranon. Unusual on the elements from 39WW2 are the light, multiple, often parallel scrapes or marks which occur on the anterior aspect of the radius diaphysis (CM 3) and the posterior aspect of the ulna (CM 13). These marks appear to have been made while radii and ulnae were still articulated.

Similar mid-diaphyseal marks are present of the radii and ulnae from the later sites, although they occur in much lower percentages. A second pattern noticeable in the larger sample of sites is the concentration of disarticulation marks on the medial/anterior portion of the proximal epiphysis (CM 1A). On all four of the later period sites, these marks are from three to four times more common on the medial (CM 1A) than the lateral (CM 1B) portion of the anterior aspect of the proximal diaphysis.

Hind Limb

Innominate. Over 50% of the innominates in the Larson assemblage (67 of 117 specimens, 57.8%), and nearly 40% of those from Sommers (9 of 23 specimens, 39.1%) are cut. The location of marks is consistent in both assemblages. Cutmarks are concentrated around the acetabulum, on the neck of the ilium, and on the lateral border of the ischium. The two sites differ, however, in the presence of cutmarks on the superior neck of the ilium in the Larson assemblage. No such marks occur on the Sommers specimens.

These patterns are consistent with the four other assemblages. Marks occur on only six of 26 specimens (26.1%) from the early Crow Creek site. In the four later assemblages they range in frequency from 54.0% (Spiry-Eklo, 39WW3) to 82.1% (Leavenworth, 39CO9).

Femur. Cutmarks occur in similar locations and in similar frequencies on the femora from both Sommers (28.6%) and Larson (31.7%). In both assemblages disarticulation marks are concentrated on the proximal femur neck and are fairly evenly distributed on the four aspects of the distal diaphysis just above the distal epiphysis.

The femora from the four additional sites also reflect this pattern; however, cutmark frequencies are higher in the three late assemblages (47.6% to 57.5%). In the Crow Creek assemblage 25.6% of femora are cut.

Tibia. Cut marks occur on the tibiae from Sommers and Larson in similar frequencies and in generally similar locations. Disarticulation marks cluster on the anterior aspect of the distal tibia (CMs 4A,5). Patterns are similar on the tibiae from the other four sites, ranging in frequency from 21.1% to 33.9%. The exception is the

Leavenworth (39CO9) assemblage in which nearly 70% of tibiae (25 of 36 specimens, 69.4%) are cut.

Summary of Cutmark Evidence

In general, cutmarks occur in frequencies of from 10% to 30% on the major carcass units from the two early sites (Sommers and Crow Creek). These frequencies are dramatically higher in all four of the later assemblages (Figure 34). Although all six assemblages show broadly similar patterns in the lower frequencies of cutmarks on vertebra and crania and higher frequencies on upper front and hind limb bones, it is only in cutmarks on the feet (carpals, tarsals, metapodials) that all six site assemblages are virtually identical. While cutmarks indicative of disarticulation and/or defleshing occur in similar locations on many of the elements in all assemblages, in almost every instance their frequencies are higher in the late assemblages.

This pattern of higher frequency of cutmarks in the later assemblage is further amplified by examination of individual elements. On the skull and mandible, marks indicative of skinning (on the lateral or buccal aspect of the mandibular horizontal ramus, on or just behind the symphysis, and across the maxilla, nasals, frontals, or parietals of the skull) are rare or absent in the two early assemblages. These marks are much more common on cranial

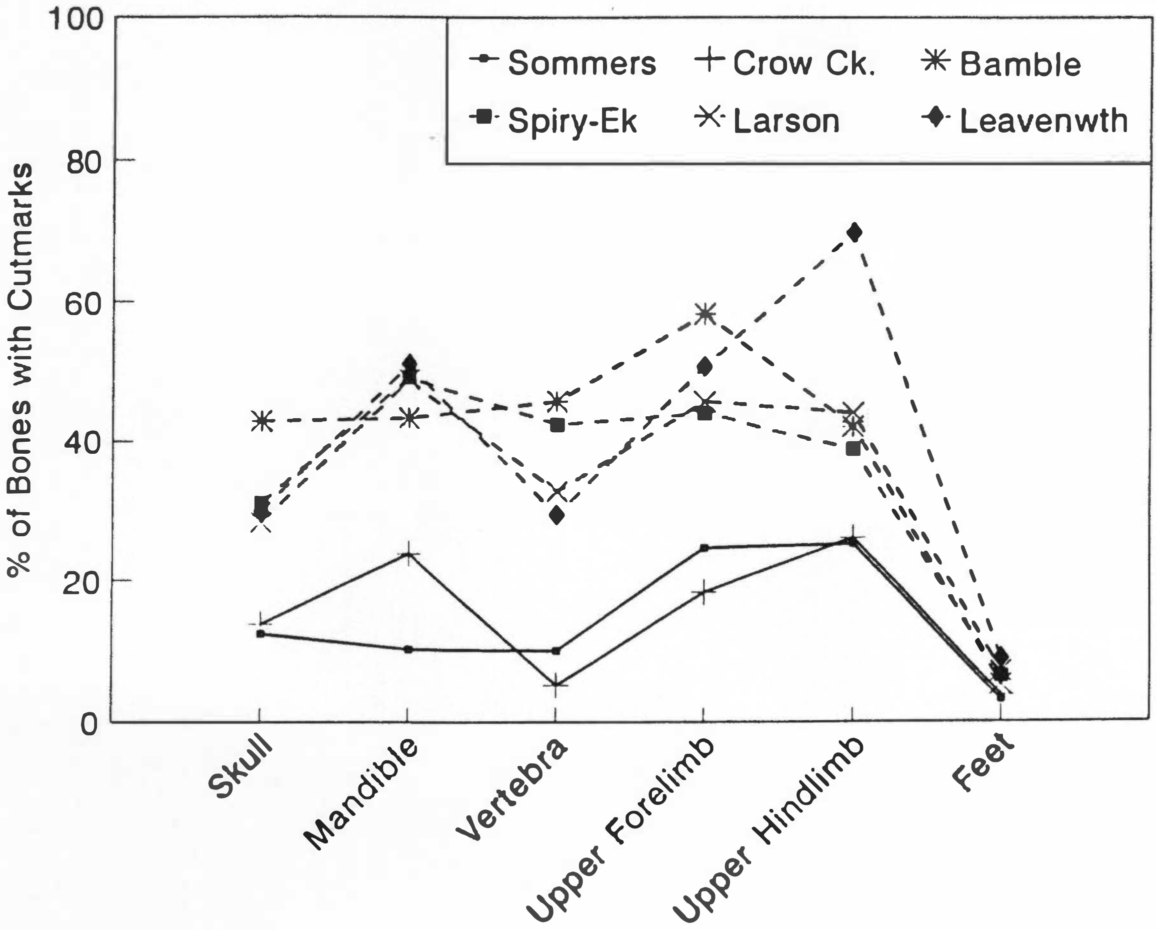


Figure 34. Cutmark frequencies on large canid bones from six sites, by generalized body segments.

elements from the later assemblages. Likewise, on the mandible, marks on the medial or lingual aspect of the horizontal ramus, indicative of tongue removal, are rare in the early assemblages but are very common on mandibles from several of the late assemblages. Cutmarks on the lateral bodies, arches, and spinous processes of thoracic and lumbar vertebrae, indicative of "filleting" or cutting away the muscle masses which lie on either side of the spinal column, are also rare in the assemblages from the early sites but are frequent in the later assemblages.

Perhaps the most dramatic example of this pattern is found on the scapula. In the late assemblages, frequent long, parallel cutmarks on the infraspinous and supraspinous fossae of the scapular blade clearly indicate routine "filleting" or removal of the meaty muscle masses which lie on this lateral aspect of the shoulder. These marks are non-existent on the scapula from the two earlier assemblages.

Skeletal Evidence for the Use of the Dog Travois on the Northern Plains

Throughout the North American Plains, prior to the introduction of the horse in the 18th century, domestic dogs served as draft animals. Even after horses became common, dogs were still used to transport loads (Figure 35), primarily in and around the villages where they were used

Figure 35. View of Ft. Union, Upper Missouri, June 1833, by Karl Bodmer (Thomas and Ronnefeldt 1976).

to transport household goods and loads of wood (Wilson 1924:206-208). With the shift to equestrian hunting and long distance travel, new ecological and economic strategies were developed (cf. Osborne 1983), and the economic value of dogs as beasts of burden would have necessarily changed.

If large, strong animals were no longer required to carry or drag heavy loads, the economic costs of feeding and maintaining great numbers of very large dogs could be avoided, and purposeful breeding for size might have ceased (Bozell 1988). Dogs which had formerly been valued primarily for their size, strength, and endurance, might now be relatively expensive to maintain, and their continuing role as a food resource might also have shifted. Skeletal evidence from the sites considered in this analysis can be used to explore these shifts in use through time.

Ethnographic and Ethnohistoric Evidence of Travois Pulling

The most common method of dog traction was the travois; two long poles crossed at one end and harnessed above the dog's shoulders, with the other ends dragging behind on the ground. The load was placed at the spread ends of the poles, either on wooden cross pieces or on a woven platform (Figure 36).

This practice was widespread throughout the Plains. Driver and Massey (1957:Map 64) list at least 37 groups which used the dog travois. These groups were located in

Figure 36. Sketches for "Training a Dog", by F. Wilson, Ft. Berthold (Gilman & Schneider 1987).

the Northern and Central plains. Driver and Massey divide these groups into those using just travois (N=21), those using both travois and dog packs (N=10), and those groups which used either pack or travois (N=6). Groups using solely the travois, including the Teton, Hidatsa, Mandan, Arikara, Pawnee, Santee, Iowa, Kansa, and Arapaho, were located primarily along the Missouri River in the Northern Plains, and to the south and east in the Central Plains. Groups using both packs and travois, including the Blackfoot, Gros Ventre, Crow, Cheyenne, Wind River, and Comanche, were located further to the northwest and southwest. Groups using either pack or travois occupied the High Plains and Southern Plains.

The dogs which pulled these travois with loads weighing up to 100 pounds were generally large, strong animals. Based on both ethnohistoric reports and skeletal measurements of archaeological canid materials, Allen (1920) describes two types of large dogs on the Plains. The "Plains-Indian dog" is described as a "medium" sized animal, "slightly smaller than the Eskimo dog; ears large, erect; tail drooping or slightly upcurved; coat rather rough, usually 'ochorous tawny' or 'whitish tawny,' or sometimes black and gray, mixed with white." The distribution of these dogs was "western North American from British Columbia south to perhaps the Mexican boundary and eastward through the Great Plains region" (Allen 1920:449).

Allen also distinguishes a larger plains dog, the "Sioux Dog", which he describes as: "A large wolf-like dog, probably closely related to the Plains-Indian Dog, but larger and gray rather than tawny in color". The distribution of this dog was "probably the north-central plains area, from the Missouri north perhaps to Saskatchewan" (Allen 1920:455).

These large dogs were frequently mentioned in the journals of early Euroamerican explorers who encountered them among the tribes of the Northern Plains and Middle Missouri area. Maximilian, who traveled along the Upper Missouri in 1834, described the dogs of the Sioux:

> The dogs, whose flesh is eaten by the Sioux, are equally valuable to the Indians. In shape they differ very little from the wolf, and are equally large and strong. Some are of the real wolf colour; others black, white or spotted with black and white, and differing only by the tail being rather more turned up. Their voice is not a proper barking, but a howl, like that of the wolf, and they partly descend from wolves, which approach the Indian huts, even in the daytime, and mix with the dogs (Maximilian 1906:210).

His observations are similar to those of Brackenridge, who visited the Arikara villages in 1810:

> The dogs of which each family has thirty or forty, pretend to make a show of fierceness, but on the least threat, ran off. They are of different sizes and colors. A number are fattened on purpose to eat, others are used for drawing their baggage. It is nothing more than the domesticated wolf. In wandering through the prairies, I have often mistaken wolves for Indian dogs. The larger kind has long curly hair, and resembles the shepherd dog. There is the same diversity amongst the wolves of this country. They may be more properly said to howl, than bark (Brackenridge 1904:114-115).

These accounts suggest that in order to produce large, strong animals, Native Americans bred village dogs with wolves. Morphometric studies of canid crania from Northern Plains archaeological assemblages (Morey 1986; Walker and Frison 1982) indicate the possible presence of these dog-wolf hybrids, as well wolves and large dogs.

Ethnohistoric documents provide information on the size of loads these dogs could move and the distances they could travel. A load of 70 to 100 pounds seems to have been common. Ewers (1958:10) stated that strong Blackfoot dogs "could drag a load of about seventy-five pounds on the A-shaped, wooden travois. A lodge cover made from six or eight buffalo cow skins was a good load for one of these dogs." Weltfish (1977:140) noted that Pawnee dogs "could drag as much as 70 pounds."

De Smet (1905:505) estimated that Assiniboin dogs carried or pulled loads of 30 to 50 pounds. Rudolph Kurz noted, "It is estimated that a dog, traveling at the rate of from 30 to 40 English miles a day, can haul a load weighing 70 pounds, and can carry a load of 50 pounds" (Kurz 1937:293). Samuel Allis, traveling with the Pawnee in the 1800s stated that dogs were able to pull a load "of seventy to one hundred pounds, according to the size of the dog" (Allis 1887:140).

The common form of travois consisted of two poles, crossed and tied at one end. Two additional cross pieces were then placed across the opposite, dragging ends of the poles, and the load was placed upon these cross pieces. Alternatively, a woven basket, upon a hoop frame, might serve as a platform for the load (Figure 36).

The most complete account of dog rearing, training, and use for travois is that of Buffalo-Bird-Woman, an Hidatsa born in 1840 in one of the last independent earthlodge villages on the Missouri River in what is now North Dakota. She and other members of her family talked extensively as informants to Gilbert L. Wilson about traditional village lifeways during his work among the Hidatsa on the Ft. Berthold Reservation from 1908 to 1918 (Gilman and Schneider 1987; Wilson 1924). The following descriptions are taken from her accounts of Hidatsa use of dogs (Wilson 1924:196-262).

According to Buffalo-Bird-Woman (Wilson 1924:199) dogs might breed year round, although she also stated (Wilson 1924:204), "As nearly as I can recollect, we expected our bitch to litter once a summer." Pregnant bitches were not used to pull travois. Litters averaged seven to ten pups, and puppies were chosen or culled according to size:

> As we wanted only big dogs, and those of the first litter never grew large, we always killed them, sparing not even one. From the second litter, we kept three or four of the puppies with large heads, wide faces, and big legs, for we knew they would be big dogs, the rest we killed (Wilson 1924:199).

She makes a distinction between the "old dogs" which her family owned before contact with Europeans, and the crossbred Native-European dogs of later years:

> Our old breed of dogs all had straight wide faces, heavy, but not short legs, and ears that stood erect like those of the coyote. The dogs were about the size of the wolf.
>
> All our dogs were about the same size. We had no small-sized dogs as we have now. All these dogs were, of course, of the old breed which are now extinct (Wilson 1924:204).

One of the primary uses of dogs, after horses were acquired, was to transport gathered wood to the village. The dogs, which were owned and trained by the women of the family, accompanied the women as they gathered deadwood in the forests along the Missouri River. According to Buffalo-Bird-Woman a dog could haul a "double armful or a little more" of wood (Wilson 1924:207). Her son Goodbird noted: "A good dog could bring in nearly one hundred pounds" [of wood]. Elsewhere, in describing a hunt made with horses and dogs, Buffalo-Bird-Woman (Wilson 1924:227) stated: "a load for one dog was one-quarter of a buffalo, that is, an Indian quarter, cut off from the backbone. The hide which weighed about eighty pounds might make a load for a dog."

The training of a dog to pull a travois took about four days. Although initially the dog feared the travois and "struggled and whined with fear", after a few days of being led by a thong while dragging a light load the dog was eager to follow its owner. Details are also provided on the making and harnessing of the travois (Wilson 1924:216-221, 281-283). Two green cottonwood or poplar frame poles were cut, which were around 8.5 feet, about 1.25 inches in diameter at the upper end and 1.75 inches at the lower where they were angled to drag flat on the ground. The poles, after drying, were notched at the upper end, crossed and lashed with a bison neck tendon tie. A woven, hoop framed, flat basket was then attached to the lower end of the framing poles to hold the load. Where the crossed poles rested on the dogs shoulders, a bison skin saddle, folded and sewn with hair out and seams up, was attached to cushion the poles. The travois was steadied by a neck collar and belly band; however, the dog actually pulled against a thick "breast band" (Figures 36 and 37, see also Henderson 1994).

Finally, Buffalo-Bird-Woman (1924:229) noted that "A dog two or three years old had acquired his proper strength and was old enough to work." At any one time, a family might own ten to twenty dogs, including working dogs, dogs being raised "that were not yet old enough to be broken to dragging a travois" and older dogs which no longer worked. She recalled: "One of our dogs lived to be about twelve years old. When a dog grew too old to work we kept him in the lodge without working" (Wilson 1924:215).

Archaeological (Skeletal) Evidence of Travois Pulling

A number of skeletal anomalies have been identified as indicative of load bearing or animal traction (Baker and Brothwell 1980:114-122; Davis 1987:164-168). The most

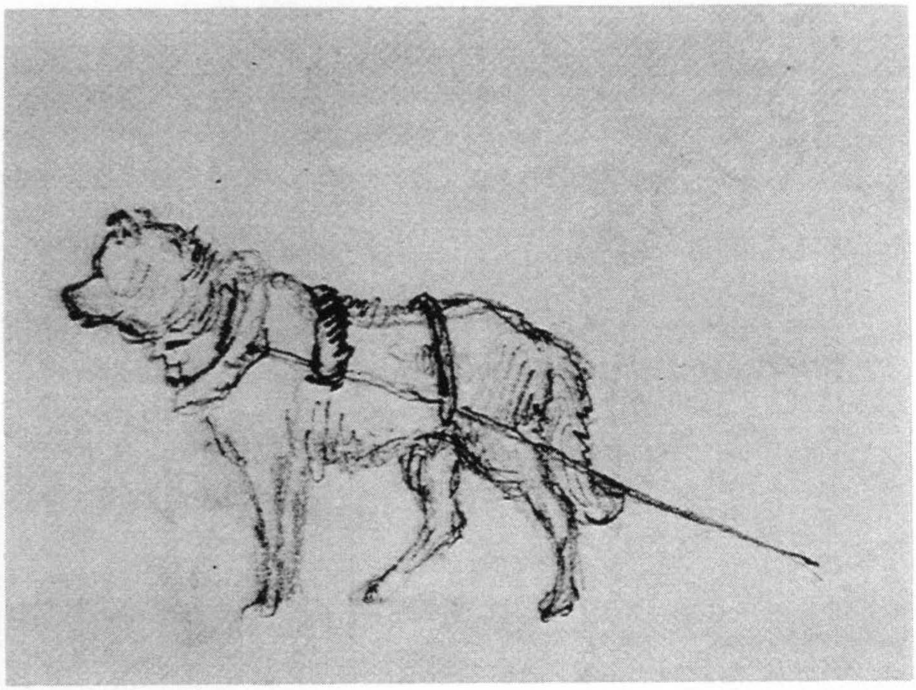


Figure 37. Sketch of a Mandan dog in travois harness, February 1834, by Karl Bodmer (Thomas and Ronnefeldt 1976).

universal of these is the occurrence of osteoarthritic changes to the joints, particularly those which are load bearing during traction (Armour-Chelu and Clutton Brock 1985; Higham et al 1981).

For domestic dogs, osteoarthritic joint changes and other skeletal pathologies have been taken as evidence of domestication as well as use of the animals for traction. Deliberate breakage of the mandibular teeth, especially the large canines, has been posited as evidence of efforts to control the dogs chewing and aggressive behavior (Arnold 1979:263; Wing 1984:231).

Skeletal Anomalies of the Skull and Mandible

There is limited evidence of breakage of the lower canine tooth on mandibles in several of the Middle Missouri assemblages considered in this analysis. However, there are several instances of osteitis, swelling, and inflammation of the lower jaw associated with broken teeth, particularly beneath the large carnassial or first molar. This suggests that broken canid teeth in the assemblages might have been the result of natural trauma, associated with chewing of some hard object which produced attendant inflammation and infection in the mandible.

A second form of potential evidence was identified by Park in the canid assemblage recovered from the Porden Point Site, Devon Island, Northwest Territory, occupied by the

Thule sometime between A.D. 1100 and 1400 (Park 1987). He notes partially healed depressed fractures on a number of presumably domestic dog crania, particularly in the area of the frontal crest and zygomatic process (Park 1987:186-188 & Figures 3-5). These partially healed fractures appear similar to those described by Baker and Brothwell (1980:93-94). Park attributes these injuries, as do Baker and Brothwell, to disciplinary blows delivered to the dogs by their Thule owners.

The majority of cranial material in the Middle Missouri assemblages is fragmentary. In particular, otherwise complete skulls often have the posterior cranial vault (parietals and posterior portion of the frontals) broken away, presumably to gain access to the brain. However, several of the more intact specimens do exhibit partially healed depressed fractures, most often on the zygomatic processes of the frontal.

A complete skull from the Post Contact Coalescent Bamble site (39CA6) shows a partially healed break on the right frontal on and just behind the zygomatic process (Figure 38). The break from the original trauma appears to be approximately 250 mm in length, and the remaining opening caused by the depressed fracture is about 8 mm wide at its widest point. There is visible bone remodeling and regrowth in the posterior portion of the injury site.

A complete skull from the Larson site (39WW2-1512) was

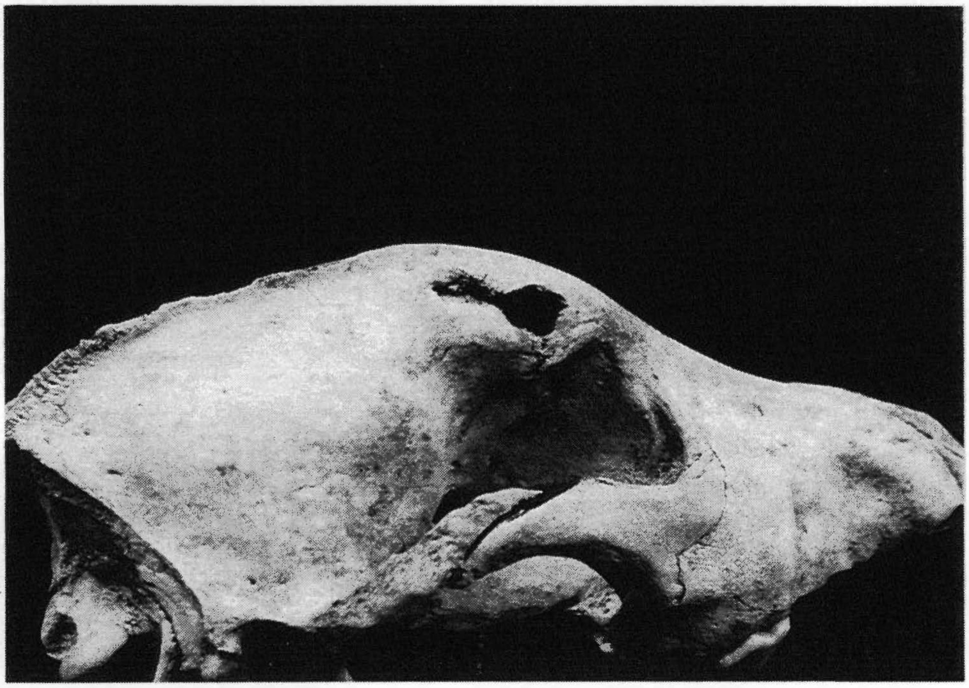


Figure 38. Large canid crania from the Bamble Site (39CA6), posterio-lateral view showing partially healed fracture of the right frontal.

identified by Morey (1986:132) as "unambiguously dog". This skull exhibits an extensive depressed and partially healed fracture immediately behind and involving the zygomatic process of the left frontal (Figures 39, 40). A portion of the frontal appears to have been broken and dislodged backwards and inwards before regrowth. Toward the rear of the skull, just above the squamous suture (Figure 39), a second partially healed injury is visible. The right dorsal aspect of the skull also exhibits a large lesion at the frontoparietal suture (Figure 41), which shows some healing and possible sloughing of necrotic bone.

That these blows did not immediately result in the animals death is indicted by partial healing of all three injuries. However, it is impossible to tell if all three occurred at or near the same time or represent repeated episodes of "disciplining". Cutmarks on both left and right tympanic bullae on this skull indicate that following death, by whatever manner, this animal was butchered, and the head was disarticulated from the body.

A large, nearly complete skull from the earlier Sommers site (39ST56-2950) also exhibits depressed fractures to the left and right frontal (Figures 42, 43). The trauma on the left frontal produced a small, depressed and displaced bone fragment, approximately 3.2 by 4 mm, which is still present within the depression. The injury on the right frontal appears to have completely separated a bone fragment

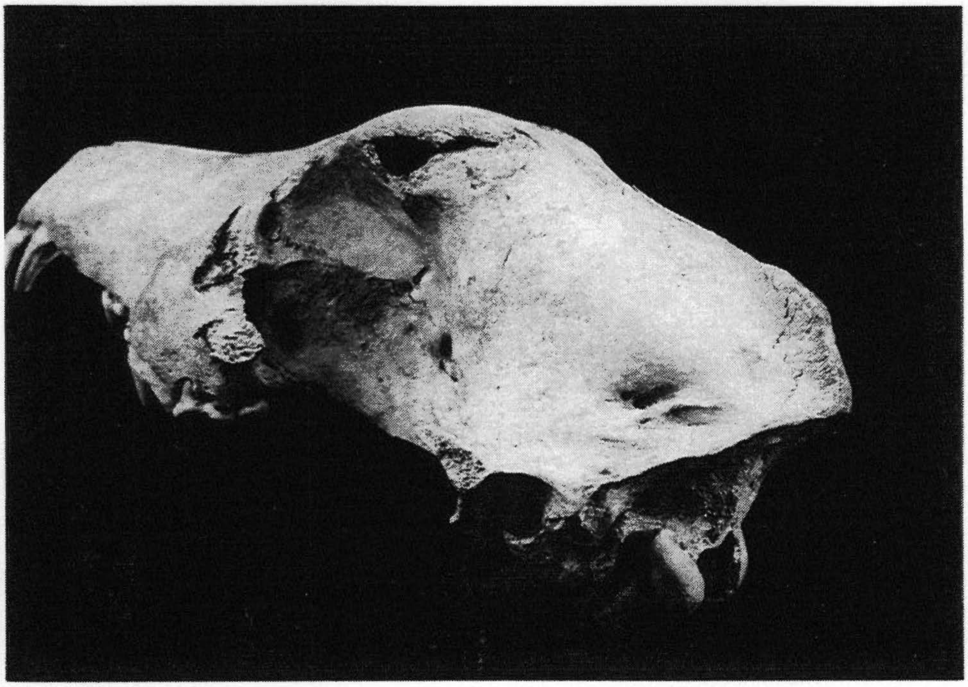


Figure 39. Large canid crania from the Larson Site (39WW2), posterio-lateral view showing partially healed fractures of the left frontal and parietal.

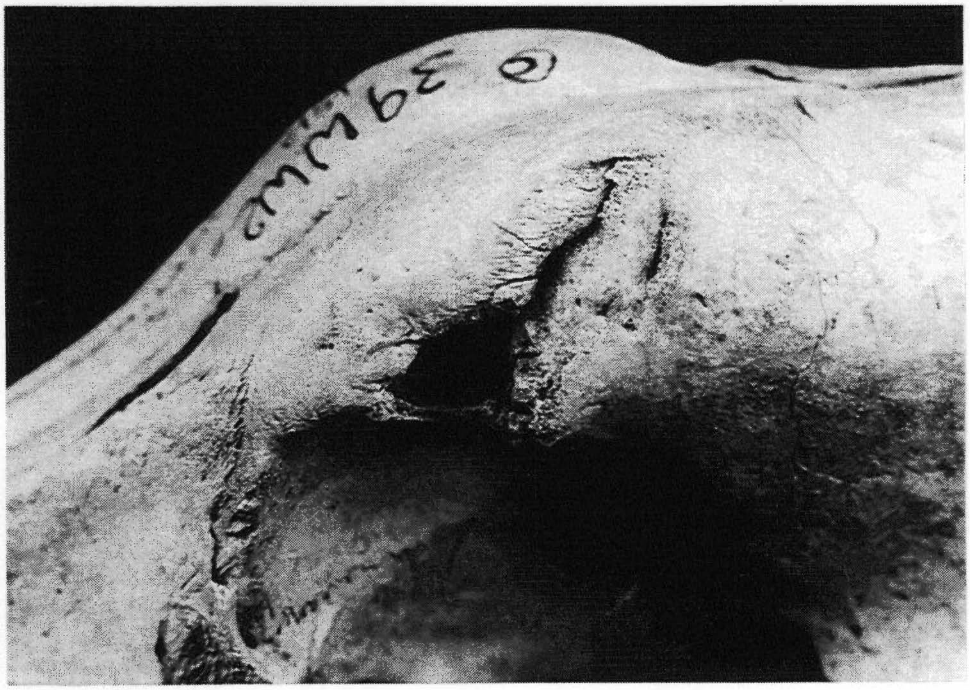


Figure 40. Large canid crania from the Larson Site (39WW2), lateral view, close up showing partially healed fracture of the left frontal.

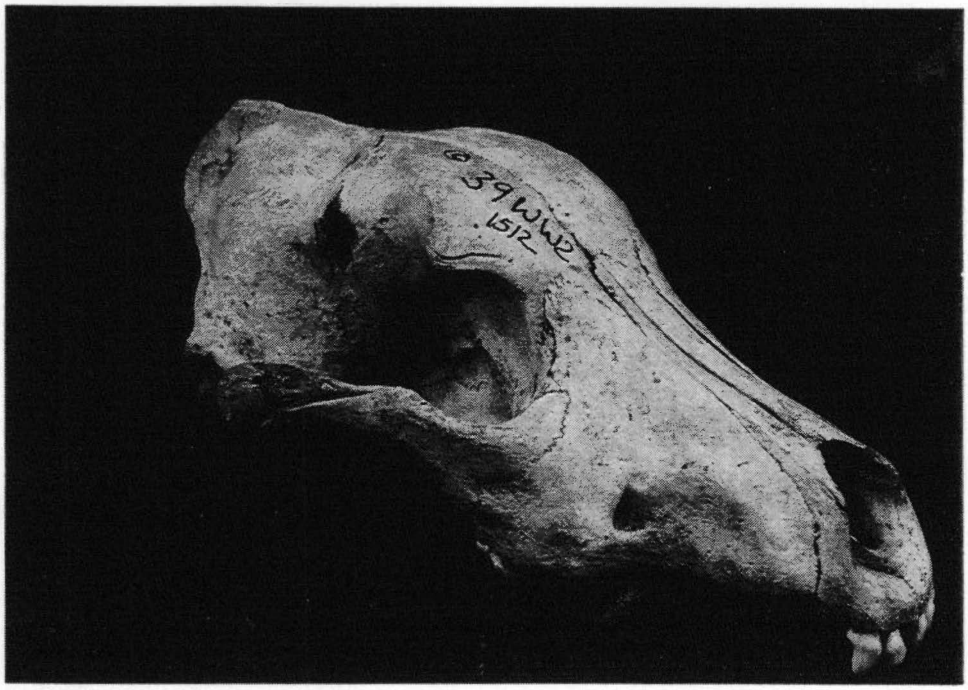


Figure 41. Large canid crania from the Larson Site (39WW2), anterio-lateral view showing partially healed fracture of the right frontoparietal suture.

Figure 42. Large canid crania from the Sommers Site (39ST56), superior view showing fractures of the left and right frontal and right parietal.

Figure 43. Large canid crania from the Sommers Site (39ST56), posterio-lateral view, close up showing fractures to right frontal and parietal.

approximately 14 mm by 16 mm in size, with further fractures radiating toward the zygomatic process. A third blow, to the right parietal, also produced an oval depressed fracture with radiating fracture lines. However, in contrast to skull 1512 from Larson, these injuries show no evidence of reknitting or healing. In this case these blows may well have resulted in the death of the animal. There are no visible cutmarks on this skull.

Skeletal Anomalies of the Vertebral Column

Although rarely applied to dogs, by far the most widely recognized skeletal indicator of traction is the development of osteoarthritis or "degenerative arthropathy" (Baker and Brothwell 1980:114-117). Arnold illustrated an articulating set of 12th and 13th thoracic and 1st lumbar vertebrae (1979, Figure 1) which exhibit "extreme osteophytoses" on the costal facets of the thoracic vertebrae and body of the lumbar vertebra, plus a distinct flattening and lipping of the spinous processes of each vertebra. He speculated that these bony reactions might be due to stress associated with the use of a pack or harness. "In this respect the osteophytoses could be bone responses aimed at strengthening the flexible vertebral column of a pack animal" (Arnold 1979:264).

Similar flexion and lipping of the spinous processes, plus osteophytic lipping and eburnation of the vertebral cranial and caudal articular surfaces, are present on an articulating set of 1st-4th lumbar vertebrae from the Sommers site (39ST56-1187) (Figures 44, 45). These vertebrae are part of a larger articular unit consisting of the 7th cervical through the sacrum, many of which show osteoarthritic changes. The dorsal spinous processes of the thoracic vertebra are severely thickened on their superior surfaces, and on the 7th through 13th vertebrae they are distinctly bent to the left. Osteophytic lipping of the vertebral articular surfaces begins in the 13th thoracic and is severest on the 1st through 4th lumbars, which exhibit eburnation on both cranial and caudal articular surfaces.

Flattening and distortion of the spinous processes is perhaps due to stress placed on the supraspinous ligament which runs along the tops of the spinous processes from the first thoracic to third coccygeal vertebra (Miller 1979:235, Figures 5-7). These processes are also the areas of insertion for the longissimus muscle system which operates to fix the vertebral column. The latissimus dorsi arises on the spinous processes of the last seven or eight thoracic vertebrae and the lumbars and eventually inserts on the major tubercle of the proximal humerus (Miller 1979:306-308, 344-345). The major action of this muscle mass is to draw the trunk forward, depress the vertebral column, support the front limb, and draw the limb against the trunk.

Figure 44. Large canid lumbar vertebra from the Sommers Site (39ST56), anterior view showing osteophytic lipping and erosion and eburnation of the cranial articular surface.

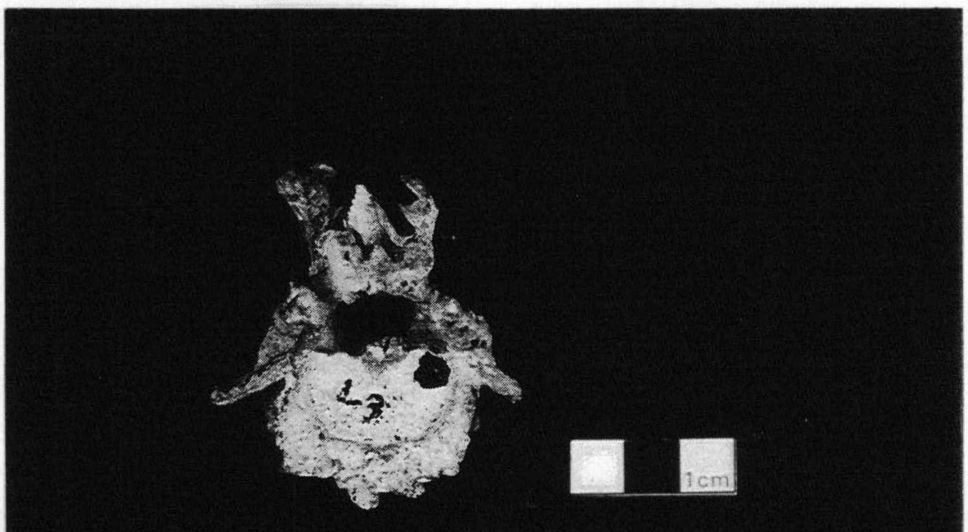


Figure 45. Large canid lumbar vertebra from the Sommers Site (39ST56), posterior view showing osteophytic lipping, and distortion of the dorsal spinous process.

Degenerative changes to the vertebrae from the Sommers site, plus similar osteophytic reactions on articulating thoracic (Figure 46) and lumbar (Figure 47) vertebral units from the Larson site (39WW2), may well be related to chronic or intermittent stress to the vertebral column associated with travois pulling.

<u>Skeletal Anomalies of the Shoulder Joint</u>

By far the most commonly cited skeletal indicator of use as a draft animal is the development of osteoarthritic reactions, particularly in the limb joints (Armour-Chelu and Clutton-Brock 1988; Baker and Brothwell 1980:114-117; Higham et al. 1981). Judd et al. (1985) describe the general progression and effects of what they term "primary arthropathies", in which "articular plates soften, fibrillate, and ulcerate, and subchondral bone is eburnated. Osteophytes develop at joint margins, and remodeling of joint structures occurs." They point out that such degenerative changes are common with advancing age; however, "when the degeneration begins early in life, or progresses rapidly and reaches a degree that results in pain and locomotor disturbances, it is regarded as pathologic." They characterize "primary degenerative arthropathy" as "an exaggeration of the same degenerative process that occurs with aging, and it is probably in large measure due to the same causes - repeated trauma and nonphysiologic stresses"

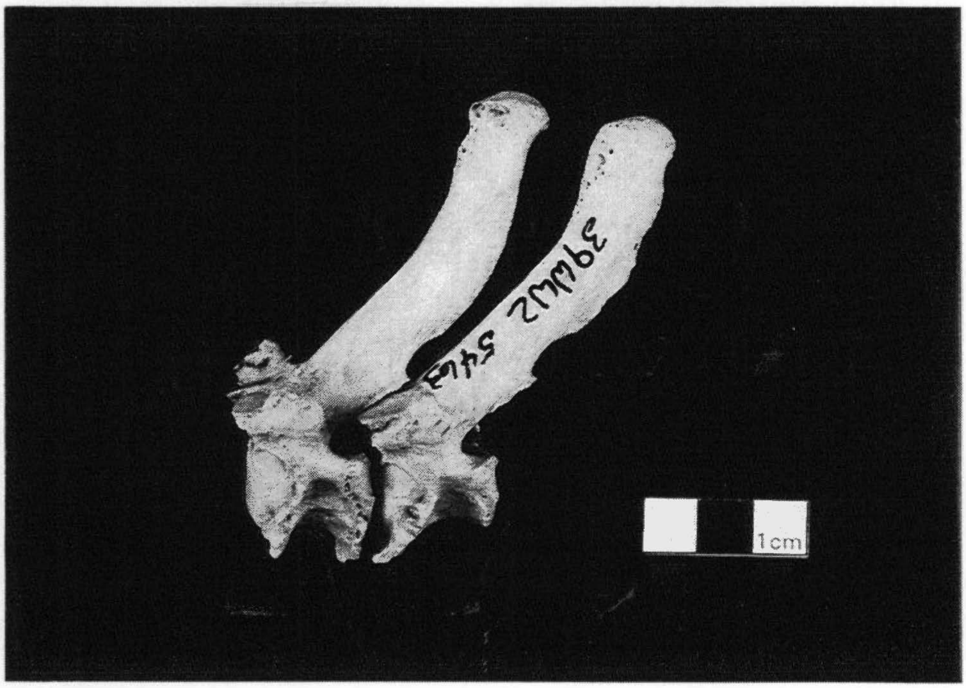


Figure 46. Large canid thoracic vertebrae from the Larson Site (39WW2), lateral view showing osteophytic lipping of the vertebral bodies.

Figure 47. Large canid lumbar vertebrae from the Larson Site (39WW2), inferior view showing osteophytic lipping of the vertebral bodies.

or "constant mechanical stresses" (Judd et al. 1988:97-98).

They also describe "arthropathy of the canine shoulder" which involves the glenohumeral joint of the shoulder, and occurs in up to 80% of dogs above the age of eight years. This condition is commonly bilateral and begins in animals around five or six years of age (Judd et al. 1988:98). They suggest that the differential occurrence of this arthropathy in the front rather than the hind limb is likely due to the fact that dogs bear 65-70% of their body weight on their forelegs (Judd et al. 1988:98).

A veterinary study of modern British Antarctic Survey sledge dogs (Bellars 1969; Bellars and Godsal 1969) produced similar results. These sledge dogs normally pull loads of up to 120 pounds in a team of nine animals harnessed by center trace. Individual dogs are fitted with custom-made harnesses which pass over their chests and distribute the load stress across the shoulders and chest, apparently in much the same way described by Buffalo-Bird-Woman (Wilson 1924:219-221, see also Henderson 1994). In the Antarctic, pups were first trained to harness at about six months, and were working full time by about nine months of age. This contrasts sharply with Buffalo-Bird-Woman's statement that dogs were not ready to pull travois until two or three years of age.

The Antarctic study determined that osteoarthritis, with attendant stiffness and slowness, led to destruction of

72% of all male dogs and 52% of all females in the sample population that survived beyond five years of age (Bellars 1969). Of 34 animals two to 11 years old (Bellars and Godsal 1969), 26 were affected by osteoarthritis of hip or shoulder joints. Nine animals were affected in the hips only and three in the shoulder joint only. Fifteen of 26 animals showed osteoarthritic degeneration of both hip and shoulder joints. The youngest animal affected was a 3.5 year old female (Bellars and Godsal 1969:17).

Erosion of articular joint cartilage was generally bilateral, and uniform in location on the femoral and humeral articular surfaces. They note:

> On the surface of an affected humerus the erosion was on the caudal curvature of the articular cartilage... Severe cases also showed smaller erosions on the opposing surfaces of the glenoid cavity of the scapula and acetabulum. These erosions are found, therefore, in the areas of greatest pressure when a dog is pulling, i.e. on the areas in direct opposition when a dog is leaning against the weight of the loaded sledge, with its limbs in extension retractions... (Bellars and Godsal 1969:29).

Sustained or intermittent heavy stress on a joint during growth may lead to improper formation of epiphyseal cartilage, thus hastening joint alteration and degeneration. Therefore, Bellars and Godsal (1969:30) suggest, "it is most important that the musculo-skeletal system of the Antarctic dogs should be allowed to mature before they are expected to haul heavy loads."

The degenerative changes described by Bellars and Godsal in the shoulder joint are analogous to those shown on an articulating scapula and humerus from the Breeden site (39ST16), a multicomponent Initial Middle Missouri through Extended Coalescent village located approximately 30 miles upriver from the Sommers site (39ST56). In these specimens, there is extensive osteophytic development around the margins of both the scapular glenoid fossa and humeral head (Figure 48). On the humerus, this osteophytic development has also extended along the margins of the biceps tendon, on the medial aspect of the humeral head, to form a nearly U shaped trough around the tendon (Figure 49). There is also eburnation on opposing surfaces of the glenoid fossa and humeral head (Figure 50). On the humeral head, eburnation occurs in precisely the location identified by Bellars and Godsal (1969) as the portion of the articular surface which would be in direct contact with the glenoid fossa when the animal is exerting maximum forward force or pull.

Skeletal Anomalies of the Scapula

Of even more potential importance is an additional anomaly which occurs on the cranial portion of the scapular blade in the pair of articular elements from the Breeden site. Most visible on the medial face of the scapula and occurring on the cranial portion of the subscapular fossa approximately 190 mm above the scapular notch, there is an area of apparent fracture, healing, and remodeling of the thin scapular blade (Figure 51). There appears to be a

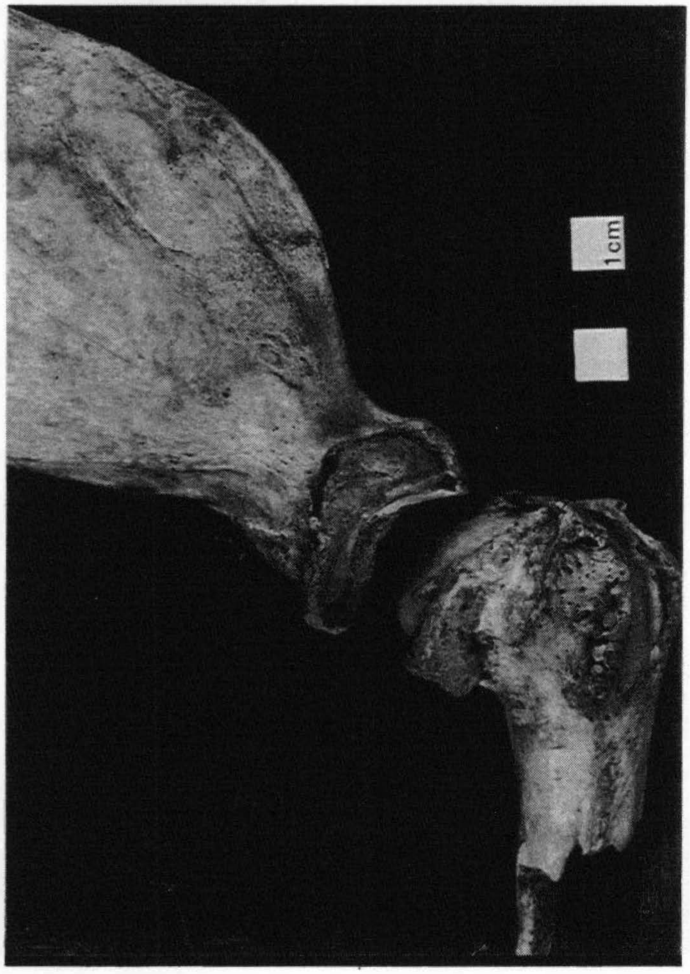


Figure 48. Large canid scapula and humerus from the Breeden Site (39ST16), medial view showing osteophytic development on the glenoid fossa and humeral head.

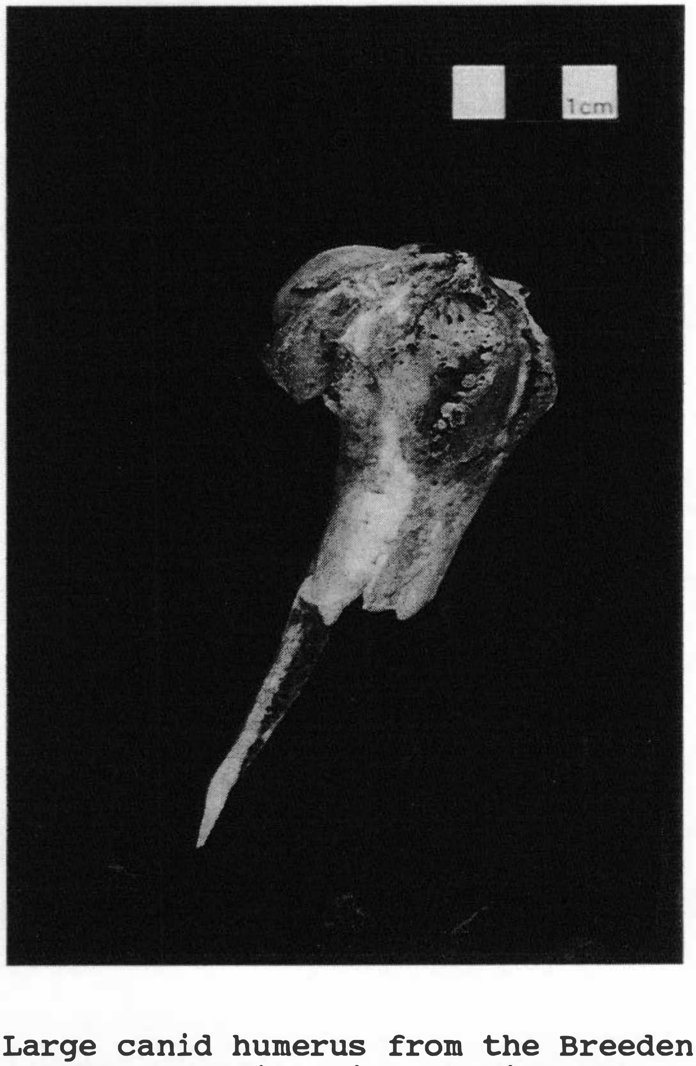


Figure 49. Large canid humerus from the Breeden Site (39ST16), medial view showing osteophytic development around the articular margin and biceps tendon.

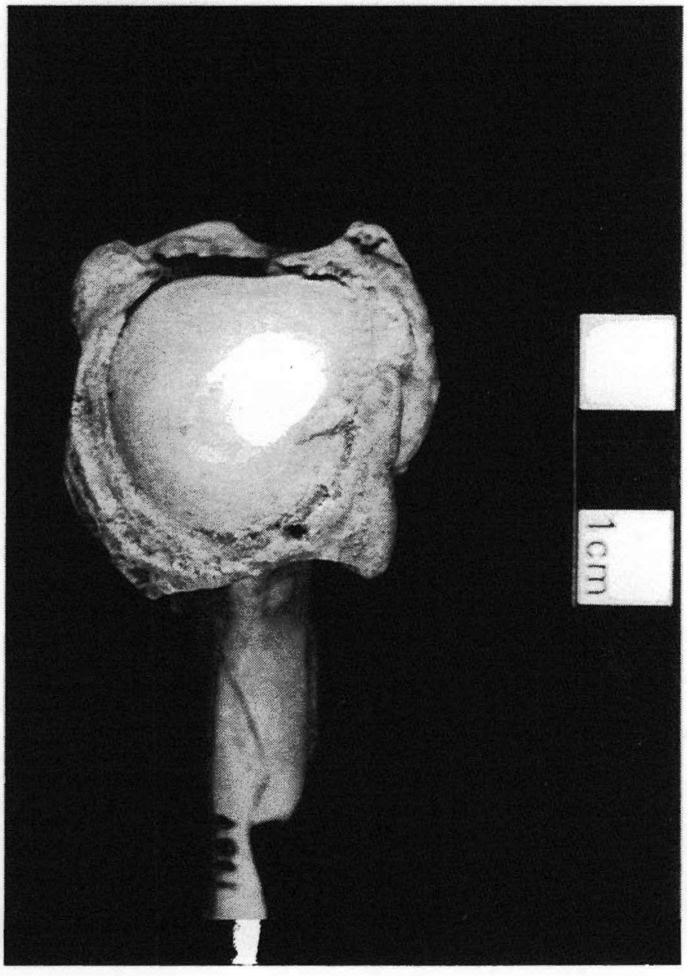


Figure 50. Large canid humerus from the Breeden Site (39ST16), posterior-superior view showing osteophytic development around the articular margin and eburnation of the articular surface.

Figure 51. Large canid scapula from the Breeden Site (39ST16), medial aspect showing partially healed fracture of the supraspinous fossa and roughening of the facies serrata.

rather extensive area of remodeling, extending approximately 540 mm lengthwise and 260 mm inward from the cranial border. Additional evidence of deformation and stress is the misaligned and incompletely reknit portion of the break visible approximately 250 mm above the scapular notch (Figure 52). There is also heavy pitting and definition of the facies serrata, the roughly rectangular area just below the cranial angle on the medial face of the scapular blade.

This is the area of insertion of the serratus ventralis muscle (Figures 53, 54). The area of greatest apparent deformation and remodeling is just above the boundary line between facies serrata and subscapular fossa, where the margins of the serratus and subscapularis muscles meet, and just below the remnants of the break noted above.

Analogous pathologies occur on canid scapula from four of the six sites considered in this analysis, including the Initial Middle Missouri Sommers site (two specimens, Figure 55), the Post Contact Coalescent sites of Larson (four specimens, Figure 56) and Spiry-Eklo (one specimen, Figure 57) and the fully historic Leavenworth site (one specimen). The scapula from the Sommers site (Figure 55) is from the same individual whose articulating, severely affected thoracic and lumbar vertebrae were described above (Figures 44, 45).

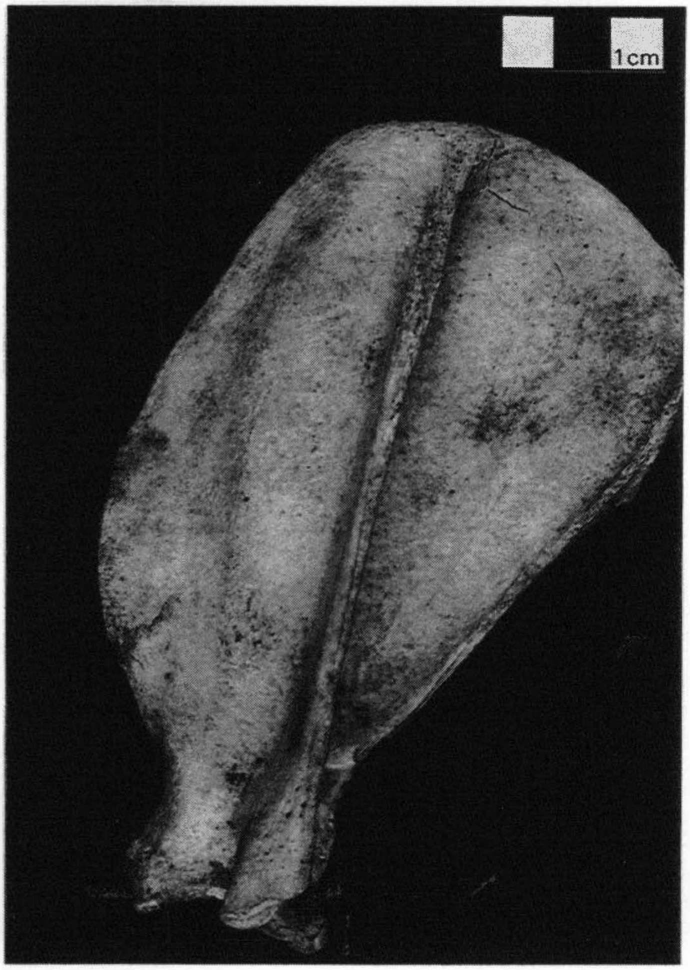


Figure 52. Large canid scapula from the Breeden Site (39ST16), lateral aspect showing healed fracture on the cranial margin of the supraspinous fossa.

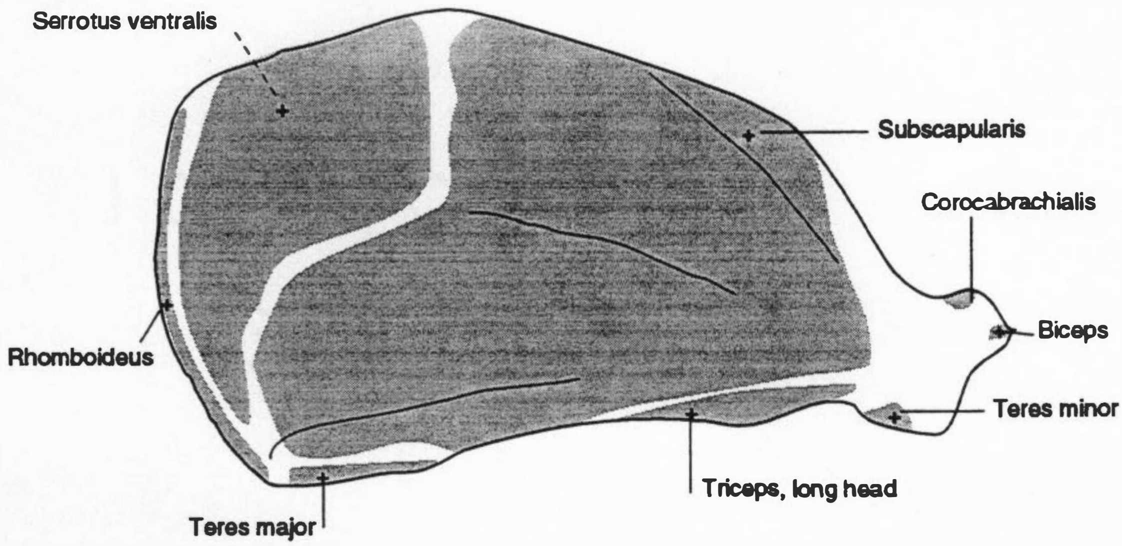
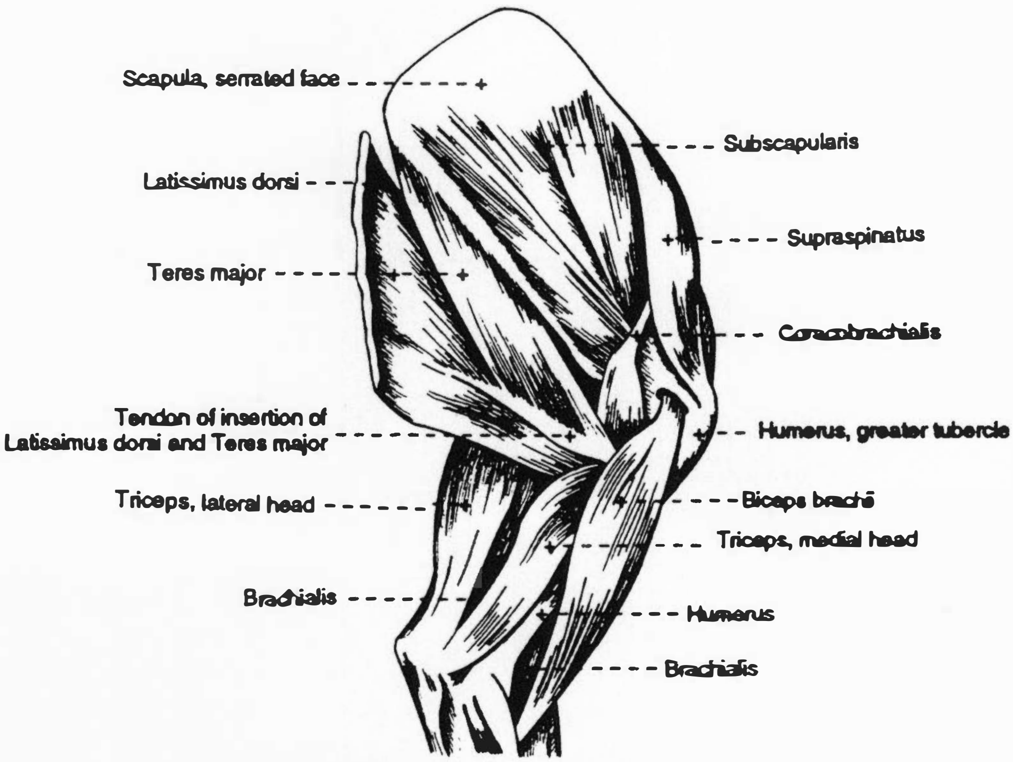


Figure 53. Schematic drawing of muscle attachment areas on the canid scapula, medial aspect (after Miller 1979).



Muscles of left shoulder and arm, medial aspect.

Figure 54. Muscles of the canid left shoulder, medial aspect (after Miller 1979).

Figure 55. Large canid scapula from the Sommers Site (39ST56), medial aspect showing healed fracture of the supraspinous fossa.

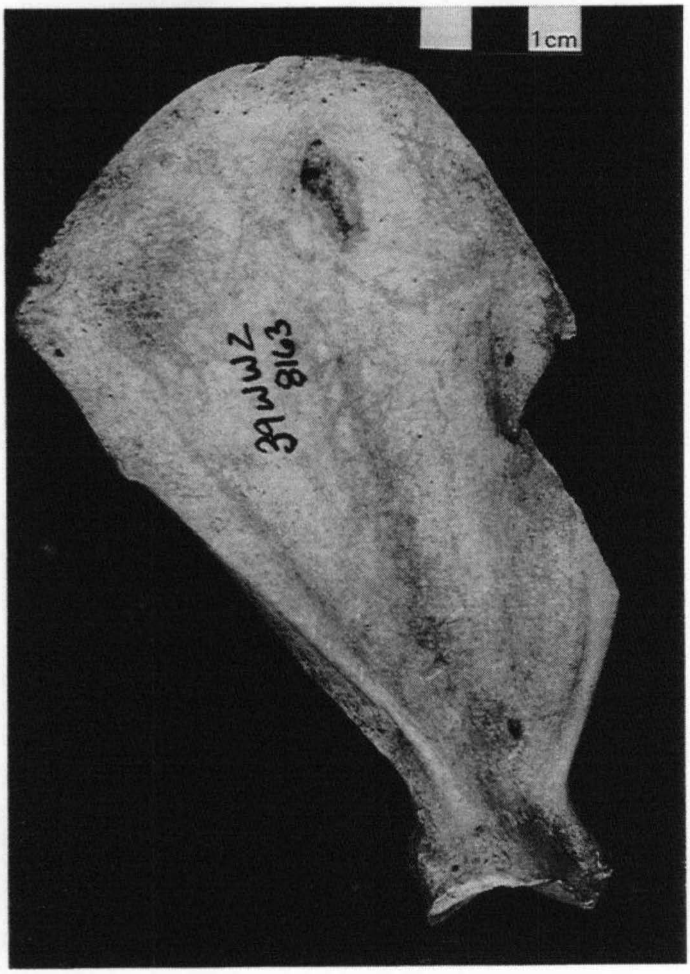


Figure 56. Large canid scapula from the Larson Site (39WW2), medial aspect showing partially healed fracture of the supraspinous fossa, and pitting of the facies serrata.

Figure 57. Large canid scapula from the Spiry-Eklo Site (39WW3), medial aspect showing partially healed fracture of the supraspinous fossa, and disarticulation marks on the scapular neck.

In each case, the deformation, fracture, and remodeling occurs on the cranial portion of the subscapular fossa at or just above the margin of the serratus ventralis. Two scapulae from the Hosterman site, not included in this analysis, also exhibit similar pathologies. On nine of 13 affected specimens from these sites, a partially healed break is still evident. The differential healing of these breaks is illustrated by the specimens in Figure 58. On the scapula on the right, from the Bamble site, the injury also involves a secondary infection. Reaction to this infection has produced a layer of fine periostitic tissue extending in a broad plane around the break (shown in lateral aspect in Figure 59). The fracture itself appears to be relatively fresh and shows little or no evidence of healing. On the element on the left (Figure 58) from the articulating humerus and scapula discussed above, the break, although apparently originally extensive, is almost completely reknit and any periostitic tissue has been resorbed.

A possibly associated manifestation on many of the specimens is the extreme roughening and pitting of the facies serrata (Figure 56), particularly at the common margin of the serratus ventralis and subscapularis muscles. On two specimens (Figure 60) a deep, irregular pit or fossa has developed in this area, directly opposed or just cranial to the location of the scapular spine on the dorsal blade surface.

Figure 58. Large canid scapulae from the Breeden Site (39ST16) on the left, and the Bamble Site (39CA6) on the right, medial aspect, cranial border, close up showing healed fracture on the Breeden element and unhealed fracture and periostitic tissue on the Bamble element.

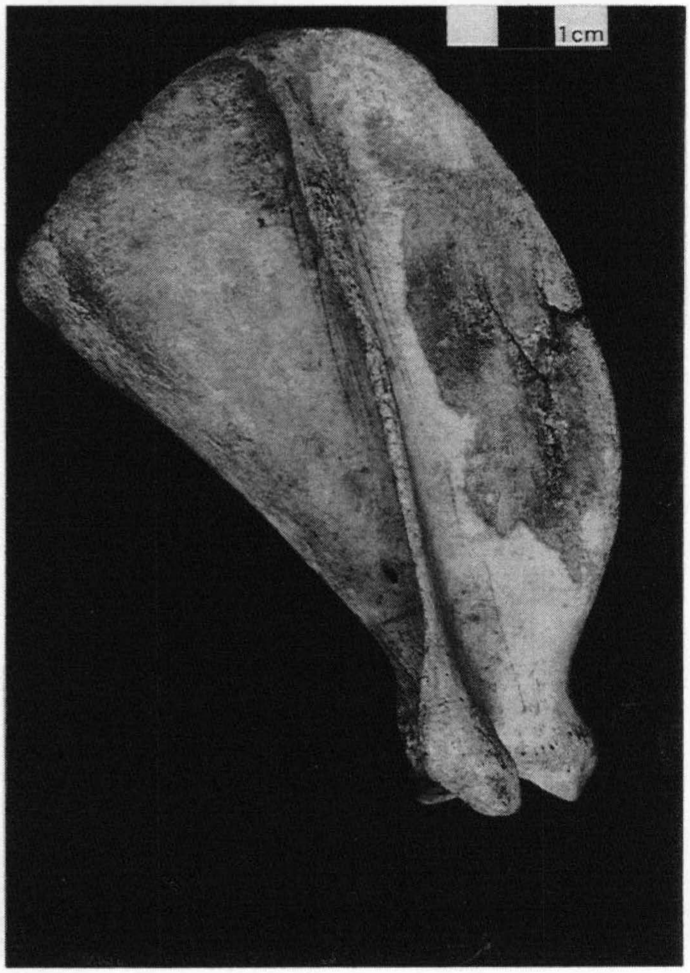


Figure 59. Large canid scapula from the Bamble Site (39CA6), lateral aspect showing fracture of the supraspinous fossa with development of periostitic tissue, and filleting marks on the supraspinous and infraspinous fossae.

Figure 60. Large canid scapula from the Larson site (39WW2), medial aspect, superior border, close up showing roughening and pitting of the facies serrata.

That the breaks and extensive remodeling in the area of the serratus ventralis are associated with the stresses of travois pulling seems evident from the repeated occurrence of trauma at the same location, on the leading edge of the scapular blade. This assumption is strengthened by the occurrence of this anomaly in association with severe osteoarthritic remodeling of the glenoid fossa and humeral head in the articulated specimens from the Breeden site (Figures 48-52). Further evidence is the association, in a single individual from the Sommers site (39ST56), of this scapular anomaly with severe osteoarthritic changes to the 1st through 4th lumbar vertebrae, and thickening and distortion of the thoracic and lumbar spinous processes.

The occurrence of homologous instances of these traumas to the leading edge of the scapula on elements from at least six Middle Missouri large canid assemblages, representing the entire Plains Village Period, suggests that it is a phenomenon worthy of further research and investigation in other Plains Village faunal assemblages from the Northern Plains and elsewhere.

Two possible causes of these injuries might be posited. Because the injuries occur uniformly on the thin leading edge of the scapular blade, it is possible that they represent pressure or stress fractures produced as a result of sudden or sustained excessive pressure imposed by the breast strap harness against which dogs press when moving a travois. Traumatic injuries from a blow or kick to a fractious animal do not seem likely, given the restricted and repetitive area of the scapular blade on which they occur. Nor could the roughening and pitting of the medial facies serrata be the result of traumatic, humanly imposed injury.

It seems more likely that some combination of stresses associated with travois pulling were imposed upon the scapular blade by the muscles which attach upon its medial and lateral surface, producing the observed anomalies and pathologies. The serratus ventralis is a very strong muscle, the action of which is to support the trunk and carry it forward and backward, as well as carry the shoulder forward and backward over the front limb (Miller 1979:342). It could potentially exert a great deal of stress on the scapular blade as the body is moved forward over the front leg, thus moving the loaded travois. Although requiring further study, it seems possible that some combination of opposing muscle stresses on the thin-bladed scapula, associated with travois pulling, produced these phenomena. This might well occur if one or more muscles inserting on either the medial or lateral aspect of the scapular blade were injured by excessive strain, and opposing muscles then exerted unanswered stresses on the scapular blade.

The extreme roughening of the facies serrata on many of the scapulae and the remodeling and healing shown at the points of breakage suggest that although chronic, these injuries were not fatal and the affected animals probably continued to be useful and productive. Conversely, they could, in some cases, represent older animals which were no longer required to work, as suggested by Buffalo-Bird-Woman.

Association of Skeletal Evidence of Travois Pulling and Cutmarks on Canid Scapula

It is notable that many of the scapulae discussed above also show disarticulation marks (Figure 57) or filleting marks (Figure 59) associated with butchering and use as food. As horses replaced dogs for long distance travel and transport of meat from the hunt, maintenance and feeding of large numbers of these animals in the villages would have become an increasingly unnecessary economic burden. Never-the-less, into the historic period, dogs continued to be used for travois pulling in the Middle Missouri Subarea, as evidenced by ethnohistoric and ethnographic records, and the skeletal evidence detailed above.

At the same time, these animals were also utilized as food. Thirteen scapulae from six Middle Missouri assemblages examined in this study showed anomalies most likely associated with travois pulling. Eight of these elements (61.5%) also exhibit cutmarks indicative of butchering. In the Initial Middle Missouri Sommers (39ST56) assemblage, two scapula show evidence of travois pulling stress; however, neither of these elements show cutmarks. In two Extended Coalescent sites, the Hosterman site (39PO7) and the Breeden site (39ST16), three elements show anomalies; although none of these scapula show cutmarks, the scapula from Breeden is associated with a humerus which exhibits cutmarks indicative of disarticulation. Thus, in the earliest Middle Missouri assemblage, neither of two affected scapula are cut, while one of three specimens (33.0%) in the two later Extended Coalescent sites shows marks indicating that travois animals were also used as food.

Eight scapula from the three late, Post Contact Coalescent sites appear to have come from travois dogs. Of these, seven elements (87.5%) exhibit disarticulation or filleting marks. They include one specimen from the Bamble site (39CA6), two specimens from the Spiry-Eklo site (39WW3), and four of five specimens from the Larson site (39WW2).

Although sample size is small (only 13 scapulae from six sites), increasingly intense use of canids as food in later periods is reflected in these elements from animals which were used to pull travois. The apparent heavy use as food in the later sites, of dogs which had pulled travois is another possible indicator of subsistence and social stress, and resultant necessary economic decisions.

CHAPTER VIII

DISCUSSION AND CONCLUSIONS

The Importance of Dogs in Plains Village Life

The journals of early European explorers and fur traders, as well as ethnographic records such as Buffalo-Bird-Woman's account of the role of dogs in Arikara life, document the integral part domestic dogs played in the village life and economy of the Plains villagers in the 18th and 19th centuries. The presence of substantial quantities of large canid remains in faunal assemblages from earlier, prehistoric time periods in the Middle Missouri and elsewhere (Bozell 1988; Snyder 1991) suggests that this association of dogs and humans was one of considerable time depth (see also Morey 1992; Olsen 1974, 1985).

Early travelers on the Plains such as De Smet and Maximilian remarked on the consumption of dog meat in association with certain rituals and greeting ceremonies. They also document the importance of dogs as an emergency food resource, particularly as Native American populations and their traditional economies were threatened and ultimately transformed by the demands of the Euroamerican fur and hide trade and devastating epidemic diseases.

Two indicators of the continued importance of domestic dogs in Native American economy have been explored. They are the use of dogs for traction and the use of dogs as food.

Dogs, Wolves and Dog/Wolf Hybrids

The archaeological assemblages considered in this analysis contain the skeletal remains of dogs, wolves, and probable dog/wolf hybrids. The diaries and accounts of early European explorers and fur traders refer repeatedly to the "wolflike" appearance of the large dogs they encountered in the villages of the Middle Missouri. They also suggest that village dogs were sometimes allowed or deliberately encouraged to breed with wolves, presumably to increase their size and strength.

The carcasses of wolves taken for their pelts also provided potential meat for human consumption. The partial accounts of the American Fur Company (Johnson 1969) record 1319 "gray wolf" pelts produced by the Upper Missouri trade and 305 pelts from the Sioux trade, in the years 1835 to 1838.

Archaeological evidence in the form of taxonomic studies by Walker and Frison (1982) and Morey (1986) provide supporting evidence for the presence of dog/wolf hybrids, and Morey's study distinguishes skulls of dogs, wolves, and possible dog/wolf hybrids in the Larson site assemblage (39WW2). However, the close genetic relationship between dogs and wolves and their nearly identical skeletal morphology makes their skeletal remains, particularly post-cranial, nearly impossible to separate. The possibility is clear, therefore, that the large canid skeletal assemblages from Middle Missouri villages almost certainly contain a mixture of large canid taxa. The potential for reliably separating skeletal elements of dogs, wolves, and hybrids is slight and beyond the scope of the present analysis.

Because of the certain admixture of large canid species in the assemblages and the difficulty in reliably distinguishing between them based on morphological or metric characteristics, all large canid skeletal materials, excluding only the coyote (Canis latrans), were considered in the present analysis. Rather than attempting to distinguish dogs, wolves, and hybrids, all large canid skeletal debris recovered in the villages was considered as representing animals associated with the village occupation, and thus at least potentially available for consumption. It was further assumed, although not subject to direct proof, that the majority of canid skeletal materials considered were the remains of domestic dogs or "domestic" dog/wolf hybrids, i.e. animals present in the villages as the result of deliberate actions of the human inhabitants, and under their control. For the purposes of these analyses, therefore, each large canid assemblage was considered as a unit, regardless of the genetic identify of the animals represented.

Faunal Assemblages from the RBS Program and T.E. White

During the River Basin Surveys program, methods of excavation were developed in response to the scope of the program and the rapid pace of excavation, often in the very presence of rising reservoir waters. These methods emphasized the recovery of cultural artifacts, primarily ceramic vessels and stone, metal, and bone tools. Unmodified faunal remains, while recognized as a source of potential information, were often selectively collected using criteria of identifiability which emphasized complete specimens or ones with at least one intact epiphysis. This selection bias was further exaggerated by the practice of discarding additional "unidentifiable" bone during analysis. These selection criteria were developed primarily in response to the suggestions of T.E. White, whose articles on butchering techniques were also instrumental in focusing interest on the potential of unmodified faunal materials.

Collection and retention practices have dictated to some extent the type of analysis used in this study. Analyses based on fragmentation patterns were impossible because no long bone shaft or epiphysis fragments, vertebral fragments, or cranial fragments were retained. However, the results of the analysis of cutmark location and intensity demonstrate the continuing potential and value of these collections.

Skeletal Evidence of Traction and Use as Food

Ethnographic and ethnohistoric sources confirm that, even after horse traction became the primary means of transporting large loads in the Middle Missouri, dogs and dog travois were still used close to the villages to transport wood and other smaller loads. Skeletal evidence from these assemblages, both early and late, also reflects the function of dogs in this capacity.

Osteoarthritic changes to joint structures in a variety of locations, particularly those most directly subject to stresses during load bearing or pulling, have been identified in both humans (Kennedy 1989) and draft animals (Armour-Chelu and Clutton-Brock 1985; Baker and Brothwell 1980). In the Middle Missouri large canid assemblages, instances of these changes were noted in the shoulder (scapula and humerus) and vertebral column (thoracic and lumbar sections).

Further evidence is the numerous instances, in at least six assemblages, of distortion and apparent stress fracturing of the cranial portion of the scapular blade, with at least partial healing and remodeling. This condition suggests that the scapula of animals employed to pull loads while still young, or those forced to repeatedly pull very heavy loads, partially failed under the pressures. However, in most cases the animals survived and healing of the fracture occurred.

In eight of thirteen instances in which scapular anomalies indicate that the animals represented were used to pull travois, the elements also exhibit cutmarks indicative of disarticulation and/or filleting. This co-occurance of skeletal anomaly and cutmarks is relatively rare in the early assemblages, but occurs on seven of eight affected scapulae from the later Post Contact assemblages. Thus, it would appear that in later periods, as traditional subsistence patterns were disrupted by the effects of the Euroamerican fur trade and increased intertribal hostilities, even animals which had potential economic use as travois dogs were increasingly exploited as food.

Skeletal Indicators of the Use of Dogs as Food

Cutmark locations and butchering objectives

At least three butchering operations or objectives are indicated by the marks inflicted on the large canid skeletal materials. Marks made during skinning are most likely to occur on those elements of the skeleton closest to the skin, and where the most effort is expended to separate the pelt from the carcass. These include the muzzle or skull, the mandible, and the feet.

On the skull, marks commonly attributed to skinning include longitudinal marks on the parietals and frontals, and especially short, transverse, and often multiple cuts across the maxilla and nasals, the latter resulting from the skin being pulled down over the muzzle and cut free of the area near the nose and mouth. On the mandible, corresponding marks appear on the buccal or dorsal surface of the horizontal ramus, and particularly in the area of the symphysis. Finally, skinning marks occur on the feet, particularly on the outer metapodials, resulting from cutting the pelt free of the paws.

Disarticulation marks are those which occur on or near the joints as a result of attempts to sever the tendinous muscle insertions and ligaments of the joint capsule. These marks are likely to occur on all elements of the carcass.

Filleting marks, resulting from the cutting and removal of meat from the skeleton, are most clearly distinguished on the scapula and vertebral spinous processes. Marks on the scapular blade, longitudinally oriented on the lateral aspect parallel to the spinous process, result as the large muscles masses which lie over the supraspinous and infraspinous processes are cut away. On the vertebrae, transverse marks on the dorsal aspect of the vertebral arch and spinous processes result from cutting and removal of the longitudinal muscle masses which lie on either side of the spinal column.

Interpreting Cutmark Locations and Frequencies Through Time

Potential indicators of a changing emphasis through time on dogs as a food resource include 1) an increase in the frequency of cutmarks on any or all skeletal elements, or 2) increases in frequency for certain types of cutmarks such as those resulting from filleting or disarticulation. Since ethnohistoric sources consistently record the preparation and cooking of dogs with skin intact, variation in the frequency of skinning marks, while not directly interpretable as indicative of increased concentration on the dog as a food resource, might provide indirect evidence for exploitation of wolf carcasses which had been skinned for their pelts, as food.

The results of this analysis indicate that cutmarks do increase in frequency in the later sites. In two early sites, cutmarks occur on 16.8% of all large canid skeletal elements in the Initial Middle Missouri Sommers site (39ST56); at the two component, Initial Middle Missouri, Initial Coalescent Crow Creek site (39BF11), cutmarks occur on 10.8% of elements. In the three Post Contact Coalescent sites, cutmark frequencies increase. They occur on approximately 43% of elements in the Bamble (39CA6) assemblage and 30% in the Larson (39WW2) and Spiry-Eklo (39WW3) assemblages. In the historic Leavenworth (39CO9) assemblage, cutmarks occur on approximately 40% of skeletal elements.

Marks associated with disarticulation increase, in most cases, from early to late in the cultural sequence.

However, it is filleting marks and skinning marks which provide the most convincing evidence of increased intensity of processing in the later time periods. Filleting marks on vertebrae increase from early to late. This is illustrated by an increase in marks on the thoracic vertebra from 1.4% (39BF11) and 11.7% (39ST56) in the early sites, to 50.0% (39CA6), 63.9% (39WW3), 50.6% (39WW2), and 23.2% (39CO9) in the later assemblages.

The changes in the occurrence of filleting marks on the scapula are even more dramatic. No filleting marks occur on the scapula from the Sommers (39ST56) and Crow Creek (39BF11) sites. In the later sites, they occur on 17.7% (39CO9) to 34.1% (39WW3) of scapula blades.

Marks indicative of skinning also increase through time. Cuts on the frontals, maxillae, and nasals are rare on cranial material from the early sites. No observable skinning marks were found on the cranial material from the Sommers site (39ST56). In the Crow Creek assemblage, probable skinning marks occurred on only two specimens. In the later site assemblages, these marks (CMs 1,2,3) occur in frequencies ranging from 0.0% to 31.6%. Probable skinning marks on mandibles (CMs 5,6,7) also increase in the later sites. On the mandibles from Sommers and Crow Creek, marks in these locations range in frequency from 2.2% to 3.4%. In the later assemblages, cutmarks frequencies range from 3.6% to 16.2%.

A final indicator of increased exploitation of large canids as a food source is an increase in the occurrence of marks on the medial or lingual aspect of the mandible, probably inflicted during removal of the tongue. These marks (CMs 8,9) occur on only one mandible from the two early sites; in the later sites they occur in frequencies of from 2.1% to 29.3%.

Summary Conclusions

In summary, variation in cutmark frequency on the skeletal remains of large canids from Plains Village assemblages in the Middle Missouri subarea support a model of increased exploitation of large canids as a food resource during the late Coalescent and Historic periods. Cutmarks on canid bones from the earlier Initial Middle Missouri period indicate that dogs were regularly used as food throughout the Plains Village Period.

During the succeeding Coalescent and Historic periods, populations of native game animals were reduced or displaced due to the hunting pressures of the fur and hide trade, intertribal conflicts increased as tribal groups competed for dwindling resources and trading relationships with European and American fur companies, and epidemic diseases devastated Native American populations. In these later periods, domestic dogs became increasingly important as a food source as evidenced by greater cutmark frequencies on canid skeletal elements in general, increased filleting marks on the scapula and vertebrae, and higher frequencies of marks indicative skinning, and disarticulation of the mandible and removal of the tongue.

In addition, a sample of canid scapulae from the later sites which show evidence of distortion and fracturing due to the stresses of travois pulling also exhibit an extremely high percentage of cut marks associated with disarticulation and filleting. The use of travois dogs for food in the later sites is yet another possible indicator of subsistence stress and the changing role of domestic dogs in the later Plains Village economies.

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APPENDIX

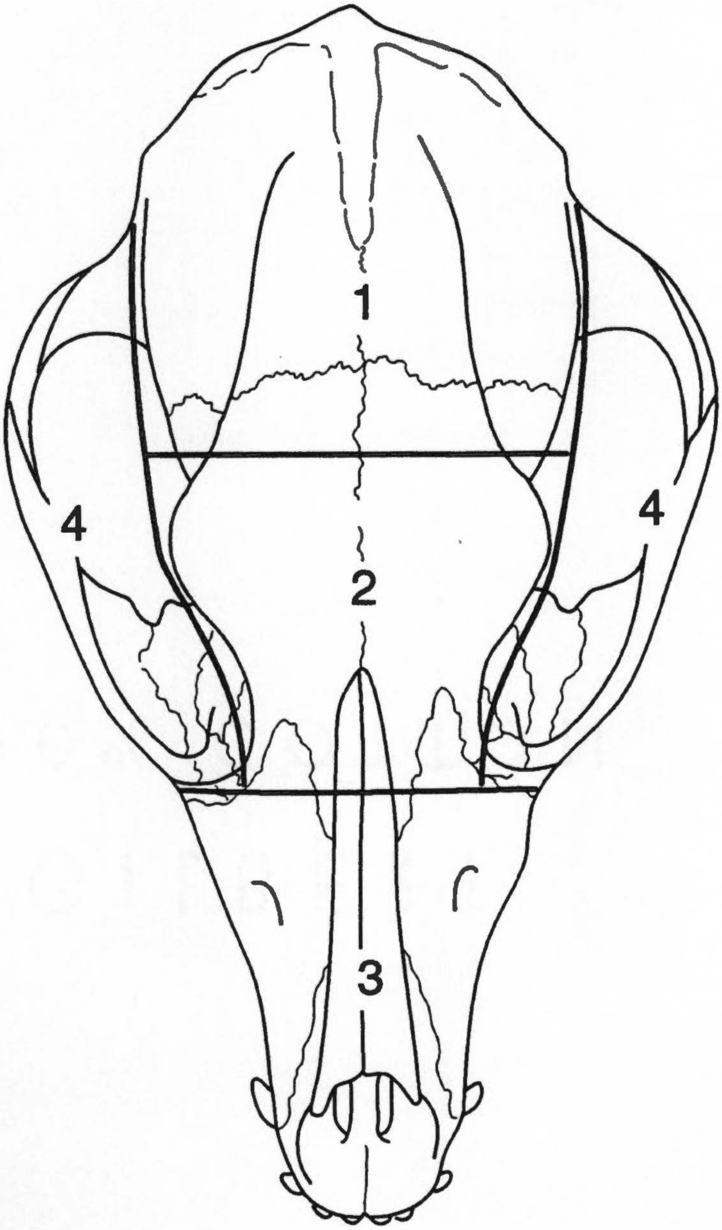

Figure A-1. Generalized cutmark locations on the canid skull, superior view.

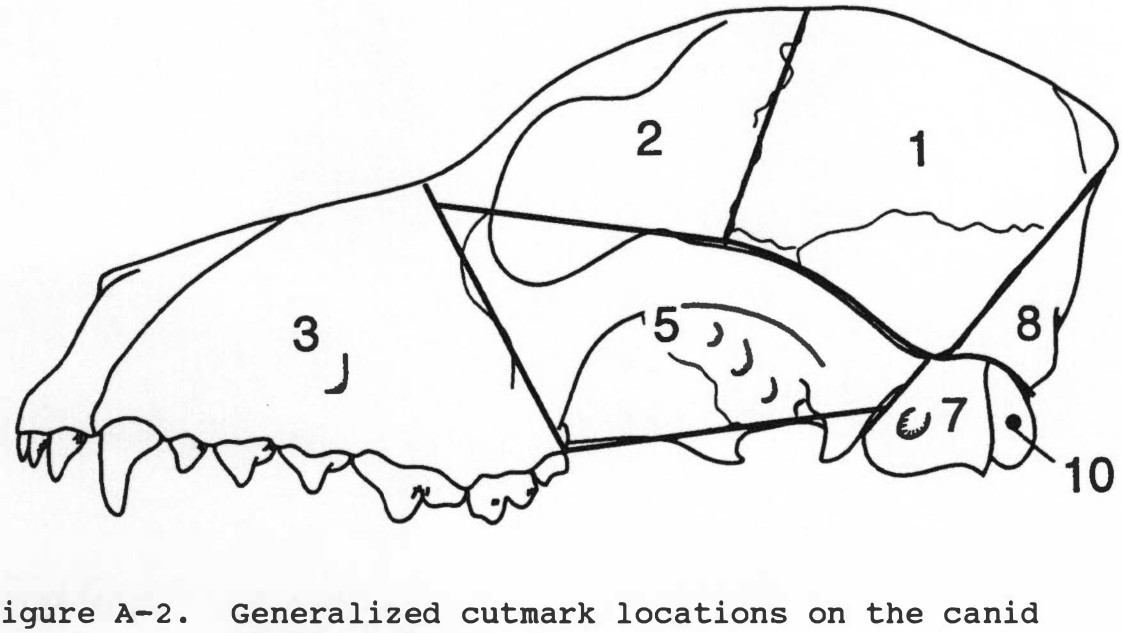

Figure A-2. Generalized cutmark locations on the canid skull, lateral view.

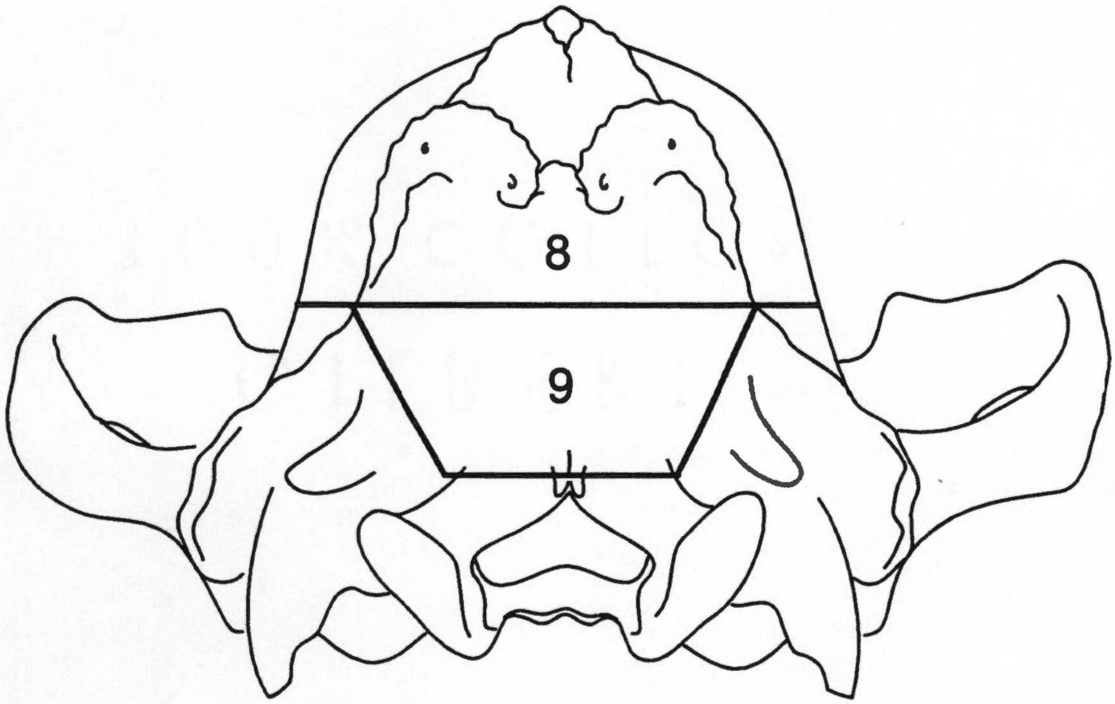

Figure A-3. Generalized cutmark locations on the canid skull, posterior view.

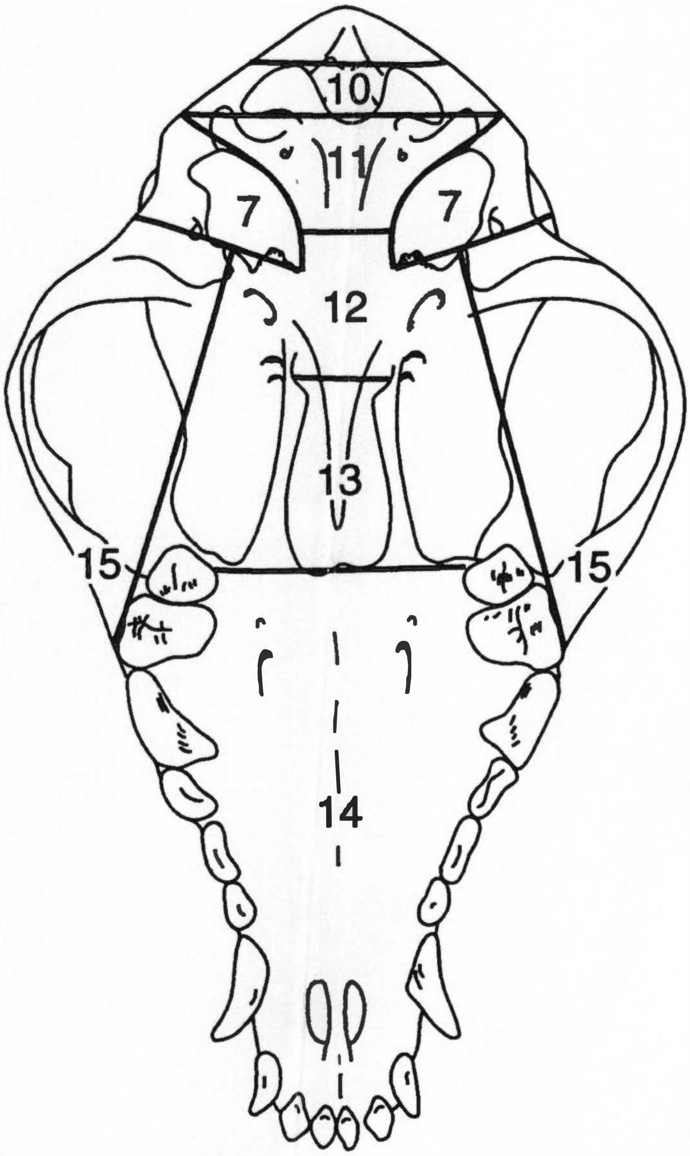

Figure A-4. Generalized cutmark locations on the canid skull, inferior view.

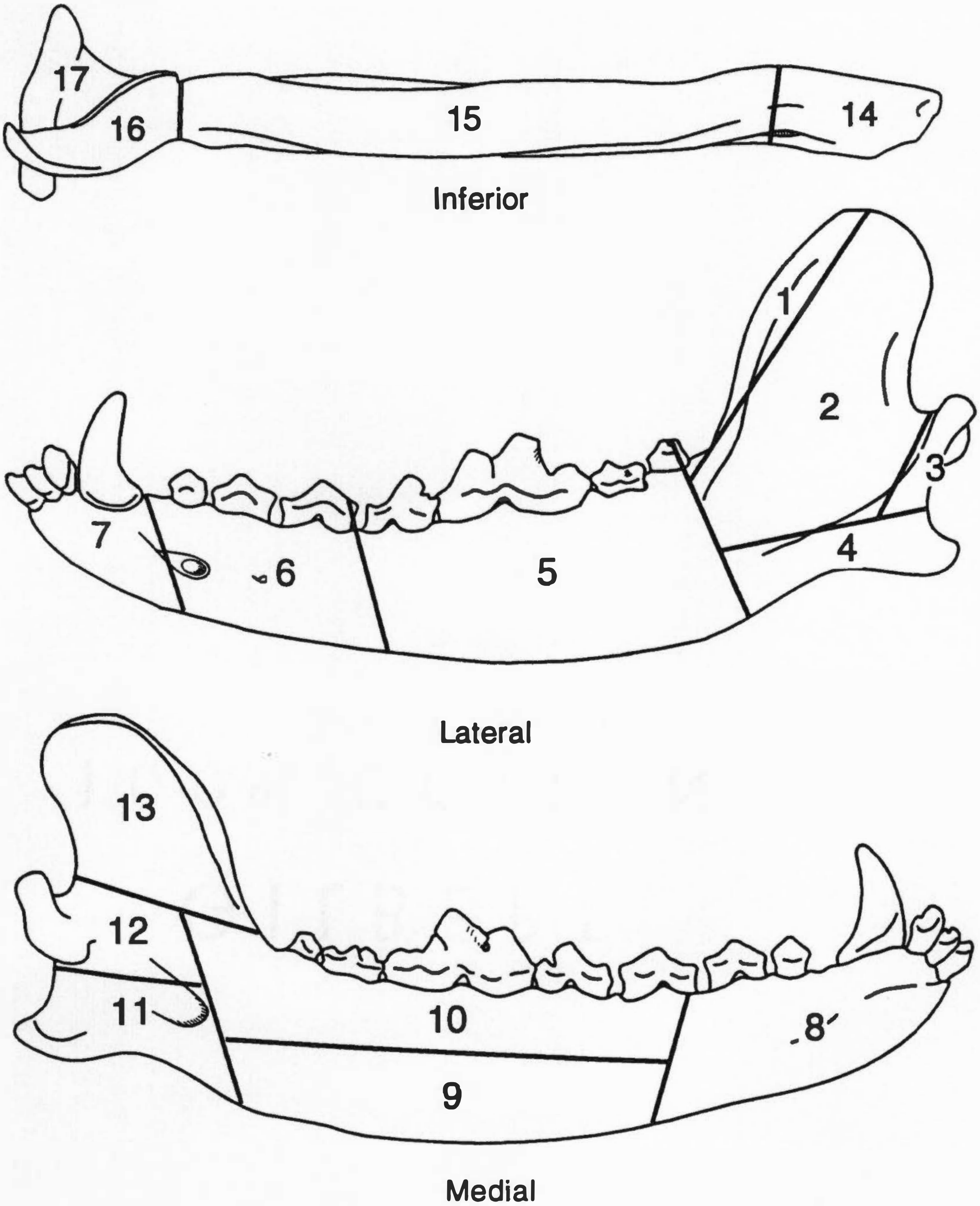

Figure A-5. Generalized cutmark locations on the canid mandible.

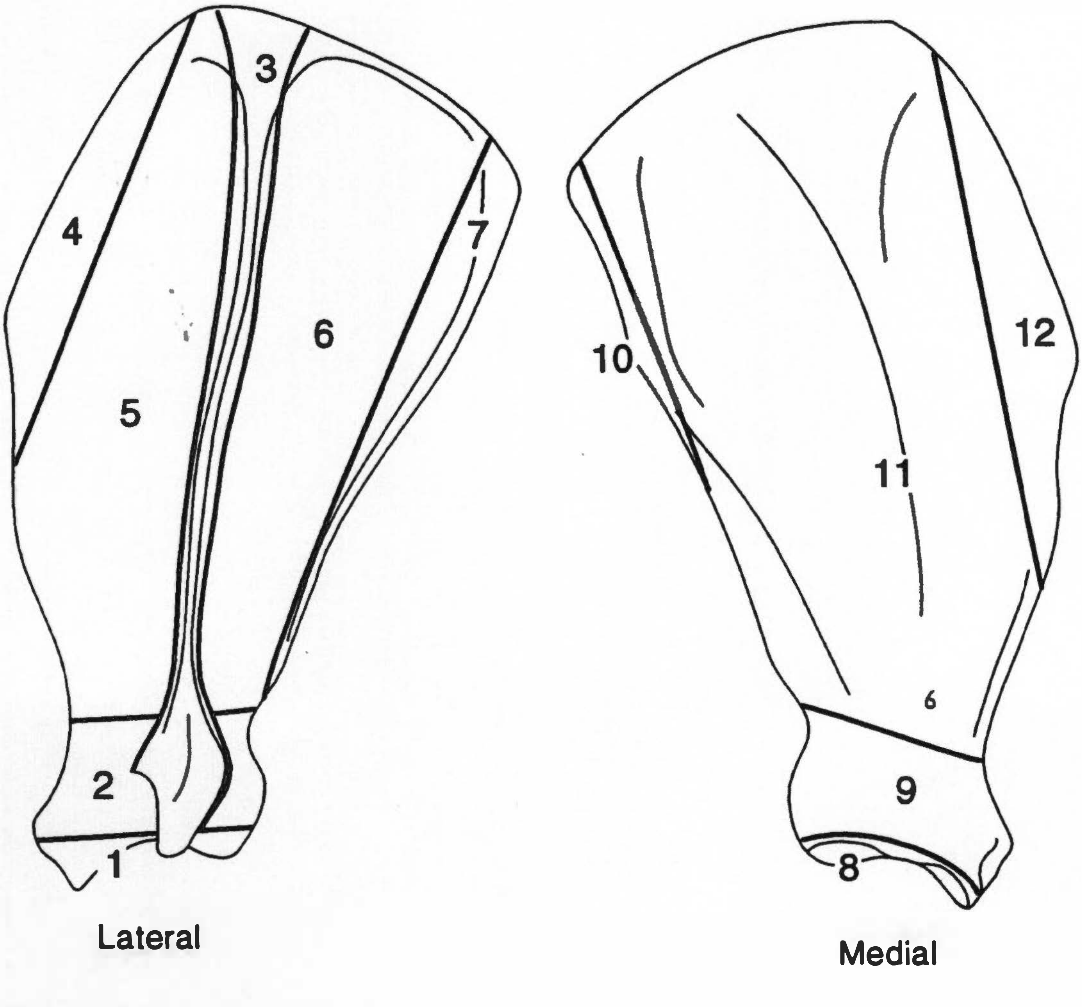

Figure A-6. Generalized cutmark locations on the canid scapula.

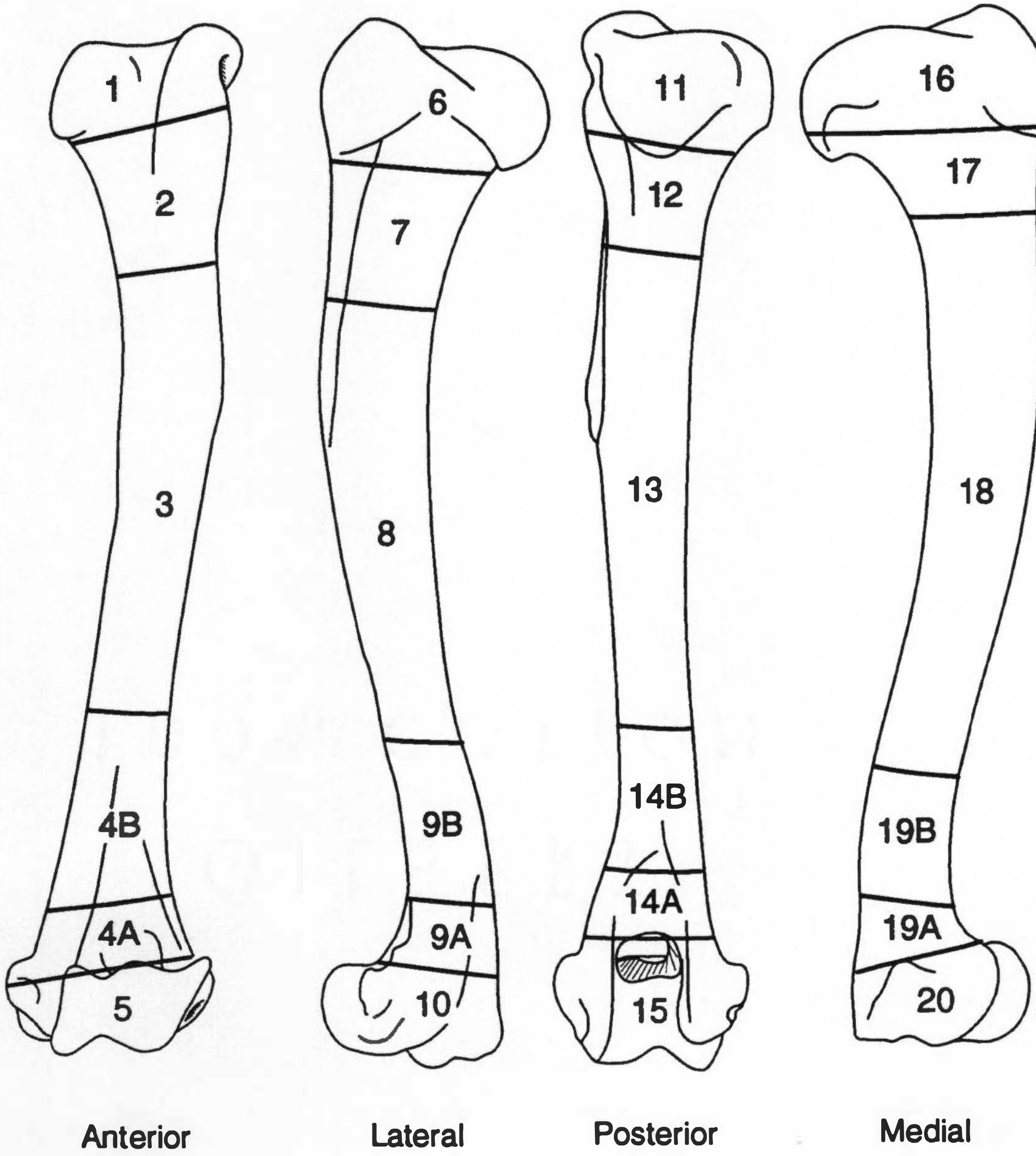

Figure A-7. Generalized cutmark locations on the canid humerus.

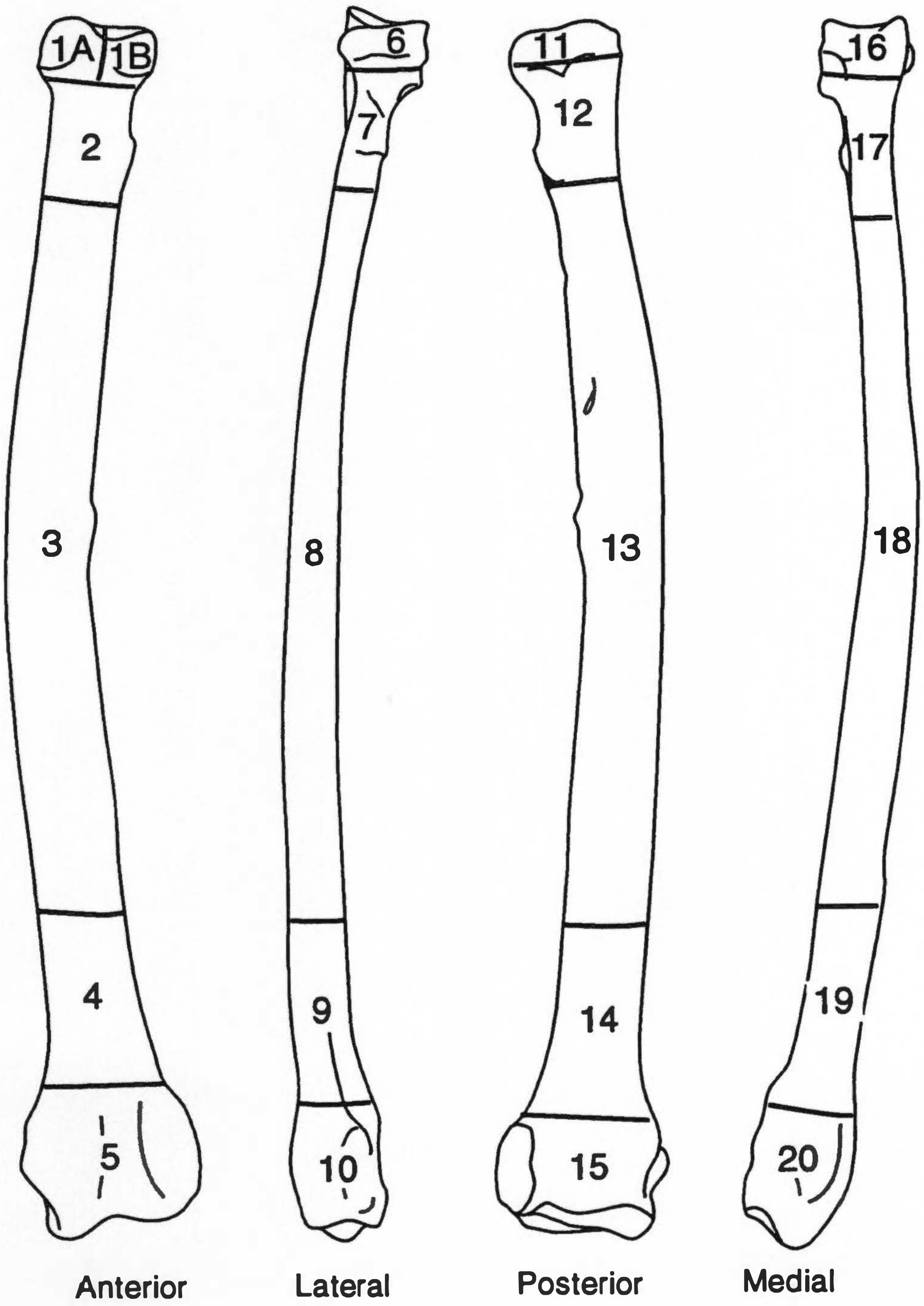

Figure A-8. Generalized cutmark locations on the canid radius.

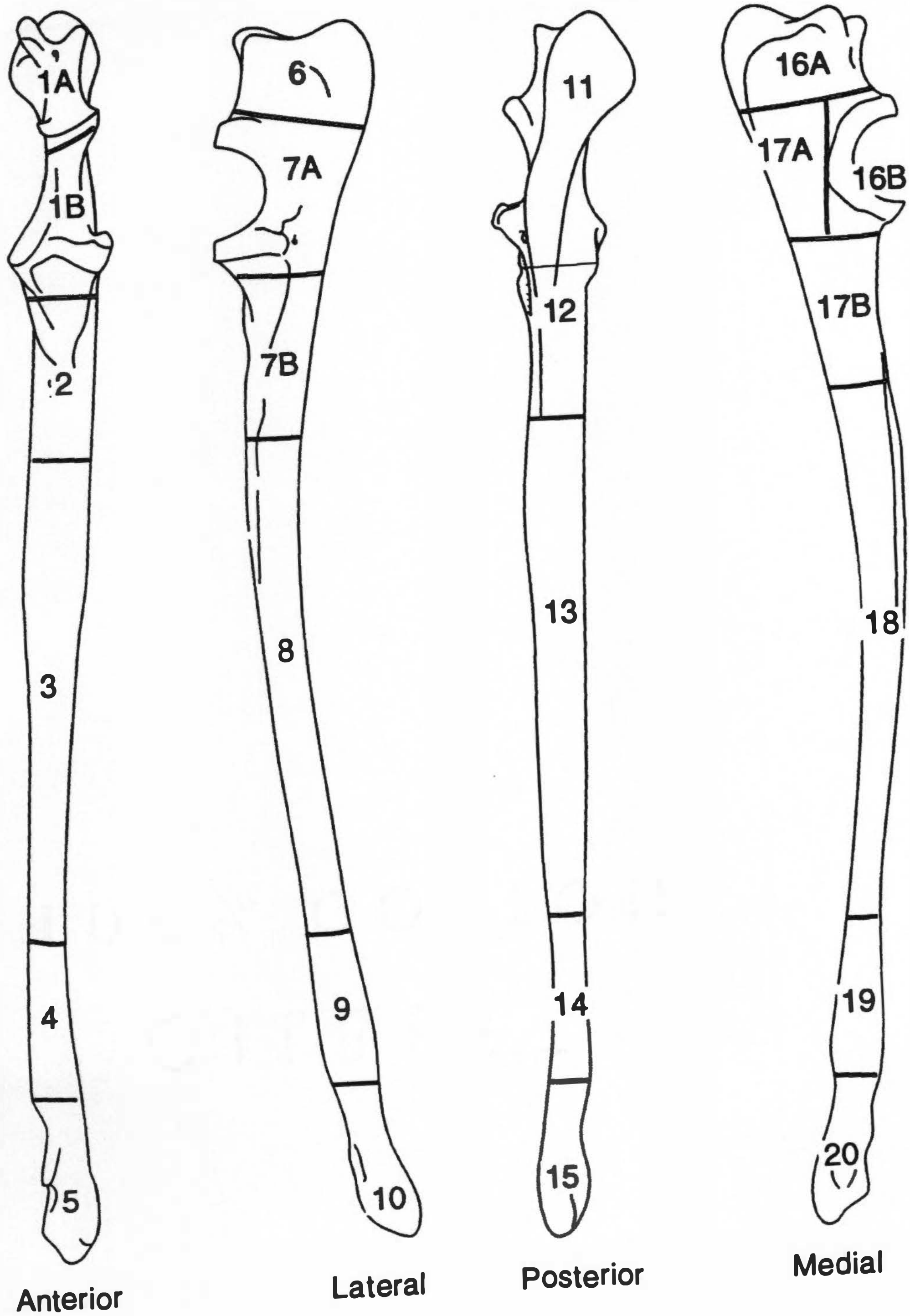

Figure A-9. Generalized cutmark locations on the canid ulna.

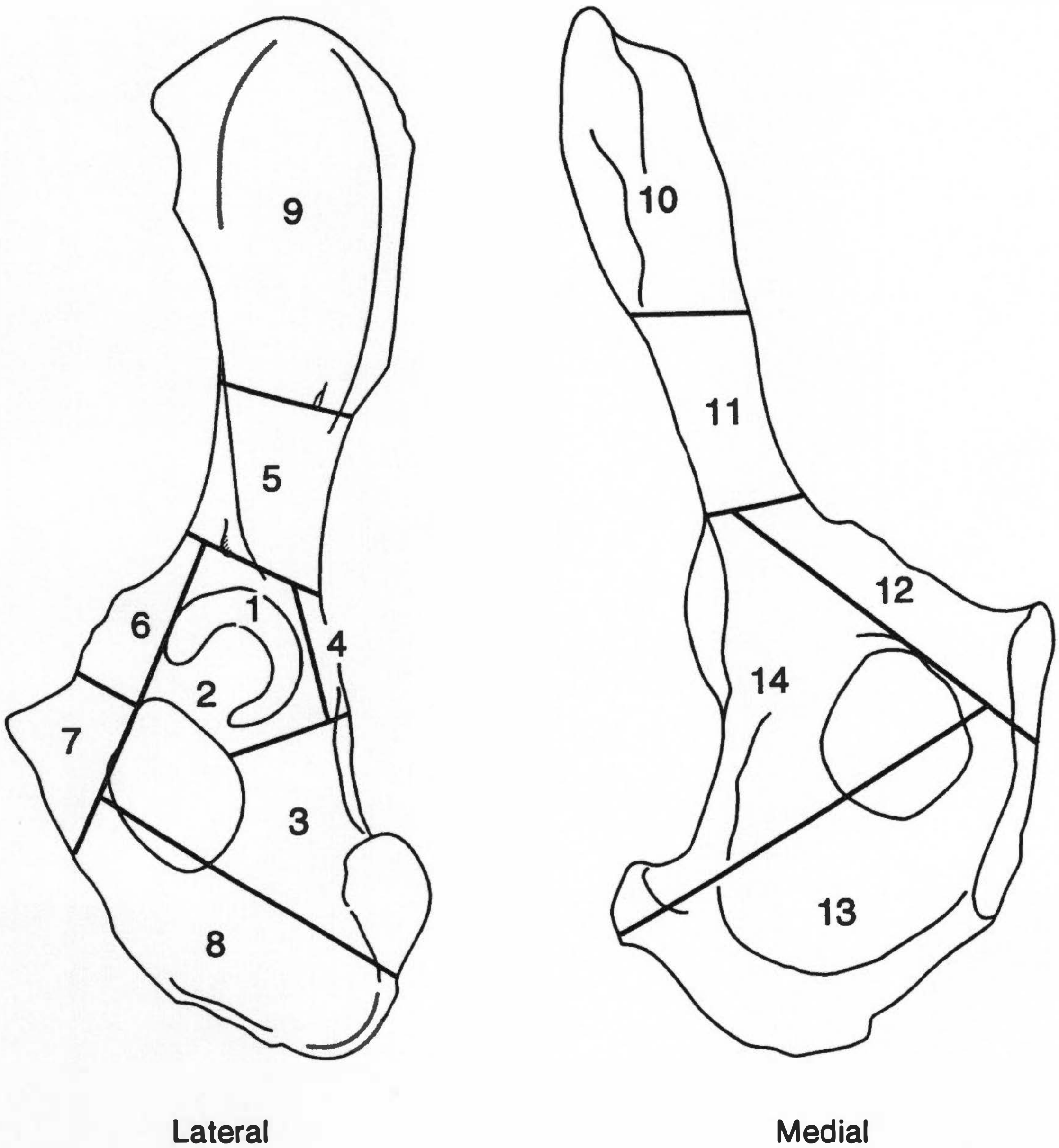

Figure A-10. Generalized cutmark locations on the canid innominate.

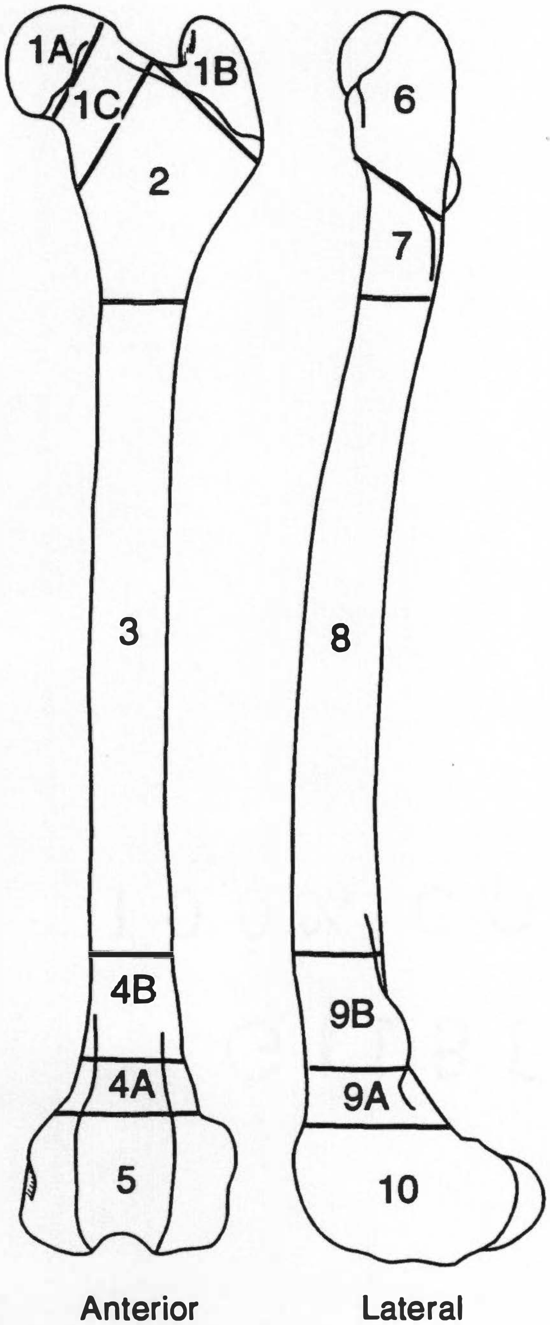

Figure A-11. Generalized cutmark locations on the canid femur.

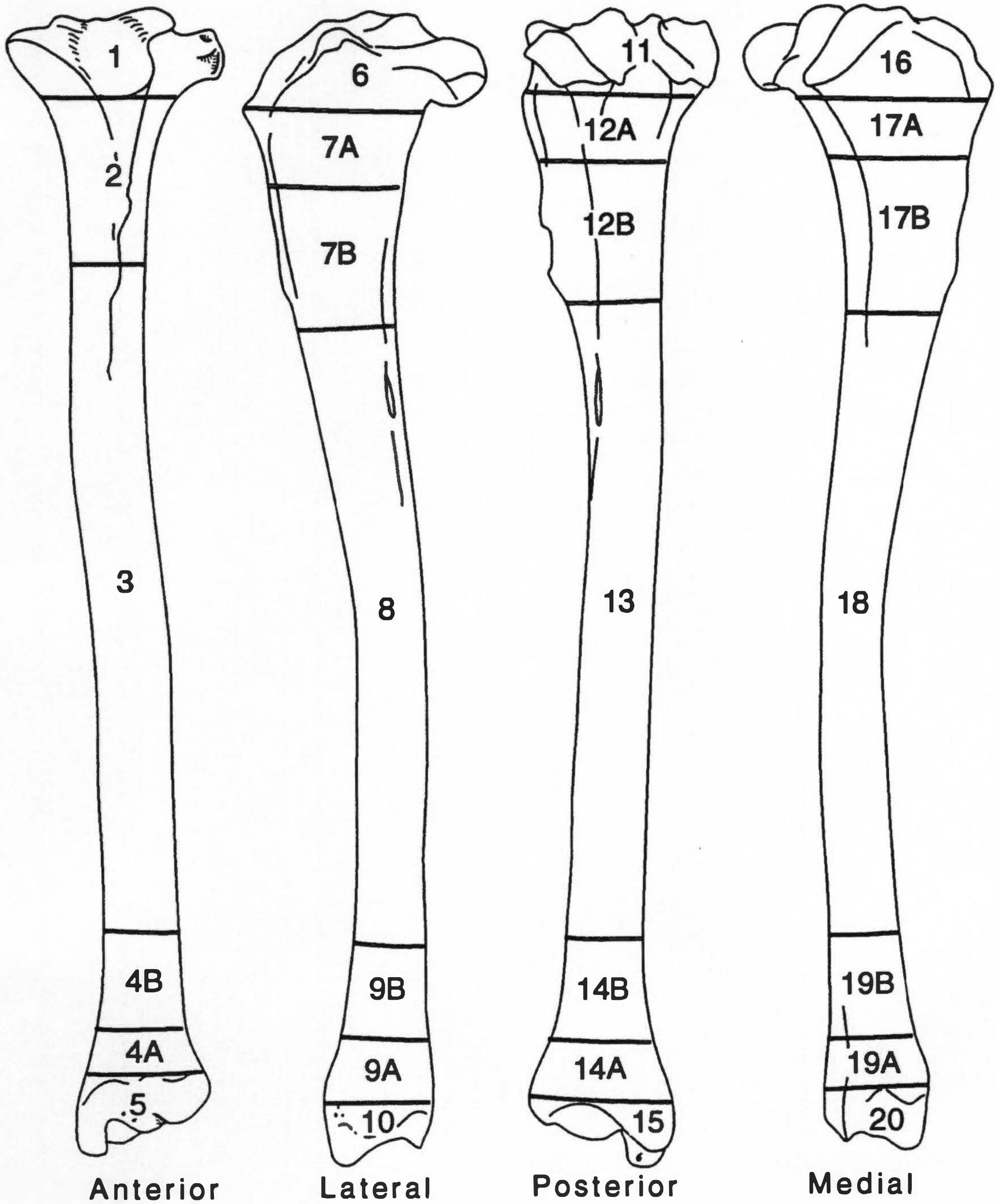

Figure A-12. Generalized cutmark locations on the canid tibia.

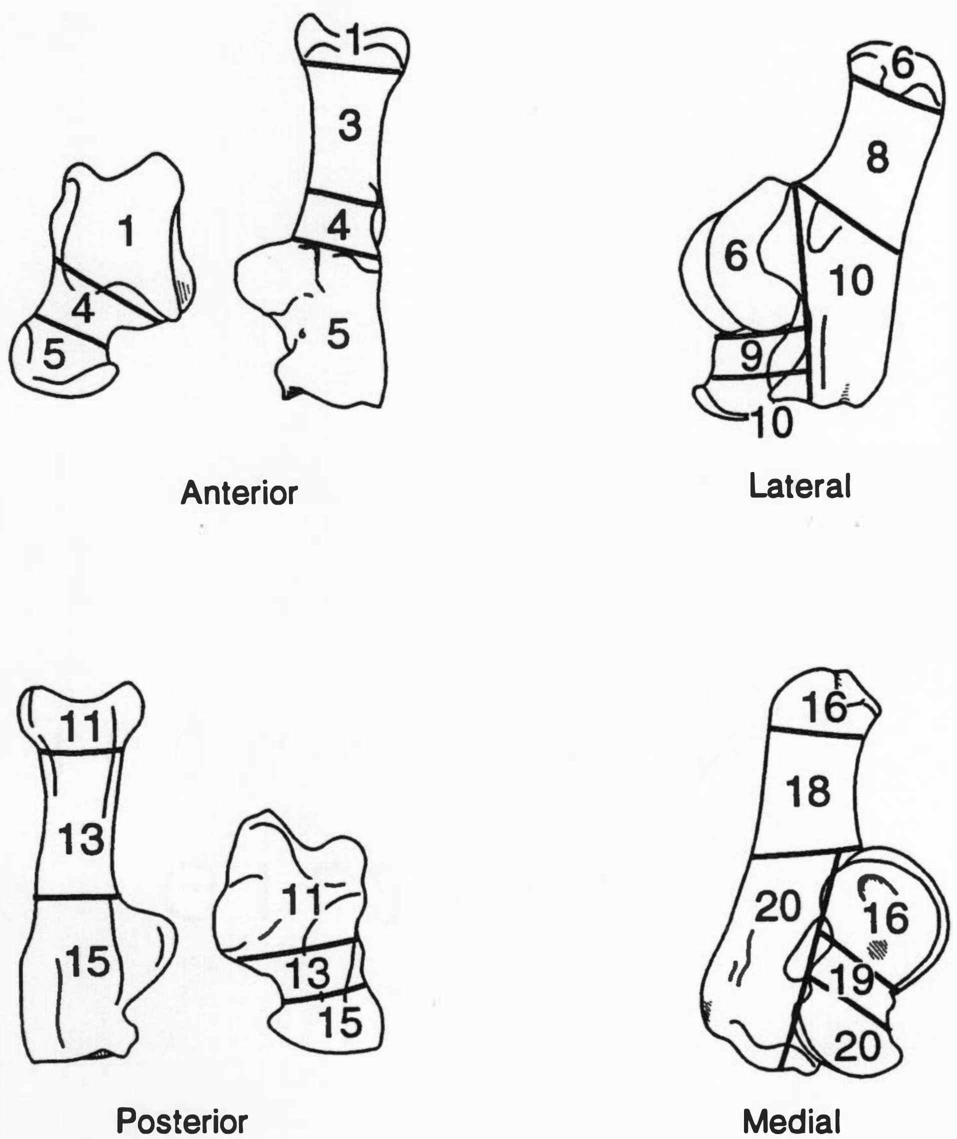

Figure A-13. Generalized cutmark locations on the canid astragalus and calcaneum.

Table A-1. Number of Large Canid Specimens (NISP) from Additional RBS Sites, Not Used in this Analysis.

Element	BF2	BF4	CH217	HU205	HU220	LM2	LM218	LM225
Skull		1	3/2	1/1	4		3	1
Mandible		1	1/1	2	4		5	
Cervicals				2	1		7/2	
Thoracics				1			12	
Lumbars							9	
Sacrum		1/1	1	1			2	
Ribs							22	
Scapula		2/1	1/1	1			3	
Humerus	1/1	1/1					6	1
Radius				3/2	1		7	1
Ulna	1/1		2/1	1/1	1	1	5	
Carpals							5	
Metacrpls	1		5		1		13/1	
Innom				2	2/1		2	
Femur	1/1		2/2				7	
Tibia							4	
Fibula							1/1	
Tarsals							10	
Metatrsls					1		13	
Phalanges					1		5	
Other							2	
Total	4/3	6/3	15/7	14/4	16/1	1	143/4	3

Number of specimens with CMs indicated following slash.

Table A-1. (cont.)

Element	LM232	PO7	SL4	ST14	ST16	ST30	ST55
Skull		22/12	32/14	7/1	4	10/1	
Mandible	3	30/22	48/20	3	16/9	3	
Cervicals	1	50/18	75/24	6/1	4/2	7	
Thoracics	1	30/8	31/4	1	1	3	
Lumbars	1	29/17	23/5			3	
Sacrum			2			1	
Ribs			2	1		2	
Scapula	1	13/6	39/7	8/1	2	2	
Humerus		21/15	43/23	8/4	4/2	6	
Radius		10/3	33/15	13/8	4	7	1
Ulna		24/10	53/17	9/4	3/2	2	
Carpals		19/2	12		6/1		
Metacrpls		50/6	112/4	21/1	31/1	9	
Innom		16/15	23/9	2/1	1	1	
Femur		17/13	49/17	4	3	4	
Tibia	1	15/6	28/11	14/7	3	10/1	
Fibula	1	7/2	9/3	2/1		2	
Tarsals		26/10	33/8	5	8/2	2	
Metatrsls		54/8	87/5	25	31/1	10	
Phalanges		138/9	79/1	2	44/2		
Other		27/1	10/1	1	6		
Total	9	598/183	823/188	132/29	171/22	84/2	1

Table A-1. (concluded)

Element	ST203	ST215	ST217	ST224	WW7	WW10	Total
Skull		2		30/9	2		122/40
Mandible			2/2	16/8	3/3	1	138/65
Cervicals	1/1	2/2	3/1	18/2			177/53
Thoracics				3			83/12
Lumbars		1/1		7			73/23
Sacrum		1		1			10/1
Ribs							27
Scapula			1	13/2			86/18
Humerus			1	18/11			110/57
Radius			1/1	16/4			97/33
Ulna			1	14/4			117/40
Carpals				5/1			47/4
Metacrpls			5/2	33/1			281/16
Innom		2/2		7/3			58/31
Femur				18/7		1/1	106/41
Tibia				15/6			90/31
Fibula				3			25/7
Tarsals			1	11/3			96/23
Metatrsls		2	5/1	55/8			283/23
Phalanges			2	27/1			298/13
Other				1			47/2
Total	1/1	10/5	22/7	311/70	5/3	2/1	2371/533

Table A-2. Number of Identified Specimens (NISP) and Number of Cutmarks by Element Portion.

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
Skull							
1	18/1 5.5%	9/0 0.0%	20/6 30.0%	47/8 17.0%	15/4 26.7%	15/1 6.7%	124/20 16.1%
2	19/0 0.0%	11/0 0.0%	21/6 28.6%	48/3 6.2%	15/2 13.3%	18/5 27.8%	132/16 12.1%
3	11/2 18.2%	11/1 9.1%	19/6 31.6%	43/7 16.3%	15/3 20.0%	9/0 0.0%	108/19 17.6%
4	10/1 10.0%	6/0 0.0%	11/2 18.2%	16/3 18.7%	6/0 0.0%	6/2 33.3%	55/8 14.5%
5	10/2 20.0%	6/2 33.3%	11/4 36.4%	16/7 43.7%	6/2 33.3%	6/1 16.7%	55/18 32.7%
7	18/1 5.5%	10/2 20.0%	21/9 42.9%	65/7 10.8%	19/4 21.0%	16/2 12.5%	145/25 16.8%
8	18/0 0.0%	9/0 0.0%	20/2 10.0%	47/1 2.1%	15/2 13.3%	15/1 6.7%	124/6 4.0%
9	18/0 10.0%	9/1 11.1%	20/5 25.0%	47/10 21.3%	15/1 6.7%	15/0 0.0%	124/17 13.7%
10	21/3 14.3%	10/3 30.0%	24/6 25.0%	65/16 24.6%	19/5 26.3%	16/2 12.5%	155/35 22.65
11	21/2 9.5%	10/2 20.0%	24/8 33.3%	65/9 13.8%	19/2 10.5%	16/4 25.0%	155/27 17.4%
12	18/0 0.0%	10/2 20.0%	21/1 4.8%	65/1 1.5%	15/0 0.0%	16/2 12.5%	145/6 4.1%
14	12/0 0.0%	12/0 0.0%	20/0 0.0%	61/0 0.0%	15/2 13.3%	10/0 0.0%	130/2 1.5%
15	10/0 0.0%	6/1 16.7%	11/1 9.1%	16/5 31.2%	6/2 33.3%	6/0 0.0%	55/9 16.4%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
Mandible							
1	32/3 9.4%	43/2 4.6%	105/20 19.0%	166/37 22.3%	40/15 37.5%	41/16 39.0%	427/93 21.8%
2	32/1 3.1%	43/1 2.3%	105/12 11.4%	166/14 8.4%	40/8 20.0%	41/6 14.6%	427/42 9.8%
3	32/4 12.5%	43/3 7.0%	105/26 24.8%	166/38 22.9%	40/9 22.5%	41/8 19.5%	427/88 20.6%
4	32/2 6.2%	43/1 2.3%	105/10 9.5%	166/17 10.2%	40/4 10.0%	41/4 9.8%	427/38 8.9%
5	29/1 3.4%	45/1 2.2%	100/0 0.0%	144/14 9.7%	41/3 7.3%	37/6 16.2%	396/25 6.3%
6	34/1 2.9%	56/0 0.0%	110/6 5.4%	164/17 10.4%	41/1 2.3%	43/2 4.6%	448/27 6.0%
7	34/1 2.9%	56/0 0.0%	110/4 3.6%	164/8 4.9%	41/2 4.9%	43/2 4.6%	448/17 3.8%
8	34/1 2.9%	56/1 1.8%	110/16 14.5%	164/28 17.1%	41/12 29.3%	43/1 2.3%	448/59 13.2%
9	29/0 0.0%	45/0 0.0%	100/3 3.0%	144/7 4.9%	41/3 7.3%	37/1 2.7%	396/14 3.5%
10	29/0 0.0%	45/0 0.0%	100/2 2.0%	144/4 2.8%	41/0 0.0%	37/1 2.7%	396/7 1.8%
11	32/1 3.1%	43/0 0.0%	105/0 0.0%	166/1 0.6%	40/1 2.5%	41/1 2.4%	427/4 0.9%
12	32/0 0.0%	43/0 0.0%	105/4 0.0%	166/5 3.8%	40/0 3.0%	41/0 0.0%	427/9 2.1%
13	32/1 3.1%	43/0 0.0%	105/1 1.3%	166/4 0.9%	40/1 2.4%	41/2 2.5%	427/9 4.9%
14	34/0 0.0%	56/0 0.0%	110/0 0.0%	164/5 3.0%	41/2 4.9%	43/1 2.3%	448/8 1.8%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
15	29/0 0.0%	45/0 0.0%	100/6 6.0%	144/12 8.3%	41/3 7.3%	37/0 0.0%	396/21 5.3%
16	32/0 0.0%	43/0 0.0%	105/6 5.7%	166/11 6.6%	40/2 5.0%	41/1 2.4%	427/20 4.8%
17	32/0 0.0%	43/0 0.0%	105/1 0.9%	166/0 0.0%	40/0 0.0%	41/0 0.0%	427/1 0.2%
Atlas							
1	9/0 0.0%	21/0 0.0%	24/2 8.3%	41/2 4.9%	16/0 0.0%	14/0 0.0%	125/4 3.2%
2	9/0 0.0%	21/2 9.5%	24/7 29.2%	40/14 35.0%	16/3 18.7%	13/1 7.7%	123/27 21.9%
3	10/1 10.0%	21/1 4.8%	25/6 24.0%	55/6 10.9%	16/4 25.0%	14/5 35.7%	141/23 16.3%
4	10/0 0.0%	21/0 0.0%	25/1 4.0%	55/0 0.0%	16/0 0.0%	14/0 0.0%	141/1 0.7%
5	10/0 0.0%	21/0 0.0%	24/1 4.2%	40/1 2.5%	16/0 0.0%	13/1 7.7%	124/3 2.4%
6	10/0 0.0%	21/0 0.0%	24/0 0.0%	40/0 0.0%	16/0 0.0%	13/0 0.0%	124/0 0.0%
7	10/0 0.0%	21/2 9.5%	25/3 12.0%	51/3 5.9%	17/1 5.9%	14/0 0.0%	138/9 6.5%
8	9/1 11.1%	21/2 9.5%	24/2 8.3%	41/4 9.8%	16/0 0.0%	14/0 0.0%	125/9 7.2%
9	9/2 22.2%	21/4 19.0%	24/13 54.2%	40/20 50.0%	16/7 43.7%	13/9 69.2%	123/55 44.7%
10	10/0 0.0%	21/0 0.0%	25/6 24.0%	54/8 14.8%	17/2 11.8%	13/3 23.1%	140/19 13.6%
11	9/0 0.0%	21/1 4.8%	24/2 8.3%	41/0 0.0%	16/0 0.0%	14/0 0.0%	125/3 2.4%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
12	9/0	21/1	24/3	40/6	16/2	13/3	123/15
	0.0%	4.8%	12.5%	15.0%	12.5%	23.1%	12.2%
Axis							
1	13/0	24/1	4/0	39/2	6/1	12/0	98/4
	0.0%	4.2%	0.0%	5.1%	16.7%	0.0%	4.1%
2	13/0	24/1	4/0	41/1	7/0	11/1	100/3
	0.0%	4.2%	0.0%	2.4%	0.0%	0.9%	3.0%
3	13/0	24/1	4/0	41/2	7/1	11/0	100/4
	0.0%	4.2%	0.0%	4.9%	14.3%	0.0%	4.0%
4	13/0	24/1	4/0	39/2	6/0	12/1	98/4
	0.0%	4.2%	0.0%	5.1%	0.0%	8.3%	4.1%
7	13/0	24/1	4/0	41/1	7/0	11/0	100/2
	0.0%	4.2%	0.0%	2.4%	0.0%	0.0%	2.0%
8	13/0	24/2	4/0	41/0	7/0	11/1	100/3
	0.0%	8.3%	0.0%	0.0%	0.0%	9.0%	3.0%
Cervical vertebra							
1	33/1	59/1	21/2	130/9	36/1	44/3	323/17
	3.0%	1.7%	9.5%	6.9%	2.8%	6.8%	5.3%
2	33/0	59/3	21/7	138/15	36/6	46/5	333/36
	0.0%	5.1%	33.3%	10.9%	16.7%	10.9%	10.8%
3	33/4	59/0	21/1	151/2	36/7	46/1	346/15
	12.1%	0.0%	4.8%	1.3%	19.4%	2.2%	4.3%
4	33/4	59/0	21/3	131/12	36/9	44/1	324/29
	12.15	0.0%	14.3%	9.2%	25.0%	2.3%	8.9%
5	33/0	59/0	21/0	138/1	36/0	46/1	333/2
	0.0%	0.0%	0.0%	0.7%	0.0%	2.2%	0.6%
6	33/0	59/0	21/0	139/0	36/0	47/1	335/1
	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%	0.3%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
7	33/1 3.3%	59/0 0.0%	21/5 23.8%	151/3 2.0%	36/6 16.7%	46/1 8.9%	346/16 4.6%
Thoracic vertebra							
2	70/0 0.0%	89/4 1.1%	18/4 22.25	133/10 7.5%	35/9 25.7%	26/8 30.8%	371/35 9.4%
3	70/1 1.4%	89/1 1.1%	18/4 22.2%	135/28 20.7%	35/8 22.9%	17/1 5.9%	364/43 11.8%
4	70/0 0.0%	92/6 6.5%	18/4 22.2%	147/22 15.0%	36/8 22.2%	36/1 2.8%	399/41 10.3%
5	70/0 0.0%	89/0 0.0%	18/1 5.5%	134/0 0.0%	35/1 2.9%	26/0 0.0%	372/2 0.5%
6	70/0 0.0%	89/0 0.0%	18/0 0.0%	135/3 2.2%	35/0 0.0%	27/0 0.0%	374/3 0.8%
7	70/0 0.0%	89/1 1.1%	18/0 0.0%	135/3 2.2%	35/0 0.0%	26/0 0.0%	373/4 1.1%
8	70/0 0.0%	89/1 1.1%	18/3 16.7%	133/8 6.0%	35/2 5.7%	26/2 7.7%	371/16 4.3%
9	70/0 0.0%	89/1 1.1%	18/2 11.1%	135/11 8.1%	30/0 0.0%	27/0 0.0%	369/14 3.8%
10	70/0 0.0%	92/5 5.4%	18/4 22.25	147/27 18.4%	36/4 11.1%	36/2 5.5%	399/42 10.5%
Lumbar vertebra							
1	37/0 0.0%	51/0 0.0%	24/2 8.3%	164/10 6.1%	67/4 6.0%	25/0 0.0%	368/16 4.3%
2	37/0 0.0%	51/3 5.9%	24/3 12.5%	164/33 20.1%	67/15 22.4%	25/5 20.0%	368/56 15.2%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
3	37/1 2.7%	51/0 0.0%	24/1 4.2%	164/19 11.6%	67/18 26.9%	25/1 4.0%	368/40 10.9%
4	37/0 0.0%	51/1 2.0%	24/3 12.5%	164/33 20.1%	67/8 11.9%	25/1 4.0%	368/46 12.5%
5	37/0 0.0%	51/0 0.0%	24/0 0.0%	164/0 0.0%	67/1 1.5%	25/0 0.0%	368/1 0.3%
6	37/0 0.0%	51/0 0.0%	24/0 0.0%	164/2 1.2%	67/0 0.0%	25/1 4.0%	368/3 0.8%
7	37/0 0.0%	51/0 0.0%	24/4 16.7%	164/7 4.3%	67/5 7.5%	25/2 8.0%	368/18 4.9%
Scapula							
1	23/0 0.0%	29/0 0.0%	35/5 14.3%	99/12 12.1%	49/7 14.3%	15/1 6.7%	250/25 10.0%
2	24/0 0.0%	25/0 0.0%	38/2 5.3%	108/10 9.2%	52/7 13.5%	17/0 0.0%	264/19 7.2%
3	16/0 0.0%	25/0 0.0%	31/2 6.4%	106/5 4.7%	41/2 4.9%	15/1 6.7%	234/10 4.3%
4	16/0 0.0%	24/0 0.0%	31/0 0.0%	91/0 0.0%	41/0 0.0%	15/0 0.0%	218/0 0.0%
5	16/0 0.0%	24/0 0.0%	35/10 28.6%	95/19 20.0%	41/14 34.1%	15/0 0.0%	226/43 19.0%
6	16/0 0.0%	24/0 0.0%	35/8 22.9%	95/22 23.2%	41/10 24.4%	15/0 0.0%	226/40 17.7%
7	16/1 6.2%	24/0 0.0%	31/3 9.7%	91/3 3.3%	41/2 4.9%	15/1 6.7%	218/10 4.6%
8	23/0 0.0%	29/2 6.9%	35/8 22.9%	99/19 19.2%	49/14 18.6%	15/6 40.0%	250/49 19.6%
9	24/1 4.2%	25/3 12.0%	38/13 34.2%	108/20 18.5%	52/14 26.9%	17/1 5.9%	264/52 19.7%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
10	16/1 6.2%	24/0 0.0%	31/1 3.2%	91/3 3.3%	41/4 9.8%	13/3 23.1%	216/12 5.5%
11	16/1 6.2%	24/1 4.2%	35/3 8.6%	95/10 10.5%	41/1 2.4%	15/2 13.3%	226/18 8.0%
12	16/1 6.2%	24/0 0.0%	31/0 0.0%	91/0 0.0%	41/1 2.4%	15/0 0.0%	218/2 0.9%
Humerus							
1	20/0 0.0%	23/0 0.0%	13/0 0.0%	17/0 0.0%	2/0 0.0%	10/0 0.0%	85/0 0.0%
2	20/0 0.0%	36/0 0.0%	22/0 0.0%	35/0 0.0%	4/0 0.0%	27/0 0.0%	144/0 0.0%
3	34/1 2.9%	38/1 2.6%	24/1 4.2%	33/1 3.0%	11/0 0.0%	32/1 3.1%	172/5 2.9%
4A	32/2 6.2%	51/18 35.3%	27/18 66.6%	54/15 27.8%	13/7 53.8%	37/15 40.5%	214/75 35.0%
4B	38/7 18.4%	50/11 22.0%	23/11 47.85	48/11 22.9%	16/7 43.7%	36/7 19.4%	211/54 25.6%
5	33/2 6.1%	49/1 2.0%	23/0 0.0%	37/4 10.8%	17/3 17.6%	23/7 30.4%	182/17 9.3%
6	20/0 0.0%	23/0 0.0%	13/0 0.0%	17/0 0.0%	2/0 0.0%	10/0 0.0%	85/0 0.0%
7	20/0 0.0%	36/0 0.0%	22/0 0.0%	35/4 11.4%	4/0 0.0%	27/0 0.0%	144/4 2.8%
8	34/0 0.0%	38/1 2.6%	24/1 4.2%	33/2 6.1%	11/0 0.0%	32/1 3.1%	172/5 2.9%
9A	32/0 0.0%	51/1 2.0%	27/1 3.7%	54/2 3.7%	13/2 15.4%	37/3 8.1%	214/29 4.2%
9B	38/2 5.3%	50/7 14.0%	23/7 30.4%	48/4 8.3%	16/2 12.5%	36/4 11.1%	211/26 12.3%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
10	33/1 3.0%	49/0 0.0%	23/0 0.0%	37/4 10.8%	17/0 0.0%	23/1 4.3%	182/6 3.3%
11	20/0 0.0%	23/0 0.0%	13/0 0.0%	17/0 0.0%	2/0 0.0%	10/1 10.0%	85/1 1.2%
12	20/2 10.0%	36/2 5.6%	22/1 4.5%	35/1 2.9%	4/1 25.0%	27/3 11.1%	144/10 6.9%
13	34/0 0.0%	38/0 0.0%	24/1 4.2%	33/1 3.0%	11/0 0.0%	32/0 0.0%	172/2 1.2%
14A	32/1 3.1%	51/7 13.7%	27/4 14.8%	54/1 1.8%	13/1 7.7%	37/5 13.5%	214/19 8.9%
14B	38/1 2.6%	50/1 2.0%	23/1 4.3%	48/3 6.2%	16/4 18.7%	36/4 11.1%	211/14 6.2%
15	33/0 0.0%	49/4 8.2%	23/0 0.0%	37/1 2.7%	17/1 0.0%	23/1 4.3%	182/7 3.3%
16	20/0 0.0%	23/0 0.0%	13/0 0.0%	17/0 0.0%	2/0 0.0%	10/2 20.0%	85/2 2.3%
17	20/0 0.0%	36/2 5.5%	22/2 9.1%	35/2 5.7%	4/1 0.0%	27/3 11.1%	144/10 6.2%
18	34/1 2.9%	38/0 0.0%	24/2 8.3%	33/2 6.1%	11/0 0.0%	32/2 6.2%	172/7 4.1%
19A	32/6 18.7%	51/11 21.6%	27/7 25.9%	54/5 9.3%	13/1 7.7%	37/10 27.0%	214/40 18.7%
19B	38/5 13.2%	50/11 22.0%	23/5 21.7%	48/10 20.8%	16/3 25.0%	36/5 13.9%	211/39 19.0%
20	33/1 3.0%	49/6 12.2%	23/1 4.3%	37/5 13.5%	17/0 5.9%	23/8 34.8%	182/21 12.1%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
Radius							
1A	19/0 0.0%	34/2 5.9%	47/17 36.2%	61/15 24.6%	34/13 38.2%	22/10 45.4%	217/57 26.3%
1B	19/0 0.0%	34/1 2.9%	47/5 10.6%	61/3 4.9%	34/2 5.9%	22/2 9.1%	217/13 6.0%
2	25/2 8.0%	39/2 5.1%	54/4 7.4%	74/9 12.2%	44/3 6.8%	36/2 5.5%	272/22 8.1%
3	35/1 2.9%	37/0 0.0%	54/0 0.0%	87/7 8.0%	40/0 0.0%	35/4 11.4%	288/12 4.2%
4	27/0 0.0%	31/2 6.4%	50/0 0.0%	86/1 1.2%	36/1 2.8%	34/2 5.9%	264/6 2.3%
5	20/1 5.0%	23/1 4.3%	38/1 2.6%	58/1 1.7%	22/1 4.5%	24/1 4.2%	185/6 3.2%
6	19/0 0.0%	34/1 2.9%	47/1 2.1%	61/0 0.0%	34/0 0.0%	22/0 0.0%	217/2 0.9%
7	25/0 0.0%	39/1 2.6%	54/1 1.8%	74/0 0.0%	44/0 0.0%	36/0 0.0%	272/2 0.7%
8	35/0 0.0%	37/0 0.0%	54/0 0.0%	87/1 1.1%	40/0 0.0%	35/0 0.0%	288/1 0.3%
9	27/0 0.0%	31/0 0.0%	50/1 2.0%	86/1 1.2%	36/0 0.0%	34/0 0.0%	264/2 0.7%
10	20/1 5.0%	23/0 0.0%	38/0 0.0%	58/0 0.0%	22/0 0.0%	24/0 0.0%	185/1 0.5%
11	19/0 0.0%	34/1 2.9%	47/0 0.0%	61/0 0.0%	34/0 0.0%	22/0 0.0%	217/1 0.5%
12	25/0 0.0%	39/1 2.6%	54/0 0.0%	74/1 1.3%	44/0 0.0%	36/0 0.0%	272/2 0.7%
13	35/0 0.0%	37/0 0.0%	54/1 1.8%	87/2 2.3%	40/0 0.0%	35/0 0.0%	288/3 1.0%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
14	27/3 11.1%	31/1 3.2%	50/0 0.0%	86/2 2.3)	36/0 0.0%	34/0 0.0%	264/6 2.3%
15	20/0 0.0%	23/3 13.0%	38/1 2.6%	58/8 13.8%	22/2 9.1%	24/1 4.2%	185/15 8.1%
16	19/0 0.0%	34/1 2.9%	47/1 2.1%	61/0 0.0%	34/1 2.9%	22/0 0.0%	217/3 1.4%
17	25/0 0.0%	39/0 0.0%	54/3 5.5%	74/1 1.3%	44/3 6.8%	36/0 0.0%	272/7 2.6%
18	35/0 0.0%	37/0 0.0%	54/0 0.0%	87/1 1.1%	40/0 0.0%	35/0 0.0%	288/1 0.3%
19	27/0 0.0%	31/1 3.2%	50/0 0.0%	86/2 2.3%	36/0 0.0%	34/0 0.0%	264/3 1.1%
20	20/0 0.0%	23/0 0.0%	38/1 2.6%	58/5 8.6%	22/1 4.5%	24/1 4.2%	185/8 4.3%
Ulna							
1A	25/1 4/05	61/4 6.6%	31/7 22.6%	106/11 10.4%	56/5 8.9%	40/7 17.5%	319/35 11.0%
1B	25/1 4.0%	61/3 4.9%	49/13 26.5%	106/23 21.7%	56/10 17.9%	40/10 25.0%	337/60 20.8%
2	39/1 2.6%	60/0 0.0%	50/0 0.0%	108/2 1.8%	56/0 0.0%	42/0 0.0%	355/3 0.8%
3	42/1 2.4%	44/0 0.0%	41/0 0.0%	91/0 0.0%	51/0 0.0%	37/1 0.0%	306/2 0.6%
4	37/0 0.0%	29/0 0.0%	32/0 0.0%	59/0 0.0%	43/0 0.0%	31/0 0.0%	231/0 0.0%
5	22/1 4.5%	15/1 6.7%	17/2 11.8%	31/2 6.4%	16/0 0.0%	13/2 15.4%	114/8 7.0%
6	25/0 0.0%	61/2 3.3%	31/2 6.4%	106/2 1.9%	56/0 0.0%	40/0 0.0%	319/6 1.9%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
7A	25/0 0.0%	61/0 0.0%	49/3 6.1%	106/10 9.4%	56/1 1.8%	40/0 0.0%	337/14 4.1%
7B	39/0 0.0%	60/0 0.0%	50/0 0.0%	108/2 1.8%	56/1 1.8%	42/0 0.0%	355/3 0.8%
8	42/0 0.0%	44/0 0.0%	41/0 0.0%	91/1 1.1%	51/0 0.0%	37/0 0.0%	306/1 0.3%
9	37/0 0.0%	29/1 3.4%	32/0 0.0%	59/0 0.0%	43/0 0.0%	31/0 0.0%	231/1 0.4%
10	22/0 0.0%	15/0 0.0%	17/0 0.0%	31/3 9.7%	16/0 0.0%	13/0 0.0%	114/3 2.6%
11	25/0 0.0%	61/0 0.0%	49/1 2.0%	106/4 3.8%	56/1 1.8%	40/1 2.5%	337/7 2.1%
12	39/4 10.3%	60/1 1.7%	50/1 2.0%	108/12 11.1%	56/4 7.1%	42/3 7.1%	355/25 7.0%
13	42/2 4.8%	44/1 2.3%	41/2 4.9%	91/12 13.2%	51/2 3.9%	37/4 10.8%	306/23 7.5%
14	37/0 0.0%	29/0 0.0%	32/1 3.1%	59/2 3.4%	43/2 4.6%	31/1 3.2%	231/6 2.6%
15	22/0 0.0%	15/1 6.7%	17/4 23.5%	31/9 29.0%	16/2 12.5%	13/5 38.5%	114/21 18.2%
16A	25/0 0.0%	61/1 1.6%	31/3 9.7%	106/4 3.8%	56/1 1.8%	40/2 5.0%	319/11 3.4%
16B	25/0 0.0%	61/0 0.0%	49/2 4.1%	106/6 5.7%	56/0 0.0%	40/1 2.5%	337/9 2.7%
17A	25/0 0.0%	61/1 1.6%	49/1 2.0%	106/3 3.8%	56/1 1.8%	40/0 0.0%	337/6 1.8%
17B	39/0 0.0%	60/1 1.7%	50/0 0.0%	108/5 4.6%	56/3 5.4%	42/2 4.8%	355/11 3.1%
18	42/0 0.0%	44/0 0.0%	41/0 0.0%	91/3 3.3%	51/0 0.0%	37/0 0.0%	306/3 1.0%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
19	37/0 0.0%	29/0 0.0%	32/0 0.0%	59/0 0.0%	43/1 2.3%	31/0 0.0%	231/1 0.4%
20	22/0 0.0%	15/1 6.7%	17/1 5.9%	31/0 0.0%	16/0 0.0%	13/0 0.0%	114/2 1.7%
Metacarpal							
1	143/1 0.7%	87/0 0.0%	31/0 0.0%	232/2 0.9%	102/0 0.0%	21/0 0.0%	616/3 0.5%
2	143/2 1.3%	87/0 0.0%	31/0 0.0%	232/3 1.3%	102/0 0.0%	21/0 0.0%	616/5 0.8%
3	143/1 0.7%	87/2 2.3%	31/0 0.0%	232/5 2.1%	102/4 3.9%	21/0 0.0%	616/12 1.9%
4	143/1 0.7%	87/2 2.3%	31/0 0.0%	232/9 3.9%	102/2 2.0%	21/0 0.0%	616/14 2.3%
5	143/0 0.0%	87/0 0.0%	31/0 0.0%	232/0 0.0%	102/0 0.0%	21/0 0.0%	616/0 0.0%
11	143/0 0.0%	87/0 0.0%	31/0 0.0%	232/0 0.0%	102/0 0.0%	21/0 0.0%	616/0 0.0%
12	143/0 0.0%	87/0 0.0%	31/0 0.0%	232/2 0.9%	102/0 0.0%	21/0 0.0%	616/2 3.2%
13	143/0 0.0%	87/0 0.0%	31/1 3.2%	232/3 1.3%	102/0 0.0%	21/0 0.0%	616/1 0.1%
14	143/0 0.0%	87/0 0.0%	31/1 3.2%	232/3 1.3%	102/0 0.0%	21/0 0.0%	616/1 0.1%
Innominate							
1	18/0 0.0%	21/4 19.0%	32/4 12.5%	73/11 15.1%	33/8 24.2%	26/5 19.2%	203/32 15.8%
2	15/0 0.0%	21/2 9.5%	32/5 15.6%	73/24 32.9%	32/11 34.4%	26/7 26.9%	199/49 24.6%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
3	8/2 25.0%	20/5 25.0%	23/7 30.4%	91/17 18.7%	34/9 26.5%	24/5 20.8%	200/45 22.5%
4	18/1 5.5%	21/0 0.0%	32/0 0.0%	73/2 2.7%	33/1 3.0%	26/0 0.0%	203/4 2.0%
5	19/3 15.8%	20/5 25.0%	30/7 23.3%	60/12 20.0%	37/4 10.8%	25/6 24.0%	191/37 19.4%
6	18/2 11.1%	21/4 19.0%	32/6 18.7%	73/11 15.1%	33/2 6.1%	26/3 11.5%	203/28 13.8%
7	15/2 13.3%	20/1 4.0%	27/3 11.1%	88/11 12.5%	32/1 3.1%	26/6 23.1%	208/24 11.5%
8	8/1 12.5%	14/0 0.0%	23/1 4.3%	91/9 9.9%	34/1 2.9%	24/6 25.0%	194/18 9.3%
9	7/0 0.0%	12/0 0.0%	17/2 11.8%	42/3 7.1%	19/2 10.5%	20/1 5.0%	117/8 6.8%
10	7/0 0.0%	12/0 0.0%	17/2 11.8%	42/3 7.1%	19/1 5.3%	20/0 0.0%	117/6 5.1%
11	19/0 0.0%	20/0 0.0%	30/5 16.7%	60/9 15.0%	37/2 5.4%	25/8 32.0%	191/24 12.5%
12	18/0 0.0%	21/0 0.0%	32/1 3.1%	73/0 0.0%	33/0 0.0%	26/0 0.0%	203/1 0.5%
13	8/0 0.0%	14/0 0.0%	23/0 0.0%	91/0 0.0%	34/0 0.0%	24/0 0.0%	194/0 0.0%
14	15/0 0.0%	21/0 0.0%	32/4 12.5%	73/2 2.7%	33/0 0.0%	26/4 15.4%	200/10 5.0%
Femur							
1A	16/0 0.0%	25/0 0.0%	11/1 9.1%	18/0 0.0%	10/1 10.0%	13/1 7.7%	93/3 3.2%
1B	16/0 0.0%	25/3 12.0%	11/1 9.1%	18/0 0.0%	10/1 10.0%	13/3 23.1%	93/8 8.6%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
1C	24/1 4.2%	29/6 20.7%	16/1 6.2%	23/1 4.3%	16/3 18.7%	31/3 9.7%	139/15 10.8%
2	24/1 4.2%	29/1 3.4%	16/1 6.2%	23/0 0.0%	16/1 6.2%	31/3 9.7%	139/7 5.0%
3	31/4 12.9%	33/0 3.0%	16/1 6.2%	30/4 13.3%	12/1 8.3%	32/0 0.0%	154/10 7.1%
4A	25/0 0.0%	35/2 5.7%	14/0 0.0%	28/0 0.0%	10/0 0.0%	31/0 0.0%	143/2 1.4%
4B	25/3 12.0%	35/2 5.7%	14/1 7.1%	28/0 0.0%	10/1 10.0%	31/0 0.0%	143/7 5.6%
5	21/0 0.0%	30/0 0.0%	8/0 0.0%	22/0 0.0%	11/0 0.0%	15/0 0.0%	107/0 0.0%
6	16/0 0.0%	25/0 0.0%	11/0 0.0%	18/1 5.5%	10/1 10.0%	13/2 15.4%	93/4 4.3%
7	24/1 4.2%	29/0 0.0%	16/0 0.0%	23/0 0.0%	16/0 0.0%	31/0 0.0%	139/1 0.7%
8	31/2 6.4%	33/0 0.0%	16/0 0.0%	30/1 3.3%	12/0 0.0%	32/0 0.0%	154/3 1.9%
9A	25/0 0.0%	35/1 2.9%	14/0 0.0%	28/0 0.0%	10/0 0.0%	31/0 0.0%	143/1 0.7%
9B	25/4 16.0%	35/0 0.0%	14/0 0.0%	28/0 0.0%	10/0 0.0%	31/0 0.0%	143/4 2.8%
10	21/0 0.0%	30/0 0.0%	8/0 0.0%	22/1 4.5%	11/0 0.0%	15/3 20.0%	107/4 3.7%
11A	16/0 0.0%	25/1 4.0%	11/0 0.0%	18/2 11.1%	10/1 10.0%	13/2 15.4%	93/6 6.4%
11B	16/0 0.0%	25/3 12.0%	11/0 0.0%	18/2 11.1%	10/1 10.0%	13/2 15.4%	93/8 8.6%
11C	24/0 0.0%	29/0 0.0%	16/2 12.5%	23/6 26.1%	16/5 31.2%	31/2 6.4%	139/15 10.8%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
12	24/1 4.2%	29/0 0.0%	16/0 0.0%	23/0 0.0%	16/0 0.0%	31/2 6.4%	139/3 2.2%
13	31/2 6.4%	33/2 6.1%	16/0 0.0%	30/2 6.7%	12/0 0.0%	32/3 9.4%	154/9 5.8%
14A	25/0 0.0%	35/2 5.7%	14/0 0.0%	28/1 3.6%	10/2 20.0%	31/2 6.4%	143/7 4.9%
14B	25/1 4.0%	35/1 2.9%	14/1 7.1%	28/2 7.1%	10/1 10.0%	31/1 3.2%	143/7 4.9%
15	21/1 4.8%	30/2 6.7%	8/1 12.5%	22/0 0.0%	11/0 0.0%	15/0 0.0%	107/4 3.7%
16A	16/0 0.0%	25/3 12.0%	11/0 0.0%	18/0 0.0%	10/1 10.0%	13/5 38.5%	93/9 9.7%
16B	24/1 4.2%	29/4 13.8%	16/0 0.0%	23/5 21.7%	16/2 12.5%	31/6 18.3%	139/18 12.9%
17	24/1 4.2%	29/1 3.4%	16/2 12.55	23/1 4.3%	16/2 12.5%	31/3 9.7%	139/10 7.2%
18	31/3 9.7%	33/0 0.0%	16/1 6.2%	30/0 0.0%	12/1 8.3%	32/3 9.4%	154/8 5.2%
19A	25/1 4.0%	35/1 2.9%	14/0 0.0%	28/0 0.0%	10/0 0.0%	31/1 3.2%	143/3 2.1%
19B	25/2 8.0%	35/1 2.9%	14/1 7.1%	28/0 0.0%	10/0 0.0%	31/0 0.0%	143/4 2.8%
20	21/0 0.0%	30/0 0.0%	8/0 0.0%	22/1 4.5%	11/0 0.0%	15/1 6.7%	107/2 11.9%
Tibia							
1	9/0 0.0%	22/0 0.0%	34/0 0.0%	49/2 4.1%	18/0 0.0%	18/0 0.0%	150/2 1.5%
2	24/2 8.3%	32/0 0.0%	50/3 6.0%	73/0 0.0%	27/0 0.0%	24/1 4.2%	230/6 2.6%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
3	46/3 6.5%	39/1 2.6%	50/1 2.0%	64/4 6.2%	32/1 3.1%	25/1 4.0%	256/11 4.3%
4A	37/1 2.7%	33/4 12.1%	45/5 11.1%	56/6 10.7%	39/1 2.6%	22/6 27.3%	232/23 9.9%
4B	37/1 2.7%	37/1 2.7%	45/4 8.9%	56/3 5.4%	39/1 2.6%	22/3 13.6%	236/13 5.5%
5	30/3 10.0%	33/5 15.1%	36/6 16.7%	50/11 22.0%	35/5 14.3%	22/12 54.5%	206/42 20.4%
6	9/0 0.0%	22/0 0.0%	34/0 0.0%	49/0 0.0%	18/0 0.0%	18/0 0.0%	150/0 0.0%
7A	24/0 0.0%	32/0 0.0%	50/0 0.0%	73/1 1.4%	27/0 0.0%	24/0 0.0%	230/1 0.4%
7B	24/0 0.0%	32/0 0.0%	50/0 0.0%	73/2 2.7%	27/0 0.0%	24/4 16.7%	230/6 2.6%
8	46/0 0.0%	39/0 0.0%	50/1 2.0%	64/1 1.6%	32/0 0.0%	25/1 4.0%	256/3 1.2%
9A	37/0 0.0%	33/0 0.0%	45/0 0.0%	56/0 0.0%	39/0 0.0%	22/1 4.5%	232/1 0.4%
9B	37/0 0.0%	37/0 0.0%	45/0 0.0%	56/0 0.0%	39/0 0.0%	22/0 0.0%	236/0 0.0%
10	30/0 0.0%	33/0 0.0%	36/0 0.0%	50/2 4.0%	35/0 0.0%	22/0 0.0%	206/2 1.0%
11	9/0 0.0%	22/0 0.0%	34/0 0.0%	49/5 10.2%	18/0 0.0%	18/1 5.5%	150/6 4.0%
12A	24/0 0.0%	32/0 0.0%	50/2 4.0%	73/1 1.4%	27/1 3.7%	24/4 16.7%	230/8 3.5%
12B	24/1 4.2%	32/1 3.1%	50/1 2.0%	73/4 5.5%	27/0 0.0%	24/1 4.2%	230/8 3.5%
13	46/2 4.3%	39/0 0.0%	50/2 4.0%	64/2 3.1%	32/0 0.0%	25/1 4.0%	256/7 2.7%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
14A	37/0 0.0%	33/2 6.1%	45/0 0.0%	56/2 3.6%	39/0 0.0%	22/1 4.5%	232/5 2.1%
14B	37/2 5.4%	37/3 8.1%	45/0 0.0%	56/1 1.8%	39/0 0.0%	22/3 13.6%	236/9 3.8%
15	30/1 3.3%	33/1 3.0%	36/0 0.0%	50/1 2.0%	35/0 0.0%	22/0 0.0%	206/3 1.5%
16	9/0 0.0%	22/0 0.0%	34/2 5.9%	49/3 6.1%	18/1 5.5%	18/0 0.0%	150/6 4.0%
17A	24/0 0.0%	32/1 3.1%	50/2 4.0%	73/2 2.7%	27/0 0.0%	24/0 0.0%	230/5 2.2%
17B	24/0 0.0%	32/0 0.0%	50/3 6.0%	73/1 1.4%	27/0 0.0%	24/5 20.8%	230/9 3.9%
18	46/4 8.7%	39/0 0.0%	50/2 4.0%	64/4 6.2%	32/0 0.0%	25/2 8.0%	256/12 4.7%
19A	37/2 5.4%	33/0 0.0%	45/0 0.0%	56/2 3.6%	39/1 2.6%	22/1 4.5%	232/6 2.6%
19B	37/1 2.7%	37/0 0.0%	45/1 2.25	56/1 1.8%	39/0 0.0%	22/0 0.0%	236/3 1.3%
20	30/2 6.7%	33/1 3.0%	36/0 0.0%	50/1 2.0%	35/1 2.9%	22/2 9.1%	206/7 3.4%
Calcaneum							
1	21/0 0.0%	15/0 0.0%	13/0 0.0%	33/0 0.0%	14/0 0.0%	14/1 7.1%	110/1 0.9%
3	21/0 0.0%	15/3 20.0%	13/0 0.0%	33/5 15.5%	14/1 7.1%	14/1 7.1%	110/10 9.1%
4	21/0 0.0%	15/0 0.0%	13/0 0.0%	33/2 6.1%	14/0 0.0%	14/0 0.0%	110/2 1.8%
5	21/0 0.0%	15/0 0.0%	13/0 0.0%	33/1 3.0%	14/0 0.0%	14/0 0.0%	110/1 0.9%

Table A-2. (cont.)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
8	21/1 4.8%	15/0 0.0%	13/0 0.0%	33/0 0.0%	14/0 0.0%	14/0 0.0%	110/1 0.9%
10	21/3 14.3%	15/0 0.0%	13/0 0.0%	33/3 9.1%	14/0 0.0%	14/0 0.0%	110/6 5.4%
11	21/0 0.0%	15/0 0.0%	13/0 0.0%	33/1 9.1%	14/0 0.0%	14/0 0.0%	110/1 0.9%
12	21/0 0.0%	15/0 0.0%	13/0 0.0%	33/0 0.0%	14/0 0.0%	14/1 7.1%	110/1 0.9%
13	21/1 4.8%	15/2 13.3%	13/1 7.7%	33/1 3.0%	14/1 7.%	14/0 0.0%	110/6 5.4%
14	21/0 0.0%	15/0 0.0%	13/0 0.0%	33/0 0.0%	14/0 0.0%	14/0 0.0%	110/0 0.0%
15	21/0 0.0%	15/1 6.7%	13/0 0.0%	33/2 6.1%	14/1 7.1%	14/0 0.0%	110/4 3.6%
18	21/2 14.3%	15/0 0.0%	13/0 0.0%	33/1 3.0%	14/0 0.0%	14/0 0.0%	110/3 2.7%
Astragalus							
1	8/1 12.55	13/2 15.4%	- -	14/4 28.6%	12/4 33.3%	5/3 60.0%	52/20 26.9%
4	8/0 0.0%	13/0 0.0%	- -	14/1 7.1%	12/1 8.3%	5/0 0.0%	52/2 3.8%
5	8/0 0.0%	13/0 0.0%	- -	14/1 7.1%	12/0 0.0%	5/0 0.0%	52/1 1.9%
6	8/0 0.0%	13/0 0.0%	-	14/0 0.0%	12/0 0.0%	5/0 0.0%	52/0 0.0%
11	8/0 0.0%	13/0 0.0%	-	14/0 0.0%	12/1 8.3%	5/0 0.0%	52/1 1.9%
16	8/0 0.0%	13/1 0.0%	-	14/0 0.0%	12/0 0.0%	5/0 0.0%	52/1 1.9%

Table A-2. (concluded)

Element CM Loc.	BF11	ST56	CA6	WW2	WW3	CO9	Total
19	8/0 0.0%	13/0 0.0%	-	14/1 7.1%	12/0 0.0%	5/0 0.0%	52/1 1.9%
Metatarsal							
1	94/0 0.0%	100/1 1.0%	36/0 0.0%	178/1 0.6%	102/0 0.0%	22/1 4.6%	532/3 0.6%
2	94/0 0.0%	100/0 0.0%	36/0 0.0%	178/0 0.0%	102/0 0.0%	22/0 0.0%	532/0 0.0%
3	94/1 1.1%	100/0 0.0%	36/1 2.8%	178/2 1.1%	102/0 0.0%	22/0 0.0%	532/4 0.8%
4	94/0 0.0%	100/0 0.0%	36/1 2.8%	178/6 3.4%	102/0 0.0%	22/0 0.0%	532/7 1.3%
5	94/0 0.0%	100/0 0.0%	36/1 2.8%	178/0 0.0%	102/0 0.0%	22/0 0.0%	532/1 0.2%
11	94/0 0.0%	100/0 0.0%	36/0 0.0%	178/0 0.0%	102/0 0.0%	22/0 0.0%	532/0 0.0%
12	94/0 0.0%	100/0 0.0%	36/0 0.0%	178/1 0.6%	102/0 0.0%	22/0 0.0%	532/1 0.2%
13	94/0 0.0%	100/0 0.0%	36/1 2.8%	178/0 0.0%	102/0 0.0%	22/0 0.0%	532/1 0.2%
14	94/0 0.0%	100/0 0.0%	36/0 0.0%	178/1 .06%	102/1 1.0%	22/0 0.0%	532/2 0.4%
15	94/0 0.0%	100/0 0.0%	36/0 0.0%	178/0 0.0%	102/0 0.0%	22/0 0.0%	532/0 0.0%

VITA

Lynn Miller Snyder was born on October 31, 1946, and grew up on a farm in rural Adams County, Illinois. She attended Marblehead primary school in Marblehead, Illinois and Seymour High School in Payson, Illinois, from which she graduated in 1964. In 1968 she received a Bachelors degree in English Literature from Quincy College, Quincy, Illinois. She received a Masters of Science degree in Library Science from the University of Wisconsin, Madison in 1974, and a M.A. in Anthropology from the University of Nebraska in 1981.

She taught grammar school music and high school English in the Chicago and Rockford, Illinois public school systems from 1969 through 1971. From 1975 through 1979 Snyder was a branch library supervisor, then reference librarian and department supervisor for the Lincoln City Libraries, Lincoln, Nebraska. While attending the University of Nebraska, and following her M.A. from Nebraska, she was employed as a graduate research assistant and later research archaeologist with the Division of Archaeological Research, Department of Anthropology, University of Nebraska.

She began her graduate studies at the Jniversity of Tennessee in 1984, where she was a graduate assistant in zooarchaeology and taught classes in cultural and physical anthropology as the graduate teaching assistant. During this time she also conducted contract work and actualistic research in zooarchaeology. For the past eight summers (1988-1995) she has participated in archaeological field work and zooarchaeological analyses in Crete and Greece. In 1991-1992 she was a Fulbright fellow at the American School of Classical Studies in Athens, Greece where she continued work on Early Iron Age faunal materials from the Kavousi Project, East Crete.

In 1992 she began her dissertation research on large canid skeletal assemblages from the Middle Missouri Subarea of the North American Plains, as a Pre-doctoral fellow at the Smithsonian Institution, Division of Anthropology, National Museum of Natural History, Washington, D.C. Since that time she has been employed as a contractor with the Smithsonian Institution, and continues to work on zooarchaeological projects in America and Greece.