8-1998

The Plains Paradox: Secular Trends in Stature in 19th Century Nomadic Plains Equestrian Indians

Joseph M. Prince
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Joseph M. Prince entitled "The Plains Paradox: Secular Trends in Stature in 19th Century Nomadic Plains Equestrian Indians." I have examined the final electronic 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.

Richard L. Jantz, Major Professor

We have read this dissertation and recommend its acceptance:

William M. Bass, Lyle W. Konigsberg, John R. Finger

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a dissertation written by Joseph M. Prince, entitled "The Plains Paradox: Secular Trends in Stature in 19th Century Nomadic Plains Equestrian Indians". I 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.

Richard L. Jantz, Major Professor

We have read this dissertation
And recommend its acceptance:

William M. Bass

Lyle W. Konigsberg

John R. Finger

Accepted for the Council:

Associate Vice Chancellor and
Dean of The Graduate School

THE PLAINS PARADOX:

SECULAR TRENDS IN STATURE IN 19TH CENTURY NOMADIC PLAINS EQUESTRIAN INDIANS

The Arapaho, Assiniboin, Blackfeet, Cheyenne, Comanche, Crow, Kiowa, and Sioux from 1800 to 1870

A Dissertation
Presented for the
Doctor of Philosophy Degree
The University of Tennessee, Knoxville

Joseph M. Prince
August 1998

DEDICATION

For Becky

Sero sed serio

In Memoria

For Bonny and Ted Prince

Who taught me the value of perseverance

in the face of great odds

And for the lifelong contributions

of recently departed eminent anthropologists

John C. Ewers

Joseph Jablow

Wilcomb E. Washburn

ACKNOWLEDGEMENTS

In the course of my research for this dissertation I have been assisted by numerous faculty members, colleagues, and friends. To all of them I am deeply indebted. In particular I would like to thank my committee chairman, Dr. Richard L. Jantz, for his abiding patience, good humor and goodwill, as well as encouragement over these many years. His friendship and scholarship have been an invaluable inspiration to myself and many others. It is through the kind auspices of Dr. Jantz that the data used here were supplied. This project owes a debt of gratitude to Dr. Lee Meadows Jantz as well, for it began as a paper she presented in 1995 (L. Meadows Jantz et al, 1995). Knowing of my interest in the subject area, she kindly made her analyses available to me to investigate the Plains area for common secular trends and their possible meaning.

I also wish to thank my other committee members. I wish to thank Dr. William M. Bass for his lifelong abiding interest in physical anthropology on the Great Plains, which has been a continuing inspiration and great service to myself as well as hundreds of other anthropologists, students, and researchers over the years. Much of the Plains scholarship coming from the University of Tennessee, Knoxville (UTK), Department of Anthropology is based upon Dr. Bass' research and collections made over 30 years ago. I also would like to thank Dr. Lyle Konigsberg for his patience and wise counsel, despite this project's decidedly low horsepower statistics, invented in fact around the turn of the last century. Dr. John Finger has kindly attempted to steer me towards some of the more salient documents and current arguments about Plains Indian history, however their interpretation remains uniquely my own.

I also gratefully received help in producing the SAS graphs presented here by a friend, Joe Whitehurst of Atlanta. Dr. Mike Logan of the Department of Anthropology, UTK, was also helpful in making his research on the Plains and the Boas data set available, as well as offering useful comments on my progress.

Dr. Steve Ousley, now of the Smithsonian Institution, provided me with some valuable suggestions and critiques as well as making his research on mortality trends in the Boas data set available. He also graciously answered some last minute questions.

Dr. Jan Simek, head of the Department of Anthropology at UTK, has also been helpful in the cause of this dissertation by running interference on my behalf before the Graduate School due to its long delay.

I want to take this opportunity to thank other researchers using secular trends in heights in various research projects to examine anthropometric as well as economic history. Dr. Richard Steckel of Ohio State University has been a valuable sounding board throughout various stages of this project and a previous one, answering unusual questions with general good humor. Dr. Steckel's work has been and continues to be tremendously enlightening to myself and to many other students of economic history. Dr. Robert Malina of Michigan State University graciously also lent an ear to my anthropometric 'Plains Paradox', and provided me with valuable feedback about some possible explanations for the trends seen. I want to thank again Marilyn Coopersmith of the

Center for Population Economics at the University of Chicago for first making the works of Dr. Robert Fogel available to me. She originally aided me in locating various members of the ongoing National Bureau of Economic Research's "Nutrition Project".

Dr. Russell Thornton of the University of California, Los Angeles, was helpful in answering questions about aboriginal population decline and its causes and consequences.

I wish to also express my gratitude for the yeoman good works of the Bartow County, Georgia library staff for their able and successful attempts to obtain various materials through their interlibrary loan department for this study. I especially want to thank Ms. Carmen Sims in this regard.

I owe a continuing profound debt of gratitude to the thousands of Indians who participated in the original anthropometric Boas survey, as well as to the many researchers who collected these measurements.

I want to thank my friends, colleagues, and family for their continued support over the years. Finally, I want to express my fondest thanks and regards to my wife, Becky Carr, for the loving concern, care and support she has always shown for me in this long-term endeavor. I dedicate this effort to her steadfastness and wisdom in staying the course despite trying circumstances.

ABSTRACT

This study documents the occurrence of secular trends in height in an historic population of 19th century nomadic Plains equestrian Indians. The eight tribal samples utilized are a subset of the Boas North American Indian anthropometric data set. A cross-sectional design was used to examine the span of years from 1800 to 1870 for adult individuals over 20 years of age, sexes analyzed separately, male n=1,123 and female n=362. Adult heights were adjusted for aging effects on three variables: standing height; sitting height; and sitting height/subischial length ratio. Combined with an unadjusted subischial length, these variables were used to examine each of the Plains tribes for secular trends. Each variable was then regressed onto year of birth using a quadratic model. Tribal samples showing significant differences ($p \leq 0.05$) among the means of the birth cohorts, and hence secular change through time, included five of eight male tribal samples, but only two of the female tribal samples. Significant regressions for adjusted standing height were seen for Sioux males and females, Crow females, and Comanche and Kiowa males. The variable adjusted sitting height suggested secular trends for the Sioux males and females, Crow females, and Assiniboin, Comanche and Kiowa males. Sioux males and females as well as Crow males showed significant trends for the variable ratio. Only Crow males showed any significant change for the subischial dimension. There do seem to be common trends in heights seen for the majority of the tribes represented in the male Plains sample, with an early decline in heights through the 1830s

to the 1850s, and then a recovery in heights in the 1860s and 1870s. This pattern is also seen for the Sioux and Crow females and is reflected in an analysis of the entire sample by sex, where each of the three age adjusted variables yielded significant results for both sexes. Comparison with contemporary populations of White Americans also shows that most of these Plains Indians remained tall at the start of the traumatic reservation period.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF FIGURES (CONTINUED)

Page

CHAPTER I: INTRODUCTION

INITIAL TERMS AND CONDITIONS

Secular trends in the stature of children and adults have been observed for decades and known for over a century (Tanner 1981, 1982). Secular trends or changes in growth refer to long-term fluctuations in the pattern of growth and development in a given population, usually over successive generations. Historically, these changes in growth do not occur continuously in any one direction, but exhibit cycles of changes in growth (here mean heights), in response to shifting environmental circumstance.

As such changes in height are quite sensitive to fluctuations and variations in economic, cultural, and socio-hygienic conditions, secular trends can serve as useful indicators of the health and nutritional status of a given population (Eveleth and Tanner, 1976, 1990; van Wieringen, 1986). Indeed, this close relationship between changes in living standards and growth patterns has been used to augment and expand standard economic histories for developing western nations during the 18th and 19th centuries, and has also proved useful in deriving improved measures of living standards for these historical populations (Floud et al, 1990; Fogel 1986a, 1986b, 1994; Fogel et al, 1983; Harris, 1994; Komlos, 1987, 1994a, 1995; Steckel, 1986a, 1986b, 1987, 1995; Steegmann, 1985).

There is ample documentary and clinical evidence that has associated low economic status, poor living or sanitary conditions, numerous disease states, and above all, malnutrition, with shorter statures, delayed growth velocities, and slower maturation (Bielicki, 1986; Bogin, 1988a; Frisancho, 1978; Martorell, 1985; Osmani, 1992a; Payne 1985, 1992). Additionally, recent epidemiological studies have suggested that height, weight, and weight for height are effective predictors of the risk of morbidity and mortality (Barker et al, 1990; Costa, 1993; Fogel 1991, 1992; Gage and Zansky, 1995; Marmot et al. 1984; Waaler 1984).

Therefore, secular trends are described as being 'positive' when denoting greater growth velocity, increased adult (or child) heights, and earlier maturation; and 'negative' designating the reverse, depressed heights over time or delayed growth. Generally, an increase in heights over time (or earlier maturation) can be regarded as a favorable indicator of a population's nutritional and health status, as these changes have historically been strongly associated with better living conditions, reduced morbidity and mortality, and improved socio-economic status.

The present study of eight tribal groups of 19th century American nomadic Plains equestrian Indians is an outgrowth of a previous study which had exclusively focused on the Sioux/Dakota Indians of the Plains of the same era (Prince 1989, 1995). A wider scope was sought to consider the experience of a broader sample of equestrian Plains Indian societies, as well as to re-examine a sample of the Sioux utilizing an updated approach to examine the occurrence of secular trends or cycles of mean adult stature during the years 1800 to 1870 (Meadows Jantz et al, 1995).

It is reasonable to assume that the histories of most population groups, when examined using historical anthropometrics, will exhibit undulating changes in growth patterns in response to shifting environmental circumstances, such as changes in nutritional status, economic welfare, and morbidity and mortality (Komlos, 1994a, 1995; Malina 1979). This study will attempt to document such secular trends in an historic sample of eight Indian tribal groups that occupied much of the Great Plains of North America during the time period examined (circa 1800-1870): The Arapaho, Assiniboin, Blackfoot, Cheyenne, Comanche, Crow, Kiowa, and Sioux. Building upon previous study (Prince, 1989, 1995), it is hoped that the common ethno-historical experiences and economic/ecological situations of these Plains Indians would enable a researcher to examine whether these pan-Indian similarities led to similar patterns of secular trends between tribal groups. Any trends observed in the data (mean adult heights) will be interpreted in light of what historians and anthropologists now know about the situation of the historic nomadic bison- hunting equestrian Plains Indian tribes that are a subject of this study. A working hypothesis was constructed about the possible shape of any commonly shared secular trends exhibited by the nomadic Plains Indians during the 19th century period under study. With the probable stress engendered by increasing White settlement and attendant decline and/or retreat of game and buffalo from traditional hunting areas (Bamforth, 1987; Flores, 1991; Sherow, 1992; Wishart, 1979; Woolworth and Champe 1974)), and increased tempo of warfare and/or conflict with the government or White settlers (Prucha 1984; White, 1978), one might expect a negative secular trend for individuals born after 1850. Additionally, the coming of the reservation period (circa 1866-1876) provides a common time horizon and a shared experience of universal importance for all the equestrian Plains tribes represented in this study. Again, with the putative stress of reservation life, such as worsening living conditions, inadequate nutrition and radical changes in activity and subsistence patterns (from nomadic hunters to government dependents and/or sedentary farmers), one would expect individuals born during the reservation period to be shorter (on average) than adults born earlier in the 19th century.

The significance of this study lies in the exploration of several important questions not commonly studied or heretofore difficult to address when involving an understanding of American Indian biological variation and adaption (Jantz and Key, 1987; Jantz et al, 1992; Jantz, 1995b): 1) An examination of an unusually long span of equestrian Plains Indian history (roughly 1800 to 1870) for secular trends; 2) The ability to assess any common secular trends among the nomadic Plains tribes under study; and 3) An assessment of Plains adult height means in comparison to contemporary White standards of the 19th century.

THE BOAS DATABASE

The samples used in this study are a subset of the larger (circa 18,000 individuals) Boas North American Indian and Siberian anthropometric data set. This collection is currently being curated at the University of Tennessee, Knoxville, and represents more than 200 tribal populations found throughout the United States, Canada, and Siberia at the end of the 19th Century (Jantz et al, 1992; Jantz 1995a, 1995b). The bulk of this data set was generated as part of a vast foresighted anthropometric survey undertaken for the World's Columbian Exposition under the direction of Franz Boas during the years (1891-1892). These data represent the largest and most comprehensive North American Indian collection of anthropometric data ever assembled (Jantz, 1995a, 1995b; Jantz and Key, 1987; Jantz et al, 1992). Collectively, the samples used in this study are believed to represent the largest historical American Indian data set ever examined for secular trends.

CHAPTER II: THE GEOGRAPHICAL, ECOLOGICAL, CULTURAL AND HISTORICAL FRAMEWORK

ECOLOGICAL AND GEOGRAPHICAL CONTEXT

For our purposes here, the Great Plains as a geographic area is that region comprising the semi-arid grasslands of mid-continent, mid-latitude North America. This region is bounded by the Rocky Mountains to the west and extends east to roughly the 98th meridian south of the present Nebraska/South Dakota border, and to approximately the 100th meridian north of the Nebraska/South Dakota border (Bamforth, 1988:5). This demarcation line on the east generally follows the 20 inch rainfall line as recognized by various researchers, but remains a fairly subjective assessment that is still prone to controversy (Blouet and Luebke, 1977). West of the 98th meridian, which bisects the present day states of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma and Texas, the grasslands generally receive less than 20 inches of rainfall every year (Figure 1) (Isenberg, 1993; Webb, 1931). Above all else, it is this highly variable and persistently sparse level of precipitation, combined with high evaporation rates from seemingly ceaseless winds, that defines and unifies the Plains (Gilbert, 1980). As noted by Holder (1970:1):

> In its essentials the country is a huge, slightly tilted surface of sedimentary formations with a soil mantle of erosional debris, rising slowly in elevation until in the western stretches of the surface is some four thousand to five thousand feet above sea level [in the Rocky Mountain front range foothills].

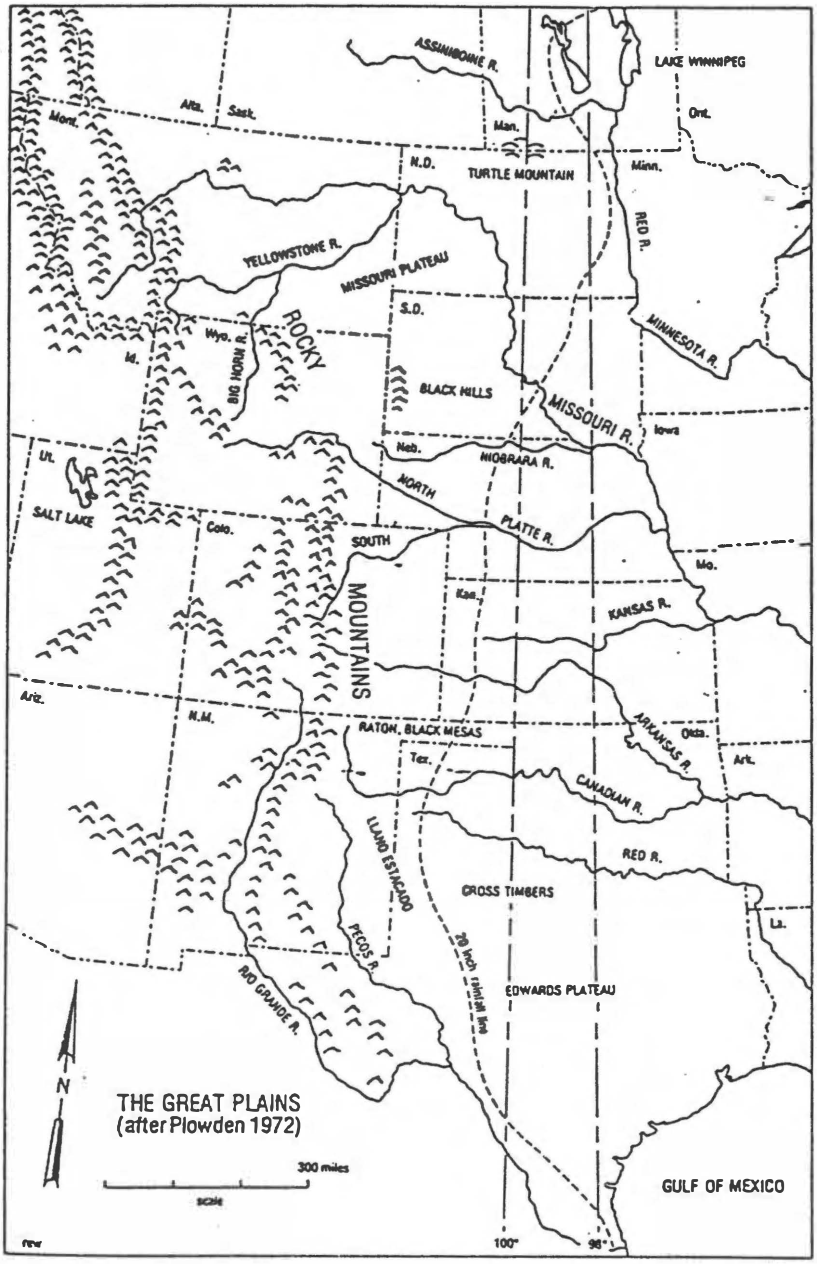

Figure 1: Map of the Great Plains

Source: Gilbert, B.M. 1980. The Plains setting. In: Anthropology on the Great Plains. W.R. Wood and M. Liberty, eds. Lincoln: University of Nebraska Press.

The northern boundary of the Great Plains extends to the southern portions of the present day Canadian prairie provinces of Manitoba, Saskatchewan and Alberta, where the grassland meets the mixed woodland of the aspen-parkland belt (Bamforth, 1988; Decker, 1991). The southern extent of the Plains extends into central Texas and the eastern portion of adjacent present day New Mexico, where the Llano Estacado plateau that these two states share lies.

Weather conditions on the Great Plains are famous for being highly variable and prone to severe temperature and climate extremes. Droughts were and are fairly frequent and rainfall can be very erratic and patchy in distribution (Bamforth, 1988; Gilbert, 1980; Isenberg, 1993; Wedel, 1977). These volatile conditions in such a semi-arid region made for a reasonably hostile and hence less desirable setting for White settlement. Whites, although transiting the Plains in great numbers during the 1840s and drawn by the 1849 California Gold Rush, did not settle in significant numbers until the 1850s (Luebke, 1977; Meinig, 1993), although the Texas and New Mexico Territories are the exceptions here (Flores, 1991; Noyes, 1993).

Precipitation across the Plains generally "...occurs as rain, falling from May to July, ranging from a mean of about 40 inches (100 centimeters) in southeastern Kansas to 14 inches (35 centimeters) in the northwestern Plains" (Gilbert, 1980:10). As noted by Bamforth (1988:56-58), climatic variability on the Great Plains can be summarized as:

> ...an east to west decrease in precipitation together with a north to south increase in temperature and thus evaporation rates to create a major northeast [to] southwest decrease in effective moisture across the Great Plains except in the Black Hills, where effective moisture increases substantially. Furthermore, this southwestward decrease is accompanied

> by a substantial increase in year to year variation in precipitation...monthly rainfall is clearly patchier in the south than in the north...As might be expected because of this, the northern Plains have much more severe winters with more snow, earlier first snows, and later last snows, more severe extreme winter conditions, and colder winter temperatures overall than do the southern Plains.

Importantly, due to higher average temperatures and wind velocity, the southern Plains region is more prone to droughts and near drought conditions, both states being "...more frequent and more prolonged than in the north" (Isenberg, 1993:35). Indeed "...variation in annual precipitation is twice as high in the Texas Panhandle as it is in North Dakota" (Bamforth, 1988:74).

Among the most common natural resources of the Great Plains were the grasses upon which vast herds of buffalo once roamed. The grassland and bison were co-evolved in adaptation to each other, and in the presence of human and animal bison predators. In the semi-arid Plains climate, they dominated the ecological community for most of the historic period examined, and indeed for some millennia previous to the 19th century (Bamforth, 1988; Barsness, 1985; Frison, 1978; Geist, 1996; Hanson, 1984; Isenberg, 1993; Wedel, 1961, 1978; Worster, 1979). Despite periodic droughts, a short growing season, low and erratic rains, and extremes of heat and cold, the hardy grasses of the Plains were able to supply sufficient forage to support an abundance of buffalo and other animals. During the historic period, the buffalo (*Bison bison*) was the largest land animal on the North American continent, and the Great Plains may have supported upwards of 28 to 30 million of these ungulates during times of optimal forage conditions (Bamforth, 1988; Flores, 1991; Isenberg, 1993; McHugh, 1972).

The predominant grass species upon which this apparent abundance rested are generally graded by size (height) with three grades identified: the eastern prairie tallgrasses growing to heights of 5 to 8 feet; intermediate ranging midgrasses growing to heights of 2 to 5 feet; and western and southwestern short grasses growing to heights of 0.5 to 1.5 feet. These common native grasses present in the historic Great Plains included: tall grasses comprising principally big bluestem (*Andropogon gerardi*) and switchgrass (*Panicum virgatum*); midgrasses including little bluestem (*Andropogon scoparius*), sideoats grama (*Bouteloua curtipendula*), western wheatgrass (*Agropyron smithii*), and needle and thread (*Stipa comata*); and short grasses including blue grama (*Bouteloua gracilis*), buffalograss (*Buchloes dactyloides*), and more southern ranging hairy grama (*bouteloua hirsuta*), black grama (*Bouteloua eriopoda*), and galleta (*Hilaria jamesii*) (Bamforth, 1988; Isenberg, 1993).

As noted by Bamforth (1988:32):

> The presence and relative abundance of these three types of grasses depend on available soil moisture, with the tall grasses dominant where moisture is most abundant and the short grasses dominant where it is least abundant.

Generally the tall grass species predominated on the eastern border and edges of the Great Plains, comprising part of the true prairie occurring from east Texas to southwest Manitoba, and grading into the mid and short grasses at about the 100th meridian to the west. From about the 98th to the 100th meridian advancing to the west, a zone of mixed mid and short grasses fluctuated with yearly variations of rainfall, grading into the more arid western High Plains steppe region dominated by the short grasses. The short grasses, representing the most well adapted grasses for the more severe semi-arid conditions created by the Rocky Mountain rain shadow, are also present in greater numbers in the more arid southernmost and western areas of the intermediate ecotone region of mixed grasses. Some researchers have also claimed that the short grasses possess a superior nutritive value for bison and other Plains herbivores, principally due to their high protein-to-carbohydrate ratio, and their ability to maintain this relatively high protein content even when dry (Bamforth, 1988; Hanson, 1984; Isenberg, 1993; Shelford, 1963; Weaver and Albertson, 1956). But as noted by Hanson (1984:104):

> There exists within and between each of these [grass] types [zones] a mosaic distribution of tall, intermediate, and short grasses in response to local ecological factors of topography, slope, drainage, soil salinity, and so on.

Critical to the support of the buffalo, overall forage production closely follows the relative level of local precipitation. Increased precipitation on local grasslands will usually increase their productivity, as measured by forage yield. Therefore even in the extreme volatility of the Great Plains environment, the resource structure does have a certain element of predictability (Bamforth, 1988). The buffalo herds probably followed a pattern of opportunistic migrations both within and between various habitats in response to the quantity and quality of locally available forage during a yearly cycle (Barsness, 1985; Hanson, 1984). Impetus for migrations might also include seasonal patterns of rain, snow, drought, and prairie fires, some deliberately set, as well as local factors of overgrazing, hunting pressures, and encroaching settlement (Bamforth, 1987, 1988; Barsness, 1985; Moodie and Ray, 1976; Shaw and Lee, 1997).

Native knowledge of the likely regional distributions of good forage and water was essential not just for the pasturing of historically large Plains Indian horse herds (Ewers, 1955; Moore, 1982; Osborn, 1983; Sherow 1992; Wedel, 1963), but for locating the buffalo herds as well (Bamforth, 1988; Carlson, 1992; Moore, 1987; Wedel, 1977). The same need and reliance in obtaining proper pasturage for horse herds also applies to the tremendous need for wood for campsites i.e. lodgepoles, firewood and the like (Moore, 1987). This led many tribal bands to repeatedly frequent favorite refugium areas on the Plains, where all essential resource elements were common and usually plentiful. For the Sioux this area was the imperially acquired Black Hills of South Dakota, where plentiful lodgepole pine, pasturage, water and buffalo could be found no matter the season (Hyde, 1956, 1967). For the Crow these central refuge places were the fiercely defended Yellowstone and Bighorn River valleys of Montana, well watered places, with a plentiful supply of ash, willow, and cottonwood trees and usually rich in buffalo (Calloway, 1986; Hoxie, 1995). These areas of usually forested refuge were largely confined to the floodplains and bottomlands adjacent to major rivers commonly referred to across the Plains as 'big timbers' (Sherow, 1992; Wedel 1963, 1977; Wells, 1965). These riparian gallery forests were historically once more widely distributed and more common than at present, and were especially crucial in providing adequate pasturage during long winter months on the Plains (Moore, 1987; Sherow, 1992). Indeed, even in the more arid and drought-prone southern Plains, historically well-known big timbers areas were available to the Kiowas (Mayhall, 1971), and the Comanches (Noyes, 1993;

Wallace and Hoebel, 1952) along the Smoky Hill (KS) and Cimarron (OK) Rivers and to the Cheyenne and the Arapaho along the Republican (NB) and Arkansas (CO, KS) Rivers (Grinnell, 1956; Trenholm, 1970). Many of the southern Plains tribes used each of these resource areas at one time or another during their nomadic seasonal rounds at different times in their history (Moore, 1987; Wedel, 1963).

In addition to the riparian gallery forests, protected areas of scarpland, ridges and cliffs sheltered scattered stands of trees from the winds and heavy snow cover throughout the high Plains uplands (Gilbert, 1980; Moore, 1987; Wells, 1965). The utility of the sheltering riparian forests were further enhanced in many cases by perennial springs or areas of sub-irrigated grasslands in valley bottoms (Moore, 1987; Wedel, 1963). As noted by Wedel (1977:5)

> Away from the streams and associated springs, surface water was available to native man only in the innumerable undrained ponds (widely termed 'buffalo wallows') scattered freely over the uplands. A notable characteristic of the High Plains, they occur by the thousands "as many as 20 per square mile in Kit Carson County Colorado (Boettcher, 1966)". Usually dry except for heavy rains, they range in size from a few tens to several thousands of yards; the larger and deeper ones may form more or less permanent ponds and lakes. These...were favorite spots for bison, attracted to their grassy margins by the lush grass, and for waterfowl, either resting or gathering for seasonal migrations.

Again as noted by Wedel (1963:5) "... throughout most of the High Plains [the most arid western Plains] there are few districts where springs, either primary or as creek bed waterholes, were more than 25 to 30 miles apart, with 10 to 15 miles probably a much likelier average". Even given the frequency of springs, streams, streambed waterholes, playa lakes and ponds, however, it is generally acknowledged that "...year round occupancy of the High Plains was impossible; and winter and dry season movements off the uplands when the bison moved out also, were undoubtedly customary" (Wedel, 1963:13). Most of the Plains tribes did indeed leave the open Plains for parts of each year, usually to visit these refuge places seasonally to secure sufficient resources (Moore, 1987). Seasonal rounds also included migrations for trade at the eastern margins of the Plains as some Sioux bands often did (Woolworth and Champe, 1974), or to trade possibly across the western margin of the Plains and into the Rocky Mountains as the Crow were documented to have done (Ewers, 1968; Wishart, 1979).

Significantly, it was this constellation of concerns over resources, in addition to trade relations and displacements due to war, that influenced local tribal band movements across the Plains (Ewers, 1955; Moore, 1987; Wedel, 1963). Additionally, the relative scarcity of either grass, wood, water or game may have indeed determined the size of residence groups (Eggan, 1966; Moore, 1987), or possible degrees of organizational and social complexity (Bamforth, 1988). Always, the trade off between the advantages of larger tribal units, i.e. in defense, warfare or for ceremonial purposes, had to be weighed against the reality that smaller bands exhausted critical, relatively scarce and widely dispersed resources at slower rates (Ewers, 1955; Moore, 1987).

Other common resources that were used by most of the Plains Indians included some typical native fauna: bison, pronghorn antelope, elk, mountain sheep, mule, and white-tailed deer as the principal game animals (Wedel, 1963). Predators such as coyote, wolf, fox, and bear were mainly hunted for furs, but the economic focus of the pre-1830s

Euro-American fur trade was the beaver, muskrat, and to a lesser extent otters, hares, mink, weasels, and raccoon (Bolus, 1972; Wishart, 1979). Indian provisionment of buffalo, pemmican, and other game for meat to these Euro-American traders was also important, and critical to the success of many trading enterprises and companies in the trans-Missouri West (Butzer, 1990; Gullason, 1994; Klein, 1983, 1992; Ray, 1974, 1988; Secoy, 1953). After the 1830s, the Euro-American fur trade with the Plains Indians increasingly focused on the buffalo robe and hide trade (Burlingame, 1929; Swagerty, 1988; Wishart, 1979). Domesticated dogs were also eaten by many Plains equestrians and were considered a delicacy, or used when little else could be had (Branch, 1962; Ewers, 1955, 1968; Gussow, 1974; Snyder, 1988).

A wide variety of plant resources was used by the Plains tribes (Carlson and Jones, 1940; Gilmore, 1919; Hellson and Gadd, 1974; Kaye and Moodie, 1978; Kindscher, 1992). Most notable among these were the timpsina or prairie turnip, wild artichokes, wild onions, choke cherries, gooseberries, buffalo berries, elderberries, wild plums, sand cherries, ground beans, sunflowers, bush morning glory, prickly pears, and nuts of all sorts (Wedel, 1978). Additionally, the inner bark of cottonwood trees was occasionally used by some tribes to feed hungry horses during severe winters (Ewers, 1955; Moore, 1987; Sherow, 1992), and the Sioux were known to use the sap from the soft maple and box elder for sugar (Hassrick, 1964).

Important cultigens like maize, beans, squash, tobacco, and sunflowers were available to the Plains nomads through a long established intertribal trade with the more sedentary horticultural communities of the Plains villagers (Lehmer, 1971; Wood, 1974). These long entrenched trade networks are well documented as existing for at least a hundred years prior to the Lewis and Clark expedition of 1804-1806 (Ewers, 1968). Indeed this critical inter-tribal trade with the earth-lodge riverine settlements of the Plains villagers, principally of the middle Missouri (the Mandan, Hidatsa, and Arikara), predates the acquisition of horses on the Plains to a protohistoric period when pedestrian buffalo hunters were the only true nomads on the Plains, using dogs as their only beasts of burden (Ewers, 1955, 1968; Hyde, 1959; Swagerty, 1988; Wedel, 1961, 1978; Wood, 1980). On the southern Plains, the Comanche and Kiowa traded with the semi-sedentary village farmers of the southeastern Plains/prairie border; the Pawnee, Wichita, Kansa, and Osage, as well as with colonial Spanish settlements and the Navajo and Pueblo people to the southwest (Brooks, 1992; Flores, 1991). The most important focus of this long-lived and widespread system of trade was the mutual barter of foodstuffs. The nomadic tribes coming to the trading centers on the Missouri and elsewhere were eager to trade the villagers for their surplus corn (cooked or raw), and other crops in exchange for dried meat, robes, leggings, furs, hides and prairie turnip flour (Albers, 1992; Driver, 1969; Ewers, 1968; Holder, 1970; Klein, 1983). Historically, these same villagers as well as Spanish (Mexican) and American frontier settlements were also the target of much of the infamous raiding for which the Plains equestrians were justly known. What might not be obtained by legitimate barter on one day might be taken by force at a later date (Ewers, 1955, 1968, 1975; Fowler, 1996; Holder, 1970; Hyde, 1967; Noyes, 1993).

Early in the historic period, the Plains villager tribes played an important role in the dissemination of much desired European trade goods to the equestrian Plains tribes. This was the case because as semi-sedentary riverine horticulturalists they were among the first tribes to be contacted on a repeated basis by European and American explorers and traders moving westward out of the Missouri Valley trench area (Holder, 1970; Jablow, 1950; Secoy, 1953; Wood, 1980). Here and elsewhere the most important commodities traded were guns, ammunition, horses, and metal tools and implements. These same tribes were also critical in supplying traders with horticultural foodstuffs (Moodie, 1980; Wishart, 1979).

CULTURE HISTORY: A BRIEF COLLECTIVE OUTLINE

The following section is meant as a brief introduction to the most common cultural elements shared by the majority of the historic nomadic equestrian Plains tribes studied here, with an emphasis on the subsistence economy.

The culture of the fabled equestrian nomads of the Great Plains was not only relatively short-lived, developing rapidly with the acquisition of the horse (circa 1760 to 1790 for a late Plains diffusion date), and flourishing for perhaps only 100 years, but was also an historically late development (Calloway, 1982; Eggan, 1966; Ewers, 1955; Holder, 1970; Oliver, 1962). The history of the mounted hunting tribes of the Plains is also one of change and transition, and is marked by frequent tribal migrations and displacements during most of the historical period before the coming of reservations (pre-

1865) (Fowler, 1996; Haines, 1976; Isenberg, 1993). By about 1600, the Arapaho, Assiniboin, Blackfeet, Cheyenne, Comanche, Kiowa and Sioux were all dwelling on the fringes of the Plains. The Comanche and Kiowa were to be found inhabiting the Great Basin area and the Rocky Mountains to the northwest. Historians consider both tribes to be among the earliest migrants onto the Plains, and hence possessing the longest association with a bison-hunting lifestyle (Flores, 1991). The Arapaho, Assiniboin, Blackfeet, Cheyenne and Sioux occupied the woodland-prairie border to the north and east. The Cheyenne and Sioux for example, had ancestral homes in the region near the western margin of the Great Lakes and the Mississippi River valley in present day Minnesota (Fowler, 1996; Haines, 1976; Isenberg, 1993). The Crow did not exist as a separate definable entity from the Hidatsa tribe of village horticulturists until about 1700 (Hanson, 1986; Wood and Downer, 1977).

As noted previously, a nomadic pedestrian big game hunting tradition existed on the Great Plains some ten millennia before the rise of the classical equestrian Plains societies after 1700-1750 (Blakeslee, 1992; Frison, 1978; Hyde, 1959; Wedel, 1961). The historical predecessors of the Plains village horticulturists occupied the eastern Plains, principally in and around the Missouri Valley trench area, since about 900 A.D. (Lehmer, 1971; Wedel, 1978; Willey, 1966). From this we can safely surmise that a diversity of cultures have occupied the Plains for over 10,000 years, and no one cultural or economic pattern can be said to describe the entire diversity seen. Indeed, as Gilbert (1980:5) reminds us:

> Thirty-three languages of six major linguistic families were spoken [on the historic Plains], and other sharp differences existed from tribe to tribe in kinship organization, religion, and political development, including law.

As noted by Hurt (1974:18) this was also true even within some Plains nomadic tribes:

> No single village or economical pattern has characterized all the Dakota Sioux since the time of European contact. In addition, that of a single tribe [band] also varied through time. This variation resulted from the many different ecological zones inhabited by the Sioux in their homeland in the headwaters of the Mississippi, and was compounded by the migrations of many of the Sioux tribes into the northern Plains at a later date.

The popular and familiar image of the historic Plains nomadic equestrians as bison hunting, tipi-dwelling, and feathered headdress wearing warriors owes its existence not only to the extensive documentation of these tribes, but also to the very fact of their storied fierce interactions with Euro-American settlers and government troops. These conflicts occurred at a time when new types of mass distribution of news events were gaining prominence (not the least of which was the telegraph), making it possible for some Plains (Sioux) chiefs to become household names. That contemporaries knew of Sitting Bull and Red Cloud, where the same could not be said of important earlier chiefs like Tecumseh or Pontiac, proves the effectiveness of such 'publicity' (Liberty and Wood, 1980). Subsequently, the lives and dogged resistance of the Plains equestrian tribes became the grist of many romanticized portrayals in early Wild West shows, dime novels and more recently films and television, to such an extent that they now perform as a stereotype for all American Indians, and indeed for 'Indianness' itself for both Indians and Whites (Ewers, 1968; Liberty and Wood, 1980; Moses, 1996).

Because the cultures of the Plains Indians were among the last to be devastated by the westward advancement of encroaching White settlements, they were and are particularly well documented with a significant body of historical, ethnographic, ethno-historic, and archaeological research and record (Bamforth, 1988). It is not my intention here to recapitulate or review this vast body of literature, although fine recent or synthetic treatments can be found (Bamforth, 1988; Campbell, 1989a; Ewers, 1955, 1961, 1967, 1968, 1972, 1975; Fowler, 1996; Holder, 1970; Haines, 1976; Hyde, 1959, 1967; Isenberg 1992, 1993; Lamar and Truett, 1996; Moore, 1987; Owsley and Jantz, 1992; Prucha, 1984; Thornton, 1987; Wedel, 1961; Weist and Sharrock, 1985; White, 1978; Wood, 1986; Wood and Liberty, 1980).

The Great Plains as a culture area has a long and distinguished history in American anthropology (Driver, 1969; Lowie, 1954a, 1954b; Kroeber, 1939; Lehmer, 1971; Scaglion, 1980; Wedel, 1940, 1961, 1977; Wissler, 1912; Wood and Liberty, 1980). Culture areas can be defined operationally as geographical territories, usually contiguous, where certain characteristic culture patterns are discernible "...through repeated associations of specific traits, and usually through one or more modes of subsistence that are related to the particular environment" (Ehrich and Henderson, 1968:563). The culture area concept has been problematic (Howard, 1975; Secoy, 1953), but is still employed as a useful heuristic and organizational device in anthropology and elsewhere (Jantz et al, 1992; Ross and Moore, 1987; Sturtevant, 1978; Waldman, 1985; Young, 1994). This function of grouping similar cultures into geographical areas is essentially fairly static, lacking chronological considerations, having as its genesis a curatorial catalog of primarily material culture and modes of subsistence for museums early in this century (Scaglion, 1980; Winick, 1970). It is not my aim to explore just how such classifications are constructed (Driver, 1969; Needham, 1980), but to note their reasonable, if circumscribed utility.

Using data from Murdock's (1967) ethnographic atlas for comparison purposes, Driver and colleagues (1972, 1975) were among the first to apply a statistical classification to elements of American Indian cultures. This method combines the elements of classical culture area approaches with the non-intuitive formal cross-cultural system created by Murdock (Scaglion, 1980). These investigations have shown that there is much internal consistency between various configurations of the classifications for tribes included within nomadic equestrian Plains 'culture' samples. These tribes combined result in a phi of around 0.68 in Driver and Coffin's (1975) analysis (Scaglion, 1980).[1] Still, even in statistical analyses, the Plains geographic area is a region of extreme diversity, due in part to the long-standing cultural differences represented by the more established Plains villager tradition occupying the eastern Plains. To a great degree the usefulness of the culture area concept relies upon identifying a specific time depth to be examined, a particular analytical framework, and a problem to be addressed, which

[1] A Phi coefficient is equivalent to a Pearson's correlation coefficient (Voght, 1993).

will dictate which elements are to be included and how boundaries might be drawn, so that fruitful comparisons can be made (Scaglion, 1980).

THE PLAINS NOMADIC EQUESTRIAN LIFEWAY, CIRCA 1800-1870

The primary hallmarks of the Plains equestrian lifeway were the heavy reliance on buffalo as a principal subsistence resource, the loss of horticulture and pottery, and the adoption of the horse (Oliver, 1962). Although this buffalo economy was not fully organized until after the migrating tribes came to occupy the Plains sometime after 1700, it seems to have been firmly established by about 1790 (Fowler, 1996; Haines, 1976; Hurt, 1974; Hyde, 1959). The level of dependence upon this single critical resource for food, tools, clothing, shelter and trade is indeed difficult to underestimate (Albers, 1992; Barsness, 1985; Ewers, 1955; Isenberg, 1993; Klein, 1983, 1992; Roe, 1970). A measure of the dependence upon hunting for subsistence (Murdock, 1967) roughly tracks the deep commitment most of the nomadic Plains bison hunting tribes had to the products of the chase. By Murdock's measure (1967:46-47), all of the tribes studied here can be historically described as at least 66% to 85% dependent on hunting as their primary subsistence mode. The Comanche and the Teton Sioux were scored at higher levels, 86% or more. The tribes that truly constitute the Plains equestrian lifeway contrast distinctly with the semi-sedentary Plains villagers, who depended on hunting for generally less than 50% of their subsistence. It should be noted, however, that the Plains villagers did in fact hunt buffalo, primarily in the winter and summer, as well as other game year-round (Drass and Flynn, 1990; Ewers, 1955, 1961, 1968; Tuross and Fogel, 1992).

For the Plains nomads, the buffalo provided for virtually all their needs. Buffalo robes were used as garments, bedding, and for trade; tanned hides served in the construction of food and storage containers, shields, saddles, moccasins, mittens, leggings, shirts, lariats, bridles, rope, and the tipi (the main type of dwelling used by all Plains equestrian tribes in all seasons). Dung or chips were used as fuel. Bones and horns were made into implements for hide processing, bows and arrowpoints, drinking cups, spoons, and other tools as well as glue. The sinews furnished thread and bow strings as well (Barsness, 1985; Branch, 1962; Driver, 1969; Ewers, 1955, 1967; Hassrick, 1964; McHugh, 1972; Roe, 1970). In trade, buffalo robes, hides, or meat could be traded for horses, guns, ammunition, metal tools (axes and knives), household utensils, ornaments, trade cloth, pottery and crops (Ewers, 1955; 1968). It was the role of the Indian as a producer of furs and hides and as a consumer of indispensable and non-reproducible European trade items like firearms and ammunition that would ultimately disrupt and reorient all native modes of life on the Plains during the 19th century (Holder, 1970; Isenberg, 1992; Jablow, 1950; Klein, 1992).

Most Plains equestrian tribes had a particular way of preparing dried buffalo meat that is still familiar to many today. Pemmican, a mixture of dried, pounded and pulverized meat often mixed with wild berries, cherries, or plums, also dried and pounded well, pits and all, was combined with hot animal fat (often laid down in layers), and was stored in tightly wrapped hide bags called 'parfleches'. These parfleches filled with pemmican were usually the size of pillowcases, and commonly weighed about 90 to 100 pounds each when finished. When the bags were filled with the hot mixture, each bag was then tramped flat so as to remove as much excess air as possible, then the seams were sealed shut by pouring hot tallow fat along them. Thus a highly portable parcel of pemmican, now six or seven inches thick, could resist spoilage for years and could be readily stored like cordwood (Barsness, 1985; Branch, 1962; McHugh, 1972). This common Plains storage technique of surplus buffalo meat was critical in extending the usefulness and storage capacity of such foodstuffs, proving especially important as a buffer during periods of shortage (Minnis, 1985). Indian pemmican was also recognized, utilized, and sought after by Euro-American traders and settlers for its unique, long-lasting and compact storage capacity (Halstead and O'Shea, 1989; Roe, 1970). Some researchers have even suggested that 'pemmicanization' was a superior preservation technique to canning in terms of a reduced likelihood of spoilage, compactness, and ease of storage and transport (McHugh, 1972). In general, the buffalo meat, fat and blood that was not immediately consumed or stewed was either dried, smoked, or made into pemmican for later use (Barsness, 1985; Ewers, 1967; Lowie, 1954b; McHugh, 1972; Nurge, 1970; Seerley, 1965).

Buffalo hunting nearly always had some communal aspect attached to it. Descriptions of actual buffalo drives do exist for the pre-equestrian and historic period, when communal efforts were directed towards running herds of bison into corrals or impoundments, over cliffs, or into dune traps (Arthur, 1975; Bamforth, 1987; Barsness, 1985; Crow, 1978; Ewers, 1955,1968; Grinnell, 1908; Jenness, 1977; Lowie, 1954a; McHugh, 1972; Roe, 1970; Schaeffer, 1978). In this manner dozens and indeed whole herds of hundreds of buffalo were able to be taken at one time (Ewers, 1961; Henry and Thompson, 1965; Lewis and Clark, 1904-05; Wissler, 1910). These ethno-historic accounts have been amply augmented by a wide range of archaeological research that documents similar pedestrian methods being used to obtain giant extinct bison variants (commonly *Bison antiquus* or *Bison occidentalis*) during the Paleo-Indian period (10,000-5,500 B.C.) (Frison, 1974, 1978; Hester, 1972; Wedel, 1978; Wheat, 1972), as well as for the late prehistoric, protohistoric, and historic periods (1500-1800 A.D.) Bison hunters (Reher and Frison, 1980; Speth, 1983).

With the acquisition of the horse and firearms after 1700 to 1750, hunting increasingly became a more individualistic pursuit for most of the Plains tribes (Klein, 1983, 1992). Traditional buffalo drives became less common, and cooperative drives were retained as a regular hunting feature largely by those relatively horse poor tribes that also retained the dog travois, here the Assiniboin are often cited (Ewers, 1955, 1961, 1968). The late historic period (circa 1800 to 1860) use of buffalo drives has been suggested for the Crow (Crow, 1978), and is reasonably well documented for the Blackfeet as well (Ewers, 1955, 1968; Schaeffer, 1978), so it is certain that the practice continued in some form well into the equestrian period. Still, after horses were adopted by the Plains tribes, the predominant method to hunt the buffalo became the horse surround or pursuit by groups of mounted hunters (Bamforth, 1987; Hanson, 1986; Klein, 1983; Roe, 1970).

To protect the status and viability of the buffalo hunt, most Plains tribes employed soldier or police societies. These were active primarily during large communal hunting efforts, principally during the summer. Police society leaders were to regulate the hunt, preventing any one or small groups of individuals from driving away or scattering the herds before a coordinated attack might be made more successfully. Soldier societies functioned in much the same manner, with leaders concerned primarily about the ultimate success of raids or counter raids on an enemy. Commonly it was the members of the soldier society that largely comprised the leadership of the police society (Eggan, 1966; Mails, 1985; Oliver, 1962).

As necessitated by their nomadic habits, the social organization of the Plains equestrians was noted to be quite flexible and fluid. As Eggan (1966:53) reminds us:

> ...[typically] tribes of the High Plains were divided into a number of bands, which camped and hunted independently for much of the year. These bands varied in size but were relatively large and often centered on a core of siblings and close relatives of the leader or chief, but anyone was free to join, whether related or not. The typical band might range in size from 150 to 50 persons but would increase or decrease according to the fortunes of warfare and hunting--hence leadership counted for a good deal.

It was this marked social flexibility that allowed the Plains equestrians to quickly adapt to changing circumstances by meeting these challenges of varying ecological and military conditions by either breaking up or recombining social units. Typically most Plains tribes spent the winter, late fall, and early spring hunting in bands or small collections of related bands. They commonly converged for summer communal hunts and important ceremonial occasions, such as the annual Sun Dance, where most if not all tribal segments were represented (Biolsi, 1984; Eggan, 1966; Moore, 1987; Oliver, 1962).

The adoption of the horse and the maintenance of large herds were other hallmarks of the Plains equestrian lifeway. It is probable that most of the Plains tribes acquired their first horses in trade or as gifts from southern Plains tribes, the Comanche and Kiowa, who in turn had obtained their first steeds from the southwestern Spanish colonial settlements or their Pueblo allies. Other routes of transmission of the crucial knowledge, culture, and practice of the care, feeding, and training of horses came from the semi-sedentary Plains riverine tribes such as the Mandans and Arikaras. The Cheyenne and Arapaho tribes played important roles as trade middlemen in this and other trade. In general, horses diffused northeastwards through the Plains, as firearms and ammunition moved southwestwards from British and French traders in the north. The latter trade was important because 18th century Spanish policy prohibited the trading of firearms, shot and powder to Indians (Ewers, 1955; Haines, 1976; Holder, 1970; Noyes, 1993; Roe, 1955; Schilz and Worcester, 1987). The importance of both these critical trade items was central to the horse culture complex of the Plains nomads, as noted by Ewers (1955:13): "Any tribe possessing either without the other was at a distinct disadvantage in opposition to an enemy owning both".

The presence of the horse on the historic Plains led to an intensification of warfare, raiding, and trading between various tribes on the Plains that largely predated Indian and Euro-American conflicts (Ewers, 1955, 1975; Secoy, 1953; White, 1978). The horse also made possible a more efficient exploitation of the buffalo resource (Klein, 1983; Hanson, 1986; Mishkin, 1940). These factors were integrated into the economic base that made the horse culture of the Plains equestrian tribes a successful if fragile cultural adaptation in the late 18th to mid to late 19th centuries (Isenberg, 1993; Klein, 1983, 1992; O'Shea and Halstead, 1989; Roe, 1955).

As Hanson notes (1986:96):

> As a new form of energy, the use of horses allowed a greater amount of work to be done in a shorter period of time. This was especially true from the standpoints of transport efficiency and weight-carrying capacity. Horses were vastly superior to pre-contact techniques of dog transport or human porters...horses could carry about five times as much as a dog (and roughly four times as much as a human) and in much less time.

Ewers (1955) suggest a lower ratio of about 3:1 for the comparative advantage of the horse over the dog when using a travois for transport. The horse travois, modeled after the dog travois that preceded it, consisted of two stout poles of lodgepole pine tied or yoked to the back of a horse, forming a crude A-frame, and extending to the rear of the horse to drag on the ground. A loading platform of two transverse primary struts formed a ladder type 'saddle' upon which household items were placed and secured. Ewers (1955) estimated that a maximum load for the average Indian pony dragging a travois was about 300 pounds.

The mobility and striking speed of good Indian 'buffalo runner' ponies permitted groups of mounted hunters to pursue the buffalo herds more effectively; to vastly increase the search radius, and to pursue and chase buffalo for longer distances. Stouter horses could also generally transport larger carcasses over longer distances (Ewers, 1955; Hanson, 1986; Osborn, 1983). The swift and highly trained specialized horses also allowed for much more devastating shock raids or charges upon an enemy, and enabled raiding parties to range over hundreds of miles in search of plunder, especially for more horses (Calloway, 1982; Ewers, 1955, 1967, 1975; McGinnis, 1980, 1990; Mishkin, 1940; Newcomb, 1950; Secoy, 1953, Smith, 1985; White, 1978).

As important as horses were in reducing the uncertainties of hunting buffalo, and for increasing transport efficiency; horses were a highly desirable commodity for trade, and soon became both a means of access to wealth (surplus hides for trade) and a Plains-wide measure of wealth themselves. The horse quickly became a measure of status and prestige. Wealthy families sought to obtain sufficient numbers of horses to transport larger tipis to accommodate increasing amounts of household goods obtained from Euro-American traders, for presentation as gifts or for bridewealth, and of course, to better hunt the buffalo. Possession of too few horses not only diminished a family's social status, but made it more difficult for a hunter to obtain proper provisionment, as well as limiting tipi size and the amount of goods that could be transported comfortably. Additionally, families not possessing any or lacking swift horses were dependent on other members of the tribe to 'lend' them horses for hunting and for camp movements; and failing this they depended on far fewer horses and used the dog travois to a greater degree. In such a manner it is postulated that increased private horse wealth led to expanded wealth and status inequalities within Plains societies (Biolsi, 1984; Ewers, 1955; Fowler, 1996; Hanson, 1986; Holder, 1970; Klein, 1983, 1992).

Estimates given for an average or 'minimum' number of horses necessary for a family, or to move an average tipi and family goods varies. Larger herds and higher numbers of horses per person were more common among the Comanche and Kiowa, and to a lesser extent for the Cheyenne and Arapaho (Ewers, 1955). Ewers (1955) noted that wealthy or large families might possess as many as 15 to 20 horses, while five to eight were considered the more typical spread from minimum to adequate, with twelve horses seen as the ideal. Moore (1982, 1987) generally agrees with this average spread from minimum to adequate, with three to six horses being considered as the minimum necessary to adequate number, and notes that a Cheyenne stock census of 1878 shows an average of 3.8 horses per 'lodge' or tipi. Additionally, he points to Cheyenne settlement claims from horses captured by the United States government after the Sand Creek massacre (1864), showing an average of 5.4 horses per family (Moore, 1987:170-171). Ewers (1955:24-27) also presents data showing the comparative difference between the number of horses possessed by the relatively horse-poor semi-sedentary riverine tribes, with generally only one horse per four to five people, versus the more typical 1:1 average for most of the Plains equestrian tribes. Moore (1982,1987) and Holder (1970) both considered a minimum of three horses per family as a sort of take off point necessary to attempt a nomadic equestrian existence. As noted by Taylor (1989), however, Plains lodge counts and the number of individuals recorded per lodge in ethno-historic and ethnographic accounts are variable through time and are dependent upon the overall tribal population trends generally.

Sustaining and maintaining the horse herds thus became an overriding concern for Plains equestrians (Ewers, 1955; Moore, 1982, 1987; Osborn, 1983; Sherow, 1992). The ability to expand and defend tribal territory also depended upon the collection and increased circulation of this horse wealth. This in turn was further incentive to raid an enemy; and obtain still more horses. Hence the horse raid became the most frequent and by far the most deadly military action on the Plains during the equestrian period (Biolsi, 1984; Ewers, 1955, 1975; Klein, 1992). Horse raiding became a substantial component of the Plains equestrian economy and intensified as the Plains nomads became increasingly enmeshed into the global scale of the Euro-American market and trade system. The principal cause for this development was probably the critical and revolutionary role the horse played in enabling these tribes to efficiently and reliably produce surplus pelts and hides for the trading market. Also highly significant was the Indians' increasing dependence upon this larger market to provide needed and/or desired trade items: crude iron for more efficient arrowheads and lanceheads, guns and ammunition, beads and ornaments, trade cloth, kettles for cooking, axes, knives, needles, awls, scissors, and other more durable metal tools and utensils, as well as alcohol and tobacco. As many researchers have also noted, mutual hostility certainly did not preclude productive trading relationships, and trading truces were often called to further facilitate such markets (Albers, 1992; Ewers, 1955, 1968, 1972; Jablow, 1950; Klein, 1983, 1992; Mishkin, 1940; Peterson and Anfinson, 1984; Pickering, 1994; Wood, 1980; Wood and Thiessen, 1985). As Wood (1980:106) reminds us, markets and especially intertribal trading fairs served many purposes besides the exchange of goods:

> In addition to staples of the trade, most anything could (and apparently did) exchange hands at trading fairs: tools, trinkets, folk tales, songs, and dances, as well as brides. The dances and other forms of social intercourse led to active sexual recruitment, which further contributed to gene flow along lines of trade. Gambling at trading fairs was rampant and provided an avenue of exchange for many goods other than those brought for the express purpose of trade...the flow of goods and ideas--not to mention of persons and disease organisms--from one area to another was a simple matter and...often exceedingly rapid.

A significant factor for Euro-American and Indian fur trade, especially early on, was the incorporation of White traders within the kinship network of Indian society as fur traders took native women as wives. This widespread practice not only facilitated better trading relationships with a broad cross section of native societies, but also aided in the necessary job of translating for the welter of different languages likely to be encountered on the Plains. The vital and necessary role these native wives and their metis offspring played as economic and cultural brokers was a pattern that was repeated time and again across the Plains. Accounts of important or prominent traders such as Bent, Culbertson, Denig, Lisa, McKenzie, Renville, Schultz, among others, certainly reveals this, and the essential role intermarriage played in the success of the trading enterprise by maintaining influence through affinal alliances within a certain public sphere of particular tribes.

Indeed, as the model of trade most familiar to the Plains tribes was one of reciprocal balanced exchange, Euro-American traders could also profit by being adopted as fictive or symbolic kin by the particular tribe with which they commonly traded. These or other social bonds had to be forged in order that trade with these tribes could proceed. This then is the genesis of the common practice of gift exchanges of food, tobacco, rum or other items with the Indians before any real trading began. Stable, peaceable, and dependable trading relations on both sides were the hoped for result (Albers, 1992; Anderson, 1984; Anderson, 1972; Brown, 1994; Buechler, 1989; Comer, 1996; DeMallie, 1994; Ewers, 1961, 1968, 1972; Fowler, 1996; Klein, 1992; Peterson and Anfinson, 1984; Pickering, 1994; Ray, 1974; Whelan, 1993; Wozniak, 1978).

Significant also was the common practice of taking captives, usually women and children, as war booty by most of the equestrian Plains tribes. Typically such captives were members of other Plains tribes, but American settlers and Mexicans were also frequently taken in raids. These captives may have come to play an important role in repopulating tribes devastated after periods of epidemic disease or a long series of intertribal wars. Again, many were incorporated within families by adoption or marriage, rather than being killed or remaining enslaved, and could provide needed extra labor to process surplus hides for the burgeoning requirements of the fur trade. Early in the historic period some of the younger captives could also become valuable commodities in the intertribal trade, a practice that many European traders also participated in (Albers, 1992; Ewers, 1994; Fehrenbach, 1974; Jablow, 1950; Klein, 1983, 1992; McGinnis, 1990; Noyes, 1993; Secoy, 1953; Walker, 1982).

As trade with Euro-Americans increased with the rise of various incarnations of the fur trade, the long-established intertribal trade declined. By 1840, the familiar trading haunts of yore, famous for Indian trading fairs, were neglected as traders came to occupy more permanent posts on the Plains. Access to these traders was a much sought after commodity to be jealously guarded and at times politically and militarily manipulated to the detriment of one's enemies. This was a common pattern, as access to trade meant access to horses and more importantly, guns. Traders not only supplied shot and powder, but also repair works for guns. As guns were an essential tool for defending one's tribe and self that usually could not be serviced other than by the supplier--the trader, the web of interdependent trade grew more inevitable (Albers, 1992; Burlingame, 1929; Ewers, 1955, 1968; Klein, 1992; Newcomb, 1950; Jablow, 1950; Secoy, 1953; Swagerty, 1988; Wishart, 1979; Wood, 1980).

Access to the fur trade and the market items it provided not only led to intertribal conflict over fur areas and hunting territory, but it was also probably a significant cause for major migrations on the Plains. The inducement of trade and such intertribal conflict over resource areas are cited as factors in the migrations of the Sioux (Anderson, 1980; Holzkamm, 1983), the Cheyenne and Arapaho (Flores, 1991; Jablow, 1953; Moore, 1987; Trenholm, 1970), as well as the Assiniboin (Ray, 1974, 1988), among the most notable examples.

The famed war complex of the Plains equestrians was probably fueled not only by a constellation of economic motives revolving around subsistence and resource procurement (Albers, 1992; Biolsi, 1984; Calloway, 1982; Jablow, 1950; Kardulias, 1990; Lewis, 1942; Mishkin, 1940; Newcomb, 1950; Oliver, 1962, Secoy, 1953; White, 1978), but also by the desire for personal enrichment, the culturally required demands for revenge, for proof of courage in battle to attain status and prestige, and for the purpose of primary socialization (Callaway, 1978; Ewers, 1967, 1975; Forbes, 1972; Grinnell, 1910; Hassrick, 1964; Hyde, 1967; Klein, 1983; McGinnis, 1980, 1990; Powell, 1981; Smith, 1938; Walker, 1982). As important and integral as intertribal warfare was for these Plains tribes, it should be remembered that most of these storied conflicts can easily be classified as 'low intensity' warfare. Most skirmishes involved small unit raids for the purposes of securing horses to feed the incessant demand for the animals that could only be fully satisfied by trade or theft (Ewers, 1955, 1967). The development of this recent nexus of the collective pursuit of trade, expanded hunting territory, and raiding for horses, guns and other plunder not withstanding, a foundation for this fabled endemic type of Plains warfare may be seen at least as far back as the pre-contact, pre-horse Woodland and Plains Village traditions of 1,000 years to 2,000 years ago, according to archaeologically derived skeletal samples (Blakeslee, 1994; O'Shea and Shipman, 1994; Owsley, 1994; Willey, 1990; Williams, 1994). As Robarchek notes (1994:312):

> The archaeological record clearly shows that this violence...was an identifiable and persistent tradition, a culture complex involving the importance of raiding, scalps, and other physical trophies, and, by implication, probably the perduring motives of prestige and revenge, motives whose importance has been clearly documented for the historic

> period. This was in short a regional cultural institution, a complex of values, ideas and behaviors that persisted for at least two thousand years.

Large-scale engagements between opposing tribal forces, while less frequent than small-scale raids, could be more devastating in a much shorter time. These actions could be precipitated by a chance meeting between two opposing factions, deliberate ambush, large-scale ceremonial or revenge raids, or as part of an ongoing concerted campaign of imperial expansion. The Sioux in particular are known for their westward expansion across the Plains, displacing many resident tribes in their wake, and threatening the livelihood and existence of others by usurping traditionally held hunting grounds (Biolsi, 1984; Ewers, 1975; Forbes, 1972; Holder, 1970; Hyde, 1967; McGinnis, 1990; Keeley, 1996; White, 1978). As noted by Calloway (1982:26), however, this fluid and dynamic situation was a common phenomenon on the Plains throughout recorded history, resulting in "...a confusion of migrations, wars, conquests, assimilation's, disruptions, transitions, and transformations among the peoples of the Plains". Where the Sioux were the dominant expansionary power on the northern Plains during most of the 19th century, the Blackfeet had been the scourge of the northwest during the 18th century and much of the 19th, and the Comanche enjoyed supremacy on the southern Plains earlier still during the late 17th and 18th centuries (Biolsi, 1984; Ewers, 1967; Haines, 1976; Hyde, 1959; McGinnis, 1990; Noyes, 1993; Secoy, 1953).

Although this type of warfare was no doubt a result of complex cultural and particular historical circumstances (Calloway, 1997; Keeley, 1996; O'Connell, 1995), the major impetus for action can also be seen in the individual motives of "cutting horses, counting coups, and performing other feats of daring [that] comprised the only way a man could gain importance in tribal society" (McGinnis, 1990: 213). War honors and the glory and respect gained from them were the only ways to obtain leadership roles within a warrior/soldier society or later as a chief, that were commonly acknowledged across most Plains equestrian tribes (Oliver, 1962). In some societies, however, by mid 19th century an enterprising young lad might acquire these honors by purchasing them outright (Isenberg, 1993).

Most researchers agree that war was not only a way of life for these Plains tribes, but also a matter of ongoing survival. Warfare did come to threaten the very existence of the more sedentary Missouri River Plains village tribes, principally due to the Sioux expansion during the early 19th century (Hyde, 1967; White, 1978). As hard pressed as some of the Plains equestrian tribes were by repeated raids from larger, stronger tribes, e.g. the Crow versus Blackfeet and Sioux (Calloway, 1986; Hoxie, 1995), some researchers have argued that few faced the prospect of total destruction from such tribal warfare. As noted by McGinnis (1990:214):

> In reality, while the war parties of the Sioux and the Blackfeet before them were numerous, the methods of fighting defied any consistent success or the destruction of another tribe, although over the years there was a definite drain in the forces of most small tribes, the sedentary ones in particular. The system of warfare placed utmost emphasis upon not losing men who provided food for their societies. In battle, individual feats were of key importance, overriding the success of the group as whole.

Other researchers, however, have noted the tremendous toll such chronic warfare could exact on small tribal populations (Ewers, 1955, 1967, 1975; Keeley, 1996). While estimates are hard to obtain, Keeley (1996) notes that typically such intertribal warfare on the Plains might account for annual warfare death rates of about 0.5%. The Blackfeet during this historic period are estimated to have lost 1.0% per year over a number of years due to warfare (Ewers, 1955), with typical Plains equestrians making four or more offensive raids per year. This coincided with the experience of other tribal societies around the world, where the casualty rates due to the high frequency of raids common in chronic low intensity warfare can quickly accumulate to make a significant impact on smaller tribal populations after only a few years (Keeley, 1996).

These very same methods, consisting largely of small-scale raids, ambushes, and strike and retreat harassment tactics (Calloway, 1997; Malone, 1993), were also used by the Plains nomadic tribes to engage the forces of the United States Army (and to a lesser extent various territorial militias), increasingly after about 1850 throughout the Plains. These tried and true methods of tribal warfare proved to be reasonably successful until the economic basis of the Plains equestrian societies was undermined by the disappearance of the buffalo with encroaching White settlement and increased hunting. Also, the Army by about 1870 began slowly and informally readopting some of these same unorthodox, more mobile, small group, guerrilla-like ambush tactics that similarly focused on disrupting the economic infrastructure of the Plains nomadic tribes (destroying or capturing horses, foodstocks, and tipis). The Army also became more successful at pursuit as they employed larger numbers of Indian scouts, often from rival tribes (Calloway, 1997; Ewers, 1967; Keeley, 1996; Lamar and Turett, 1996; McGinnis, 1980, 1990; Utley, 1973, 1984, 1988; Wooster, 1988). Finally, as noted by Keeley (1996: 75), "...by exploiting their logistic superiority, civilized soldiers could continue harrying and abrading primitive social groups, especially during the harshest seasons, giving them no time to rest, recuperate, or replenish supplies of food and ammunition".

Most researchers, however, agree with Utley (1984: 170) in the assessment that "...the [Plains] Indians did not succumb to [United States] military conquest" (Hyde, 1967; McGinnis, 1990). It was the increasing number of immigrants and livestock traversing, and finally settling on Indian lands or hunting territory, disturbing and hunting game, and depleting other resources that finally forced the Plains Indians onto reservations from the mid 1860s to the mid 1870s (Hyde, 1967; Lamar and Truett, 1996; Moore, 1987; Thornton, 1987, 1997; Utley, 1988; White, 1984). Additionally, a significant impetus for the U.S. government peace policy of this era was the realization by the government of the true costs and tremendous difficulties of these military campaigns. According to Hagan (1976:4), "The cost of killing an Indian was estimated at one million dollars by a senator who set the cost of one day's campaigning on the Plains at $125,000 to $250,000 (in 1867)".

ESTIMATES OF HISTORIC ABORIGINAL RATES OF BISON UTILIZATION

Attempts at estimating historical aboriginal rates of bison utilization are reasonably common, but are still fraught with multiple difficulties. Detailed studies have been made of particular markets, regions, and fur trade companies (Peterson and

Anfinson, 1984; Ray, 1974, 1988; Swagerty, 1988). Most attention, however, has been focused on the Indian trade in and production of furs for market and not on an overall accounting of total Indian buffalo usage.

What does remain clear from the historical record is the very early and persistent nature of the great surplus of buffalo on the Plains, relative to native needs. Spanish explorers spoke of this tremendous abundance among the pedestrian nomads of the south central Plains as early as the 1530s; early French traders were similarly impressed by Sioux foot hunters in Minnesota in the 1600s. This surplus of hides, robes, and meat fueled a famous and widespread trade network that was a feature of tribal life on the Plains for hundreds of years, lasting until European traders grafted onto it successfully by the 1830s on (Barsness, 1985; Ewers, 1968; Isenberg, 1993; Roe, 1970; Wishart, 1979).

Estimates of Indian usage in the literature are varied, and rest upon differing assumptions of ecology or documentation. Exclusive of gathered foodstuffs and other game, Brown (1986) has calculated the average pre-reservation Plains Indian (Comanche) consumed about 1.9 pounds of buffalo meat per day, exhausting about seven bison a year for the average family 'tent' or tipi of eight people. Brown (1986) further estimates that on average about 40 hides, perhaps 27 at a minimum are required per tent for the usual household furnishings, e.g. the tipi, robes, ropes, clothing, shoes, parfleche bags, etc. Brown's calculations, however, depend upon the caloric content of the usable meat from the buffalo carcass, which he assesses at a relatively high 750 pounds.

Ewers (1955) claimed that one bison would feed an average family of eight for about 16 days, and figured that 24 buffaloes could feed this same group for one year. Ewers (1955: 168) further cites a calculation that Henry (1965) made in 1806, noting that the average bison cow yielded about 400 pounds of meat exclusive of the offal, with bulls averaging about 550 pounds. As most Plains Indians had a decided preference for cows, but did in fact utilize and consume the offal (Anderson et al, 1971; Branch, 1962; Barsness, 1985; Flores, 1991; Isenberg, 1993; Nurge, 1970; Prince, 1989; Roe, 1970), one might assume that a conservative and likely estimate of the usable 'meat' furnished by the average buffalo was less than 550 pounds from a bison weighing around 1,400 pounds.[2] Again, actual historic consumption patterns might indicate that there was plenty of wastage involved in actual procurement. There are many ethnographic accounts of hunts where Indians just obtained the choicest parts of the buffalo (the tongue, hump or ribs) and left the rest for scavengers (Branch, 1962; Barsness, 1985; Ewers, 1955, 1961; Roe, 1970). In times of scarcity, we can be reasonably assured of maximum utilization of a carcass (Speth, 1983), but in a culture that was accustomed to incredible abundance, it remains uncertain how often the 'light butchering' may have prevailed in the field, even given the usual lean Plains winters (Biolsi, 1984; Ewers, 1955; Isenberg, 1993).

The ease by which a small group of mounted hunters could take an abundance of buffalo has also been noted by many researchers. Ewers (1955: 169) has stated that a

[2] Barsness (1985:17) notes that "eight and a half year old bulls average 1,650 pounds...[and] cows weigh 600 to 800 pounds less..." in a modern sample of national park bison.

man with an adequate horse could garner four to five buffalo in a single hunt. He further notes that:

> Two Blackfoot hunters on horseback could kill enough buffalo to provide over a ton of meat in a matter of minutes on a single chase. Yet the average family possessed only enough pack animals to transport about a quarter of that weight in meat, in addition to household equipment, when camps moved (Ewers, 1955: 169).

Denig (Ewers, 1961) claimed that a group of 80 to 100 mounted hunters could kill anywhere between 100 and 500 bison in one hour, depending on their luck. This sort of quick success has also been mentioned by others (Barsness, 1985; Branch, 1962; Roe, 1970), with some claims that eight to ten bison could be secured by one Plains Indian in a good hunt (Klein, 1992). Others calculated that each Cheyenne male was killing perhaps 44 bison a year (Flores, 1991).

This abundance and surplus was also reflected in meat stores. There exist a few accounts of Army details burning literally mountains of dried meat when destroying Plains villages during the various military campaigns of the 1860s and 1870s (Grinnell, 1956; Roe, 1970). In one account, General Alfred Sully discovered what he estimated to be 500,000 pounds of dried meats in 1863 after torching a Sioux village of about 400 lodges. By some estimation this hoard represented possibly upwards of 1.5 million pounds of fresh meat, and was easily at least a 70-day food supply for the entire village (Barsness, 1985).

Some of Brown's (1986) estimates seem to be confirmed by historical and ethnographic accounts. Several usage estimates do seem to agree on about 6.0 or 6.5

bison per person per year as the average Plains Indian consumption rate (Ewers, 1955; Flores, 1991; Isenberg, 1993). Ethnographic sources such as Fowler (1898) Denig (Ewers, 1961), and Ewers (1955, 1967) are also in reasonable concordance on the typical production levels for hides per family or tent, usually counted as about eight people depending on circumstances (Ewers, 1955, Taylor, 1989). Most sources agree that one buffalo hide could normally be tanned or prepared in about one week by one wife during the usual winter season. Again, depending on circumstances, most critically whether the woman was largely relieved of other duties, this period could be shortened to three days. The usual production numbers arrived at were about 10-20 hides a year per tipi, and 20-30 or more if more wives were involved. Again, this is given estimates of about 47-54 buffaloes being used on average per tipi or tent per year (Barsness, 1985; Ewers, 1955, 1961, 1967; Flores, 1991; Hassrick, 1964; Isenberg 1993; Roe, 1970; Wishart, 1979). Seemingly these hide production figures may just apply to robes for trade. This is borne out by rare estimates of tribal production levels for hides mentioned by Burlingame (1929). Burlingame (1929: 273) cites an estimate for Crow hide production during the period 1830-1840 when their population was probably between 3,360-4,500, of about "500 packs of robes a year". At ten robes per pack, this represents about nine to twelve robes per family per year made for the market. Similarly, Blackfeet production levels were estimated for the year 1854 (Burlingame, 1929:278) as being about "20,000 in trade" of about 150,000 bison killed. This represents about 22 hides per family per year for trade, given a population around 7,000.

Overall, production levels of hides or robes by Indians for the market varied considerably by year, but for the crucial period of 1835 to 1875, it was generally in the range of 90,000-100,000 per year. As we have seen for the Blackfeet, Denig (Ewers, 1961) estimated that only one out of every four buffalo killed by the Plains Indians ever made it to market to be included in a robe/hide count. This calculation could also be readily applied to the White hide hunters of the late 1860s and 1870s (Barsness, 1985; Branch, 1962; Burlingame, 1929; Isenberg, 1993; Roe, 1970). Importantly, it is difficult to assess how to include the thousands of barrels of salted buffalo tongue and tons of buffalo meat sent east within the various calculations of overall bison utilization (Roe, 1970).

Further complicating matters for economic modeling is the indisputable fact that some Indian families just did better in the hide trade than others. There has been an argument of long duration in Plains anthropology that the demands of the hide trade helped to produce the very social changes that greatly expanded such social inequalities within nomadic Plains tribal societies. This is particularly true with the documented expansion of plural wives (polygamy) during the early to mid 1800s. As women's labor was the critical limiting element to the production of skins for market, the taking of more than two wives became common in some nomadic Plains societies, and this development was noted particularly among the Blackfeet (Ewers, 1955, 1961, 1967; Klein, 1983; Lewis, 1942). As only wealthy men could afford more than two to three wives, this adaptation towards the adoption of more wives only exacerbated the wealth and status differentials between the rich and poor within Plains nomadic societies. These differentials were manifested by the number and quality of horses, wives, and lodges an especially good family of hunters and hide producers could accumulate (Ewers, 1955, 1967, 1972; Klein, 1983, 1992; Pickering, 1994).

As Ewers (1967:95) notes, a very rich chief among the Blackfeet might have ten wives, he further quotes the characterization of trader Charles Larpenteur in 1860 (1898:2:40):

> It is a fine sight to see one of these big men among the Blackfeet, who has two or three lodges, five or six wives, twenty or thirty children, and fifty to a hundred horses; for his trade amounts to upward of $2,000 a year.

By way of comparison, if this dollar amount were interpreted as income, it would clearly put this larger than average family in the upper quintile of wealth for 1860 in a well-situated frontier community like Utah (Kearl and Pope, 1986). This dollar amount, however, probably can be better seen as the value of such trade to the trader. Still, it can not be doubted that some Plains Indian men became quite wealthy as a direct result of the fur trade.

At the height of the hide trade in 1872-1874, it is calculated that Indians were only responsible for slightly less than one-third of all the buffalo skins shipped east by rail (Branch, 1962; Burlingame, 1929; Roe, 1970). This contrasts sharply to one estimate of less than 5% of all buffalo killed being killed by Euro-Americans around 1820 (Coman, 1912). By 1880, some 5,000 professional buffalo hunters and thousands more skinners stalked the Plains (Klein, 1992). They were joined by swelling numbers of unemployed railroad workers and homesteaders, responsible for at least 50,000 bison a year taken as personal provisions in 1872-1874 (Roe, 1970). With the help of newly established rail lines (1868), the Homestead Act (1862), new tanning processes that could utilize thinner summer hides (1870), and the advent of cattle ranching, the stage had been set for this final extirpation of the buffalo from the Plains (Isenberg, 1993; Klein, 1992).

After arguing for and against various solutions to the 'Indian Question' throughout the latter half of the 19th century, the Army, Congress, and a good many citizens were willing to acknowledge that Colonel Dodge (and sundry others) had hit upon the proper direction when he stated in the 1870s, "Kill every buffalo you can, every buffalo dead is an Indian gone" (Isenberg, 1993: 380; CIA 1873). The Plains Indians' narrowly focused bison-based subsistence economy proved to be vulnerable to the voracious appetite for land and resources of the newly arrived settlers, and to the newly minted, more accurate and powerful Sharps .50 caliber buffalo rifles of the commercial hide hunters. The hunting of the buffalo not only picked up with these added demands, but harried the herds to such an extent that their regular patterns of subsistence, migration and reproduction were disturbed (Bamforth, 1987; Isenberg, 1993). By the end of the hide trade after 1883, this tremendous source of wealth was all but exterminated. It was just a few years prior to this (1876-1877) that the Army was able to confine the last substantial group of Plains Indians (the western Sioux) onto reservations (Hagan, 1988).

Once on the reservations, the Plains Indians were allotted a government ration meant to replace the buffalo. The most generous provisions were afforded to the mighty and numerous Sioux, this by the Fort Laramie Treaty of 1868 and the Treaty of 1876. The government was obligated to supply 1.5 pounds of net beef per person per day for every Sioux Indian over the age of four, in addition to various other items such as corn, beans, bacon, coffee, sugar and flour. Those under four were allotted one pound of net beef (CIA, 1891; Kappler, 1971; Prucha, 1994). In actual practice, all the Plains Indians received some level of rations well into the reservation period. These provisions were usually counted as some fraction of the standard Sioux ration, typically consisting of only one pound of net beef per person per day as the chief component (CIA, 1900). Strangely enough, the standard daily ration for the French voyagers of the late 1700s and early 1800s was 1.5 pounds of pemmican per man (Henry and Thompson, 1965; Roe, 1970). This is also in light of estimates that the Plains Indians perhaps ate about three to five pounds of fresh meat per person per day (Barsness, 1985; Ewers, 1968). Six to eight pounds of dried buffalo meat or three pounds of pemmican is also cited as a common daily ration for fur traders throughout the 19th century (Barsness, 1985; Branch, 1962, Roe, 1970).

BRIEF TRIBAL HISTORIES

What follows are eight short sketches of the tribal histories of the Plains equestrian groups under study. These histories are not meant to be comprehensive, but to provide a framework for the discussion and interpretation sections to follow.

The Arapaho

The Arapaho were known to be dwelling on the Plains by about 1780-1790, having migrated from the northeast woodland borderlands of Manitoba and Minnesota to the upper Missouri River valley in present day North Dakota possibly as early as 1700 (Fowler, 1982; Schilz, 1982; Trenholm, 1970). The Arapaho are part of the Algonquian language family, Arapaho being one of five Plains Algonquian languages spoken on the northern Plains during the historic period. Others included Blackfoot, Cheyenne and Plains Cree (Hollow and Parks, 1980). Formerly the Arapaho possessed five subdivisions: 1) the Nakasinenas, or northern Arapaho; 2) Nawunenas, or southern Arapaho; 3) Basawunenas; 4) Hanahawunenas; and 5) Hitunenas or Atsinas/Gros Ventres (usually treated separately). The northern and southern divisions became the principal divisions in the Arapaho tribe, with the Basawunenas and Hanahawunenas being subsumed into the northern Arapaho by an early date. The Atsina or Gros Ventres separated from the Arapaho proper sometime before 1780, and will not be considered here (Fowler, 1994; Parks et al, 1980; Trenholm, 1970).

Following a familiar Plains pattern, the Arapaho migrated frequently during their history, mostly moving southwards through the Plains. By the early 1800s the Arapaho were ranging from the Cheyenne River to the north, but more generally southwards into the territory bounded on the north by the North Platte River in eastern Wyoming and to the south by the Arkansas River in eastern Colorado (Figure 2).

The Arapaho became closely allied with the fellow Algonquian-speaking Cheyenne at a fairly early date, an association that continued until the early reservation period of the 1870s-1890s (Berthrong, 1976; Shaw, 1980). The Cheyenne and the Arapaho shared much of the same hunting territory in both the northern range above the Platte River, and later, after the 1830s, among southern divisions of both tribes south of the Platte to the Arkansas River. Facing increasing Sioux hostility, both the Arapaho and the Cheyenne were forced out of many of their northernmost haunts around the Black Hills of South Dakota and migrated southwards along the front range of the Rocky Mountains. By the 1830s, both tribes had formed southern divisions that normally ranged far below the Platte River to occupy lands in southeastern Colorado and down into the Arkansas River valley. A significant impetus for this split was the location of Charles Bent's first trading fort along the Arkansas River in 1833, which was constructed with the lucrative robe and horse trade with the Arapaho and Cheyenne in mind. Other trading posts and forts were located in Arapaho and Cheyenne territory on the Platte and Arkansas Rivers between 1834 and 1839. The attraction of the vast herds of horses maintained by the Spanish, Kiowa and Comanche, as well as the lure of trade and plunder

Figure 2: Map of Plains Tribal Territory, ca. 1850

Source: Haines, F. 1976. The Plains Indians. New York: Thomas Crowell.

from New Mexican (Spanish) settlements, made the Arkansas River valley a key resource and staging area for many southern equestrian tribes (Flores, 1991; Fowler, 1982; Gussow, 1974; Moore, 1987; Schilz, 1982).

In moving southwards, both the Arapaho and Cheyenne came into conflict with and displaced the southern dwelling Comanche as well as the Kiowa. The Kiowa were also driven by the Sioux from the northern Plains at an earlier date. This conflict over southern Plains resource areas produced a decades-long series of intertribal wars between the southern Arapaho and southern Cheyenne raiding from their Colorado territories against the Apache, Kiowa and Comanche to the south, occupying areas of present day New Mexico, Texas, and Oklahoma. It was not until a truce was concluded in 1840, primarily in order to preserve mutual access to the hide and horse trade, that tensions between these southern equestrian tribes lessened. Raids and wars upon other targets, notably the sedentary tribes of the southern Plains (the Pawnee), as well as White settlements and wagon trains continued to some extent up to the beginning of the reservation period for most of these southern equestrian tribes. The Arapaho are usually counted as being less frequent participants here, and for their early and notable efforts to remain on 'friendly' terms with American authorities in both the northern and southern parts of their territory. The Arapaho, however, historically made war upon the Crow, Pawnee, Ute and Shoshoni, on the north and central Plains, while maintaining a series of intermittent and tenuous alliances with the Sioux as well as the Cheyenne (Calloway, 1982; Flores, 1991; Fowler, 1994; Gussow, 1974; Jablow, 1950; Shaw, 1980; Trenholm, 1970).

By the 1840s and 1850s, increasing immigrant traffic on the Platte River road, Oregon Trail, and Santa Fe Trail, brought miners and settlers to the central and southern Plains in swelling numbers. This process was accelerated by the discovery of gold at Pike's Peak in Colorado in 1858. This had the effect of reducing and displacing the buffalo herds as well as other game in a time-honored fashion in advance of pressures from growing White settlements on the frontier (Bamforth, 1987; Branch, 1962; Fowler, 1982; Shaw and Lee, 1997; Waldman, 1985). From the mid 1840s on, and especially during the early 1860s, there were recurrent ethnographic accounts of hungry or starving Arapaho in many areas due to these increasing pressures on their prime resource areas. These developments led to increasingly tense relationships with American authorities and Whites in general throughout the 1850s. Despite a treaty establishing and confirming rights to tribal territory in 1851, open hostilities with American forces and White settlers were often seen during the 1860s through the mid1870s. In a recurring scenario seen across the Plains, hostilities were often brought about due to the Army's unwillingness or inability to prevent trespass by White settlers upon Indian lands, despite the agreements for Arapaho and Cheyenne reservations in 1851, 1861, 1865, 1867 and 1868 (Fowler, 1982; Kappler, 1971; Schilz, 1982; Trenholm, 1970). This deterioration in the ecological-economic situation was furthered by many other factors as well: promised treaty annuity goods being missing, late or misappropriated; the westward expansion of the railroads in the 1860s and 1870s; the intense competition for forage, water and wood from growing horse and stock herds and settlements that further stressed buffalo herds; direct competition with American commercial buffalo hide hunters from the 1860s on producing severe overhunting; and the possibility of a drying period during which droughts were more frequent during the mid 1840s to the mid 1850s on the southern Plains (Bamforth, 1988; Flores, 1991; Fowler, 1982; Isenberg, 1993; Sherow, 1992). These stresses and series of massacres at the hands of the Army or territorial militias on the central/southern Plains (Sand Creek in 1864 and Washita in 1868), as well as more ruthlessly effective military campaigns in general, led most Arapaho to occupy reservations by the mid 1870s. This process was somewhat accelerated in the more marginal territory of the southern Arapaho where permanent reservations were proposed as early as 1865-1867, and occupied generally from 1869, with the final reservation located in Oklahoma in 1889. The northern Arapaho, some of whom were a party to the 1868 Fort Laramie and 1876 Sioux treaties, wandered for a time from reservation to reservation before occupying a permanent reservation with the Shoshoni along the Wind River in Wyoming by 1878 (Bamforth, 1988; Fowler, 1982; 1994; Prucha, 1994; Trenhom, 1970; Waldman, 1985).

Significant historical disease episodes afflicting the Arapaho include the 1780-1782 and 1831-1832 smallpox epidemics which reportedly killed 25% or more of the tribe, with the 1849 cholera epidemic accounting for possibly greater losses. Smallpox in

1861-1862, measles in 1877, and influenza in 1889-1890 beset the Arapaho with still more heavy losses (Ewers, 1973; Isenberg, 1993; Taylor, 1977; Trenholm, 1970).

Population estimates by tribe are shown in Table 1. As the territory inhabited by the northern and southern divisions of the Arapaho did overlap to some extent, it is difficult at times to apportion respective population numbers for each division. In the 1830s these populations were roughly equal, but the southerners outnumbered northerners in later years. In 1875, 47% of Arapaho were in the north, and by the 1890s only 43% of Arapaho remained on northern reserves (Fowler, 1982; 1994; Gussow, 1974; Trenholm, 1970).

The Assiniboin

By 1780, the Assiniboin occupied a vast swath of territory on the northernmost extent of the Plains in present day southern Saskatchewan and Manitoba in Canada, including the drainages of Qu'Appelle, Assiniboin, and Souris Rivers. The Assiniboin linguistically belong to the Dakota branch of the larger Siouan language family. About five Siouan language groups were spoken on the Plains historically, with the Dakota forming the largest dialect division. The Assiniboin were once thought to have split off from the Sioux, although this remains uncertain. (Decker, 1991; Ewers, 1961; Haines, 1976; Hollow and Parks, 1980; Lowie, 1909; Parks and DeMallie, 1992; Parks et al, 1980; Thwaites, 1896-1901).

There are various accounts of the number of Assiniboin tribal subdivisions; Denig recognized at least six (Ewers, 1961), while Nicollet claimed nine bands (DeMallie,

Table 1: Estimated Tribal Population Sizes

Period or Year	Arapaho	Assiniboin	Blackfeet	Cheyenne	Comanche	Crow	Kiowa	Sioux
1780 [a]	3,000-3,100	8,000-10,000	10,000-15,000	3,500	7,000	4,000	2,000	25,000
1800 to 1810		8,000 (1809)[b]	5,200 (1809)[b]					
1815 to 1830s	3,600 (1835)[c]	6,500 (1815)[d] 2,882 (1838)[do]	5,000-6,000 (1825-1833)[a]	3,000 (1835)[c]		4,500 (1833)[e]	2,640 (1835)[f]	
1840 to 1850s	3,000 (1865)[g]	4,000-5,000 (1850)[h] 3,700 (1858)[bp]	7,300 (1858)[bi]	2,800 (1855)[b]	1,800 (1851)[j] 1,500 (1855)[b]	3,360 (1855)[b]	2,800 (1855)[b]	25,000 (1840)[g] 30,000 (1855)[b]
1860 to 1870	2,531 (1865)[b]	2,000-2,400 (1857-62)[k]	6,120 (1864)[b]	2,900 (1865)[b]	1,800 (1865)[b] 2,538 (1869)[g] 3,000 (1870)[g]	3,657 (1865)[b]	1,800 (1865)[b] 1,896 (1870)[j]	24,228 (1865)[b]
1875 to 1877	2,800 (1875)[b] 3,229 (1875)[g] 2,964 (1877)[l]	1,719 (1877)[l] 2,446 (1879)[iq]	5,450 (1874)[g]	3,452 (1875)[b] 3,236 (1877)[l]	1,700 (1875)[b] 2,600 (1874)[j] 1,695 (1877)[l]	3,420 (1875)[b] 3,300 (1877)[l]	1,700 (1875)[b] 1,090 (1877)[l]	29,797 (1875)[b] ≈30,000 (1877)[l]
1880 to 1885	2,755 (1885)[m]	2,365 (1880)[m] 4,140 (1884)[ip]	7,680 (1884)[ip]	3,596 (1885)[b]	1,476 (1885)[b]	3,470 (1880)[m] 2,682 (1884)[n]	1,152 (1885)[b]	23,875 (1885)[b]
1895	1,840[b]	3,255 (1894)[bp]	5,393[bp]	3,418[b]	1,553[b]	2,287[b]	1,126[b]	26,318[b]

a.Ubelaker, D.H.1992. The sources and methodology for Mooney's estimates of North American Indian populations. In: The Native population of the Americas in 1492. W.M. Denevan, ed. Madison: University of Wisconsin Press. b. Wissler, C. 1936b. Population changes among the northern Plains Indians. Yale University Publications in Anthropology No. 1. New Haven: Yale University Press. c. Gussow, Z. 1974. Cheyenne and Arapaho aboriginal occupation. In: Arapaho-Cheyenne Indians. Z. Gussow, L.R. Hafen, and A.A. Ekirch. New York: Garland Publishing. d. Decker, J.F. 1991. Depopulation of the northern Plains natives. Social Science Medicine. 33:4:381-393. e. Ewers, J.C. 1955. The horse in Blackfoot Indian culture. Washington, DC: Smithsonian Institution Press. Reprinted in 1980. f. Mayhall, M.P. 1971. The Kiowas, second edition. Norman: University of Oklahoma Press. g. Commissioner of Indian Affairs (CIA). Annual reports of the Commissioner of Indian Affairs to the Secretary of the Interior. Washington: U.S.G.P.O. h. Ewers, J.C. and Denig, E.T. 1961. Five Indian tribes of Upper Missouri: Sioux, Arickaras, Assiniboines, Crees, Crows. Norman: University of Oklahoma Press. i. Wissler, C. 1936c. Changes in population profiles among the northern Plains Indians. Anthropological Papers of the American Museum of Natural History. Vol. 36, Part 1. j. Kavanagh, T.W.1996. Comanche political history: an ethno-historical perspective, 1706-1875. Lincoln: University of Nebraska Press. k. Hayden, F.V. 1862. Contributions to the ethnology and philology of the Indian tribes of the Missoui Valley. Transactions of the American Philosophical Society. 12: 231-461. l. Thornton, R. 1981.Demographic antecedents of a revitalization movement: Population change, population size, and the 1890 Ghost Dance. American Sociological Review. 46: 88-96. m. U.S. Bureau of the Census. 1910. Indian population in the United States and Alaska. Washington, DC: U.S.G.P.O. n. Hoxie, F.E. 1991. Searching for structure: reconstructing Crow family life during the reservation era. American Indian Quarterly. Summer. 15:287-309. o. Canada only? p. Canada and U.S. q. U.S. only.

1975), Lowie (1909) cited 17 bands, and Kennedy's (1961) informant was able to cite no fewer than 33 band names. Generally, however, two major groups were recognized by observers, an eastern Assiniboin group closely allied with their Cree neighbors, and a northwestern group that in Canada have come to be known as the Stoney (Kennedy, 1961; Jenness, 1977; Parks et al, 1980).

The Assiniboin were contacted by the earliest Jesuits, European explorers and traders while dwelling in the broad sweep of wilderness generally ranging west of Hudson's Bay, and Lake Superior, in particular. For a substantial part of the 18th century they were important middlemen trading European goods to more distant and remote tribes on the northern Plains. By their fortuitous location as trade middlemen with early access to both English and French trade guns, they were a powerful and numerous tribe by the end of the 18th century. Indeed, many European traders took Assiniboin and Cree wives, producing a sizable metis community by the 1820s, some of whom went on to help establish the famed Red River settlement in present day Manitoba. The Assiniboin fought early persistent wars with the Sioux and Crow to the south, and the Blackfeet to the west, primarily to keep their monopoly of trade with Europeans intact. They also made raids upon the Missouri River tribes, despite acting as middlemen in Anglo-Canadian dealings with these Mandans, Arikara and Hidatsas as well. A disastrous smallpox epidemic in 1780-1882 dramatically affected the Assiniboin, as did the 1837 epidemic of smallpox on the northern Plains. Always regarded as shrewd traders by Europeans, sometime after 1780 a segment of the Assiniboin moved south towards the

Missouri to take advantage of trade opportunities, frequenting the newly established American trading posts that were located on the upper Missouri by the early 1800s. This drew a number of bands to haunts in Montana and North Dakota territory by the 1820s (Calloway, 1982; Decker, 1991; Dollar, 1977; Ewers, 1961, 1968; Fowler, 1996; Kennedy, 1961; Ray, 1974, 1988; Roe, 1970; Schilz, 1984; Wishart, 1979; Wood and Thiessen, 1985).

At a fairly early date the Assiniboin became closely allied with their Cree neighbors in the Canadian north (Mendelbaum, 1940). By 1830, this association included not only the sharing of hunting territory, but co-residence, intermarriage, and a general blurring of ethnic boundaries in some instances as well (Albers and Kay, 1987; Sharrock, 1974). While some have argued that this necessitates consideration of a fused ethnicity in a Cree-Assiniboin entity (Sharrock, 1974), other researchers have noted that this phenomenon of shifting and highly mobile boundaries between various tribes on the Plains, allied or not, was fairly common (Bamforth, 1988; Calloway, 1982; Haines, 1976). Moreover, periods of co-residence and intermarriage were also fairly common on the Plains between allied or nearby tribes, as seen for the Arapaho and Cheyenne (Moore, 1987; Shaw, 1980).

Being closely associated with trade networks, the Assiniboin had several deadly encounters with episodes of epidemics that had a profound impact on their population. In 1819-1820, an epidemic of measles and whooping cough caused an estimated 25% mortality among the tribe. The 1837-1838 smallpox epidemic on the northern Plains had widespread and disastrous effects; it probably produced a 60% mortality toll on the Assiniboin, according to Denig (Decker, 1991; Dollar, 1977; Ewers, 1961).

By the 1840s, Denig (Ewers, 1961) and other observers could foresee the demise of the buffalo on the northern Plains (Isenberg, 1993; Wishart, 1979). By this time, the Assiniboin were pushing west, seeking better hunting prospects in the territory of the Crow and Blackfeet. Predictably, this led to an increased tempo of intertribal warfare, with raids and reprisals and the intermittent attempts at alliances with some groups (the Crow), in order to engage larger tribes (the Sioux or the Blackfeet), more effectively (Ewers, 1961; McGinnis, 1990). Reduced in number by disease, never strongly supplied with horses, and surrounded now by more powerful enemies, there are accounts of hunger and starvation among the southern bands located on the Missouri River by 1846, with similar additional accounts from observers in 1855 (Ewers, 1955; 1961; Isenberg, 1993). By dint of long-standing trading relationships, most of the Assiniboin were said to be reasonably accommodating to White-Europeans by the mid 1800s, and rarely fought with them in later years (Ewers, 1961; Kennedy, 1961). This did not prevent the Assiniboin, however, from participating in habitual tribal warfare with the much larger Sioux, Blackfeet, and other tribes well into the reservation period of the 1870s (McGinnis, 1990).

The most important formal treaty of the 19th century made with the American government was the 1851 Fort Laramie Treaty. Indeed it is testimony to the relative lack of conflict with American forces that this was the only formal treaty made between the

United States government and the Assiniboin in the 19th century (Kappler, 1971; Prucha, 1994). Soon after this treaty of 1851, the bands in the U.S. began to settle into tribal reserves, the first centered around the Milk River in present day eastern Montana by about 1855 (Kennedy, 1961). This reservation was succeeded by the Fort Peck reservation, which was shared with a substantially larger number of Yanktonai Sioux after the latter tribes' 'surrender' in 1876. By the 1860s, different segments of the Assiniboin made some reasonable accommodations with the Yanktonai Sioux as well as their former Gros Ventre enemies. The Fort Belknap Gros Ventre/Atsina Reservation also became the home for probably slightly less than half of the U.S. Assiniboin by the 1860s, and although outnumbered by the Sioux, these tribes were together still raiding portions of the Sioux as late as 1879 (Kennedy, 1961; McGinnis, 1990; Parks et al, 1982). Although not a formal party to the Fort Laramie Treaty of 1868, which stipulated a specified ration for the Sioux, the Assiniboin were provided with a relatively high level of rations, however inconsistently. This may have been due in part to occupying a reservation with the Yanktonai Sioux who were a party to the 1868 treaty as well as the more generous treaty of 1876 with the Sioux in practice, if not by exact statute (CIA 1874-1876, 1900; Kennedy, 1961; Kappler, 1971; Prucha, 1994). There is yet another account of starvation among the Assiniboin during the winter of 1883-1884, due to the absence of buffalo and a delay in treaty rations and annuity goods, and 300 persons were said to have perished (Kennedy, 1961).

In Canada, beginning in 1874 with Treaty #4, and continuing through Treaties #5 (1875), #6 (1876), and #7 (1877), the Canadian Assiniboin/Stoney were assigned reservations in areas of present day Alberta and Saskatchewan. The Canadian treaties contained no common consideration for the provisionment of regular rations to Indians, and thus were much less generous in this regard than the usual practice in the United States. Much suffering, disease, and death were the result of this relatively rigid and inflexible Canadian policy. A significant number of Canadian Assiniboin around the Qu'Appelle and Sakatachewan Rivers disputed the provisions of their treaties, leading to conflict with the Canadian government during the early 1880s. Starvation and/or malnutrition are mentioned for the years 1881-1882 and for some years leading up to the Red River Rebellion of 1885, which involved mostly the metis and some of the Cree (Fowler, 1996; Patterson, 1972; Surtees, 1988; Titley, 1991; Waldman, 1985).

Again, although it is difficult to apportion the number of Assiniboin above and below the United States-Canada border, by 1884 about 53% of the entire Assiniboin tribe were living on reservations in the United States. The situation was reversed in 1894, however, with about 54% of the tribe now counted as living on reserves in Canada (Wissler, 1936b) (Table 1).

The Blackfeet

The Blackfoot Confederacy is composed of three closely related tribes: the Blackfeet proper; the Blood; and Piegans (Ewers, 1967; Parks et al, 1980). Collectively, the Blackfeet occupied a vast expanse of territory on the far northwestern Plains. In 1780, this territory extended from the North Saskatchewan River in present day Saskatchewan and Alberta, south to the southern headwaters of the Missouri in Montana, and west from about the 105th meridian to the Rocky Mountains. The Blackfeet alliance, which included the smaller Gros Ventre and Sarsi tribes as early allies,[3] shared some of this highly contested northern territory with their traditional enemies, the Assiniboin and the Cree (Decker, 1991; Ewers, 1967, 1975). They were considered by most European and American observers to be a large, strong and aggressive nation when first contacted by European traders in the early to mid 1700s and were soon seen raiding over vast distances on the Plains (Ewers, 1955, 1967; Jenness, 1977).

The Blackfeet (or Siksika) are members of the widespread Algonquian language family (Hollow and Parks, 1980), with the Piegans being the southernmost located, the Bloods intermediate and the Blackfeet proper the northernmost members of the Confederacy. The Piegan and many Blood bands could be found south of the international border increasingly after the 1830s (Ewers, 1955; Parks et al, 1980).

Befitting a proud Plains tradition, the Blackfeet fought incessant and early wars against most of their neighbors, and the Crow and Sioux in particular in later years (the 1830s on). Moving westward and then southwestward, by the mid to late 1700s the tribes of the Confederacy were displacing the northwestern tribes of the Kootenai, Nez Perce, Flathead and portions of the Shoshoni from their previous hunting territories along the

[3] The Sarsi or Sarsee are not considered a part of the Blackfeet confederacy, just a closely allied tribe for the purposes of defense and warfare (Bamforth, 1988; Ewers, 1967, 1975; Parks et al, 1980).

eastern front of the Rockies in southern Alberta and Montana. The leading western edge of this contested terrain remained a flashpoint for continual battles into the reservation period, as did most other frontiers between Blackfeet and neighboring tribal hunting territories (Calloway, 1982; Ewers, 1955, 1975; McGinnis, 1990).

The Blackfeet were deeply antagonistic and suspicious towards Euro-American traders from the earliest times, but despite this became incorporated within the fur trade economy at a fairly early date by the British. The Blackfeet were largely responsible for creating a climate of danger and threat towards American traders and trappers in the northwestern Plains that dated to the time of the Lewis and Clark expedition, when the Americans had killed two Piegans. As a direct result of this violent first encounter, traders could not safely venture into Blackfeet country until 1831, and White mountain men trappers were twice driven from the Missouri River headwaters in the territory of present day Montana before 1825 by Blackfeet harassment and raids. American trading posts finally came to Blackfoot country by the early 1830s, drawing a considerable number of bands into a more southerly interaction sphere south of the international border (Ewers, 1967, 1972, 1975; Henry and Thompson, 1965; Lewis and Clark, 1904-1905; Lewis, 1942; Wishart, 1979).

Like their Assiniboin neighbors in this north country, the Blackfeet were periodically devastated by severe outbreaks of epidemic diseases. Much like the Assiniboin, seasonal rounds placed these tribes in spatial concentrations during the summertime at the much utilized river transit points on the Plains and Woodland zones also heavily exploited by Euro-American traders. These more intensive interactions are seen as the principal reason why such epidemics were particularly devastating for the Blackfeet and other tribes (Decker, 1991; Dobyns, 1992; Dollar, 1977; Ewers, 1955, 1972; Trimble, 1989, 1992). It is estimated that the Blackfeet lost upwards of 50% of their population in the great smallpox epidemic of 1780-1782, with the next serious outbreak probably taking the same proportion or larger (possibly 75%), with it in 1837-1838 (Decker, 1991; Dempsey, 1965; Ewers, 1967; Taylor, 1977). The Blackfeet population seemingly slowly recovered from these disasters up until 1858 (Decker, 1991). Repeated epidemics, however, of smallpox in 1869-1870 and scarlet fever and/or measles in 1864-1865, as well as the heavy toll exacted in continual intertribal warfare contributed to a decline in population, and hence greatly diminished Blackfeet military power by about 1870 (Ewers, 1967, 1972, 1975).

The Blackfoot country was blessed with an abundant supply of buffalo until relatively late (1874-1877), and hence the Blackfeet were constantly fending off trespass from all quarters until the buffalo were depleted and the Indians more confined to reservations by the late 1870s (Bamforth, 1988; Dempsey, 1965; Ewers 1967, 1975).

Although usually remote from most immigrant traffic on the Oregon Trail, increasing overland traffic required the United States government to address the matter of safe passage in the Treaty of Fort Laramie in 1851. In doing so, they formally recognized the portion of the Blackfeet territory located south of the international border, encompassing part of the upper Missouri River drainage, including areas drained by the upper Musselshell and Yellowstone Rivers in Montana (Ewers, 1955, 1967; Janke, 1987; Kappler, 1971). The most important treaty made between the Blackfeet and the United States government was the one signed on the Judith River in 1855. Besides the usual stipulations requiring peaceful co-existence on the Plains, this treaty did have an annuity provision, a long-term tradition of most Indian treaties. Importantly, neither this treaty nor the subsequent unratified treaties of 1865 or 1868 contained provisions for regular rations from the government. The Blackfeet ceded territory south of the Teton River to rapidly expanding White settlement in these latter unratified treaties, as gold was discovered in the Montana Territory in 1862. The first Blackfeet agency was established in 1855 at the fur trading post of Fort Benton along the Yellowstone River. Tensions only escalated in the decade and a half to follow, precisely due to the great influx of immigrants into this previously remote haven, and in particular over the Bozemen 'road' which cut directly through traditional Blackfeet hunting territory to the gold fields. John Bozemen himself was killed by the Blackfeet in 1867, as the Sioux and northern Cheyenne and Arapaho fought during 1866-1868 to close this road to immigrants and have the garrisons of U.S. troops removed (Ewers, 1967; Hyde, 1956, 1967; Waldman, 1985).

By 1858, United States Indian Agent to the Blackfeet Alfred Vaughan was already noting that the range of the buffalo on the Plains was contracting, a fact he repeatedly tried to impress upon the Blackfeet, to little effect. Still, the Blackfeet remained well supplied and were able to raid at will, "...equally at home on both sides of the [international] boundary" (Ewers, 1967:254), throughout the 1860s and 1870s and well into the 1880s. They were able to use this 'medicine line' to good effect to avoid retribution for horse raids and the occasional murder of settlers of the Montana territory. Once again, the United States' unwillingness to honor treaty obligations to stem the influx of White settlers encroaching upon defined and agreed upon Blackfeet hunting territory is seen as a principal impetus for some of the raids. Although engaged in constant small-scale raids, the Blackfeet seemingly rarely engaged government forces during this latter period in any great numbers. The significant exception to this observation was a punitive expedition by U.S. forces that killed 173 peaceful Blackfeet during the winter of 1870. The Blackfeet were also suffering from a smallpox epidemic during this period (1869-1870) that possibly brought with it a 15% to 20% mortality toll. These two simultaneous events broke the power of the Confederacy and they were never again a serious threat to White settlements in either the U.S. or Canada. Another significant cause of injury and death during the years 1869-1874 was the unrestricted trade in liquor and the debilitating effects this had on these Indians (Dempsey, 1965; Ewers, 1955, 1967, 1975; McGinnis, 1990; Waldman, 1985).

Clarification of the confused status of the Blackfeet (mainly Piegan) in the United States was attempted by an executive order establishing a large reservation in Montana in 1873. As was often the case, however, events overtook this plan as it was noted that settlers were already grazing thousands of cattle on the land set aside. After much political play with the boundaries of a proposed reservation, a Blackfoot agency was established in 1875 on land that encompasses the present day Blackfoot reservation in Montana. Still, it was two more decades before both the Canadian and United States governments could properly determine on which side of the border some of these Blackfeet properly belonged.

By 1883 the Blackfeet faced a crisis from the rapid disappearance of the buffalo from their country which had provided the great beasts with their last refuge on the Plains. Around 1875, the United States government had instituted rations for the Blackfeet that were similar to the Sioux ration regimen that allowed 1.5 pounds of net beef per person per day. Until the buffalo disappeared, however, these rations were rarely depended upon by the Blackfeet. Insufficient planning and late and inadequate congressional appropriations for these rations led directly to the starvation deaths of perhaps one-quarter of all United States Blackfeet in 1883-1884 (Ewers, 1955, 1967, 1968).

For the Canadian Blackfeet (northern Blackfeet, most Bloods and some northern Piegan bands), official reservations came with Treaty #7, made with the Canadian government in 1877 assigning lands in Alberta to these Indians. In this northernmost territory of the Blackfeet, the buffalo had all but vanished by 1879, a year when severe starvation is also noted for many Canadian Blackfeet. Once again, this situation was made worse by insufficient levels of rations, only in this instance seemingly by design rather than merely by accident (Dempsey, 1965; Ewers, 1967; Goldfrank, 1944; Surtees, 1988).

While it is difficult to ascertain various proportions represented by the three Blackfeet tribes, Ewers (1955) offers Agent Vaughan's figures for the year 1860, indicating that at that time the southern dwelling Piegan represented about 50% of the total population. As Wissler (1936b) notes, the proportion of Blackfeet counted as 'Canadian' versus 'American' did fluctuate dramatically through the years, and by 1894 the U.S. population of Blackfeet represented about 44% of the total population (Table 1).

The Cheyenne

As of the mid 1700s, the Cheyenne still resided on the Sheyenne River in present day North Dakota, as fairly typical middle Missouri village horticulturalists. It was only after 1780 that they came to be known as nomadic equestrians. They became exemplars of this new lifeway, famous for their war exploits and fierce resistance to White encroachments (Berthrong, 1963; Grinnell, 1923; Jablow, 1950; Moore, 1987; Waldman, 1985).

The Cheyenne are members of the Algonquian language family (Parks et al 1980). By about 1833 they were split into northern and southern divisions, which some regard as forming separate tribal identities, sometime after this date (Moore, 1974, 1987). They are usually treated, however, as one entity, as in the 'Cheyenne nation' (Grinnell, 1923; Moore, 1987). The northern Cheyenne consisted primarily of three bands during the 19th century, the Sutaio, the Totoimana, and Omisis. The seven remaining southern bands were the Wotapio, the Hevhaitaneo, the Oivimana, the Hisiometaneo, the Heviksnipahis, the Masikota, and the Hotametaneo (Moore, 1987). They were early and long allied with the Arapaho, and much of their broad historical chronology is fairly similar. Befitting their late shift to nomadism, the Cheyenne retained some of their horticultural practices at least up until the 1830s (Gussow, 1974; Shaw, 1980).

By 1805, the Cheyenne had migrated southwestwards to the area around the Black Hills, and along the Cheyenne River of South Dakota. The Cheyenne, facing increased pressure from the Sioux, followed the Arapaho south on the Plains. The Cheyenne had been observed raiding Spanish settlements far to the south, and also trading at Santa Fe as early as 1804 (Berthrong, 1963; Kurtz, 1989; Lewis and Clark, 1904-05). As elements of the Cheyenne moved south in the early 1810s and 1820s, they became renowned as trade middlemen between the villagers of the middle Missouri to the east, and the nomadic tribes of the Kiowa, Comanche, and Arapaho located to the south and west. By the time Charles Bent constructed his trading fort along the Arkansas River in 1833, the Cheyenne were already gradually relinquishing this role to deal directly with Euro-American traders. Again, the Sioux interest in monopolizing trade to the Middle Missouri villagers also played a role here. By the early 1830s, southern segments of both the Cheyenne and Arapaho came to occupy lands between the Platte and Arkansas Rivers, in present day Nebraska and Colorado (the Platte) and western Kansas and eastern Colorado (the Arkansas). The lure of trade and the clearance of the Kiowa and Comanche from this region gradually drew the majority of the Cheyenne south sometime after this period (Berthrong, 1963; Gussow, 1974; Jablow, 1950; Kurtz, 1989; Moore, 1987; White, 1978).

The Teton Sioux formed an alliance by about 1840 with the northern bands of the Arapaho and especially with the northern Cheyenne that remained fairly intact for at least the next 40 years. As a result, in the northern Plains territory the northern Cheyenne and Arapaho shared parts of their territory with some western Sioux bands. Again, typical of a Plains tradition, the Cheyenne waged war against most of their neighbors at one time or another. Consistent targets in their northern area of operation above the Platte River were the Crows, Shoshoni and Pawnee. In the south, they warred intermittently with the Kiowa and Comanche before 1840, with periodic raids on the Utes and other inter-mountain tribes a continuing feature until the early reservation period. They later joined with their Arapaho allies as well as mixed groups of raiders from the other nomadic tribes to wreak havoc upon southern horticulturalists, Euro-American settlers, and wagon trains alike, increasingly from the 1850s on (Calloway, 1982; Gussow, 1974; Jablow, 1950; Secoy, 1953; Shaw, 1980).

Moore (1987) among others does comment upon the cosmopolitan character of the Cheyenne nation, and of the frequent adoptions and intermarriages that promoted trading relationships and cemented affinal ties to neighboring groups. This integration of people from many different tribes and ethnic groups may be responsible for the fairly consistent Cheyenne population size throughout the 19th century (Table 1). This despite estimates that the Cheyenne possibly lost more people per capita to wars and conflicts with Whites than any other tribe on the Plains (Shaw, 1980). The adoption of captives or kin and intermarriages were common occurrences for the Plains Indians, something that should be remembered when considering demographic analyses (Moore and Campbell, 1989, 1995).

As immigrant traffic increased on the south-central Plains, the Cheyenne became party to the 1851 Fort Laramie Treaty. Subsequent treaties with the United States government during this period were invariably made with the Arapaho as well, and shall not be recapitulated here (Kappler, 1971; Prucha, 1994). Following a familiar pattern across the south central Plains, Cheyenne observers noticed a decline in buffalo since the late 1840s. The suddenness of the influx of White transportation, farming, ranching and mining operations disturbed the bison resource base, as well as permanently altered the ecological balance of the region by seriously depleting the vital riparian Republican and Smoky Hill watersheds by the 1860s (Flores, 1991; Moore, 1987; Shaw and Lee, 1997; Sherow, 1992).

As the southern Cheyenne and southern Arapaho were directly in the path of the immigrant trails, the Santa Fe and the Oregon along the Platte and Arkansas, conflict over these previously prime resource areas was inevitable. Hostilities between these southern Cheyenne, in particular a division known as the Dog Soldiers, against such Euro-American encroachments were almost constant from this time (1850), until well into the reservation period. Subsequently, hundreds of raids were made into Kansas, Nebraska, Colorado, and points south to acquire horses, stock, and other plunder. The Cheyenne reputation as skilled and feared warriors was made during this period of intense hostilities with Whites, lasting almost to 1875 (Berthrong, 1963, 1976; Moore, 1987; Utley, 1984, 1988; Waldman, 1985). During this time, the southern Cheyenne bore the brunt of several of the deadliest military campaigns on the southern Plains. The 1864 Sand Creek Massacre in Colorado killed more than 200 men, women, and children, most of them from peaceful bands then occupying reservation lands. The 1868 Battle of Washita in Oklahoma saw about 100 surviving members of these same largely peaceful bands of Cheyenne under the great Cheyenne 'Peace Chief' Black Kettle killed, along with this most significant of Cheyenne chiefs. The Battle of Summit Spring in northeast Colorado put an end to the ambitions of the southern Dog Soldiers and 50 more Cheyenne lives in 1869, ending their most serious threat to settlements on the southern Plains (Berthrong, 1963, 1989; Hoig, 1980; Utley, 1984; Waldman, 1985, 1990). Remaining southern Cheyenne gradually began to occupy their reservation in Oklahoma, established in 1869, in great numbers from the early 1870s on. The last serious outbreak of hostilities occurred during 1874-1875 when allied southern nomadic tribes tried unsuccessfully to dispel hide hunters who were finishing off the last of the great southern buffalo herds (Moore, 1987; Utley, 1984, 1988; Waldman, 1985).

The northern Cheyenne participated in most of the important battles on the northern Plains as close allies to the Sioux. As such, they played vital roles in the last of these storied conflicts in 1875-1876, including the Battle of the Little Bighorn in Montana. These northern bands had expected to be assigned to a reservation in the north, but were removed to the southern Arapaho-Cheyenne reservation in Oklahoma by 1877. There they were beset by disease, primarily malaria, and malnutrition from lack of adequate rations. This despite being party to a treaty made with the government in 1876 that stipulated a relatively generous level of rations to the northern Cheyenne on par with those provided to the Sioux. Not wanting to succumb to the death and disease they experienced daily in their new home, some of these northern bands sought to escape from the reservation later in 1878. This prompted a famous pursuit by the Army, which led eventually to more deaths at the hands of U.S. troopers in the Fort Robinson Massacre in Nebraska. This also led, however, to the establishment of a northern Cheyenne reservation on the Tongue River in eastern Montana by executive order in 1884. Remaining Cheyenne staying at the Sioux Pine Ridge Reservation moved to the Tongue River in 1891 (Berthrong, 1976; Campbell, 1989b; Kappler, 1971; Moore, 1974; Powell, 1981).

Most accounts of the early reservation period after the buffalo was largely hunted out, from about 1875 on the southern Plains, tell of disease and destitute Indians. Descriptions tell of fairly miserable conditions, replete with short, reduced, missing, or late rations that seemingly were a constant feature of the Cheyenne-Arapaho reservation in Oklahoma well into the mid 1880s (Berthrong, 1976, 1989; Campbell, 1989b; Ewers, 1973; Nespor, 1989; Powell, 1981). The northern Cheyenne on the reservation in Montana were said to have scarcely fared much better in 1886-1890, with a high toll taken by disease and short or manipulated rations (Campbell, 1989b; Nespor, 1989).

Other important historical disease episodes known to be experienced by the Cheyenne include the 1780-1782 smallpox epidemic, and the 1849 cholera epidemic that affected most of the immigrant roads, both having mortality estimates of over 25% loss resulting from them (Ewers, 1973; Taylor, 1977).

Although there was much traveling back and forth along a north-south axis on the Plains, by 1892 most Cheyenne lived in the south with only about one-third of them living in the northern Plains at this time (Moore, 1987).

The Comanche

The Comanche, along with the Kiowa, are considered to be one of the earliest groups of nomadic Indians to occupy the Plains on a continuous basis. There is considerable debate and confusion over the earliest recorded history of the Comanche bands or if they can even be considered a fully integrated tribe (Brown, 1986; Flores, 1991; Foster, 1991; Hagan, 1976; Hyde, 1959; Kavanagh, 1996; Noyes, 1993; Oliver, 1962). Famed as raiders and traders, they were among the first Plains Indians to conduct regular commerce with Europeans (the Spanish and the French), and were subsequently among the earliest to breed, train, and trade horses to other Plains tribes (Jablow, 1950; Kavanagh, 1996; Noyes, 1993). Though famous for their constant and long range raids, the Comanche were also renowned for maintaining consistently large horse herds, evidenced by high horse-to-person ratios (Bamforth, 1988; Ewers, 1955; Osborn, 1983; Sherow, 1992; Smith, 1985).

The Comanche were separated from the Shoshoni/Numic people sometime before the 18th century, and are classified as Uto-Aztecan speakers (Hollow and Parks, 1980). Various divisions of the Comanche are known to have cycled in and out of existence during their history on the Plains, with plenty of debate and opinion on their number, meaning, existence and orthography. Generally, however, about five major divisions were recognized by western observers around 1850 in Texas, Oklahoma, and Kansas: the northern most Yamparicas; the southernmost Panatekas; the Nokonis; the Quahadas; and the Tenewas; most of whom survived in one form or another into the reservation era (Foster, 1991; Hagan, 1976; Kavanagh, 1996; Noyes, 1993; Oliver, 1962; Wallace and Hoebel, 1952).

By the 1780s, the Comanche had moved southwest from eastern Wyoming into the Plains, driving the Apache from the Plains and occupying a vast swath of territory stretching from present day southwestern Kansas, southeastern Colorado, eastern New Mexico, and eastern Oklahoma to its southernmost extent in central Texas. The Comanche were soon dispossessed from much of this range by the influx of the Arapaho, Cheyenne, and Kiowa during the early 1800s, compacting their territory to mostly those areas of Texas and Oklahoma south of the Arkansas River (Bamforth, 1988; Noyes, 1993; Secoy, 1953; Waldman, 1985; Wallace and Hoebel, 1952).

By the end of the 18th century (1786), most of the Comanche had reached a reasonable accommodation and alliance with the Spanish colonial administration (as Texas was then part of Mexico), that lasted substantially until the late 1810s. By 1806, the Comanche and the Kiowa made peace and formed an alliance to create one of the most devastating group of raiders seen on the Plains (John, 1984, 1985; Kavanagh, 1996; Noyes, 1993; Price 1985). The 19th century saw the Comanche and their allies, the Kiowa at first and later the Arapaho and Cheyenne after 1840, pose one of the most persistent and long-lived threats to settlement of the southern Plains and Texas. This alliance was often termed the 'Comanche barrier' (Fehrenbach, 1974; Richardson, 1991). Captives, plunder of livestock, and the horse and stock trade became increasingly important to the Comanche as economic mainstays in addition to the buffalo, the latter source being prone to decline due to periodic drought and other factors (Flores, 1991; Foster, 1991; Kavanagh, 1996). In later years, many claims for thousands of dollars worth of stolen stock were made against the Comanche and allied raiders (Kavanagh, 1996).

As Anglo-Americans began to trade and settle in the Comancheria region by the 1820s, they faced the same sort of 'raid and trade' Comanche economic strategy that so bedeviled Spanish colonial administrators for most of the previous century. Conflict on the Texas frontier between settlers and Comanche bands eventually led to the formation of the famed Texas Rangers, whose sole function from 1835 until 1875 was to contain the Comanche, usually offering them no quarter where found. Though the Comanche enjoyed reasonable and mutually productive relations with many Anglo-American traders, they came to be regarded as a pernicious scourge by settlers and legislators alike, despite their critical role as trade middlemen to the New Mexico and Texas territorial economies (Fehrenbach, 1974; Foster, 1991; Kavanagh, 1996; Noyes, 1993; Waldman, 1985). Again, such a role in trade relations was not at all unusual for many of the Plains nomadic tribes (Albers, 1992; Ewers, 1972; Klein, 1992; Peterson and Anfinson, 1984).

The Comanche and Kiowa fought a series of wars with the encroaching southern Cheyenne and Arapaho from about 1825 to 1840, principally over access to resources around the Arkansas River valley. By the mid to late 1840s, the tempo of conflict between the Comanche and various incarnations and assemblies of Texas Rangers and militias had also increased, despite several attempts at peace treaties during the years 1835-1842 made with Texas, and treaties in 1846 and 1853 with the United States government. In the late 1840s several observers commented on the diminishing availability of buffalo and other game animals on these southern Plains. This scarcity was further impetus for more frequent raids by the Comanche for stock and captives in Mexico as well as Texas (Flores, 1991; Foster, 1991; Kappler, 1971; Kavanagh, 1996; Noyes, 1993).

Disease from settlers or migrants also beset the Comanche, with smallpox, devastating the community in 1780-1781, killing perhaps one-quarter of them in 1816, and again felling possibly 4,000 others upon its return in 1839-1840. Cholera broke out on the Santa Fe Trail in 1849, further decimating the Comanche once again, and possibly killing another 25% or more of them (Ewers, 1973; Fehrenbach, 1974; Kavanagh, 1996). Ewers (1973) estimates that more than 75% of the Comanche population was lost to disease during just the 19^{th} century.

By the 1850s, Texas citizens, long the only Anglo-European settlers living in such close and tenuous quarters with Plains nomadic raiders, began to feel the necessity of confining the Comanche to reservations. Reservations were begun by the State of Texas for the Comanche by 1855, but at this time only a few hundred (450 or so) southern Comanche would associate with them. The burgeoning need for land by settlers and increasing numbers of immigrants inevitably led to conflict and ignite yet another series of military campaigns sent against the Comanche and Kiowa during the late 1850s, the late 1860s, and the early to mid 1870s. Indeed the seriousness with which governmental authorities assessed this threat to settlements is indicated by the creation of the first U.S. cavalry regiment, formed in 1855 specifically to counter the Indian threat to the Texas frontier (Fehrenbach, 1974; Foster, 1991; Utley, 1984; Waldman, 1985).

In 1859, the Comanche were ostensibly removed to the Oklahoma territory north of the Red River. This forced move did not prevent many bands from continuing to raid Texas to such an extent that the frontier was pushed back 100 miles in several areas as these counties were effectively depopulated. This ruinous process in response to widespread raiding was to continue throughout the Civil War period until the famed 1868-1869 Army campaign on the central and southern Plains. The Kiowa and Comanche signed treaties with the government in 1865 and 1867 that were made to stop these depredations on settlements in return for scheduled annuities and reservation land in and around Fort Sill, Oklahoma. The inducements of the Treaty of Medicine Lodge in 1867 still did not prevent significant segments of the Comanche and smaller numbers of Kiowa from raiding Texas, New Mexico, and Mexico regularly into the early 1870s. These raids brought on the final period of active United States military engagement with the southern Plains tribes during the Red River War of 1874-1875. By 1875, nearly all the Comanche were confined to their reservation and the buffalo were nearly wiped out on the southern Plains due to a combination of overhunting and competition for range from swelling stock herds (Fehrenbach, 1974; Flores, 1991; Foster, 1991; Hagan, 1976; Utley, 1984, 1988; Wallace and Hoebel, 1952).

Credible reports of hunger and severe deprivation are mentioned in most accounts of the early Comanche and Kiowa reservation experience. Near constant food crises during the years 1868 to 1885 were brought about due to the lack of a specific treaty provision for a level of rations, and the usual late, missing, or short rations, supplies and annuities. Late appropriations were a recurrent problem and no doubt a contributing factor in the toll several epidemics took in 1877, 1882, and 1892 among the Comanche and Kiowa (Ewers, 1973; Hagan, 1976; Mayhall, 1971; Wallace and Hoebel, 1952).

There exists considerable debate on the size of the Comanche community with some historians offering consistently high estimates of around 20,000 (Flores, 1991), while anthropologists and ethnologists have claimed significantly lower high-end estimates of around 7,000 during the early to mid 19^{th} century (Brown, 1986; Noyes, 1993; Ubelaker, 1992). Consistent mid range estimates for the Comanche population rarely exceeded 3,000 to 4,000, yet it was notoriously difficult to actually count the Comanche, so many estimates may be prone to error (Bamforth, 1988; Foster, 1991; Hagan, 1976; Kavanagh, 1996; Wallace and Hoebel, 1952).

The Crow

The Crow, like the Kiowa and the Comanche, have an obscure early history. Archaeological and ethno-historical analysis indicates that the Crow gradually separated from the Hidatsa, semi-sedentary horticulturists of the Plains Village tradition, culminating sometime between 1675 and 1750 A.D. (Ewers, 1961; Hanson, 1986; Hoxie, 1995; Willey, 1966; Wood and Downer, 1977). The Crow continued to be closely allied with the Mandan and Hidatsa by trade relationships well into the modern reservation era. Besides this historic association with the middle Missouri River tribes, the Crow also played a critical trade middleman role linking the Plateau and Great Basin Indian tribes to the Plains. This was via the Shoshoni Rendezvous trade fair held regularly in southwest Wyoming, until it was largely supplanted by the market penetration of Euro-American traders by the 1840s-1850s (Ewers, 1961, 1968; Swagerty, 1988; Wood and Thiessen, 1985).

The Crow are classified as part of the large Siouan language group, one of five principal Siouan groups on the Plains (Hollow and Parks, 1980). At the time of the first recorded contact with Europeans in 1805, there were three tribal divisions, but only two are usually recognized as having survived through to the early reservation era: the Mountain Crow and the River Crow. The latter group tended to hunt and travel along the far upper reaches of the Missouri River north of the Yellowstone River in present day Montana, while the Mountain Crow occupied the Yellowstone Valley and its southern drainages. The Mountain Crow were considered the main body of the tribe, and were consistently the largest division (Hoxie, 1995; Lowie, 1956; Parks et al, 1980).

Migrating west from their ancestral middle Missouri homelands in present day North Dakota, the Crow wrested a territory chiefly in present day eastern Montana and north central Wyoming from the Shoshoni or Snakes by the early 1800s. By supplanting the Shoshoni, Comanche, and Kiowa from this far northwestern territory on the Plains, the Crow became the target of unceasing intertribal aggression over this rich but continuously contested area in the Yellowstone and Bighorn River country up until the 1880s. Hard pressed and constantly beset by larger tribes on all sides, principally the Sioux to the east and the Assiniboin and Blackfeet to the north, the Crow valiantly fought on and in the 1860s and 1870s offered their services as scouts to the U.S. Army in order to better punish their enemies (Bedford, 1975; Calloway, 1986; Hoxie, 1995; McGinnis, 1990).

Again, the cause of this continuous intertribal warfare and raids upon the Crow was their fortuitous position occupying some of the best and last game refugiums on the Plains and in the trans-mountain region. The high Plains and the mountainous valleys of the upper Yellowstone, Bighorn, Powder and Wind Rivers also provided favorite sheltering winter locales for European trappers, several neighboring Indian tribes, and bison herds as well. From this rich territory the Crow derived their wealth in furs and hides and used their position as trade middlemen to leverage and maintain historically large horse herds. Trade and war was also alternatively made with the Plateau tribes of the Flathead and Nez Perce and the Plains and Great Basin Shoshoni. Horses were traded in the west, with the latter tribes, and guns, ammunition, and trade goods were obtained from the eastern middle Missouri tribes, the Hidatsa relations, and the Mandan. Crow access to these Mandan and Hidatsa villages became increasingly tenuous during the early 1800s as the westernmost divisions of the Sioux expanded to occupy the Black Hills and portions of the Powder River country (Calloway, 1986; Ewers, 1955, 1961; White, 1978; Wishart, 1979).

The Crow quickly became acquainted with European traders by the first decades of the 18th century, and remained on reasonable terms with most traders and the Army throughout their pre-reservation existence. Possibly because of the Crow's remote territory on the Plains, Whites were relatively infrequent visitors, and proved far less deadly in direct hostile encounters than did the surrounding Blackfeet, Sioux and their allies (Hoxie, 1995; Wood and Thiessen, 1985). As with other well-situated Plains nomads, the Crow grew rich from the fur trade; lodges (tipis) grew larger, husbands acquired more (plural) wives to work beaver and buffalo skins, more trade goods were obtained, and still more horses amassed for hunting, trade and transport. Crow women became justly famous for the high quality of the furs they dressed for American and European markets. As the Crow grew more powerful through their access to trade and the wealth it brought, they also became more dependent and integrated into the Euro-American market system. Unsurprisingly, it was the precarious military situation that greatly assisted in this integration process, and trading to maintain a steady supply of arms, ammunition and tools was essential to the Crow's survival on the Plains (Hoxie, 1995; Klein, 1983; Secoy, 1953; Wishart, 1979).

By 1825, American fur traders had expanded into Crow territory, establishing important trading posts along the Yellowstone River and its tributaries by the 1830s and 1840s. As the Crow remained remote from these trading forts for most of the year some traders came to stay with the Crow, and a few lived with the Crow for an extended period of years and marry into the tribe (Algier, 1986; Hoxie, 1995; Swagerty, 1988; Wishart, 1979). The early 1840s saw the wholesale collapse of the beaver population in Crow country and the shift was made to trade in buffalo robes and hides soon afterwards. By this time the Crow were gradually withdrawing from some of the eastern and southern portions of their territory under constant pressure from the Sioux and their allies, the northern Cheyenne and Arapaho. For many years prior to the 1850s, the contested boundary between Sioux and Crow tribal territories lay at the western bank of the Powder River in present day eastern Wyoming and Montana. At the same time the Crow continued to be attacked and raided by their larger northwest rivals the Blackfeet over access to buffalo herds and trade (Burlingame, 1929; Calloway, 1986; Ewers, 1961, 1972; Hoxie, 1995; White, 1978; Wishart, 1979).

As Hoxie (1995: 77) so aptly puts it, by the 1840s life for the Crow was being constrained into an ever "tightening geographical circle" as the Crow were assailed by powerful tribal enemies in every direction. This caused the constituent bands of the Crow to rarely gather or meet as larger entities for fear of attack. By the 1850s, the Sioux pushed west beyond the Powder River to harass and raid the Crow in the Bighorn and Little Bighorn valleys, the very center of Crow territory. The Blackfeet, despite their own heavy losses in warfare and through disease, raided the same region from the north, traveling south of the Yellowstone River. This ongoing conflict caused American traders to flee in its wake, and the Crow had severe difficulty maintaining lines of communication with outside traders from the mid 1850s on, despite occasional intertribal peace ventures. Ever besieged, the Crow proved to be formidable foes for their enemies, as both Sioux and Blackfeet accounts attest. As the Crow became more circumscribed in travel and action, their warrior societies became comparatively more important, as military discipline was an evermore crucial element of survival (Bad Heart Bull, 1967; Bray, 1985; Calloway, 1982; Ewers, 1961, 1967; Higginbotham, 1981; Howard, 1976; Hoxie, 1995; McGinnis, 1990).

The Crow were party to the 1851 Fort Laramie Treaty with the United States, providing for the safer transit of immigrants over the Oregon Trail, which followed the North Platte River on the Plains. This treaty also tried to formally define the territory claimed by the Crow, this at the very time large sections of it were being overrun with Blackfeet and Sioux raiders. The lack of any means of enforcing provisions of the treaty by U.S. authorities led to the Crow typically being unable to receive expected goods from annuities stipulated by the treaty. As the trader Edwin Denig saw it, by the 1850s the Crow were so assailed by their tribal enemies as to be on the road to extinction (Ewers, 1961; Hoxie, 1995; Kappler, 1971; Prucha, 1994).

The war torn decades of the 1860s and 1870s saw the increasing presence of immigrants and settlers to Crow country. The discovery of gold in western Montana and Idaho in 1862 predictably led to a new rush of migrants seeking their fortune in this once remote corner of the Plains. Similarly, the role of this rugged land as a refuge from various conflicts and White settlements on the Plains brought on new encroachments from many Indian tribes searching for increasingly scarce game, forage, or safety. The Crow now found themselves increasingly destitute, as trading companies withdrew from the area due to unprofitability. This last feature was among the most damaging, as it meant vital annuity trade goods could not often be collected, further isolating the Crow. It was thus unsurprising that the Crow chose sides and stood with the U.S. government and its troopers against their persistent Sioux enemies during Red Cloud's war of 1866-1867 over the Bozeman Trail in Montana. The Crow had hopes that this desperate alliance with the American authorities would help to expel the Sioux from their territory in the Yellowstone valley, but were generally disappointed in the results. By the Fort Laramie Treaty of 1868, the Crow were forced to cede the vast majority of their territory that had previously been recognized by the U.S. in the 1851 treaty. In return, a supposedly more secure smaller reservation was created for them in Montana, where most settled by the early 1870s. Here too they remained targets of Assiniboin, Blackfeet and Sioux raiders for the next decade, encouraging the Crow to assist the Army in its northern Plains campaign of 1876-1877 against the Sioux. Although the famous Battle of the Little Bighorn was fought on former Crow territory, with General Custer using Crow scouts, the Crow never again gained full or useful possession of the lands once lost to the Sioux (Hoxie, 1995; Hyde, 1967; Kappler, 1971; McGinnis, 1990; Smith, 1986; Utley, 1984, 1988).

Further gold strikes in Montana inevitably led to clamor from White settlers for still more reductions in the Crow reservation in subsequent years, a process that no Plains reservation escaped from. Here as elsewhere on the Plains, hostile and powerful ranching and farming interests saw to it that such Crow concessions accrued to the maximum benefit of these business concerns. By the early to mid 1880s, as the buffalo disappeared from this last range, more pressure was put on the Crow by ranchers due to the inevitable theft or poaching of cattle and horses by hungry Indians. In 1883, the Northern Pacific rail line was completed across Crow lands, creating more problems with unauthorized grazing on Crow range land and dispersing remaining buffalo herds. Also by 1880, as White encroachment, settlements, and stock theft increased in the area in and around the reservation, it became increasingly obvious that the Crow could no longer subsist by hunting alone. This was another familiar realization made about the same time or sooner over all the Plains. By the early 1880s the Crow were almost entirely dependent upon government rations for their subsistence. Although the Fort Laramie Treaty of 1868 had stipulated a relatively generous daily ration of one pound of beef per person, there are periodic reports of missing, short and inadequate rations, especially during the early to late 1880s on the Crow reservation. By this time reasonably complete records began to be kept indicating great losses for the Crow due to disease and warfare causing a dramatic population decline in the 1880s and into the 1890s. These deaths seem to be centered upon a cohort born between 1881 and 1890, during the last agency relocation of 1884 and indicate a very high mortality rate (1:3 or 33%) for children under 12 (Hoxie, 1991, 1995; Janke, 1987; Smith, 1986).

Other notable epidemic disease episodes known to have afflicted the Crow include the disastrous smallpox pandemic of 1780-1782, measles in the 1847 and cholera in the 1849 epidemic. All are suspected of causing high to moderate mortality resulting in the deaths of an estimated 10% to 25% of the population for the last two occurrences and more than 25% for the mortality toll for the late 18th century smallpox (Hoxie, 1995; Taylor, 1977).

The Kiowa

The Kiowa are usually regarded as one of the earliest migrants onto the Plains, although their early history seems necessarily obscure (Fowler, 1996; Haines, 1976; John, 1985; Mayhall, 1971; Wright, 1978). Always considered to be one of the smaller Plains tribes, at an early date the Kiowa became affiliated with an even smaller group of eastern Apache that became known as the Kiowa Apache[4] by the early 1800s (Bamforth, 1988; Bittle, 1971; Fowler, 1996; Lamar and Truett, 1996; Richardson, 1940; Ubelaker, 1992).

---

[4] The Kiowa Apache, usually numbering between 200 and 300 members during the late 19th century are generally included in Kiowa population figures, and for most of the 19th century were considered to be part of the Kiowa tribe (Bittle, 1971; Fowler, 1996; Mayhall, 1971; Parks et al, 1980; U.S. Census, 1910).

The Kiowa are the lone representatives of the Kiowa-Tanoan language family on the Plains. The Kiowa-Apache were considered part of the Athapaskan language family and separate from the Apache-Navajo dialect (Hollow and Parks, 1980; Parks et al, 1980).

The historic origins of the Kiowa place them in territory encompassing present day western South Dakota, southern Wyoming and eastern and western Montana sometime before 1720. By 1800, the Kiowa were displaced from these former territories on the northern Plains by the Sioux, and began a southern migration expanding through present day Nebraska and Colorado before coming into possession of lands in Oklahoma, southwestern Kansas and northern Texas by the first decade of the 19^{th} century (Calloway, 1982; Fowler, 1996; John, 1985; Mayhall, 1971).

After first warring with the Comanche, by 1806 the Kiowa had cemented what became a long and profitable alliance with these southernmost Plains Indians. The Kiowa assisted in the Comanche led efforts to push the Mescalero and Lipan Apaches southwestwards from the Colorado River drainage and the Plains. The Pawnee tribe and the Wichita confederation village tribes were also frequent raiding targets, as were the Caddo and Tonkawa confederations in Texas. To the west, the Navajo, Ute, and Jicarilla Apache were counted as enemies, although many of these same tribes could expect to be included in trading relationships with the Kiowa or Comanche at different times as well. Friendly trading relations continued to be maintained with northern Plains tribes also. The Crow, Arapaho, Shoshoni, and the Missouri River tribes often benefited from the horses, livestock, captives, and plunder the Kiowa deftly extracted from Mexican and American settlements on a regular basis (Fowler, 1996; Kavanagh, 1996; Lamar and Truett, 1996; Mayhall, 1971).

By the 1820s, the Kiowa were engaged in the critical role of Indian trade middlemen to both native Plains tribes and the nascent economies of established and newly created European settlements in Texas. That much of this trade was predicated upon theft and the wide dispersal of the fruits of the same did not seem unduly troubling to many parties to these transactions, native or European at this time. Again, much like their close Comanche allies, the Kiowa excelled at horse theft, and maintained relatively larger horse herds as noted by higher than average numbers of horses per capita (Ewers, 1955; Foster, 1991; Kavanagh, 1996; Mayhall, 1971; Osborn, 1983; Sherow, 1992).

Some researchers regard the Friendship Treaty of 1837 made with the government as marking the zenith of Kiowa power and prestige (Mayhall, 1971). From this time forward, the Kiowa were beset with increasing challenges and trouble stemming from newly arrived European immigrants and migrants traversing portions of their territory along the Santa Fe Trail, bringing disease and death with them as well. Some of the worst episodes to afflict the tribe came from these ordinary interactions with European migrants, settlers, and traders. Epidemics of smallpox struck in 1801-1802, 1816, 1839-1840 and in 1861-1862, the latter three episodes possibly producing mortality estimates approaching or exceeding 25%, as did the 1849 cholera epidemic occurring principally along the immigrant trails (Ewers, 1973; Kavanagh, 1996; Mayhall, 1971; Prucha, 1984).

From the time peace was made with the Cheyenne and Arapaho in 1840, the Kiowa faced a much more vigorously prosecuted warfare from territorial, state and federal forces that continued to harry and pursue the Comanche and their allies for the next 35 years. Accounts of the decreasing availability of game are also noted in Kiowa histories from at least the 1850s on. Once again this led to increased raiding by the Kiowa in Mexico and Texas, and the predictable governmental response of treaty making in an attempt to protect the vital immigrant roads with the Fort Atkinson Treaty of 1853. Hunting in the Kiowa territory south of the Smoky Hill and Arkansas Rivers became more difficult due to both migrant traffic and encroaching Anglo-European settlements after 1850. Very dry years are also noted for some of the 1850s. Continued and intermittent raids upon the immigrant roads for captives, plunder and livestock earned the Kiowa a feared reputation as marauders on par with their better known close allies the Comanche (Bittle, 1971; Flores, 1991; Fowler, 1996; Mayhall, 1971; Kappler, 1971; Prucha, 1994; Shaw and Lee, 1997).

Late or missing annuities from the 1853 treaty only led to further reported destitution of the Kiowa and Comanche, spurring on raiding as well. Again, as with the Comanche, these developments helped to force the ostensible removal of the Kiowa to Indian Territory (Oklahoma) in 1859. As raiding of settlements and wagon trains continued, government troops were sent against the Kiowa and Comanche with ever more destructive results during the late 1850s, 1860, and the mid to late 1860s through about 1875. These mounting pressures led to the signing of the Little Arkansas Treaty of 1865 and the Medicine Lodge Treaty of 1867 with the government assuring reservation lands around Fort Sill, Oklahoma, and scheduled annuities for the Kiowa in return for promises of peace, a halt to raiding, and the relinquishing of tribal lands. By the late 1860s, the coming of the railroads sounded the death knell for the great southern herds of buffalo, as White hide-hunting outfits set out to make their fortunes on the Plains. The Kiowa now clearly faced a deteriorating situation on many fronts, and remained discontented as they saw their resources being depleted at rates previously deemed incredible. Despite repeated attempts by some Kiowa chiefs to maintain the peace and to restrain their warriors from raiding, some of the Kiowa were clearly implicated in further widespread raiding in Texas and Mexico well into the early 1870s. Larger and more determined Army campaigns in 1868-1869 and 1874-1875 finally brought these destructive ventures to an end, and firmly confined the Kiowa to their reservation in southwest Oklahoma (Bittle, 1971; Mayhall, 1971; Monahan, 1972; Sherow, 1992; Utley, 1984, 1988).

The early reservation experience for the Kiowa seems by most accounts to be fairly miserable, even given an enormously sympathetic Quaker agent in one Lawrie Tatum. Measles and fevers devastated the community in 1877, as did whooping cough and malaria in 1882. As with the Comanche, supplies and rations were habitually late, more noticeably and chronically so beginning in the mid to late 1870s, when the buffalo were effectively hunted out. Starvation for the Kiowa is mentioned in 1888, and in 1892 a measles epidemic caused the death of an estimated 220 members of the tribe, mostly children (Bittle, 1971; Ewers, 1973; Mayhall, 1971; Pennington, 1978; Zwink, 1979).

The Sioux

At the time of the first White contact, the Sioux were primarily Woodland Indians living in the region near the western margin of the Great Lakes, an area that now comprises most of mid and southern Minnesota, and some adjacent areas of Iowa, Wisconsin, and North and South Dakota. At this time (ca. 1640-1700), it is believed that the tribe was divided into three major geographical divisions: East (Santee); Middle (Yankton); and West (Teton), and further divided into seven bands or original 'council fires.' These and other important bands are shown in Figure 3 (Feraca and Howard, 1963). As mentioned above, the Sioux were the largest community of Siouan language speakers, with three or four dialect divisions noted within the tribe (Hollow and Parks, 1980).

Migrations were quite frequent during the first hundred years of Sioux history after White contact. Under constant pressure from their French-allied and better armed Algonquin neighbors, the Sioux gradually moved out of their territory around the headwaters of the Mississippi (in Minnesota), and into the Minnesota River valley in southwest Minnesota. From this region, the middle and western divisions of the Sioux began to drift slowly westward, following the buffalo herds, until they reached the open plains of the Missouri Basin, in the present state of South Dakota. By 1775, the western Tetons had reached the Black Hills of southwest South Dakota and eastern Wyoming. Eventually the domain of the Teton and Yankton Sioux came to include most of the territory of South Dakota, as well as portions of North Dakota, Nebraska, and Wyoming (Hyde, 1967; Satterlee and Malan, 1968; Schell, 1975). For our purposes, we shall refer to

Western Sioux (Plains) (Teton Dakota)	Middle Sioux (Plains) (Yankton)	Eastern Sioux (Santee)
Oglala	Yankton	Mdewakanton
Brule	Upper Yanktonai	Wahpeton
Hunkpapa	Lower Yanktonai	Wahpekute
Blackfoot		Sisseton
Sans Arcs		
Miniconjou		
Two Kettles		

Figure 3: Divisions of the Sioux (Dakota) and Significant Bands

Source: Prince, J.M. 1995. Intersection of economics, history, and human biology: Secular trends in stature in nineteenth century Sioux Indians. Human Biology. 67:3:389.

both these Yankton and Teton Sioux as 'Plains' Sioux. By about 1800, the Plains Sioux were already consolidating their position and settling into the territories that were formerly occupied by the Crow, Kiowa, Arapaho and Apache tribes, rapidly displacing these older Plains tribes southward and westward from 1825 on.

By the end of the 18th century, the Sioux were already exemplars of the Plains nomadic lifeway. By 1850 they were more numerous than any other nomadic tribe on the Plains, and were by far the most successful in the imperial acquisition of territory. Indeed, as we have seen from the histories above, the entire history of the northern Plains can be largely written as either tribal alliances with the Sioux (mostly the northern Cheyenne and Arapaho), or bitter chronic warfare with these lords of the northern and central Plains (Bamforth, 1988; Fowler, 1996; Hyde, 1956, 1967; Howard, 1966; McGinnis, 1990; White, 1978).

The Sioux expanded dramatically both west and south by the 1830s. In the south in the Platte River country, they usurped the Pawnee, Ponca, and Omaha villager tribes, as well as assail migrants along the immigrant trails by the late 1840s. The terror sown by their incessant raids brought on a concentration of governmental efforts at alternatively peace and force that are justly storied and famous in the annals of the West (Calloway, 1982; Utley, 1984, 1988; Waldman, 1985; White, 1978; Wooster, 1988).

The Sioux had advantages beyond numbers; they historically had unusual access to at least two primary trade centers. The famed Dakota Rendezvous on the James River in present day southeastern South Dakota, and the Arikara trade center on the middle Missouri afforded the Sioux a superior level of access to trade outlets, which they frequently used to their military and economic advantage. The period from 1820 to 1845 saw a marked increase in the fur trade, and an influx of travelers to the northern and central Plains. Advancing lines of Euro-American settlements to the east in Minnesota caused the disappearance and retreat of the buffalo from these former ranges east of the Missouri River from 1845 on (Buechler, 1989; Ewers, 1968, 1972; Hickerson, 1974; Pickering, 1994; Secoy, 1953; Swagerty, 1988; Whelan, 1993; Wood and Thiessen, 1985).

Increasing White settlement as well as the depletion of game, both first seen in the eastern portions of the Sioux territory and gradually spreading westward, became a serious concern for first the Santee and then the Yankton Sioux from about 1840 on. Ethnographic reports mention that the Yankton and the eastern division Santee were facing famine conditions for several years from 1845 to 1850 along the Missouri valley trench region and in Minnesota. By 1850, this scarcity of game led a sizable portion of the Yanktons, represented by most of the Yanktonai bands, to hunt and more closely associate with the far-ranging western division Teton Sioux. The Teton Sioux territory now included the mountainous areas of eastern Montana and Wyoming once claimed by the Crow (Howard, 1972; Hurt, 1974; Hyde, 1967; Woolworth and Champe, 1974).

The Santee, facing these same severe pressures since the mid-to-late 1830s, became the first Sioux to be forced onto a permanent reserve in Minnesota, by treaties ratified in 1851. The Yankton bands proper were next compelled into negotiations with the government and by a treaty signed in 1858, agreed to cede their territories east of the Missouri River and withdraw to a reservation in South Dakota (Kappler, 1971; Prucha, 1994). By the 1850s, the Teton as well as the Yanktonai Sioux were regarded as 'hostiles' for their depredations upon the swelling number of newly arrived settlers to the Dakota Territory. In order to protect these settlers against the threat to livestock and horses, the U.S. Army first came to occupy the routes through Dakota Sioux territory, as well as to conduct more concerted and larger military campaigns against the Sioux (Hyde, 1967; McGinnis, 1990; Olson, 1965).

The intense period of Indian-White hostilities that are characterized as the Plains Indian Wars (1862-1876) was ignited by the Minnesota Santee outbreak of 1862 (Hyde, 1967). Most sources agree that the lack or non-delivery of treaty specified annuity payments and goods was the base cause of the outbreak. As a direct result, ethnographic accounts note that for several years prior to 1862, many of the Santee Sioux were destitute and hungry, and hundreds are said to have died of starvation. As a result of the conflict, those Santee remaining in Minnesota were removed to a reserve in the Dakota Territory, where from 1863 to 1866 there were also reports of widespread hunger and some starvation among these Sioux (Bowler, 1944; Danziger, 1970; Hyde, 1956; Prucha, 1984; Schultz, 1992).

The Teton and the many western Yanktonai were not subdued until the loss of game and buffalo forced them to make a comparatively favorable treaty with the U.S. government in 1868, after several peace commissions had been sent to them. The government's new peace policy (1875-1876) that shrewdly calculated that it was far cheaper to liberally feed the Sioux than to fight them, was a modest success in reducing hostilities. The famous campaign of 1876 involving General Custer came as a result of the government's efforts to force the remaining 1/2 to 1/3 of 'nontreaty' Sioux onto reservations. Although the government lost the Battle of the Little Big Horn, the military soon occupied all Sioux reservations, forcing a definitive close to the period of independence for this largest group of Sioux Indians (the Teton and Yanktonai represented about 75% of all Sioux at the time) (Hyde, 1956, 1967; Olsen, 1965; Prucha, 1984, 1994; Prince 1989; Textor, 1896).

By the Treaty of 1876, these Sioux were afforded unusually favorable terms in consideration for relinquishing claims to the Black Hills (South Dakota) as well as the hunting rights to lands in Montana and Wyoming. The chief provision of this agreement was the promise of certain specified rations to the treaty Sioux to continue until these Sioux became self-supporting. Seemingly no other Indian treaty provided this specific assurance of rations for such an indefinite period of time (CIA 1900; Prince, 1989). In 1876 the Sioux still retained a vast unified reservation sprawling over much of present day South Dakota, west of the Missouri River. The 'Great Sioux Reservation' was reduced by about half by 1890 through further land cessions and the General Allotment Act of 1889, whose primary purpose was to throw open these lands to Euro-American settlement (Bowler, 1944; CIA 1900; Johnston, 1948; Kappler, 1971; Prucha, 1976; Textor, 1896; Utley, 1963).

These daily rations are specified for each individual as follows: "1 ½ pounds (lbs.) of beef (or ½ lb. of bacon in lieu of), ½ lb. corn, ½ lb. flour; and for every 100 rations--4 lbs. of coffee, 8 lbs. sugar, 3 lbs. of beans" (CIA 1900:6-7). As late as 1900, the

Commissioner of Indian Affairs figured the value of a full ration at $50.00 per capita per annum, showing that for the year 1900 most Teton Sioux received the equivalent of about 70% of the full specified ration.

While the Sioux were one of the last tribes confined to a reservation on the Plains, mortality statistics indicate that they were hardly immune from the high morbidity and mortality regimens common to most Plains Indian reservations. Despite this, there is indication that their reservations in general were less prone to ration shortages, possibly due to the treaty agreements they were granted by the U.S. government (CIA 1870-1885; Hyde, 1967; Prince, 1989, 1995).

As noted by White (1978:329), "Through historical accident the very conquests of the Sioux protected them from disease [epidemic outbreaks]". By the 1820s and 1830s many of the western Sioux were ranging far from the Missouri and trade routes which were the main epidemic corridors on the Plains. A government vaccination program in 1832 also succeeded in vaccinating well over a thousand Yankton, Yanktonai, and Teton Sioux, who were then immune to the ravages of the great smallpox epidemic of 1837-1838 (Taylor, 1977; Trimble, 1992). The wide-ranging nomadic habits of the Sioux served to aid many segments of the tribe in avoiding some of the worst consequences of several epidemics seen on the Plains. This fact also probably helped enable the Sioux to maintain their population at fairly consistently high levels into the 1870s. Serious epidemics affecting the Sioux included the 1800-1803 smallpox pandemic, estimated to have killed 10% to 25% of the population. The 1818 outbreak of smallpox largely affected bands of Yankton Sioux along the White River in present day South Dakota and produced similar mortality estimates. The return of this scourge was seen in 1850-1851 and in 1859-1860, with this latter episode perhaps causing slightly higher mortality than most previous episodes.

Cholera also visited the Sioux in 1849-1850, although the mortality due to this devastating Plains pandemic was largely confined to those Sioux groups along the Platte River immigrant roads, and thus affected mainly the Brule Sioux, sparing the bulk of the tribe once again. A great and notable measles, whooping cough, and influenza outbreak occurred on the largest Sioux reservations during 1889-1890. This occurrence was held responsible for the excess deaths of many children during this period of strife leading up to the Wounded Knee Massacre of 1890 (Dobyns, 1992; Dollar, 1977; Hyde, 1956; Mooney, 1892-1893; Taylor, 1977; Thornton, 1987; Trimble, 1989, 1992; Utley, 1963; White, 1978).

CHAPTER III: RATIONALE AND METHODOLOGY

SECULAR TRENDS IN HEIGHTS AS AN INDICATOR OF NET NUTRITIONAL AND GENERAL HEALTH STATUS[5]

Anthropometric measures have long been utilized as indicators of general economic welfare and nutritional and health status. Of these measures, height--either reported for given ages, the age at which growth ceases, attained adult stature, or the rate of change or increase in height during childhood--has enjoyed the longest tradition of use, stretching back over 150 years (Tanner, 1981, 1982). Anthropometric measures of weight and height are thus said to "...reflect accurately the state of a nation's public health and the average nutritional status of its citizens" (Eveleth and Tanner, 1976:1), and are utilized by agencies like the World Health Organization to regularly assess the nutritional status of the population of less-developed countries.

There is ample documentary and clinical evidence of a variety of environmental conditions having a negative effect upon growth. In general, past studies have associated low economic status; poor living, e.g. crowding, or sanitary conditions; numerous disease states; poor access to health care; psychological stress; and above all, malnutrition, with shorter statures, delayed growth velocities, slower maturation, and reduced muscle and skeletal mass (Bielicki, 1986; Bogin, 1988a; Cameron, 1996; Frisancho, 1978; Martorell, 1985; Tanner, 1988; Tanner and Preece, 1989; Ulijaszek, 1996). It should be

---

[5] This section is taken substantially from Prince (1989).

remembered, however, that human growth is the result of a complex interplay of not only various environmental factors but hereditary determinants as well:

> Two genotypes which produce the same adult heights under optimal environmental circumstances may produce different heights under circumstances of privation. Thus two children who would be the same height in a well-off community may not only be smaller under poor economic conditions, but one may be significantly smaller than the other. This type of interaction, called non-additivity of genotype and environment, may be quite detailed and specific in its effects. If a particular environmental stimulus is lacking at a time when it is essential for the child (times known as 'sensitive periods'), then the child's development may be shunted, as it were, from one line to another. We know, as yet, little of the details of such interactions, but quite enough to make overly-simplified models scientifically suspect (Eveleth and Tanner, 1976: 222).

In this regard it has long been observed that American Black children, when matched for socioeconomic status variables with White children, show a consistent advancement over these Whites in skeletal maturation and in the formation and emergence of permanent teeth (Garn and Bailey, 1978). While African Black children seem to be similarly advanced over European Whites at birth (Masse and Hunt, 1963), by two or three years of age the Africans fall behind the Europeans in these developmental measures. This is probably due to the adverse nutritional, disease, and socioeconomic factors that could not be corrected for--representing greater detriments to growth in the African population (Bogin, 1988; Garn and Bailey, 1978). While well off American Blacks will attain adult statures similar to or above comparable American Whites, few African Blacks are afforded this opportunity. This example also illustrates the importance of critical periods of growth; growth retardation during the first few years of life largely determines the later achievement of shorter adult stature (Beaton, 1992; Henry and Ulijaszek, 1996; Martorell, 1985; Martorell and Habicht, 1986).

While the relative primacy of malnutrition among the many environmental factors affecting growth has often been suggested (Eveleth, 1986; Golden, 1996; Gopalan, 1992), it must be remembered that such nutritional influences are usually seen in conjunction with changes in morbidity and mortality, and are inevitably almost always associated with synergistic interactions with infections and numerous disease states (Chen and Scrimshaw, 1983; Gage and O'Connor, 1994; Kielmann et al., 1983; Martorell, 1980, 1985; Martorell and Habicht, 1986; Van Wieringen, 1986; Wood, 1983). As stated by Taylor (1983: 228):

> Synergism between common infections and malnutrition probably accounts for more mortality, morbidity, and reduced growth and development than any other combination of factors. Infections such as diarrhea and measles, which would be self limited in normally nourished children, continue to be major causes of mortality in children who are malnourished. In addition, common infections precipitate overt malnutrition where nutritional status is borderline.

Currently there seems to be agreement on the assessment that the variation in height (and in other anthropometric measures) attributed to environmental factors far outweighs that which can be ascribed to hereditary influences, especially when considering populations in developing countries/situations usually experiencing poverty and/or other sub-optimal conditions (Eveleth, 1986; Gopalan, 1992; Martorell and Habicht, 1986; Osmani, 1992a; Steckel, 1995; Tanner, 1994).

As a measure of nutritional status, stature is said to be a cumulative one, presenting in some sense a record of an individual's nutritional history of how effectively he or she has coped with past episodes of stress that may have led to stunting or reduced growth rates. Stunting or growth delay need not be a permanent condition if the given environmental insult is experienced for a short duration of time. In such an instance catch up growth (Steckel, 1987; Tanner, 1978) is usually successful in compensating for this delay by accelerating 'normal' growth velocities during periods of more favorable circumstances. If this period of nutritional stress, however, is prolonged (yet not severe), maturation and growth will be delayed, and will continue beyond the age at which the growth of well-fed adolescents ceases. Final achieved height may also consequently be depressed in such an instance. Frequently, an individual's response can combine these two reactions in order to achieve an adequate level of catch up growth. In general it is the periods of prolonged and severe undernutrition that are typically associated with truncated growth patterns and permanent substantial stunting (Bogin, 1988a; Frisancho, 1978; Gopalan, 1992; Kielmann et al., 1983; Martorell, 1985; Martorell and Habicht, 1986). It is also important to note that a mortality risk gradient from mild to severe malnutrition has been demonstrated (Haas, 1990; Martorell, 1980, 1985; Payne, 1992), and that even the poor in the U.S. who experience moderate, chronic undernutrition have demonstrated resultant cumulative growth deficits (Garn and Clark, 1975).

Nutritional adequacy in and of itself is not a simple concept. Nutritional requirements may vary according to a number of conditions, but can be thought of in terms of an energy or nutrient balance between the intake of essential nutrients and the physiological claims upon the body in order to maintain basal metabolic rates, the support of normal growth and maturation in children, the repair and replacement of tissues, and necessary levels of physical activity (Beaton, 1992; Fogel, 1994; Malina, 1987). Recommendations for energy and nutrient intakes must typically consider age, sex, body size, level of physical activity, stage of growth and maturation, and various physiological states, e.g. infections and/or illness, pregnancy and lactation (Gopalan, 1992; Greene and Johnston, 1980; Malina, 1987; Stallings and Zemel, 1996; Strickland, 1990). Additionally, nutritional adequacy can be influenced by a number of culturally mediated dietary practices and activity patterns such as food preferences or taboos, food preparation, food distribution, health practices, housing quality, sanitary conditions, mother's health status, and time of weaning and choice of supplemental foods for infants (Martorell and Habicht, 1986; Osmani, 1992a, 1992b; Payne, 1992; Scrimshaw and Young, 1976; Shell-Duncan 1995; Steckel, 1995; Strickland, 1990; Taylor, 1983). Accordingly, it is useful to think of nutritional status as a measure of the net nutritional balance between food consumption and the various claims on that consumption (Fogel, 1986, 1992, 1994). Malnutrition defined within this framework is the consequence of a deficit in food energy relative to need or an inadequate intake of any essential nutrient (amino acids and protein, vitamins, essential fatty acids, and minerals) (Beaton, 1992; National Academy of Sciences, 1980; Scrimshaw and Young, 1976). Malnutrition, no matter how provoked, affects growth in that this condition ultimately determines nutrient availability at the cellular level, with the attendant results of reduced rates of cell accumulation and the size of cells eventually leading to some extent of compromised functionality (Fogel, 1994; Jackson, 1985; Ulijaszek, 1996; Winick and Brasel, 1980). The further consequent results of these deficits are body wasting, and growth delay or retardation during the developmental years, which if not later made up by catch up growth will result in permanent stunting and shorter mean statures. Accordingly, it is generally agreed that mean heights provide the best indication of a population's cumulative nutritional status over time (Floud, 1992, 1994; Floud et al, 1990; Greene, 1980; Harris, 1994; Steckel, 1995; Tanner, 1982).

As noted above, the causes of malnutrition are frequently complex, involving multidimensional interactions with many disease states, and particularly infection. The particular virulence of this synergistic interaction is indicated by the assessment of some researchers that malnutrition should be regarded as one of the world's most prevalent immunodeficiency diseases (Cunningham-Rundles, 1984; Martorell, 1980, 1985). A particularly deadly combination between infection and malnutrition is seen in the diarrheal diseases, which are easily the principal cause of death from infections in children in developing countries (Chen and Scrimshaw, 1983). While a clear association can be seen between childhood illnesses (in particular, diarrheal diseases) and depressed physical growth in developing countries, this relationship is often not found in developed nations (Gopalan, 1992; Martorell, 1985; Martorell and Habicht, 1986). This further highlights the different environmental contexts in which these two disparate populations are found. Children (and adults) in the developing world experience a greater disease load and more exposure to infectious agents due to the contamination of food and water, poor personal or group hygiene and sanitation in regards to food handling, and incomplete cooking. They also generally endure infectious illnesses which are more frequent, of longer duration, and of greater severity than do their counterparts in the industrialized world (Martorell, 1980, 1985; Osmani, 1992b, Payne, 1992; Shell-Duncan, 1995).

It is important to note, however, that all infections have the capacity to worsen the nutritional status of any individual or population, regardless of the infectious agent responsible. This effect can be derived by a number of mechanisms: reduced appetite, vomiting, diarrhea, decreased nutrient absorption when the gastrointestinal tract is affected, increased metabolic loss or poor utilization of energy and nutrients, and cultural practices that may dictate dietary restrictions during illnesses (Martorell, 1980, 1985; Rotberg and Rabb et al, 1983). It should be remembered that such episodes of infection divert nutrients from growth, and cause the body to draw heavily upon nutrient reserves, which in turn may cause growth to cease for the duration of the infectious event (Golden, 1996; Jackson, 1985; Martorell and Habicht, 1986). This then provides a good rationale of how malnutrition can be brought about with a disease state as a primary cause, illustrating the point that simple inadequate nutrient intake, in any context, can not be said to explain all of the variation seen in the nutritional status of a population--or the mean height series that is the principal measure of this status.

As mentioned previously, an already depressed nutritional status within an individual or a population generally is capable of reducing resistance to infection, consequently increasing the frequency and severity of many infections. These effects are mediated through a variety of mechanisms: depressed immunocompetence, reduced production of antibodies, less effective phagocytosis, weakened epithelial barriers, and lower lysozyme production (Cunningham-Rundles, 1984; Jackson, 1985; Martorell, 1980; Osmani, 1992b; Rotberg and Rabb et al, 1983; Wood, 1983). As not all infections are nutritionally sensitive, and the body's resistance to sufficiently virulent pathogens incidental in any case, there is a range of infections that can be identified in which the nutritional status of subjects often plays a deciding role in the outcome of such episodes and in possible subsequent mortality. These infections need to be both nutritionally sensitive and of an intermediate degree of virulence. These are apt to include the same common childhood ailments (measles, chicken pox, mumps, and rubella) that are familiar to most people even within industrialized countries. That well-nourished children in the developed world usually manage to avoid the sequelae of stunting in association with these familiar conditions further indicates the importance of nutritional status in interceding in such contexts and allowing for catch up growth, which quickly made up the losses seen from the more infrequent episodes of these illnesses (Fogel, 1986a; Gopalan, 1992; Martorell, 1980; Rotberg and Rabb et al, 1983). Other illnesses that are known to be definitely influenced by nutritional status are tuberculosis, pertussis (whooping cough), pneumonia, and most respiratory infections, most intestinal parasites, cholera, herpes, malaria, the diarrheal diseases, as well as many other illnesses caused by viruses, mycobacteria, protozoa, and fungi (Cunningham-Rundles, 1984; Martorell, 1980).

Finally, it is within this context that mean heights can be utilized as an indicator of the net nutritional and general health status of a population (Fogel, 1994; Steckel, 1995; van Wieringen, 1986). While acknowledging that this relationship can be quite complex, and that the effect of growth delay will vary from one disease state to another and within different contexts, health status is still inevitably reflected in a mean height series in a generalized manner (Beaton, 1992; Tanner, 1981, 1982, 1994). Fogel (1986:116), recognized that:

> an oversimplified approach which assumes strict proportionality or some other simple relationship between stunting or its absence will miss or greatly underestimate . . . much of the range of diseases occurring among well-fed populations.

This includes most chronic diseases. The interactions between many disease states (particularly infections) and malnutrition have definite consequences for nutritional status, particularly in underdeveloped situations, namely an increased risk of infection and mortality as well as physical growth retardation. Again, we are reminded by Fogel (1986: 33) that:

> although mean height is a good measure of nutritional status, it does not by itself indicate whether fluctuations in net nutrition are due to fluctuations in the consumption of food, in the claims on the food intake, or in the efficiency with which food is converted into outputs.

It remains difficult to decompose the effects of these various factors on growth and mortality, and no direct attempt will be made in this study in this regard.

Secular trends or changes in growth refer to long-term alterations in the pattern of growth and development in a given population. Generally these changes do not occur uninterruptedly in any one direction, but exhibit cycles of changes in growth (here mean heights) in response to shifting environmental circumstances, as described above. These fluctuations are described with the adjective 'positive,' denoting greater growth velocity, increased adult (or child) heights, and earlier maturation; and the adjective 'negative,' designating the reverse situation, depressed heights over time or delayed growth. In general, an increase in height (over time) or earlier maturation can be regarded as a favorable indicator of a population's nutritional and health status, as these changes are strongly associated with better living conditions, reduced morbidity and mortality, and improved socioeconomic status (Bielicki, 1986; Eveleth, 1986; van Wieringen, 1986).

It should be mentioned, however, that a tall stature as such is not 'better' than a smaller one, only that given adverse conditions (undernutrition, poor living standards) a population may not be able to express the maximum size permitted by the genes, an outcome that has only recently been realized throughout the industrialized world (Eveleth and Tanner, 1976; Gopalan, 1992; Tanner, 1981). While severe malnutrition and accompanying poor social and living conditions do seem to be associated with certain motor coordination and cognitive deficits during early childhood (Balazs et al, 1986; Wooten and Jackson, 1996), this does not necessarily imply that our 19th century

European or American ancestors, who fell into the 25th percentile of a modern height distribution (at age 18) never came to express their 'full' normal intellectual or cultural potential (Komlos, 1987; Steckel, 1986a). Tall statures do seem, however, to confer some longevity, morbidity, and mortality advantages to those who possess them.

While it is noted that positive secular changes are usually concomitant with favorable trends in a variety of indices of economic well-being and improved living standards, these growth changes are entirely reversible given periods of economic or living standard deterioration. Indeed, such a cycle in heights can be seen for native-born White males within the United States during the later 19th century. Fogel (1986, 1992, 1994) and others (Steckel, 1994, 1995) have reported that the mean heights of these Americans declined after 1830 and only recovered this statural loss after about 1890.

MATERIALS AND METHODS

The Composition and Derivation of Samples Utilized

The adult height data analyzed for secular trends for this study are derived from the Boas data set, and consist of anthropometric measurements obtained by Dr. Franz Boas from Native Americans [Indians] and collected for the World's Columbia Exposition held in Chicago in 1892 (Boas, 1894a, 1895). These data were rediscovered by Dr. R.L. Jantz in 1982, and are currently being utilized in several ongoing research programs at the Department of Anthropology, University of Tennessee, Knoxville (Jantz, 1995a, 1995b; Jantz et al, 1992).

Although collected under similar circumstances, as most of the Plains Indians were on reservations or under government agency oversight at the time, e.g. at a boarding school, it can be shown that within the tribal samples discernibly different contexts do exist. This is particularly true for students who may have been measured at distant boarding schools or individuals in the employ of such agencies. It is clear, however, that most of the subjects represented in the database were measured at or near particular Indian agencies or on reservations, as they existed in the early 1890s. Again, these reservations may not well reflect the highly changeable 1800 to 1870 tribal occupancy or tenure on the Plains, but merely the latest bureaucratic relocation at time of measurement (Jantz et al, 1992, Prucha, 1976, 1984; Ross and Moore, 1987; Schmeckebier, 1927).

Within certain tribal designations some bands or divisions can be shown to be over-represented in the tribal samples. This is especially true of the tribes with far flung northern and southern divisions, like the Arapaho and the Cheyenne. By observation place noted in the records, seemingly no northern Cheyenne are included in this present sample of male adults. Similarly, the northern Arapaho are most likely over represented in this sample, with the historically (1875-1892) larger segment of southern tribe members being undercounted. Again, due to highly variable population figures, it is difficult to be precise, but it appears that the Arapaho sample is missing possibly about 33% to 36% of the southern Arapaho estimated to be present in the larger population. Likewise, with all northern Cheyenne being absent from the male Cheyenne sample, approximately 34% to 38% of the Cheyenne are thus unrepresented here (CIA 1875-

1890; Gussow, 1974; Moore, 1987; U.S. Census, 1910; Wissler, 1936b). Another factor to consider that further complicates such static accounting are migrations by individuals who may have been born in the north country, but who later settled in the south. This type of migration was fairly frequent, and can be documented to a certain degree for at least three generations of Cheyenne (Moore, 1987). Thus it is entirely possible that a southern Cheyenne or his/her parents were born in the north. It is probably only in the 1860s that just over 25% of the Cheyenne listed in the 1900 census were born in the south in either Oklahoma or Indian Territory (Moore, 1987).

Tribes straddling the U.S.-Canadian border faced similar problems, not only with accurate counts due to highly mobile populations, but also with a natural or necessary tendency to over sample the U.S.-based Assiniboin and Blackfeet. For the Assiniboin it is presently not possible to estimate this effect, but it seems that about 23% of the historic (circa 1892) Canadian Blackfeet are unrepresented by this present sample (Ewers, 1955, 1967; Wissler, 1936b).

The composition of various tribal samples can then be said to be variable and opportunistic, as is true of most historic anthropological samples (Jantz, 1995b). The analysis published by Sullivan (1920) shows that all three major divisions of the Sioux are included in the Boas data set in proportions that roughly reflect the various major band populations (ca. 1891-1892) within the larger Sioux tribe (Prince, 1989). As we have seen above, this probably can not be safely claimed for most of the tribal samples used here.

Only individuals possessing both salient measures (standing height and sitting height) were included in the analysis. Although a previous analysis (Prince, 1989, 1995) utilized all individuals ascribed to a given tribe (Sioux), the present analysis uses only subjects identified as being full-blooded, or nearly so. This was judged from 'tribe' 'tribe of mother' and 'tribe of father' entered on the original data sheets (Jantz et al, 1992). This is done to attempt to counter the effects of admixed individuals present in the sample (Logan and Ousley, 1996), although it should be acknowledged that this effort may not be completely adequate (Moore and Campbell, 1995). Therefore individuals noted with less than a 0.75 or ¾ 'blood quantum' were excluded from the analysis.

As previously noted, all individuals indicated as members of a particular tribe were pooled, regardless of where they were sampled. The Blackfeet Confederacy includes the constituent tribes of the Blood and the Piegan. A previous analysis had excluded females due to low sample sizes. At least four female tribal samples, however, had reasonably adequate sample sizes (n>25), and so they will be reported on here to attempt to provide a more complete picture of possible trends in the sample (i.e. the Comanche, Crow, Kiowa, and Sioux). Table 2 shows the sample composition by tribe and by sex.

Problems of Samples Utilized

As alluded to above, there is a series of issues pertaining to the unique nature of the Boas data set and samples derived from it that need to be addressed. As Szathmary

Table 2: Sample Size by Tribe and Sex

Tribes/Sex	Arapaho	Assiniboin	Blackfeet	Cheyenne	Comanche	Crow	Kiowa	Sioux	Totals
Male	57	22	58	29	73	227	73	584	1,123
Female	4	1	13	2	31	96	32	183	362
Totals	61	23	71	31	104	323	105	767	1,485

(1995) and others (Jantz, 1995b; Jantz et al, 1992) have noted, small sample sizes are indeed a persistent problem in the Boas tribal samples. This primarily has the effect of increasing variances, which affects the ability to detect significant differences between populations. Normally, sample sizes below n=25 should be rejected. For heuristic purposes I will report on several samples that fall below this criteria: the Assiniboin males (n=22) and the Blackfeet females (n=13). It is recognized that statistical inferences from such small sample sizes will remain unreliable and suspect. As simple summary statistics for most of these tribes have not seen the light of day for several decades (Sullivan, 1920; Wissler, 1912; 1971), I feel that it is useful to report on such measures here, regardless of sample size. As noted by Jantz (1995b), and others (Logan and Ousley, 1996), the Boas data set is the largest historical anthropometric collection ever gathered on North American Indians. The unique nature of this data set is not diminished by the lack of modern sampling techniques by the diligent and foresighted 19th and early 20th century researchers who collected these data.

The relative paucity of data from females has also been commented upon (Moore and Campbell, 1995). Szathmary notes (1995: 339) this dearth may be due to particular cultural prohibitions "...but also because most women, including aboriginal women today, dislike being touched by strange men". Almost all of the observers for the Boas database were indeed males and where the one female observer was present in Siberia, the female subject participation rates improved greatly.

A much more serious issue concerns the possible effects of admixture (Little and Malina, 1986). Near significant results have been reported on the correlation of increased height with degree of admixture in the Boas database (Logan and Ousley, 1996). This effect seemingly was well appreciated by some of the original investigators to utilize the Boas data set (Boas, 1894b; Wissler, 1971). Wissler for one, however, remained skeptical of this effect due to contradictory results (Wissler, 1911, 1971). What seems to be the most consistently noted biological effect of increased admixture and intermarriage with White-Europeans or Americans is the subsequent greater effective fertility of mixed bloods. This is probably due in part to increased infant and child survivorship and possibly reflective of generally better social or economic conditions (Boas, 1894b; Campbell, 1991; Hrdlicka, 1931; Logan and Ousley, 1996; Swan and Campbell, 1989). These differentials could easily persist within tribes with some population segments experiencing differing utilization of health care, previous disease experience, access to rations, types of dwellings, access and instruction on the need for clean water, ability to generate cash income, and farm and land productivity being all factors that would likely enter into consideration (Johnston and MacVean, 1995; Lee, 1997; Pope, 1992; Smith, 1983). Additionally, the common Plains Indian practice of taking captives was also a significant source of admixture (Ewers, 1994; Fowler, 1996; Moore and Cambell, 1995). In some instances this may have had a homogenizing effect on some populations (Jantz and Meadows, 1995). Again, we attempted to minimize the degree of mainly White admixture by excluding any subject with less than a ¾ Indian 'blood quantum' from the analysis. While this solution is not wholly satisfactory, as it remains difficult to control for actual admixture in such a manner (Moore and Campbell, 1995), it is the most practical way to proceed without a detailed examination of tribal rolls and individual family histories.

The Boas data set presents the concern of the composite nature of the collection. This is because the Boas data are essentially a composite set of measures taken by several observers. Dr. Boas himself instructed observers in the proper techniques of measurement, and one of his students trained others in these methods on the West Coast, all in an effort to minimize interobserver error and variation (Jantz, 1995b; Jantz et al, 1992). Within the last two years, R.L. Jantz has acquired a copy of the actual instruction sheets provided to observers (Boas and Putnam, no date), indicating that the standard battery of measurements described were routine and seemingly taken after Topinard (1885). Importantly, wherever possible, Boas also sent more than one observer to the same tribes. To further minimize interobserver variation, Boas also provided each observer with a standard set of instruments, and training sessions included practice in their use. While these controls can not be said to be wholly adequate (Jantz, 1995b; Jantz et al, 1992; Szathmary, 1995), they were certainly exemplary for the time.

The small sample sizes that characterize several tribal samples also raises the question of possible bias or truncated height distributions (Fogel et al, 1982; Fogel et al, 1983). Bias may arise in the Boas tribal samples due to factors such as incompletely characterized sampling protocol, unrepresentative, or non-random samples, or simply missing or lost original data sheets. From an accounting given by Boas (1895), there is good concordance with the male tribal sample sizes from that day to this study, something that is remarkable given the passage of time. Still, the fact that heights are well distributed normally allows for methods that can robustly estimate heights, even in historical military recruit samples where the lower end of the height distribution is known to be truncated (Floud et al, 1990; Fogel et al, 1982; Fogel et al, 1983; Margo and Steckel, 1983; Steckel, 1988a, 1995; Wachter, 1981; Wachter and Trussell, 1982). Given this fact, most bias should not seriously distort secular trends in heights as long as the distribution of individual or mean heights retains an approximately normal distribution (Fogel et al, 1983; Steckel, personal communication, 1988, 1996). Accordingly the normality of the height distributions was explicitly tested using the proc univariate procedure in SAS (1990) which provided graphical stem and leaf and box plot diagrams as well as normal probability plots for each variable tested, by tribe and by sex. The Shapiro-Wilk test was also utilized in this procedure, which tested the normality of the underlying distribution for each variable. All of the tribal samples, where $n \geq 20$ had distributions that could be characterized as normal at the $p \leq 0.10$ level of confidence on the Shapiro-Wilk's 'W' measure. An examination of the stem and leaf and box plots produced by this procedure did reveal some kurtosis for some variables, but all indicated an approximately normal variable distribution with few exceptions. Kurtosis in the distributions for the Cheyenne males was noted as well as for Blackfeet and Comanche females.

The overall total sample was also tested in this manner, with sexes analyzed separately. The resulting distributions could easily be characterized as normal at the $p \leq 0.05$ level of confidence on the Shapiro-Wilks 'W' measure. Kurtosis and skewness were also found to be minimal for these two large sub-samples (male and female).

There is a possibility that poor accounting for ages also may be a source of bias. As noted by Fogel et al (1983), however, accuracy in the age of subjects would only have minor effects on the determination of a secular trend in the final heights of adults, as growth has ceased by this time and errors on the order of +/- two years can be tolerated. Still, some of the tribal samples do seem to show this type of age heaping (Steckel, 1987) to a moderate degree when an inspection of the actual ages in the samples is made. By analysis for secular trends by decade of birth, it is thought that this type of bias can be greatly minimized, if not eliminated from the current study (Steckel, personal communication, 1996).

METHODS AND ANALYSIS

Secular change in stature is perhaps best studied using longitudinal data, when available (Relethford, 1995). There have been, however, very few longitudinal studies that have provided data relating to the change in adult heights in populations over the age of 20 (Borkan et al, 1983; Cline et al, 1989). It is generally acknowledged that change in adult height over time is due to two main factors: 1) the effects of aging on height, with the compression of intervertebral disks, weakening or imbalance of muscle groups, postural changes, and osteoporosis tending to decrease stature with advancing age; and 2) discernible secular trends, where a birth cohort effect can be observed in final attained stature (Cline et al, 1989; Himes and Mueller, 1977; Relethford and Lees, 1981; Rogers, 1982; Rossman, 1986). These relationships can also be influenced by differential migration and survival (Bogin, 1988b; Malina, 1979; Relethford and Lees, 1981). Again, the major factors affecting height might be better controlled and apportioned if one were conducting a longitudinal study or a comparison of same. Because the Boas data set is cross-sectional in nature, a way of partitioning the effects of aging and secular trends on changes in adult stature is required.

A previous study (Prince, 1989, 1995) utilized a height-adjustment method suggested by Himes and Mueller (1977); however, it appears that this method is sensitive to the type of relatively small sample sizes commonly encountered in many anthropological samples (Relethford, 1995). Additionally, the Himes and Mueller method assumes that statural loss due to aging occurs mainly through disk compression and changes in the spine. While such statural loss may occur primarily in the spine (Susanne, 1980), this method may not capture the entire whole body effects of such loss, and further assumes that trunk and leg proportions remain constant during secular change in height. Given this, the choice was made to utilize a formula presented by Cline et al (1989) to adjust for age related stature loss. The Cline et al method takes into account the non-linear effects of aging, unlike Himes and Mueller (Relethford and Lees, 1981). Two formulae were derived by Cline et al (1989) from a study of a large longitudinal sample of White American adults, one for males and one for females:

$$\text{Males: Max Height} = \text{Standing Height} + 3.27651 - 0.16541\,(\text{age}) + 0.00209\,(\text{age})^2$$

$$\text{Females: Max Height} = \text{Standing Height} + 5.13708 - 0.237765\,(\text{age}) + 0.00276\,(\text{age})^2$$

Thus, the adjustment for each case is added to the observed standing height to become 'max height'. Sitting height is also adjusted similarly and becomes 'max sitting height'. Subischial length is derived by subtracting max sitting height from max height. Thus, the bodily dimensions that are examined for secular change include max height (or max standing height), max sitting height and subischial length. The ratio created by max sitting height/subischial length is also studied to examine any secular change in this relationship. All heights are in centimeters (cm).

The years of birth are calculated by subtracting the age of the individual from the year of final observation, 1892. Each of the variables, max height, max sitting height, subischial length and ratio, is then regressed on to year of birth (YOB). The model used is as follows:

$$Y = b_0 + b_1\,(\text{YOB}) + b_2\,(\text{YOB})^2$$

Where Y = each of the predicted variables

These fitted lines are then plotted, using decade means for the sake of clarity. The null hypothesis being tested is that year or decade of birth has no effect on max heights, max sitting heights, ratio, or subischial length as defined above, at a $p \leq 0.05$ level. This polynomial regression is accomplished utilizing the SAS GLM (General Linear Model) procedure (SAS II, 1990).

Simple summary statistics for unadjusted and adjusted ‘max’ variables are given in Appendix A-1 for males by tribe and decade of birth, and Appendix A-2 for females. Please note that Blackfeet are listed as Piegan in the Appendices.

CHAPTER IV: RESULTS AND DISCUSSION

RESULTS OF ANALYSES ON TRIBAL HEIGHT SERIES

The results of the analyses for secular trend by tribe will follow an overall assessment of possible trends for the entire Plains sample (males n=1,123; females n = 362). Some common trends among the various tribes might be further illuminated in this manner.

Utilizing the quadratic regression mentioned above, each variable was tested for secular trends with sexes being analyzed separately. The results of these initial regressions are presented with the outcome of the statistical tests for the significance of the regressions displayed preceding the plots for each. These tests are reproduced directly from the output of the SAS (SAS Institute, 1990, 1996), PROC GLM procedure, which displays the results of each regression in an ANOVA format. PROC GLM yields the F test statistic for Type I, or sequential, sums of squares, recommended for polynomial models without interaction terms (SAS Institute, 1990, 1996). Again, all regressions except subischial were performed using adjusted heights, which corrects each reported height for the expected rate of statural loss per year after age 40, and produces an estimated maximum height for all ages in the sample (Cline et al, 1989). The null hypothesis tested here and elsewhere was that there were no differences ($p \leq 0.05$) among the means of the various years, within each sample.

The first tests for secular change or trends yielded significant results for the overall Plains male and female samples for the variables max height, max sitting height, and ratio (max sitting height/subischial length). All heights are displayed in centimeters. As the tests on the variable subischial length were not significant, they will not be presented here. The results of these quadratic regressions by variable are seen in Figures 4, 6, and 8 for males, and Figures 10, 12, and 14 for females. Accordingly when the Plains sample is pooled with sexes analyzed separately, it is fairly clear that there are significant differences between the means of the birth cohorts, and hence the results show a secular change through time. The results of these significant regressions are shown in Figures 5, 7, and 9 for the Plains males, and Figures 11, 13, and 15 for Plains females. Indeed, analysis shows that simple regressions would also adequately demonstrate these differences between decade means for the variables max sitting height and ratio in both male and female samples of Plains Indians. The quadratic model, however, is probably the better fit for the data, with the possible exception of 'ratio' and hence the curve of line in Figures 9 and 15 may be misleading. This last variable may be heavily influenced by the greater numbers of Sioux males in the sample, n=584 compared to n=539 for all other Plains Indian males. This is indeed a distinct possibility affecting all the variables of both sexes, and one good reason why any analysis for secular trends should concentrate on tribal data.

If the data for the entire sample were analyzed using simple linear regression, some estimates of the rates of such secular change can be obtained. Recognizing that this

General Linear Models Procedure

Dependent Variable: MAXHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	403.4329243	201.7164622	5.29	0.0052
Error	1120	42733.6184772	38.1550165		
Corrected Total	1122	43137.0514015			

R-Square	C.V.	Root MSE	MAXHT Mean
0.009352	3.579628	6.176975	172.5591

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	135.0196201	135.0196201	3.54	0.0602
YOB2	1	268.4133042	268.4133042	7.03	0.0081

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	266.6019963	266.6019963	6.99	0.0083
YOB2	1	268.4133042	268.4133042	7.03	0.0081

Figure 4: Male Test of Significance for the Regression of Max Height by Decade of Birth for Entire Plains Sample

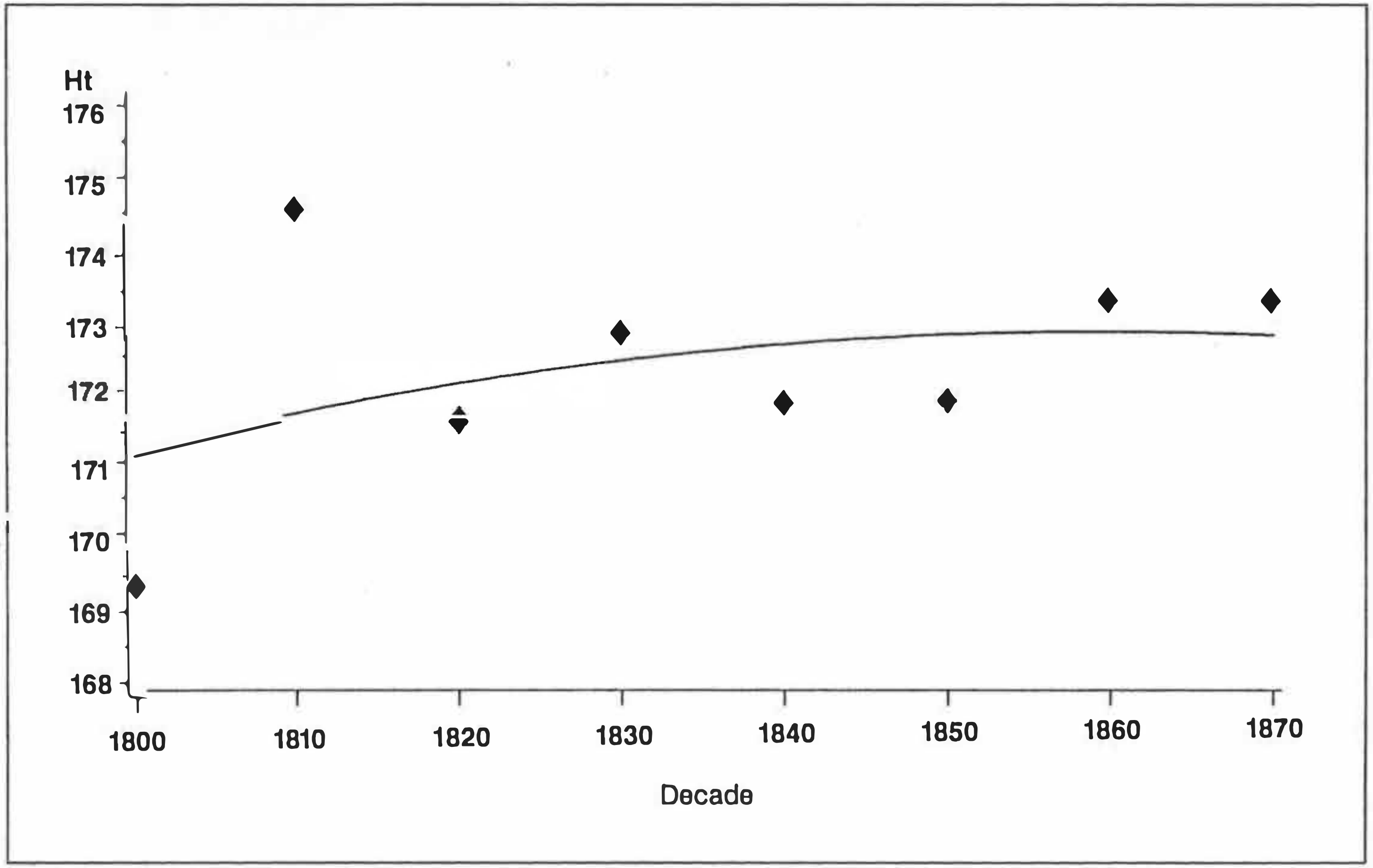

Figure 5: Plot of Significant Quadratic Regression for Male Max Height by Decade of Birth for Entire Plains Sample

General Linear Models Procedure

Dependent Variable: MAXSITHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	341.0733975	170.5366988	13.49	0.0001
Error	1120	14162.2858385	12.6448981		
Corrected Total	1122	14503.3592360			

R-Square	C.V.	Root MSE	MAXSITHT Mean
0.023517	3.988585	3.555967	89.15360

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	270.1780301	270.1780301	21.37	0.0001
YOB2	1	70.8953674	70.8953674	5.61	0.0181

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	69.58523216	69.58523216	5.50	0.0192
YOB2	1	70.89536739	70.89536739	5.61	0.0181

Figure 6: Male Test of Significance for the Regression of Max Sitting Height by Decade of Birth for Entire Plains Sample

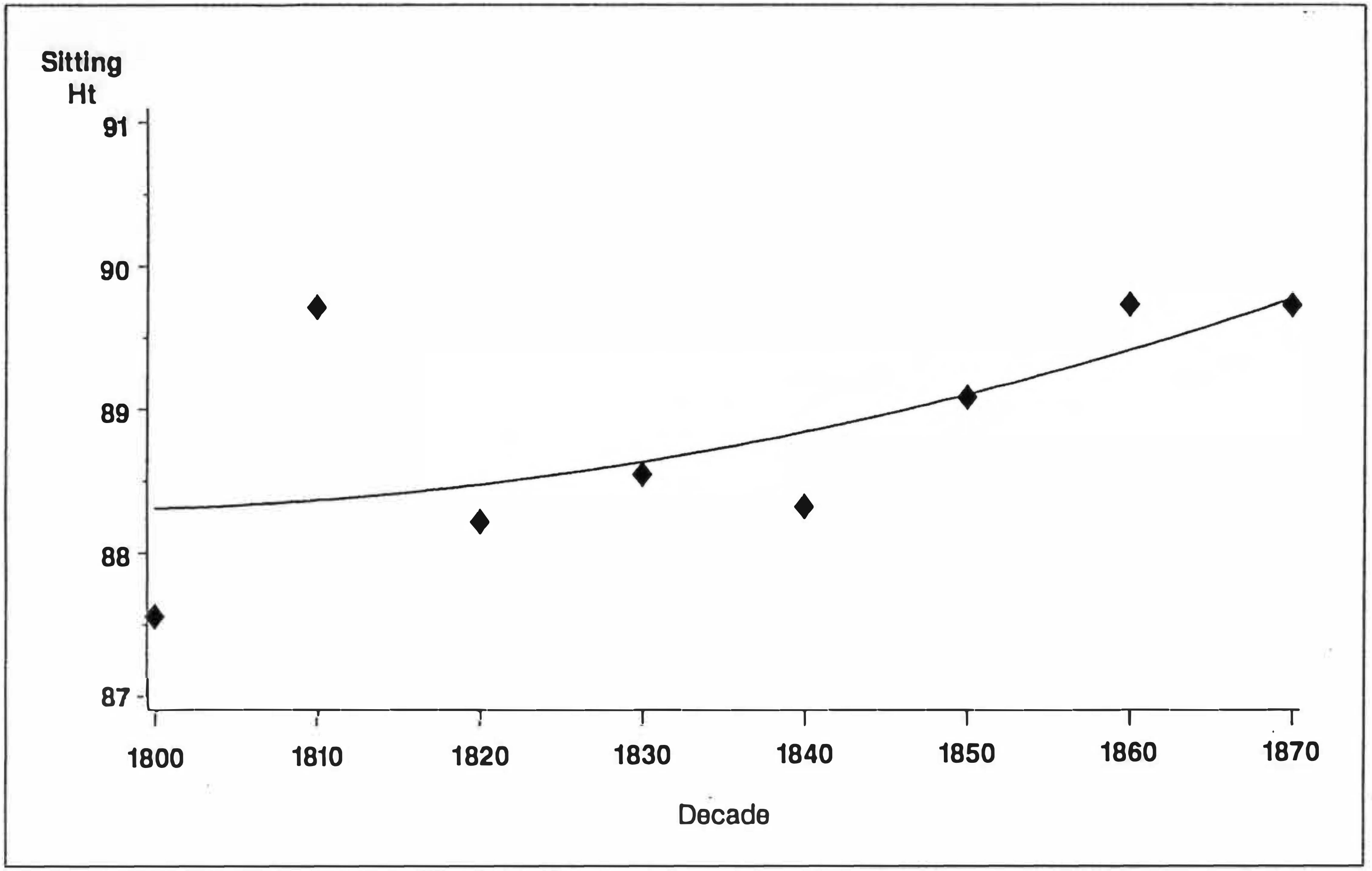

Figure 7: Plot of Significant Quadratic Regression for Male Max Sitting Height by Decade of Birth for Entire Plains Sample

General Linear Models Procedure

Dependent Variable: RATIO

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.06698615	0.03349307	6.99	0.0010
Error	1120	5.36435984	0.00478961		
Corrected Total	1122	5.43134598			

R-Square	C.V.	Root MSE	RATIO Mean
0.012333	6.455920	0.069207	1.071993

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	0.06692059	0.06692059	13.97	0.0002
YOB2	1	0.00006556	0.00006556	0.01	0.9069

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	0.00008696	0.00008696	0.02	0.8928
YOB2	1	0.00006556	0.00006556	0.01	0.9069

Figure 8: Male Test of Significance for the Regression of Ratio by Decade of Birth for Entire Plains Sample

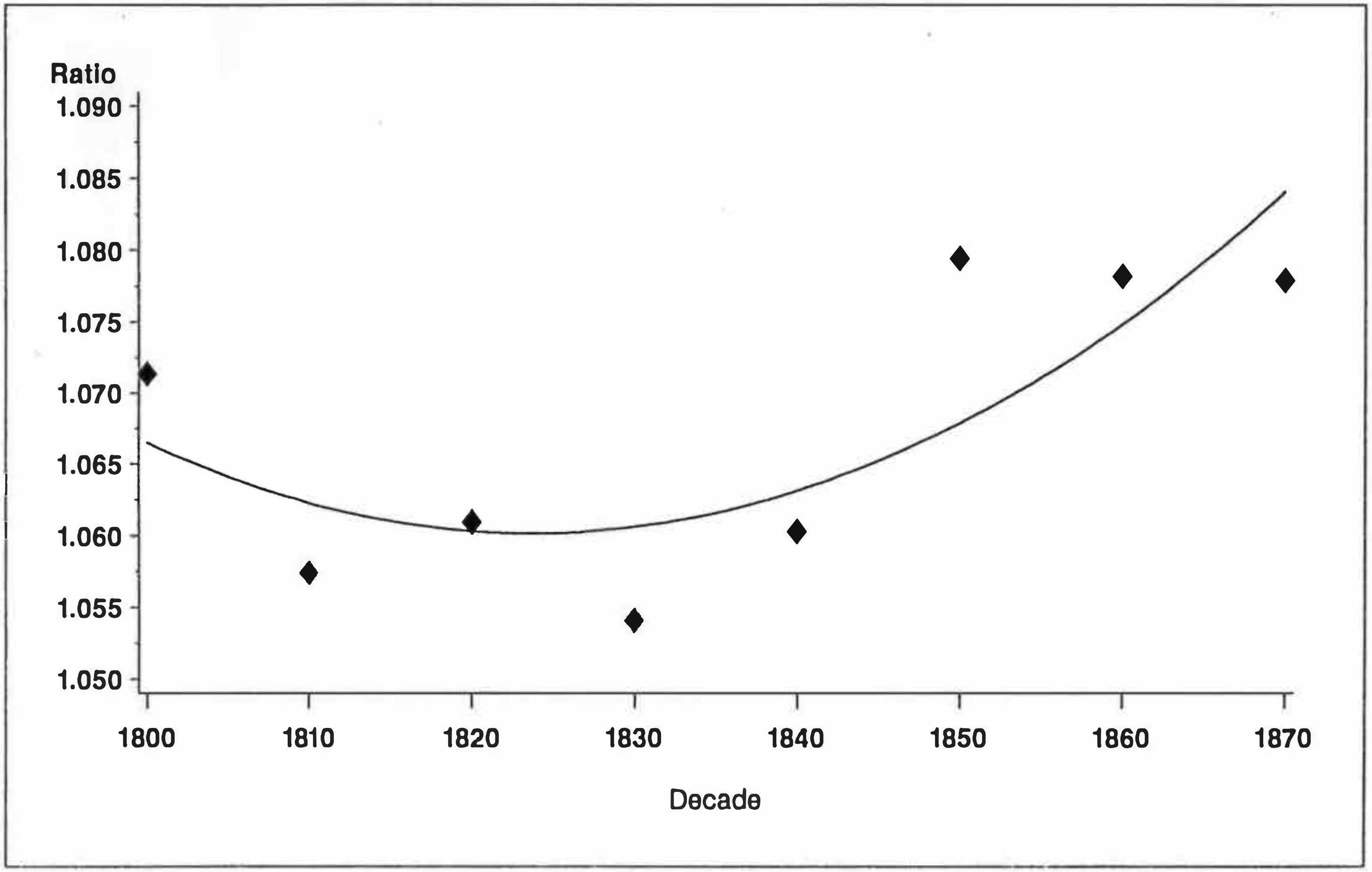

Figure 9: Plot of Significant Quadratic Regression for Male Ratio by Decade of Birth for Entire Plains Sample

General Linear Models Procedure

Dependent Variable: MAXHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	333.5358553	166.7679276	6.66	0.0014
Error	359	8990.4065383	25.0429151		
Corrected Total	361	9323.9423935			

R-Square	C.V.	Root MSE	MAXHT Mean
0.035772	3.133647	5.004290	159.6954

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	108.7443797	108.7443797	4.34	0.0379
YOB2	1	224.7914756	224.7914756	8.98	0.0029

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	223.2453181	223.2453181	8.91	0.0030
YOB2	1	224.7914756	224.7914756	8.98	0.0029

Figure 10: Female Test of Significance for the Regression of Max Height by Decade of Birth for Entire Plains Sample

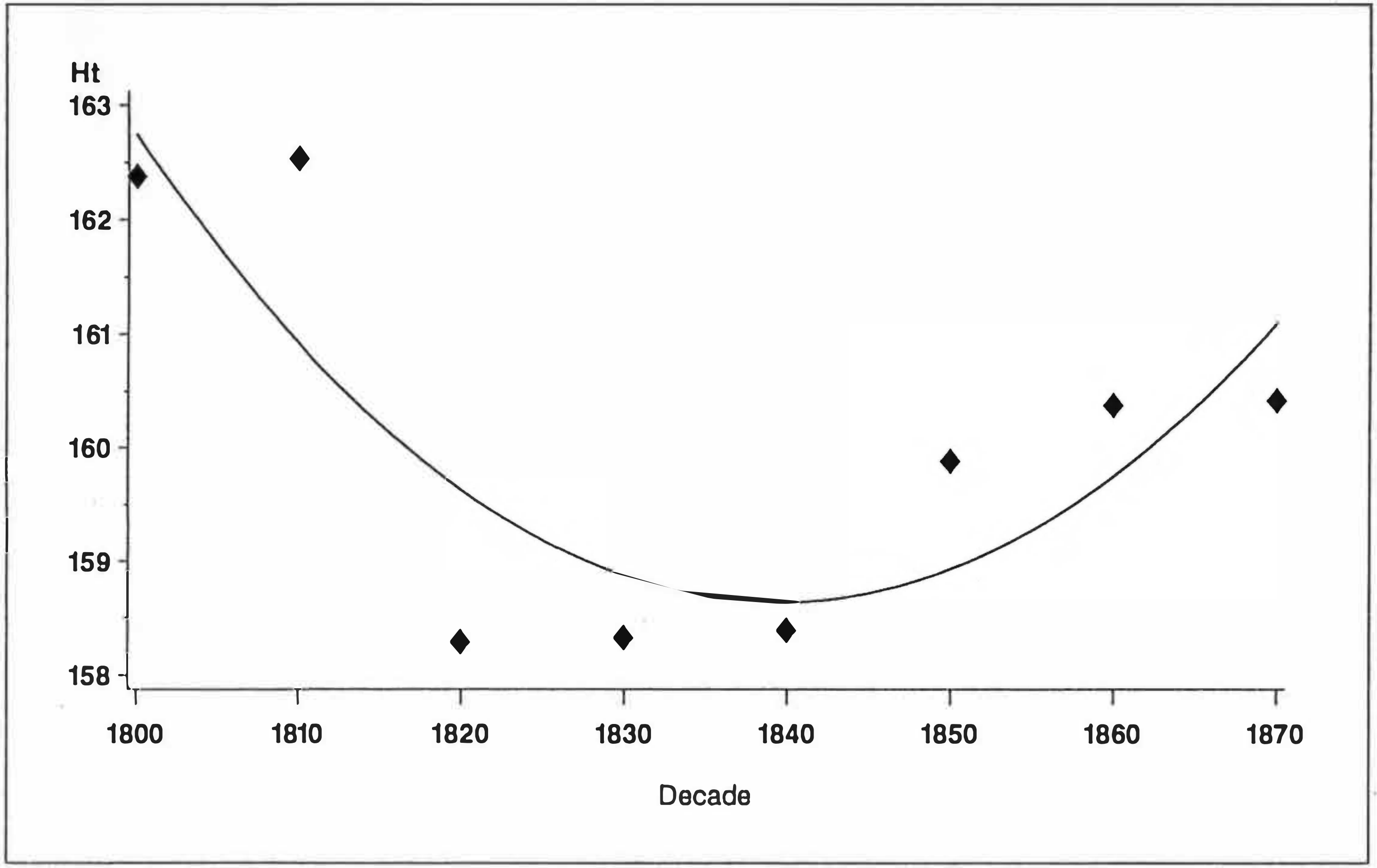

Figure 11: Plot of Significant Quadratic Regression for Female Max Height by Decade of Birth for Entire Plains Sample

General Linear Models Procedure

Dependent Variable: MAXSITHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	385.2219355	192.6109678	16.10	0.0001
Error	359	4296.1571904	11.9670117		
Corrected Total	361	4681.3791259			

R-Square	C.V.	Root MSE	MAXSITHT Mean
0.082288	4.191952	3.459337	82.52330

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	256.6054450	256.6054450	21.44	0.0001
YOB2	1	128.6164905	128.6164905	10.75	0.0011

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	126.8263334	126.8263334	10.60	0.0012
YOB2	1	128.6164905	128.6164905	10.75	0.0011

Figure 12: Female Test of Significance for the Regression of Max Sitting Height by Decade of Birth for Entire Plains Sample

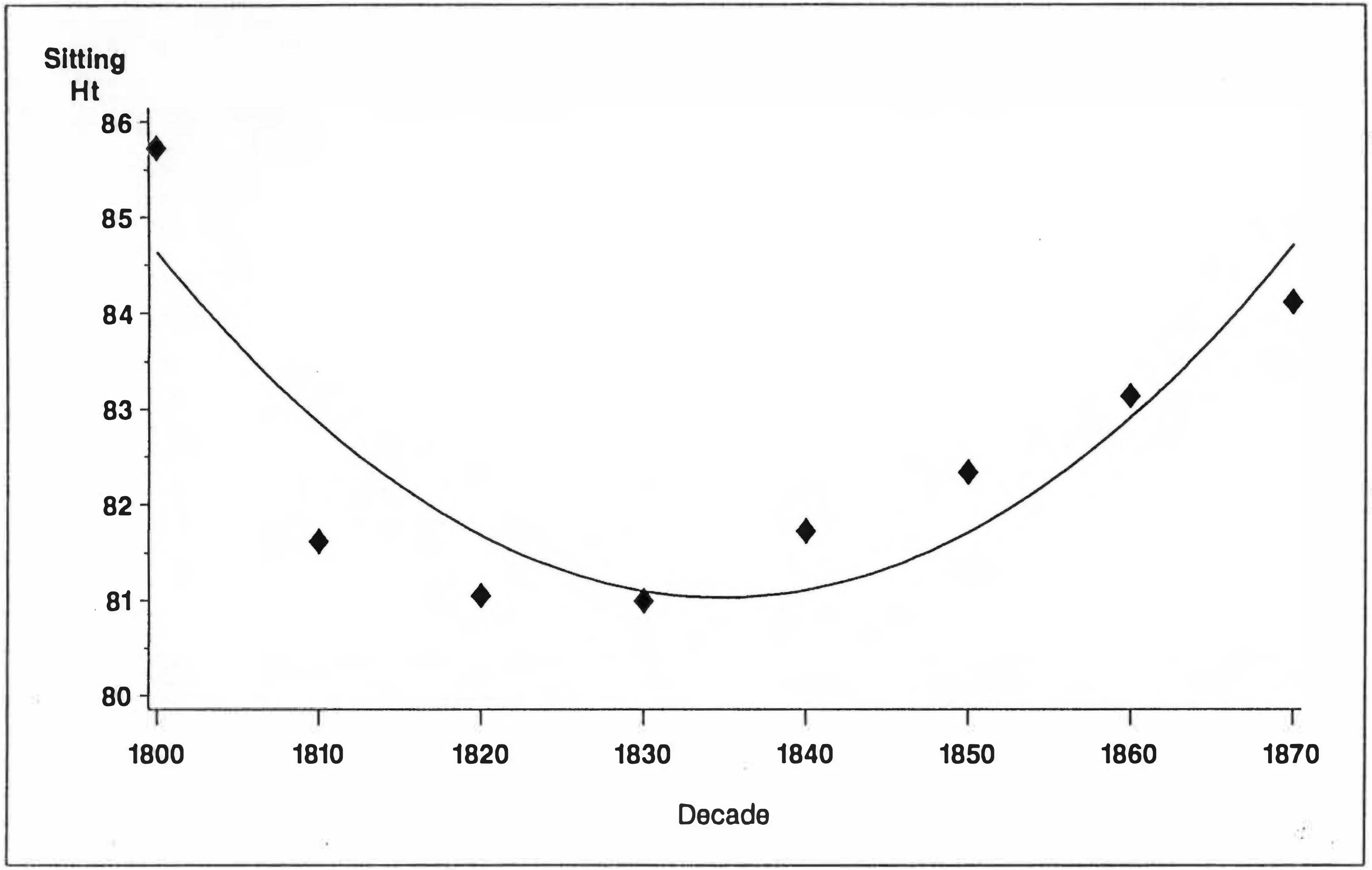

Figure 13: Plot of Significant Quadratic Regression for Female Max Sitting Heights by Decade of Birth for Entire Plains Sample

General Linear Models Procedure

Dependent Variable: RATIO

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.09241927	0.04620963	7.66	0.0006
Error	359	2.16474028	0.00602992		
Corrected Total	361	2.25715954			

R-Square	C.V.	Root MSE	RATIO Mean
0.040945	7.238019	0.077653	1.072842

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	0.08162244	0.08162244	13.54	0.0003
YOB2	1	0.01079683	0.01079683	1.79	0.1817

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	0.01050552	0.01050552	1.74	0.1877
YOB2	1	0.01079683	0.01079683	1.79	0.1817

Figure 14: Female Test of Significance for the Regression of Ratio by Decade of Birth for Entire Plains Sample

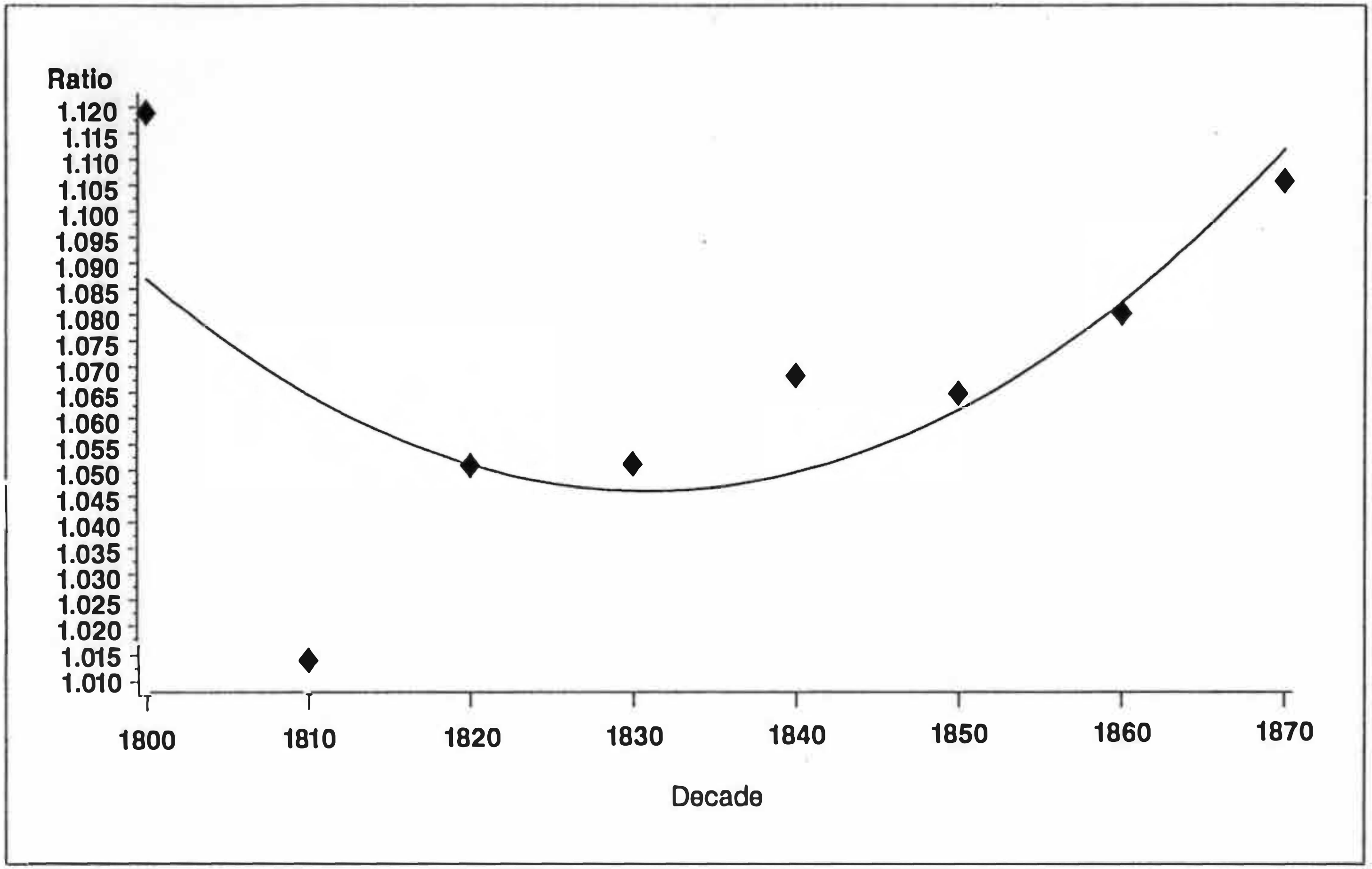

Figure 15: Plot of Significant Quadratic Regression for Female Ratio by Decade of Birth for Entire Plains Sample

model is less efficient in accounting for the variation present than is the quadratic model, significant regressions (probability of F, $p \leq 0.05$) can be obtained for some of the variables. Utilizing such an analysis, max height for female Indians is increasing at an estimated 0.038 cm per year ($p=0.04$), but as shown in Figure 11, this seems to be occurring after the 1820s. More significant regressions are seen in Figure 16, where female max sitting height is also shown in a simple regression on birth year. These results produce estimates of 0.059 cm per year increases for female Indians ($p=0.0001$), and a 0.036 cm per year rise in max sitting heights for male Plains Indians ($p=0.0001$). These estimates of rates of secular change seem to be in line with others made from long bones rather than anthropometric proportions on other historic American populations (L.Meadows Jantz, 1996). Again, the trends seen in Figure 7 (male max sitting height) and Figure 13 (female max sitting height) also show a general increase since about the 1820s. This is the trend that contributes to the strong increase in the value of the ratio, measuring max sitting height/subischial length for both sexes, seen after about 1820 to 1830. Again, however, the trends seen here seem to be swamped by the disproportionate effect of the higher numbers of Sioux in the sample.

The tests for secular trends by tribe revealed that of eight tribes studied, only two male samples did not show any significant or near significant change over time in any of the four dimensions. An examination of secular trends for the female tribal samples reveals the obverse, with only two tribes, the Crow and the Sioux, showing any significant change through time in any dimension.

sex=M

Dependent Variable: MAXSITTHT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	270.17803	270.17803	21.279	0.0001
Error	1121	14233.18121	12.69686		
C Total	1122	14503.35924			

Root MSE	3.56327	R-square	0.0186
Dep Mean	89.15360	Adj R-sq	0.0178
C.V.	3.99677		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Type I SS	Type II SS
INTERCEP	1	22.362765	14.47943887	1.544	0.1228	8926013	30.286137
BRTHYEAR	1	0.036013	0.00780688	4.613	0.0001	270.178030	270.178030

sex=F

Dependent Variable: MAXSITHT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	256.60545	256.60545	20.877	0.0001
Error	360	4424.77368	12.29104		
C Total	361	4681.37913			

Root MSE	3.50586	R-square	0.0548
Dep Mean	82.52402	Adj R-sq	0.0522
C.V.	4.24829		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Type I SS	Type II SS
INTERCEP	1	-26.144061	23.78353360	-1.099	0.2724	2465297	14.851895
BRTHYEAR	1	0.058624	0.01283037	4.569	0.0001	256.605445	256.605445

Figure 16: Tests for Significant Simple Linear Regressions for Max Sitting Height for Males and Females for Entire Plains Sample

We shall first discuss the male results of these regressions by tribe. Again, where applicable, the statistical results will be presented preceding the graphical presentations. The results will be in alphabetical order by tribe, displaying all significant ($p \leq 0.05$) regressions, and moving through max heights, max sitting heights, ratios, and subischial length. For max heights, three tribes yielded absolutely significant regressions, the Comanche, Kiowa, and the Sioux (Figures 17, 18, and 19). The regression for the variable max height also indicated near significant results for two other Plains tribes, the Arapaho and the Crow (Figures 20 and 21). These results are shown graphically by the height means for each decade in Figures 22 and 23. Tests on the variable max sitting height produced significant regressions for four tribes, the Assiniboin, Comanche, Kiowa and Sioux (Figures 24, 25, 26, and 27). It should be noted here that the Comanche registered a very near significant regression for max sitting height at $p=0.0533$, and will be included as also indicating a significant secular trend in the analysis as well as in the resulting plot (Figure 28). For the variable ratio, here indicating the primacy and increase in sitting height as well, only two tribes proved to have significant regressions, the Crow and the Sioux (Figures 29, 30, and 31). Only the Crow show a significant change in the dimension of subischial length; the significant regression (Figure 32) is displayed graphically in Figure 33. That the Crow males are the only sample to show any significant change in this dimension is highly curious. The finding that four male tribal max sitting heights showed a significant secular shift is also reasonably unusual. Previous experience of secular increases in height involved primarily lower segment

---------------------------- TRIBE=COMANCHE -----------------------------

General Linear Models Procedure

Dependent Variable: MAXHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	270.9021827	135.4510913	3.51	0.0354
Error	70	2704.2117523	38.6315965		
Corrected Total	72	2975.1139350			

R-Square	C.V.	Root MSE	MAXHT Mean
0.091056	3.699857	6.215432	167.9912

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	54.7640872	54.7640872	1.42	0.2378
YOB2	1	216.1380954	216.1380954	5.59	0.0208

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	216.8042926	216.8042926	5.61	0.0206
YOB2	1	216.1380954	216.1380954	5.59	0.0208

Figure 17: Test for Significant Quadratic Regression by Tribe for Max Height, Comanche Males

------------------------------- TRIBE=KIOWA --------------------------------

General Linear Models Procedure

Dependent Variable: MAXHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	321.9183909	160.9591954	5.50	0.0061
Error	70	2049.0411769	29.2720168		
Corrected Total	72	2370.9595677			

R-Square	C.V.	Root MSE	MAXHT Mean
0.135776	3.175491	5.410362	170.3788

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	183.0687804	183.0687804	6.25	0.0147
YOB2	1	138.8496105	138.8496105	4.74	0.0328

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	137.5146401	137.5146401	4.70	0.0336
YOB2	1	138.8496105	138.8496105	4.74	0.0328

Figure 18: Test for Significant Quadratic Regression by Tribe for Max Height, Kiowa Males

------------------------------- TRIBE=SIOUX --------------------------------

General Linear Models Procedure

Dependent Variable: MAXHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	368.6461166	184.3230583	5.88	0.0030
Error	581	18202.7135195	31.3299716		
Corrected Total	583	18571.3596361			

R-Square	C.V.	Root MSE	MAXHT Mean
0.019850	3.239208	5.597318	172.7990

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	368.3196315	368.3196315	11.76	0.0006
YOB2	1	0.3264851	0.3264851	0.01	0.9187

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	0.23453828	0.23453828	0.01	0.9311
YOB2	1	0.32648510	0.32648510	0.01	0.9187

Figure 19: Test for Significant Quadratic Regression by Tribe for Max Height, Sioux Males

------------------------------ TRIBE=ARAPAHO ------------------------------

General Linear Models Procedure

Dependent Variable: MAXHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	240.3926460	120.1963230	2.64	0.0803
Error	54	2455.8486057	45.4786779		
Corrected Total	56	2696.2412516			

	R-Square	C.V.	Root MSE	MAXHT Mean
	0.089158	3.868853	6.743788	174.3098

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	1.1022261	1.1022261	0.02	0.8769
YOB2	1	239.2904199	239.2904199	5.26	0.0257

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	239.1422965	239.1422965	5.26	0.0258
YOB2	1	239.2904199	239.2904199	5.26	0.0257

Figure 20: Test for Quadratic Regression by Tribe for Max Heights, Arapaho Males

--------------------------------- TRIBE=CROW ---------------------------------

General Linear Models Procedure

Dependent Variable: MAXHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	254.0562841	127.0281420	2.84	0.0603
Error	224	10007.5571284	44.6765943		
Corrected Total	226	10261.6134125			

R-Square	C.V.	Root MSE	MAXHT Mean
0.024758	3.850511	6.684055	173.5888

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	13.7106343	13.7106343	0.31	0.5801
YOB2	1	240.3456497	240.3456497	5.38	0.0213

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	240.7870816	240.7870816	5.39	0.0212
YOB2	1	240.3456497	240.3456497	5.38	0.0213

Figure 21: Test for Quadratic Regression by Tribe for Max Heights, Crow Males

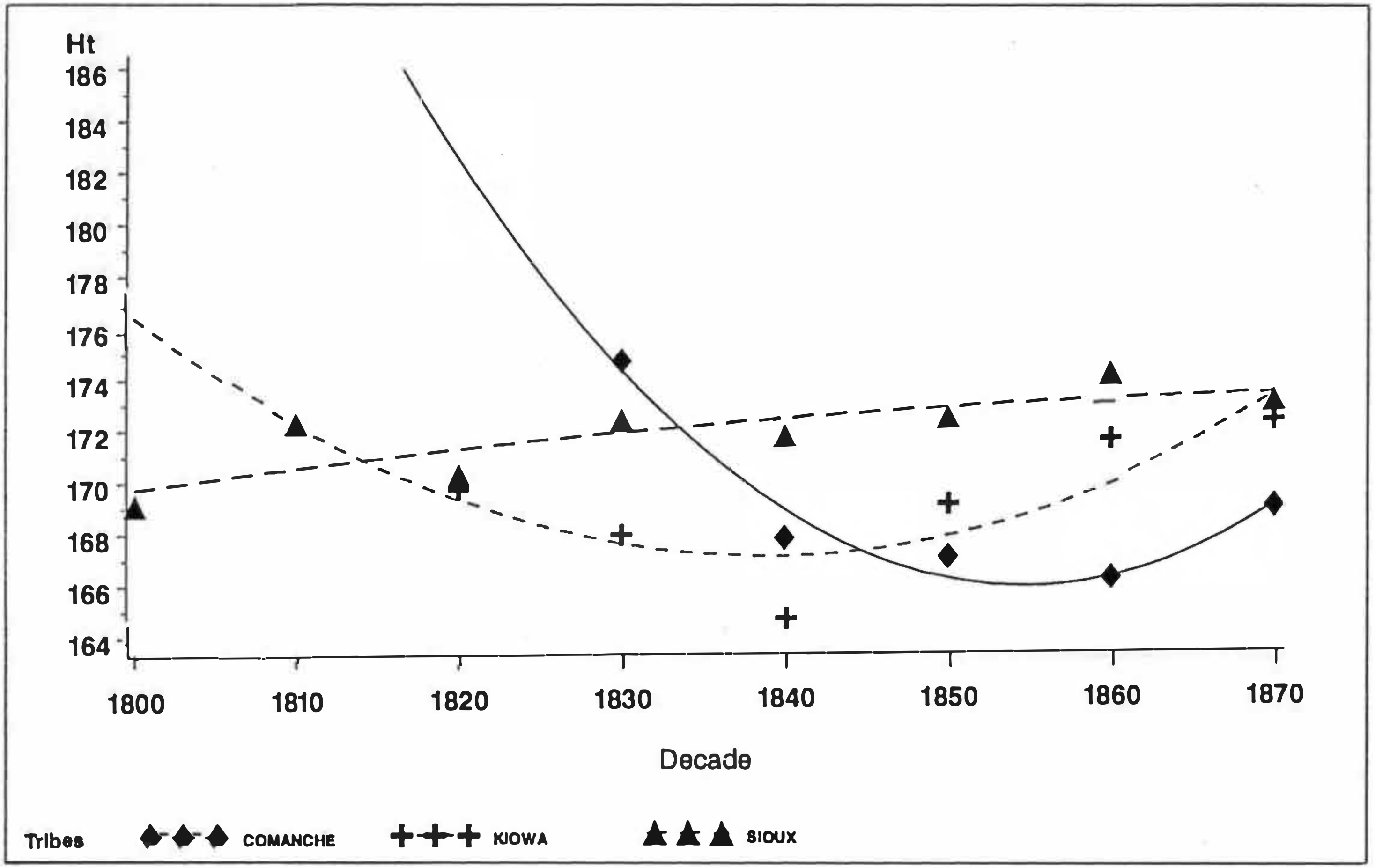

Figure 22: Plot of Significant Quadratic Regressions for Male Mean Max Heights by Decade of Birth, Comanche, Kiowa and Sioux

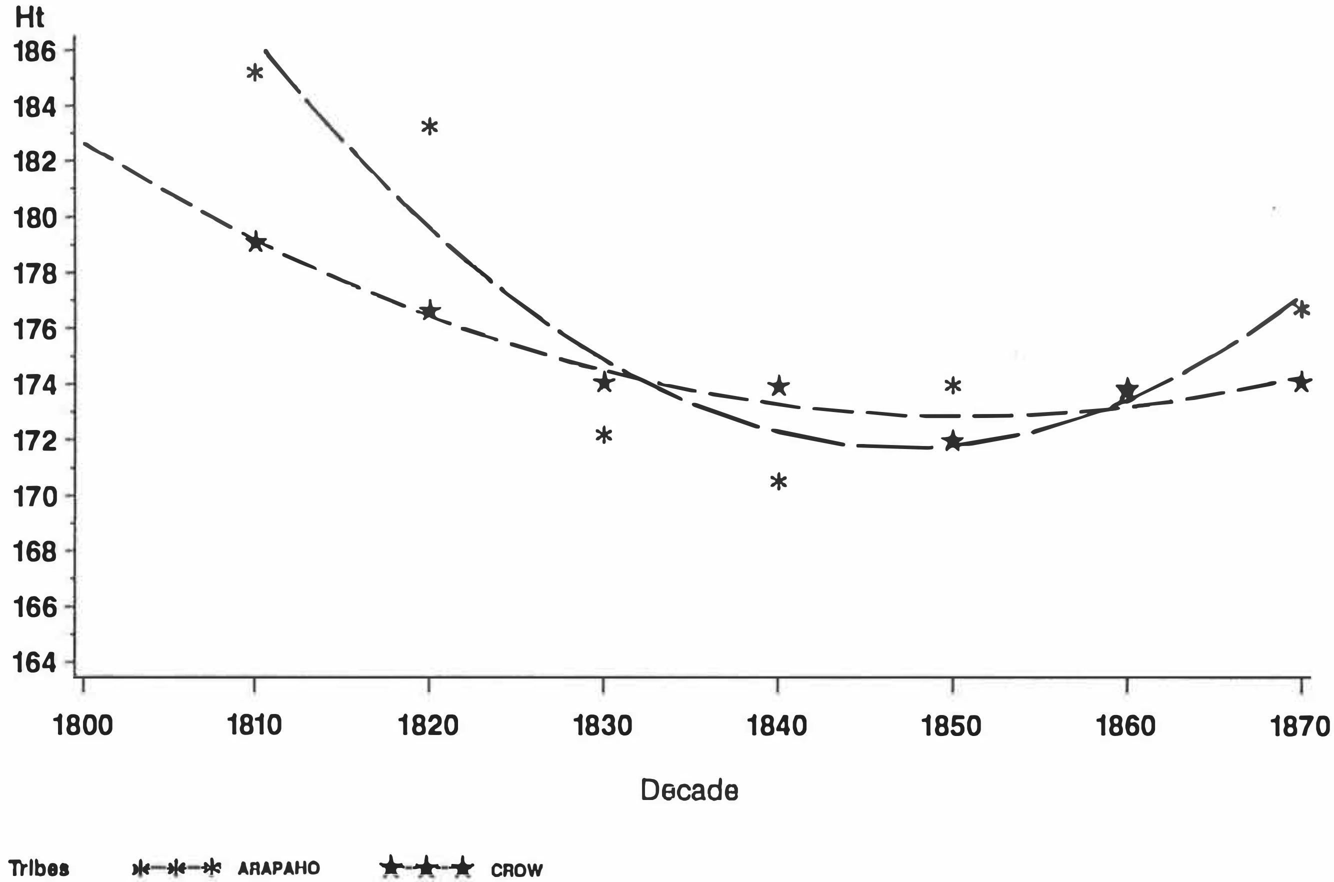

Figure 23: Plot of Regressions for Male Mean Max Heights by Decade of Birth, Arapaho and Crow

------------------------------ TRIBE=ASSINIBO ------------------------------

General Linear Models Procedure

Dependent Variable: MAXSITHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	91.03685677	45.51842839	4.36	0.0276
Error	19	198.20760026	10.43197896		
Corrected Total	21	289.24445703			

R-Square	C.V.	Root MSE	MAXSITHT Mean
0.314740	3.686400	3.229857	87.61550

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	0.49313578	0.49313578	0.05	0.8302
YOB2	1	90.54372099	90.54372099	8.68	0.0083

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	90.63794769	90.63794769	8.69	0.0083
YOB2	1	90.54372099	90.54372099	8.68	0.0083

Figure 24: Test for Significant Quadratic Regression by Tribe for Max Sitting Heights, Assiniboin Males

------------------------------ TRIBE=COMANCHE ------------------------------

General Linear Models Procedure

Dependent Variable: MAXSITHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	74.82754373	37.41377187	3.06	0.0533
Error	70	856.35037772	12.23357682		
Corrected Total	72	931.17792145			

R-Square	C.V.	Root MSE	MAXSITHT Mean
0.080358	3.993783	3.497653	87.57745

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	5.18151840	5.18151840	0.42	0.5173
YOB2	1	69.64602534	69.64602534	5.69	0.0197

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	69.76200671	69.76200671	5.70	0.0196
YOB2	1	69.64602534	69.64602534	5.69	0.0197

Figure 25: Test for Significant Quadratic Regression by Tribe for Max Sitting Heights, Comanche Males

------------------------------- TRIBE=KIOWA -------------------------------

General Linear Models Procedure

Dependent Variable: MAXSITHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	86.47262636	43.23631318	5.24	0.0075
Error	70	577.04846346	8.24354948		
Corrected Total	72	663.52108982			

R-Square	C.V.	Root MSE	MAXSITHT Mean
0.130324	3.197793	2.871158	89.78562

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	39.99952921	39.99952921	4.85	0.0309
YOB2	1	46.47309715	46.47309715	5.64	0.0203

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	46.11176271	46.11176271	5.59	0.0208
YOB2	1	46.47309715	46.47309715	5.64	0.0203

Figure 26: Test for Significant Quadratic Regression by Tribe for Max Sitting Heights, Kiowa Males

------------------------------- TRIBE=SIOUX -------------------------------

General Linear Models Procedure

Dependent Variable: MAXSITHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	314.8932414	157.4466207	13.33	0.0001
Error	581	6860.7569184	11.8085317		
Corrected Total	583	7175.6501598			

	R-Square	C.V.	Root MSE	MAXSITHT Mean
	0.043884	3.871388	3.436354	88.76285

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	313.5200767	313.5200767	26.55	0.0001
YOB2	1	1.3731647	1.3731647	0.12	0.7332

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	1.19127910	1.19127910	0.10	0.7509
YOB2	1	1.37316473	1.37316473	0.12	0.7332

Figure 27: Test for Significant Quadratic Regression by Tribe for Max Sitting Heights, Sioux Males

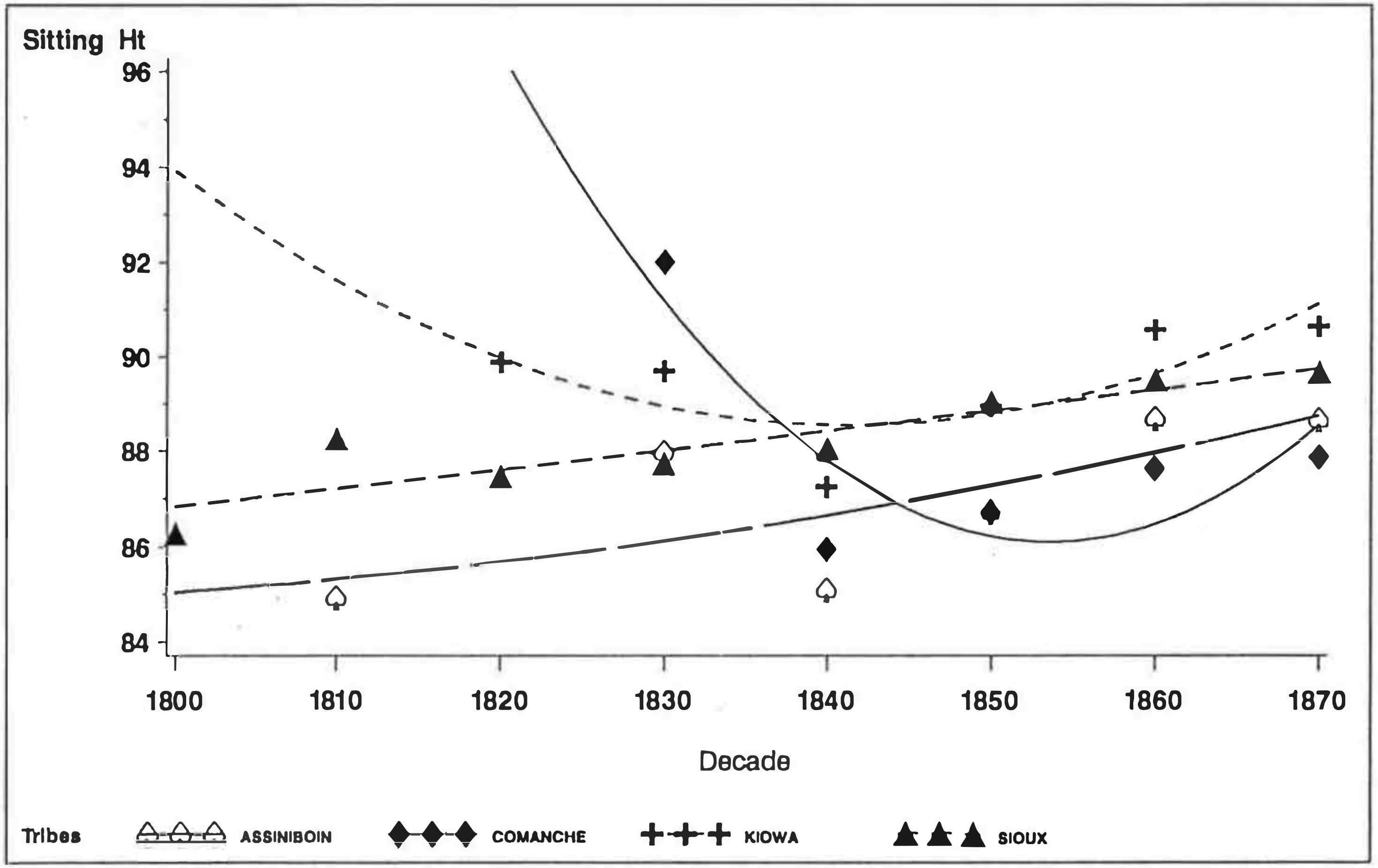

Figure 28: Plot of Significant Quadratic Regressions for Male Mean Max Sitting Heights by Decade of Birth

-------------------------------- TRIBE=CROW --------------------------------

General Linear Models Procedure

Dependent Variable: RATIO

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.02736999	0.01368499	3.54	0.0306
Error	224	0.86578306	0.00386510		
Corrected Total	226	0.89315304			

	R-Square	C.V.	Root MSE	RATIO Mean
	0.030644	5.724725	0.062170	1.085990

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	0.00933515	0.00933515	2.42	0.1216
YOB2	1	0.01803483	0.01803483	4.67	0.0318

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	0.01813525	0.01813525	4.69	0.0314
YOB2	1	0.01803483	0.01803483	4.67	0.0318

Figure 29: Test for Significant Quadratic Regression by Tribe for Ratio, Crow Males

```
------------------------------ TRIBE=SIOUX ------------------------------

                     General Linear Models Procedure

Dependent Variable: RATIO
                                     Sum of            Mean
Source                    DF        Squares          Square    F Value      Pr > F

Model                      2     0.03785135      0.01892568       3.95      0.0197

Error                    581     2.78085028      0.00478632

Corrected Total          583     2.81870163

                    R-Square           C.V.        Root MSE             RATIO Mean

                    0.013429       6.531778        0.069183               1.059179

Source                    DF      Type I SS     Mean Square    F Value      Pr > F

YOB                        1     0.03761899      0.03761899       7.86      0.0052
YOB2                       1     0.00023236      0.00023236       0.05      0.8257

Source                    DF    Type III SS     Mean Square    F Value      Pr > F

YOB                        1     0.00020630      0.00020630       0.04      0.8356
YOB2                       1     0.00023236      0.00023236       0.05      0.8257
```

Figure 30: Test for Significant Quadratic Regression by Tribe for Ratio, Sioux Males

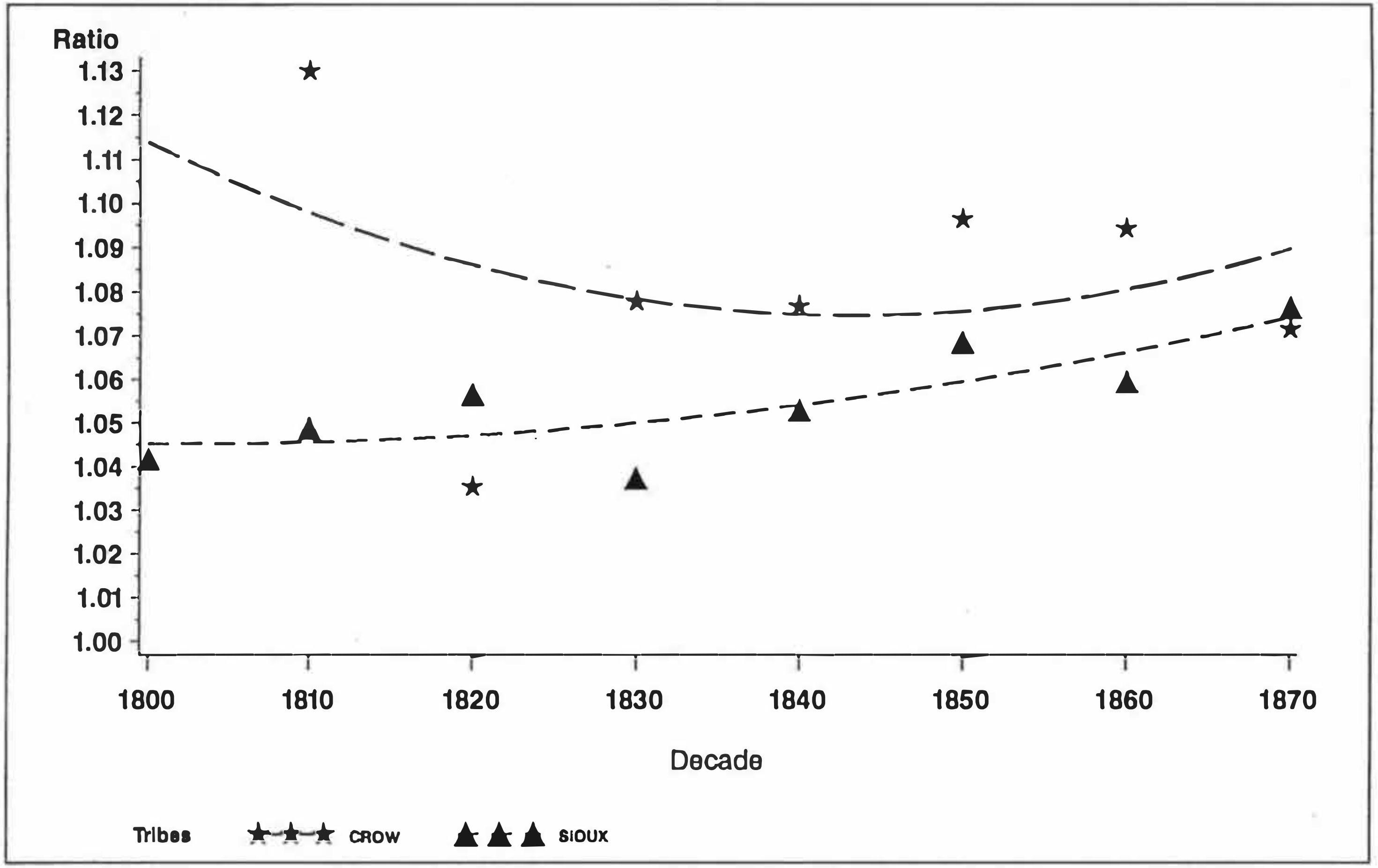

Figure 31: Plot of Significant Quadratic Regressions for Male Mean Ratio by Decade of Birth, Sioux and Crow

```
--------------------------------- TRIBE=CROW ---------------------------------

                      General Linear Models Procedure

Dependent Variable: SUBISCH
                                     Sum of             Mean
Source                  DF          Squares           Square    F Value      Pr > F

Model                    2      206.8786276      103.4393138       4.84      0.0087

Error                  224     4784.5729143       21.3597005

Corrected Total        226     4991.4515419

                  R-Square             C.V.         Root MSE           SUBISCH Mean

                  0.041447         5.546622         4.621656               83.32379


Source                  DF        Type I SS      Mean Square    F Value      Pr > F

YOB                      1       35.3981988       35.3981988       1.66      0.1993
YOB2                     1      171.4804288      171.4804288       8.03      0.0050

Source                  DF      Type III SS      Mean Square    F Value      Pr > F

YOB                      1      172.0821248      172.0821248       8.06      0.0050
YOB2                     1      171.4804288      171.4804288       8.03      0.0050
```

Figure 32: Test for Significant Quadratic Regression by Tribe for Subischial Length, Crow Males

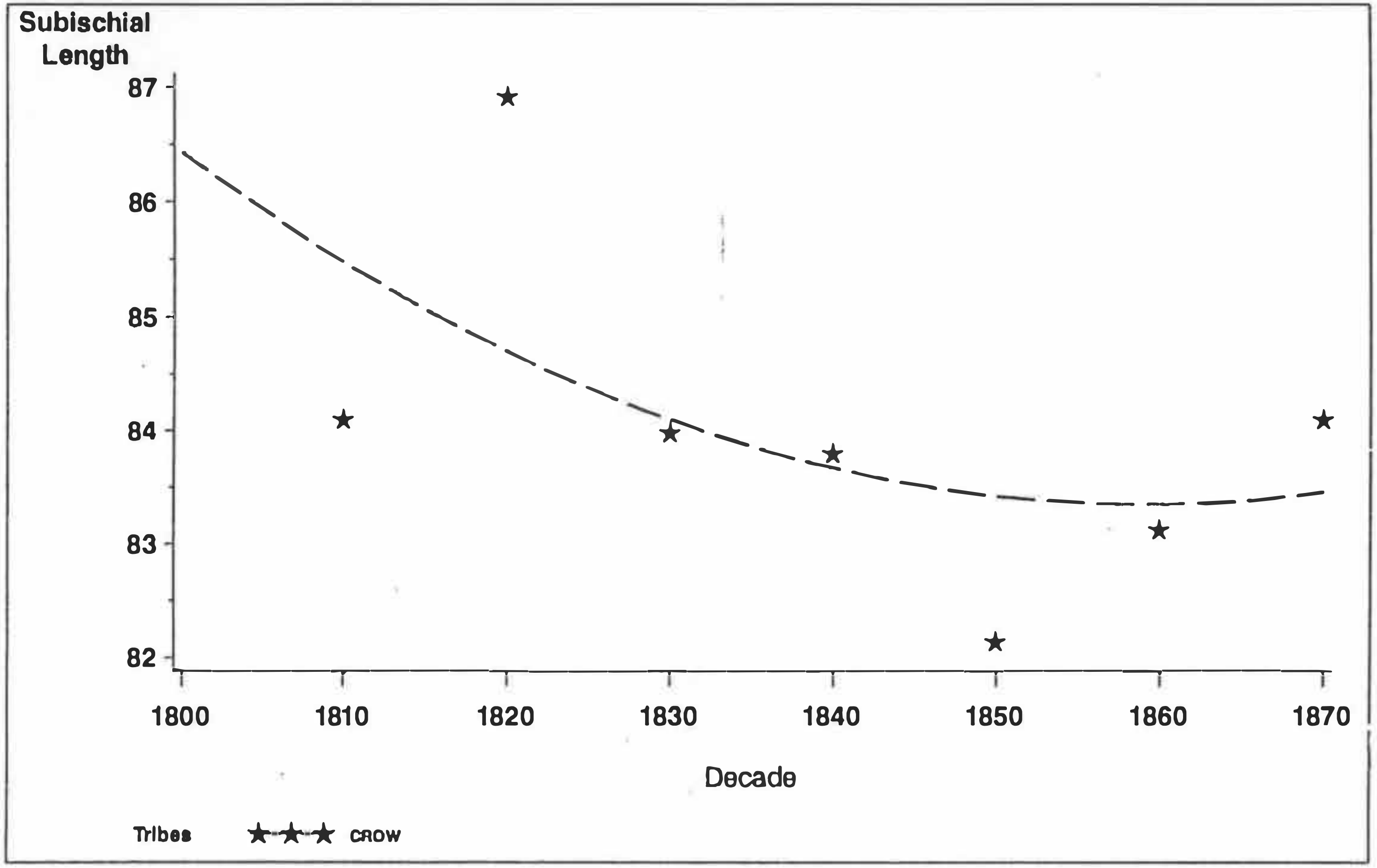

Figure 33: Plot of Significant Quadratic Regression for Mean Subischial Length by Decade of Birth, Crow Males

change, i.e. change in the leg length (Eveleth and Tanner, 1990; Malina, personal communication, 1996; Tanner, 1981; van Wieringen, 1986).

As with the analysis for the overall sample, where there are simple linear relationships between any one of these variable dimensions for any given tribe, an estimate of the rate of secular change can be obtained. The Sioux are the best examples here, with a simple linear regression for male max height, significant at p=0.0006, producing a slope (increasing) of 0.0573 cm per year. Similarly, a simple regression for Sioux male max sitting height, significant at p=0.0001, yielded an increasing slope of about 0.06 cm per year. Once again, these estimates of rates of change are well in line with findings of other positive secular trends for comparable Sioux and White American samples since 1800 (Fogel, 1986a; L.Meadows Jantz, 1996; Malina, 1979; Prince, 1989).

Moving to the analysis for females by tribe, only two tribes proved to have significant regressions ($p \leq 0.05$), indicating a secular change over time for the dimensions and variables tested. The regressions for max heights generated significant results for the Crow and the Sioux (Figures 34 and 35). The results are shown graphically in plots of the height means for each decade in Figure 36. Tests on the variable max sitting height produced similar results with both the Crow and the Sioux females showing significant regressions (Figure 37). The plot of max sitting height showing decade means is seen in Figure 38. Only the Sioux females displayed a significant regression for the variable ratio (Figure 39) and the resulting plot is displayed in Figure 40.

```
------------------------------- TRIBE=CROW -------------------------------

                    General Linear Models Procedure

               Number of observations in by group = 96

                            The SAS System                               161
                                       15:17 Monday, November 3, 1997

------------------------------- TRIBE=CROW -------------------------------

                    General Linear Models Procedure

Dependent Variable: MAXHT
                                     Sum of            Mean
Source                  DF          Squares          Square   F Value     Pr > F

Model                    2      153.4370970      76.7185485      3.63     0.0303

Error                   93     1965.5524949      21.1349731

Corrected Total         95     2118.9895919

                  R-Square             C.V.        Root MSE           MAXHT Mean

                  0.072411         2.889697        4.597279             159.0920


Source                  DF        Type I SS     Mean Square   F Value     Pr > F

YOB                      1      153.4065654     153.4065654      7.26     0.0084
YOB2                     1        0.0305316       0.0305316      0.00     0.9698

Source                  DF      Type III SS     Mean Square   F Value     Pr > F

YOB                      1       0.01793577      0.01793577      0.00     0.9768
YOB2                     1       0.03053160      0.03053160      0.00     0.9698
```

Figure 34: Test for Significant Quadratic Regressions by Tribe for Max Height, Crow Females

------------------------------ TRIBE=SIOUX --------------------------------

General Linear Models Procedure

Dependent Variable: MAXHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	332.2181855	166.1090927	6.60	0.0017
Error	180	4530.6254166	25.1701412		
Corrected Total	182	4862.8436020			

R-Square	C.V.	Root MSE	MAXHT Mean
0.068318	3.123607	5.016985	160.6151

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	113.5924167	113.5924167	4.51	0.0350
YOB2	1	218.6257688	218.6257688	8.69	0.0036

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	216.9584131	216.9584131	8.62	0.0038
YOB2	1	218.6257688	218.6257688	8.69	0.0036

Figure 35: Test for Significant Quadratic Regressions by Tribe for Max Height, Sioux Females

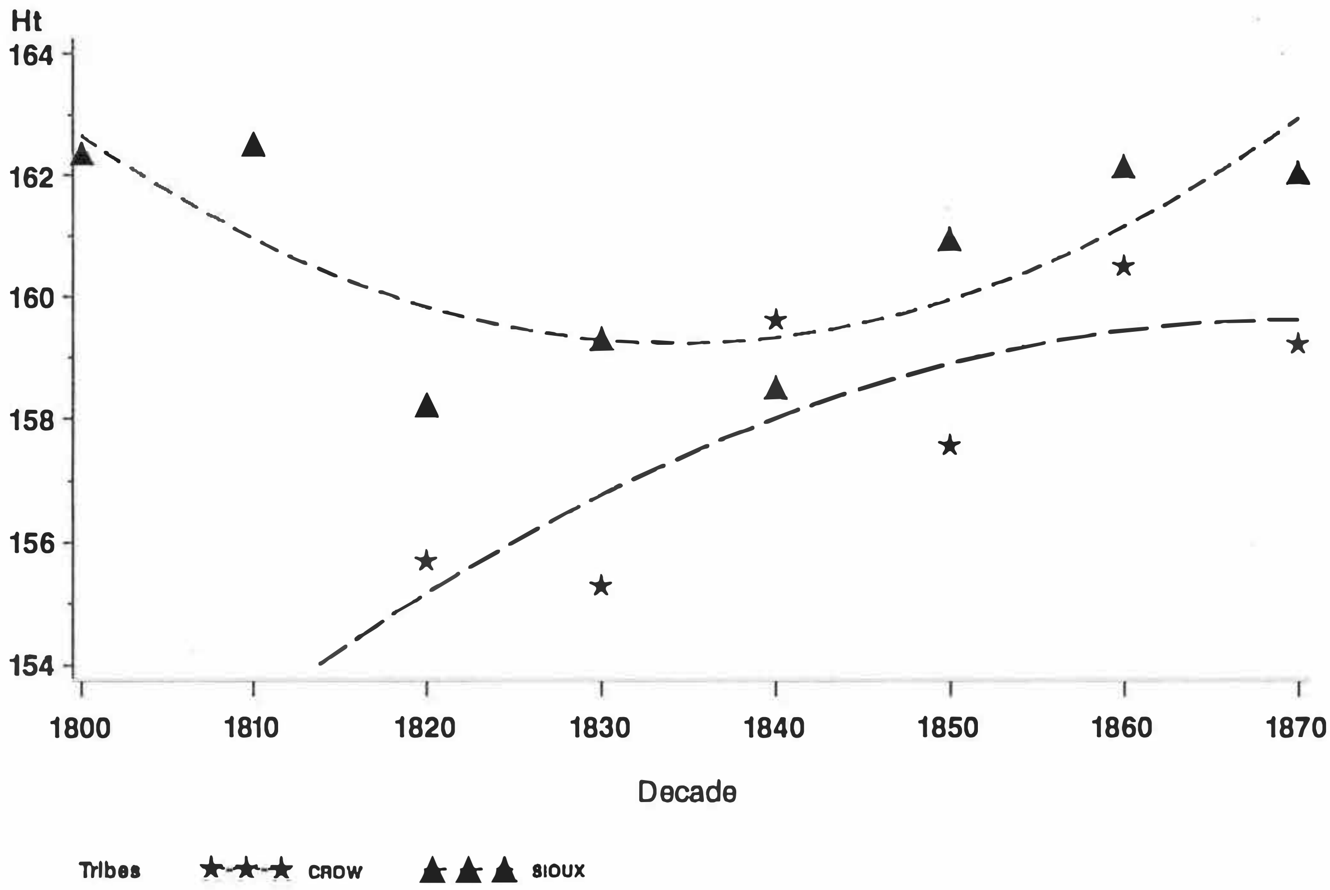

Figure 36: Plot of Significant Quadratic Regression for Female Mean Max Heights by Decade of Birth, Sioux and Crow

-------------------------------- TRIBE=SIOUX --------------------------------

General Linear Models Procedure

Dependent Variable: MAXSITHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	423.2159761	211.6079881	18.14	0.0001
Error	180	2100.1673902	11.6675966		
Corrected Total	182	2523.3833664			

R-Square	C.V.	Root MSE	MAXSITHT Mean
0.167718	4.142331	3.415786	82.46050

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	225.1176446	225.1176446	19.29	0.0001
YOB2	1	198.0983315	198.0983315	16.98	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	195.8686765	195.8686765	16.79	0.0001
YOB2	1	198.0983315	198.0983315	16.98	0.0001

-------------------------------- TRIBE=CROW --------------------------------

General Linear Models Procedure

Dependent Variable: MAXSITHT

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	57.97661187	28.98830593	3.25	0.0434
Error	93	830.74769402	8.93277090		
Corrected Total	95	888.72430589			

R-Square	C.V.	Root MSE	MAXSITHT Mean
0.065236	3.603177	2.988774	82.94830

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	42.75502246	42.75502246	4.79	0.0312
YOB2	1	15.22158941	15.22158941	1.70	0.1950

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	15.38998887	15.38998887	1.72	0.1926
YOB2	1	15.22158941	15.22158941	1.70	0.1950

Figure 37: Test for Significant Quadratic Regression by Tribe for Max Sitting Height, Crow and Sioux Females

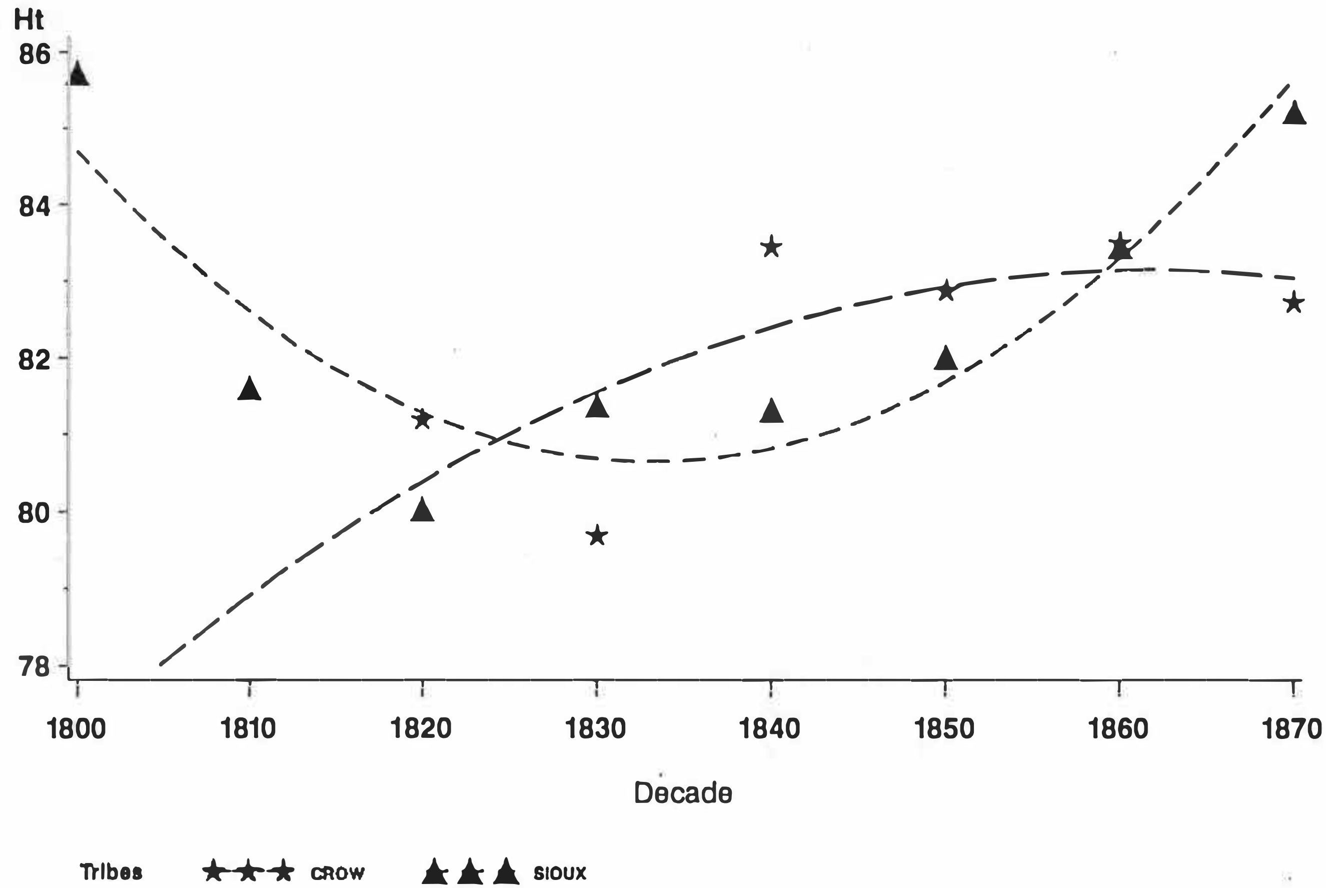

Figure 38: Plot of Significant Quadratic Regression for Female Mean Max Sitting Heights by Decade of Birth, Crow and Sioux

------------------------------ TRIBE=SIOUX ------------------------------

General Linear Models Procedure

Dependent Variable: RATIO

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.09682200	0.04841100	7.85	0.0005
Error	180	1.10970788	0.00616504		
Corrected Total	182	1.20652988			

R-Square	C.V.	Root MSE	RATIO Mean
0.080248	7.415730	0.078518	1.058801

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YOB	1	0.06411979	0.06411979	10.40	0.0015
YOB2	1	0.03270221	0.03270221	5.30	0.0224

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YOB	1	0.03221944	0.03221944	5.23	0.0234
YOB2	1	0.03270221	0.03270221	5.30	0.0224

Figure 39: Test for Significant Quadratic Regression by Tribe for Ratio, Sioux Females

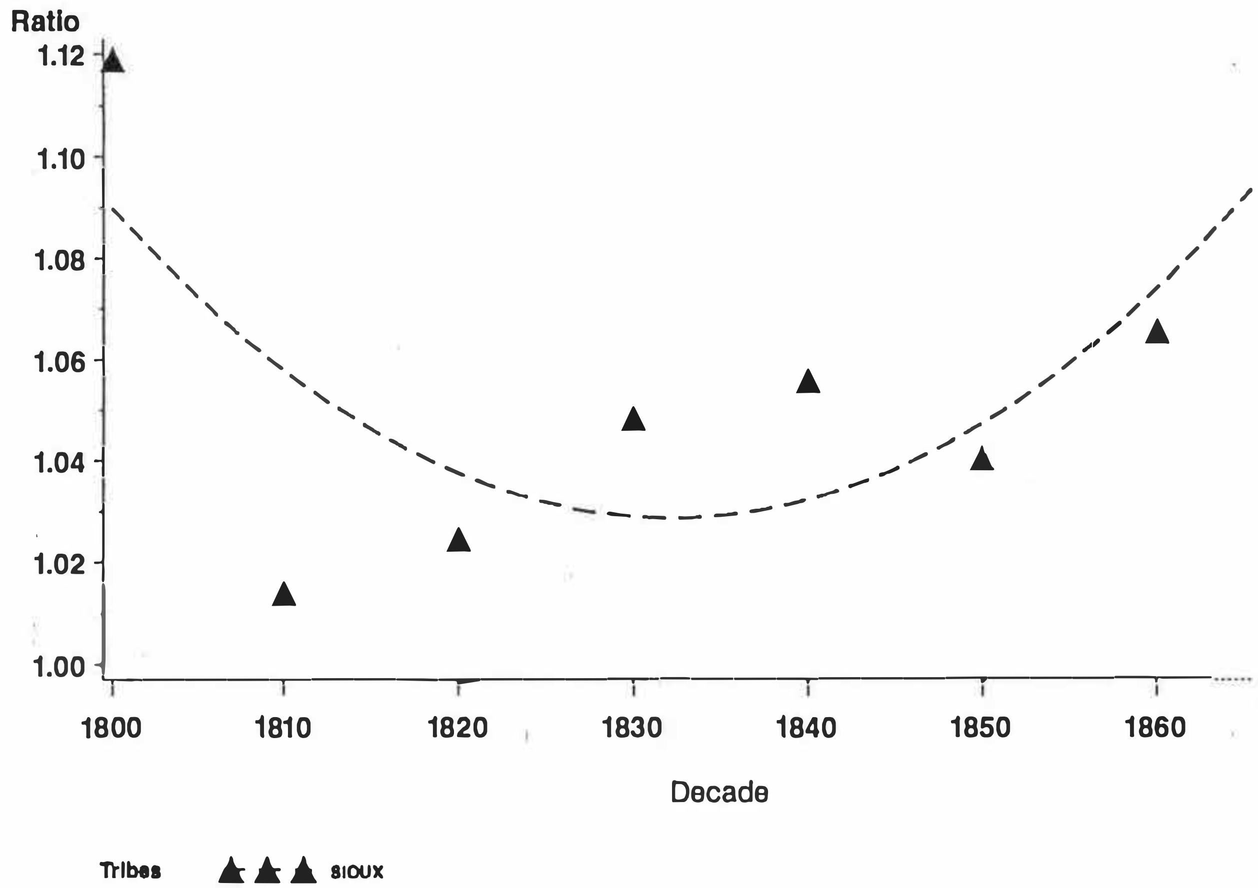

Figure 40: Plot of Significant Quadratic Regression for Female Mean Ratio by Decade of Birth, Sioux

As with the analysis for the male sample by tribe, where simple linear relationships can be discerned, an estimate of the rate of secular trend can be produced. For the females, the variable max height analyzed in such a manner yields an increase of about 0.05 cm per year for the Sioux (p=0.039), and about 0.01 cm per year for the Kiowa (p=0.008). An analysis for the variable max sitting height by simple linear regression generates a rate of change (increase) for Sioux females at 0.066 cm per year (p=0.001).

STATURE COMPARISONS WITH OTHER POPULATIONS

Before undertaking a further examination of the results, we might want to consider stature comparisons with the native-born White American male population originally provided by Fogel (1986a, 1986b) seen in Table 3. As these data were gathered from military conscripts (Fogel et al, 1982), there is currently no national (United States) sample of adult female heights for the same period. Although other researchers have produced additional estimates of American White male heights for the 18th and 19th centuries (Sokoloff, 1995; Steckel, 1994, 1995), I have chosen to use Fogel's estimates for the sake of continuity (Prince, 1989, 1995). Fogel's (1986a, 1986b) estimates also have the advantage of being widely published along with a detailed rationale of how they were derived. They also provide readily available cohort estimates by decade. It should be noted that exact stature comparisons with European nations are of less utility, since it is universally acknowledged that from the 1790s until

Table 3: Stature Comparisons with native-born White American Males and Plains Indian Males by Decade of Birth [a]

Year or Decade	Arapaho	Assiniboin	Blackfeet	Cheyenne	Comanche	Crow	Kiowa	Sioux	Native-born Whites [b]
1820	183.29 [c]	--	166.68 [c]	--	--	176.66	169.89[c]	170.45	172.9
1825									173.1
1830	172.21	168.26 [c]	166.35[c]	176.11[c]	174.85	174.08	168.10 [c]	172.53	173.5
1835									173.1
1840	170.56	167.26	174.39	174.49 [c]	168.02	173.95	164.82	171.89	172.2
1845									171.6
1850	174.00	164.18 [c]	170.37	176.00	167.31	172.00	169.35	172.58	171.1
1855									170.8
1860	173.66	174.21	172.25	177.42	166.53	173.88	171.72	174.23	170.6
1865									171.1
1870	176.76	167.99	174.44	176.31	169.32	174.12	172.41	173.16	171.2
1875									170.7

Note: All heights in centimeters.

a. Heights rounded to the nearest .01. Indian values are mean max heights.
b. Source: Fogel, R.W. (1986). Nutrition and the decline in mortality Since 1700: Some additional preliminary findings. NBER Working Paper No. 1802. Cambridge, MA: NBER. p. 144. Only Fogel's Whites utilized five-year birth cohorts. Data taken from military conscripts and is not available for 1800-1815.
c. Very low cell numbers (n≤3), see Appendix A-1

after World War II, Americans were the tallest national population in the world, with Europeans of the time measuring several centimeters (cm) shorter than American contemporaries (Floud, 1992; Fogel, 1992; Steckel, 1994, 1995).

It has long been observed that the Plains Indians were among the tallest American Indians, and indeed were relatively tall when compared to White Americans and Europeans (Boas, 1894a; Sullivan, 1920; Wissler, 1911, 1912). Comparisons of Sioux children aged 6-17 measured by Boas (1892) and Wissler (1911) with contemporary samples of well-situated White American and European children also show that these Sioux were generally taller than most groups of contemporary Whites (Prince, 1989; Steckel, 1987). Knowing that Americans represented an exceptionally tall population during the 19th century, we can better interpret the data presented in Tables 3 and 4, and in the previous analysis.

For the comparisons that can be made, the male Plains Indians do show diversity in the max heights (Table 4). In general, the more southern dwelling Indians (the Comanche and Kiowa) are the shortest. An exception here appears to be the Arapaho, until it is recalled that the northern Arapaho are over-represented in our sample. The Assiniboin also appear to be relatively short, confirming their status as the poor relations of the northern Plains (Ewers, 1961). Again, as Bamforth (1988) and other researchers (Flores, 1991; Sherow, 1992) remind us, the southern Plains were always more prone to drought conditions, and were the first areas to be almost completely denuded of the once substantial buffalo herds by about 1875 (Isenberg, 1993; Roe, 1970). The other tribal

Table 4: Overall 19th Century Plains Male and Female Mean Max Heights [a]

Tribes/Sex	Arapaho	Assiniboin	Blackfeet	Cheyenne	Comanche	Crow	Kiowa	Sioux	Overall Plains Mean Max Heights
Male	174.30	169.58	171.96	176.66	167.99	173.58	170.37	172.80	172.56
Female	161.76 [b]	159.16 [b]	160.52 [b]	161.52 [b]	156.67	159.09	158.49	160.61	159.70

Note: All heights in centimeters.

a Heights rounded to the nearest .01

b Low values of n, n<20. See Table 2.

anomaly that is apparent is the Cheyenne; they somehow still manage to sustain the tallest max heights recorded here. This may indicate that the Cheyenne were still able to exploit the more intact resource areas of their northern range into the 1850s-1870s. This might also be a reflection of the relative robust military prowess that allowed the Cheyenne greater access to horses and territory to hunt buffalo (Biolsi, 1984; Ewers, 1955).

A closer examination of Table 3 will reveal the depths of what we can term the 'Plains Paradox'. The continued maintenance of tall statures by these Indians, even in the face of environmental deterioration, a constant tempo of military campaigns after 1850, and confinement upon reservations, should be seen as quite remarkable. That some Plains nomadic tribes were actually able to sustain a secular increase in stature or its components, i.e. max sitting heights, during this time period is more surprising still. (See Figure 41 for a view of the Plains in 1870). The paradox is deepened by comparison with the White sample of American males, these cohorts are declining in height from about 1830 on and bottom out somewhere in the 1880s, before trending upwards once again, after 1890 (Fogel, 1986a, 1986b; Steckel, 1995). In 1850, four Plains tribes exceeded the White benchmark height, by 1860, seven tribes did. In 1870, six tribes still top the White conscripts in height. This essentially repeats a pattern first described by Prince (1989, 1995) for the Sioux and is suggestive of a Plains wide pattern of cycles in heights, at least

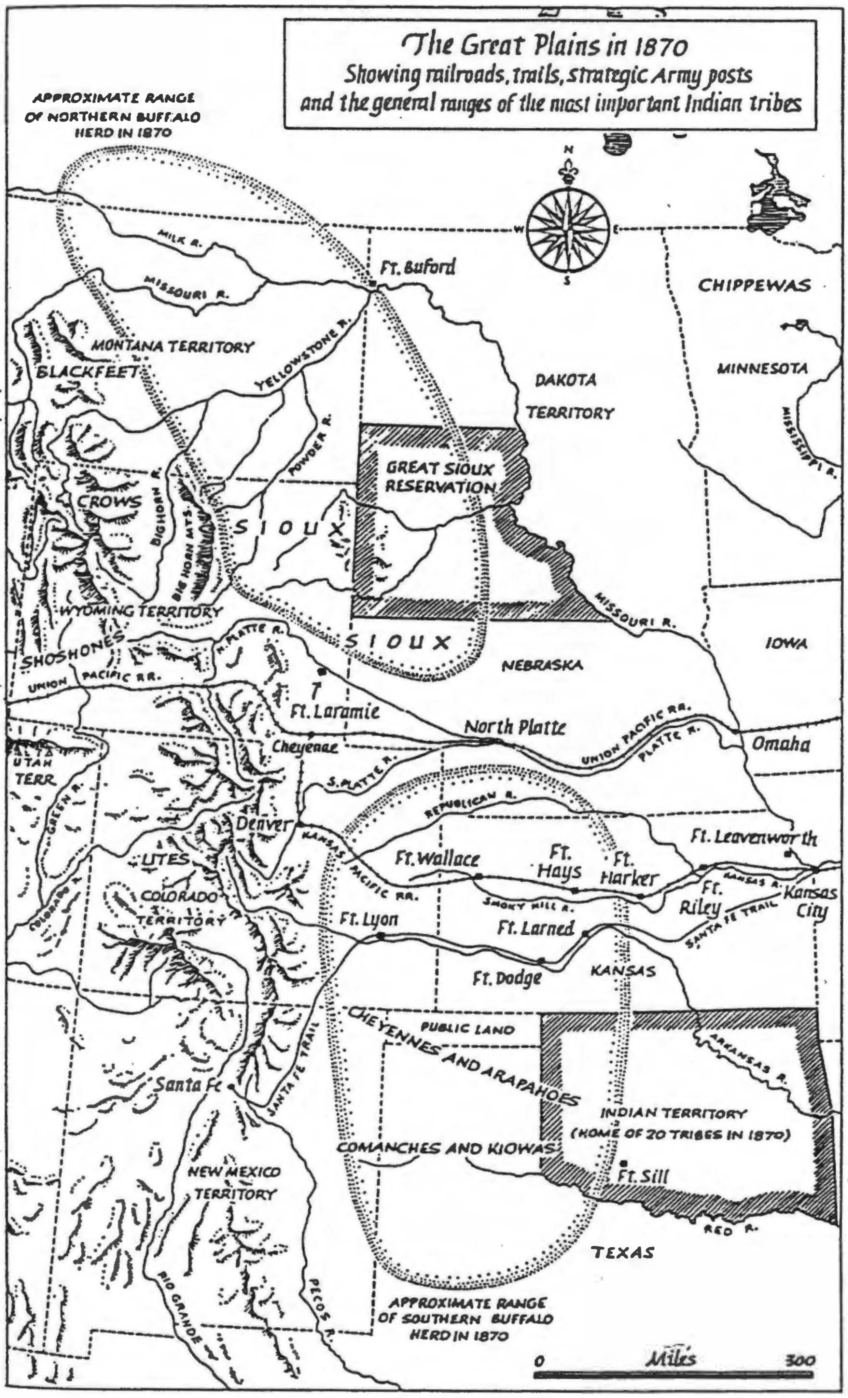

Figure 41: Map of the Great Plains in 1870

Source: Prucha, F.P. 1976. American Indian policy in crisis. Norman: University of Oklahoma Press.

for the male sample. The common pattern exhibited by the male data is one of relatively tall initial statures for many of the Plains tribes followed by a decline that seems to reach its lowest points in the decades of the 1830s through the 1850s, before recovering in the 1860s and 1870s. Of course, some of the Plains tribes exhibit some variation for male max heights. For the Assiniboin, their height never fully 'recovered' from the low values seen in the 1850s to the level seen in the 1830s or the 1860s for that matter (Table 3). This situation may be severely impacted by low sample size (Appendix A-1).

Heights collected by Lee Meadows Jantz (1996) derived from corrected cadaver lengths are also used here as good proxy measurements for female heights during the period 1850-1870 (Table 5), although here again these comparable sample sizes are reasonably small ($n \leq 20$). Female trends in height for the Sioux and the Crow, the only female tribal samples to display statistically significant secular changes, also reflect the same general pattern seen in males. There is an early decline in stature and a recovery by the 1860s to 1870s (Figures 36 and 38, Chapter IV).

INTERPRETATION OF THE INFLUENCE OF DISEASE BEFORE 1870

To restate our central proposition, knowing of the particular histories of the Plains tribes in question, are there common experiences that these tribes encountered during the time period under study, roughly 1800 to 1870, that would influence such an outcome? As mentioned previously, within a group or population context, an individual's adult height "...is probably the best single indicator of his or her dietary and infectious disease

Table 5: Female Plains Tribal Max Height Comparisons with a White 19th Century American Female Population (1850-1870) [a]

Tribes/Decade	Arapaho	Assiniboin	Blackfeet	Cheyenne	Comanche	Crow	Kiowa	Sioux	19th Century Whites (from corrected cadaver lengths) [b]
1850s	168.45	--	163.70	161.52	158.00	157.58	157.61	160.97	157.89
1860s	156.70	--	160.90	--	156.53	160.52	160.56	162.17	162.03
1870s	165.19	159.16	162.94	--	156.00	159.24	152.24	162.07	157.71

Note: All heights in centimeters.

a Rounded to the nearest .01

b Source: Meadows Jantz, L. 1996. Secular change and allometry in the long limb bones of Americans from the 1700s through the 1970s. University of Tennessee, Knoxville. Unpublished PhD dissertation. Department of Anthropology.

history" (Elo and Preston, 1992: 202). Accordingly, we shall examine these factors in greater detail, starting with an accounting of some of the disease pressures faced by the nomadic Plains Indians. For the time period examined, we have very limited resources to investigate this aspect of the health status of the Plains populations.

As noted previously (Chapter III), a close inter-relationship has long been recognized between secular trends in growth patterns and patterns of morbidity and mortality (Coclanis and Komlos, 1995; Costa, 1993; Floud et al, 1990; Fogel, 1986a, 1986b; Gage and Zansky, 1995; Kunitz, 1987; Lee, 1997; Malina, 1979; Pope, 1992). Accurate mortality data before 1870, however, is difficult to find in the United States beyond the eastern seaboard. It is harder still to find estimates that involve any state in the Trans-Mississippi West much before 1890, or that cover rural areas out west (Condran and Crimmins, 1979; Condran and Crimmins, 1980; Davin, 1993; Haines and Anderson, 1988; Higgs, 1973). As all reservations of the Plains Indians were located out west in rural settings, this is a limiting factor. Another factor to consider is that accurate reservation census data were first taken only from the mid 1870s for most of the Plains tribes then on reservations. The first federal census to enumerate all Indians living on reservations waited until 1890 (Shoemaker, 1992). Monthly agency physician's ('sanitary') reports were only instituted on the reservations after 1874. These reports are highly variable in quality and in conjunction with tribal census records, reported to the Commissioner of Indian Affairs, are generally only trusted from about 1880 on for these particular tribes (Allen, 1975; Campbell, 1989b; CIA 1875; Nespor, 1989; Putney, 1980).

This leaves us with well known literary and historical sources to recount the numerous various epidemic episodes that afflicted the Plains Indians before 1870, and the many widespread effects of these encounters (Campbell, 1989a; Decker, 1991; Ewers, 1973; Taylor, 1977, 1989; Thornton, 1997; Wissler, 1936a, 1936b, 1936c). Certain long-term trends might be discerned if the record of these epidemic episodes is compared with the patterning seen in the plots of mean max heights by decade of birth.

For the better part of the 19th century, the groups studied here assumed a nomadic equestrian adaptation that proved highly successful in exploiting the buffalo—the principal economic and subsistence focus for these tribes.

This adaptation was a cultural shift that was completed shortly after some of these groups migrated onto the Plains (Assiniboin, Blackfeet, Sioux), and generally since the introduction of the horse (circa 1750-1780 for the latest adaptation by the mounted Plains tribes). Some groups, like the Cheyenne and the Sioux, shed horticultural roots to adopt this new nomadic equestrian lifeway. The tremendous success of this adaptation allowed most of these tribes to range and hunt over vast expanses of territory. They also avoided some of the more extreme effects of European introduced disease and epidemic episodes that had previously decimated the more densely housed village-dwelling horticulturists of the Missouri and Rio Grande rivers during the 1700s (Garenne et al, 1994; Isenberg, 1993; Trimble, 1989).

Still, disease was enormously influential in shaping the demographic, cultural, and historical destinies of these and other Plains tribes (Campbell, 1989a; Ewers, 1973;

Isenberg, 1993; Jantz, 1995c; Ramenofsky, 1987; Taylor, 1977, 1989; Thornton, 1987; Thornton et al,1991). It is reasonable to believe that the tremendous toll of various epidemic diseases was largely responsible for the common experience of statural decline before 1850 for the male Assiniboin, Comanche, Crow, Kiowa, and possibly Blackfeet, as well as Sioux and Crow females. In this, as in most aspects, however, the Sioux represented a special case. While not exempt from the epidemics that periodically swept the Plains, they were fortunate enough to avoid many of the most serious effects prior to 1850. Taylor (1977, 1989) reminds us that part of the Sioux population (the Teton Oglalas) was increasing in 1837, in spite of the infamous smallpox epidemic of that year. Taylor (1977) and Trimble (1992) attribute this fortuitous escape to the 1832 immunization efforts by the Upper Missouri Superintendency and some fur trade companies, and to the fact that these Sioux ranged farther away from the focus of the epidemic--the Missouri River. Thus possibly more than ½ of the Sioux escaped the devastating effects of the 1837-1838 epidemic (Prince, 1989). Taylor (1989) further attributes the drop in estimated population figures among an aggregate sample of northwestern Plains tribes to the massive mortality seen among the Assiniboin and Blackfeet tribes, who were severely affected by this epidemic.

The common denominator in the swift introduction and efficient dissemination of these epidemics was the increasing enmeshment of all the Plains tribes in the fur trade economy by the early 1820s. As adaptations to the European invasion and the abundant buffalo, the creation of the Plains nomadic way of life afforded a modicum of protection from epidemics--but for the frequent and seemingly constant contact of traders with some segment of these tribes throughout the 19th century (Dobyns, 1992; Isenberg, 1993; Trimble, 1992). It is probably the cumulative and diffuse effects of several epidemic episodes that is partly reflected in the height profiles described here. It should also be remembered that a population's response to disease and the social disruption caused by epidemics is dependent upon many factors--including settlement practices, nutrition (quality and availability), health and social practices, and previous nutritional/health status (McGrath, 1991; Sommerfeld, 1994; Thornton et al, 1991; Trimble, 1994).

Epidemics of principally smallpox and whooping cough, and secondarily, an undefined infection Taylor (1977) identifies as streptococcal, sickened most of the Plains tribes in the years 1800-1803 (Thornton, 1987). Thereafter, epidemics visited the Plains on a cycle with a mean of just under 10 years--just about the time required to produce a new group of susceptible children (Vehik, 1989). The 1815-1816 smallpox epidemic is credited with killing 4,000 Comanches and a lesser number of Kiowa along the Rio Grande and Red rivers of Texas (Ewers, 1973; Isenberg, 1993). The 1818-19 outbreak of smallpox or measles claimed a high number of Assiniboin, Blackfeet, and a smaller proportion of Yankton Sioux along the White River of South Dakota. In 1833, smallpox is recorded as devastating the Crows in the northwestern Plains, and was also responsible for high mortality among the Arapaho. Estimates of Crow mortality are appallingly high at this time (40%-50%). The Great Plains smallpox epidemic of 1837-1838 severely impacted the Blackfeet, Cheyenne, Crow, Assiniboin, Kiowa, and Comanche. Many ethnographic reports claim that upwards of ½ of some tribes were wiped out due to its ravages. The crushing mortality seen by the Blackfeet was quite remarkable, with possibly upwards of 2/3 of their number perishing (Decker, 1991; Dollar, 1977; Ewers, 1967, 1973; Thornton, 1987). The Sioux and the Arapaho were much less severely beset. An epidemic of measles was also seen in the years 1845-1846 throughout most of the northern Plains, but most groups experienced low mortality from it, with the exception of the Assiniboin, who showed a more elevated mortality rate (Taylor, 1977). In 1848, the Crow were again visited by measles and smallpox, with smallpox returning in 1856 to claim an even higher toll among them.

The next great epidemic on the Plains was the 1849-1850 cholera outbreak. Fortunately for the Sioux, the mortality due to this devastating epidemic was largely confined to those Sioux groups along the Platte River (the Brule), sparing the bulk of the tribe once again. The Brule Sioux, however, were also severely debilitated by measles at this time, adding to their troubles. Mortality from this new scourge was particularly high among the Arapaho, Crow, Cheyenne, Comanche and Kiowa, again with perhaps upwards of 50% of these latter three tribes destroyed. The great transit of immigrants to the Gold Rush in California is seen as being responsible for the transmission of this novel bacteria to many of these groups, including the Sioux.

The return of smallpox was seen in 1859-1860 by the Sioux, where its toll was more fearsome than the 1837-38 outbreak. In 1861-1862, the Kiowa, Cheyenne and the Arapaho were afflicted with this malady, with the Arapaho being severely sickened. Soon after this time the toll of epidemics begins to be a reservation experience that is followed with more than a passing interest by Indian Agency physicians throughout the Plains (Allen, 1975; Putney, 1980; Walker, 1906, 1982).

This brings us directly to our paradoxes. How was it possible for the Sioux of both sexes to effectively maintain a positive secular trend throughout the bulk of the 19th century? And why is it that the data show that the common experience of the Assiniboin, Comanche, Kiowa, and Crow males, and Crow females, is suggestive of a recovery in some component of stature after the 1850s?

We can try to answer this question in part by looking to the exemplary case of the Sioux. The Sioux were well known as masters of the high Plains. They were particularly successful in warfare, and at one time or another actively fought with most every tribe on the northern Plains. But as Bamforth (1988) notes, the key to the spectacular triumphs of the Teton Sioux was the area they fortuitously migrated to and held at the edge of the Black Hills in South Dakota. This area was then among the most productive grasslands on the Great Plains, enabling a greater carrying capacity for plentiful buffalo. Thus we know why the Sioux referred to the Black Hills as their 'meat pack' (Hassrick, 1964; Hyde, 1967). Bamforth (1988) also shows how this favorable and integral buffalo ecology was responsible for the Teton Sioux being able to maintain the highest population densities on the Great Plains, as well as a high degree of social complexity, measured as the number of bands or societies within each tribe. Bamforth (1988) postulates that the Teton Sioux were highly effective in their constant territorial expansion by military conquest precisely because they possessed a greater number of complex social groups capable of efficiently incorporating larger numbers of warriors as well as integrating larger hunting parties (Biolsi, 1984; Hyde, 1967; McGinnis, 1990; White, 1978). This in turn may have helped the Sioux to maintain both higher social complexity as well as higher population numbers, with the ecological basis being the very productive portion of the Plains they occupied.

The Crow and the Blackfeet were also relatively favorably situated in relation to the buffalo ecology of the Plains, but to a slightly lesser degree than the Teton Sioux (Bamforth, 1988). Distinct historical circumstances, like the occurrence, severity, and frequency of disease episodes (in the Blackfeet), or the fact that the Crow, despite being beset on all sides of their territory by hostile tribes, did manage to occupy very productive grasslands, may be responsible for the differential we see between these groups and the Sioux in overall mean statures (Table 4, Chapter IV).

Similar differential and particular historical factors may also help explain why the horse-poor Assiniboin, regarded by observers in the mid 19th century as poor relations to other Plains tribes, should show a secular trend in male max sitting heights, while the more organized and militaristic Blackfeet did not (Ewers, 1955, 1961, 1967). Both suffered seemingly similar devastating effects from the 1837-1838 smallpox epidemic (Decker, 1991). Again, however, small sample size may be affecting this result (see Appendix A-1).

The Comanche are particularly interesting, especially considering that they managed to show a positive secular trend in max heights. Occupying the southernmost and least productive, most ecologically unpredictable part of the Plains after 1750, they possessed twice the number of horses per person than the Sioux (Bamforth, 1988; Ewers, 1955), were very successful at mounted warfare, and highly feared as raiders and horse rustlers. Yet they were a destroyed society by about 1850, due in part to the fact that they occupied territory that was no more than a day's ride from White settlements for most of the 19th century. As such, they were continually the target of at times grimly effective territorial and U.S. military campaigns about 20+ years earlier than other Plains tribes. The U.S. Calvary was specifically first invented to harass, discourage, remove, and otherwise eliminate the Comanche problem/barrier on the southern Plains of Texas (Fehrenbach, 1979; Fowler, 1996; Lamar and Truett, 1996). They are also the shortest Plains tribe reported on here (Tables 3 and 4, Chapter IV).

ECONOMIC AND ENVIRONMENTAL PERSPECTIVES

Our central paradox remains: Why the common increase in statural dimensions (male mean max heights or mean max sitting heights) after the 1850s? This finding would certainly belie the increasingly intensive U.S. military engagements throughout the Plains during this period (Utley, 1984, 1988). The Civil War, in retrospect, may have provided a significant respite in such hostilities throughout the Plains. It is unclear, however, if the ever present inter-tribal warfare was also less intense on the Plains during this period (McGinnis, 1990). Increasing immigration from land hungry settlers, as well as commercial buffalo hunting, and the coming of the railroads only led to pronounced environmental degradation and resource depletion from the 1850s forward on the Plains (Flores, 1991; Moore, 1987; Shaw and Lee, 1997; Sherow, 1992).

This paradox is deepened with consideration that the next most common experience for individuals born during the years 1854 through the mid 1870s was the beginning of the reservation era for ever increasing numbers of the Plains tribes in this study. As seen in Table 3 (Chapter IV), the reservation experience reflected universally for all Plains tribes by the decade of 1870, shows a continuing recovery in the male max heights for five of the eight tribes represented. This is similar to a previous finding (Prince, 1989, 1995) that Sioux adults (born in the 1870s and 1880s) and Sioux children (born between 1892-1907) did not experience any negative secular trend during the stressful early reservation period.

Significantly, although all the tribes discussed here were supplied with rations by the U.S. government (CIA, 1900), perhaps only the more numerous and once mighty Sioux were provided these provisions in a relatively consistent, timely, and useful manner. In retrospect, the Sioux made two very comparatively favorable treaties with the U.S. government (1868 and 1876) (Kappler, 1971), which specified a particular level of rations that the government was obligated to supply. The latter 1876 treaty was seemingly the only one made with the government that included this ration with an open ended proviso for these benefits to continue until the Sioux became self-supporting. This unique circumstance, coupled with their previous warlike reputation (McGinnis, 1990, Utley, 1988; Wooster, 1988), somehow may have garnered the Sioux some additional political leverage that other Plains tribes, particularly the southerners, simply could not exert (Olson, 1965; Priest, 1942; Prucha, 1984). It was the practice of the government to extend the Fort Laramie (1868) Treaty provisions for rations to other northern Plains tribes or tribal segments. The Crow, the northern Cheyenne, and northern Arapaho obtained rations initially as stipulated by treaty for a particular time period; the Assiniboin and the Blackfeet by sheer necessity after about 1875 (Ewers, 1967; Kappler, 1971; Prucha, 1994). All Plains tribes were still being supplied with rations into the 20th century (CIA, 1900, 1901), well beyond any time period stipulated by treaty. What does seem to be reflected in the histories of these other non-Sioux tribes is the clear sense that supplies and rations were provided to most of these nomadic tribes on a much more haphazard basis. Somehow, supplies appeared more subject to the vulnerabilities of Congressional schedules, local and federal politics, and weather and transport problems. Again, it is difficult to follow this situation closely, due to the fact that regular accounting for supplies sent seem to be readily available for many of these tribes only after 1875 (CIA, 1874-1876) (Table 6).

It remains a distinct possibility that since the government typically did not supply a full level of rations until the buffalo were depleted, some of these Plains tribes could have safely subsisted on the remaining herds of buffalo until the mid 1870s (Isenberg, 1993; Roe, 1970). This scenario is more likely for the favorably positioned Crow and the Sioux (Bamforth, 1988), who strangely enough are the only two tribes to show a positive secular trend in the female samples (Figures 36 and 38: Chapter IV, above). The

Table 6: Annual outlays of gross beef (lbs.) by the Indian Office for Some Plains Indian Agencies in 1875 and 1876 (per capita) [a]

Fiscal Year	Arapaho-Cheyenne [b]	Assiniboin	Blackfeet	Comanche Kiowa	Crow	Sioux (all reservations)
1875	1,900,000 (304) [d]	900,000 (NA) [c]	100,000 (18)	2,300,000 (523-676) [f]	1,500,000 (439)	32,265,000 (1,000-1,075)
1876	3,000,000 (484) [e]	900,000 (NA)	300,000 (60)	2,650,000 (630-951)	1,500,000 (454)	13,600,000 (453) [g]

a. Gross beef taken as cattle weights.
b. Southern reservation
c. Combined reservation total, other tribes included
d. Rounded to nearest whole number
e. Population estimates are for 1877.
f. Reflects a range of population estimates
g. This actually represents an anomalous low value for the Sioux.
Most values from 1875-1892 for the Sioux fall between 600-800 pounds per person.

Blackfeet were similarly advantaged in having a very hospitable environment for and possessing one of the last buffalo herds, but seemingly repeated bouts of epidemic disease and warfare prevented them from fully expressing this advantage.

The Sioux, however, were highly advantaged in another respect. For several years during the early 1870s, they were not only supplied with full and abundant rations (Table 6, Chapter IV), they were also still able to successfully hunt the buffalo until at least 1876 for the Western Teton Sioux (Hyde, 1967; Prince, 1989; Textor, 1896).

Possibly this situation represents a common overhang effect of an abundant buffalo resource extending into the early reservation period. This would seemingly belie the experience of the two southern tribes, the Comanche and the Kiowa, showing a statistically significant positive secular trend for male max height and male max sitting height. These tribes were living and hunting in the most marginal areas for buffalo herds, and by the 1850s, many of the southern refuge areas so critical for game were seriously depleted and degraded (Bamforth, 1988; Flores, 1991; Sherow, 1992). Still, accounts of successful hunts into the latter years of the 1870s (1876-1877), are not hard to find for the Comanche and Kiowa (Hagan, 1976; Mayhall, 1971), or the Cheyenne and Arapaho (1877-1878) (Berthrong, 1976; Pennington, 1979).

There are reports of the difficulty in obtaining buffalo off the Comanche-Kiowa reservation by the late 1860s, and some reports of hunger for this same period. By 1868, the agent responsible for the reservation saw enough need to distribute rations to these

Indians, despite the fact that none were stipulated by treaty (Foster, 1991; Hagan, 1976; Kavanagh, 1996).

As Table 6 (Chapter IV) and previous works have shown (Prince, 1989, 1995), where supplies were contracted for by the Indian Office, there is at least the possibility that at times many of the Plains tribes were amply supplied with that portion of the ration we can follow down to the individual agencies, the beef. Again, this was particularly true for the Sioux, with average per capita available beef being about 600-800 pounds per person across all major Sioux reservations consistently from 1874 to1892 (Prince, 1989, 1995). Although very difficult to estimate, the Sioux may have been able to consume more total meat while supplied with 'liberal' rations than the average White American of roughly the same time period. While historic 19th century American food consumption patterns are the subject of continuing research (Cuff, 1992; Gallman, 1996), the levels of meat consumption suggested by the figures for the Sioux agencies are quite impressive even given liberal allowances for loss, waste, and fraud. This seems to be the case partly because of a decline in U.S. overall meat consumption from about 1849 until 1879 (Cuff, 1992; Komlos, 1987). Holmes (1907) cited figures for total dressed meat consumption per family (4.6 persons) per year in the United States in 1900 at 855 pounds and a total annual per capita meat consumption of 185.8 pounds. In the nearest estimate applicable to the case presented here, Komlos (1987) suggests a per capita annual meat consumption of 161 pounds in 1879, while Bennett and Pierce (1961) cite estimates for 1879 that show per capita annual consumption of all animal derived foods at 620 pounds.

Comparisons with British consumption levels are still more dramatic, with Howe (1972) noting that meat consumption based on carcass weight rarely exceeded 130 pounds per capita per year before the 1950s. Oddy (1970) estimated that most laborers consumed only about 1.6 pounds of meat per week, with higher status families consuming 3.2 pounds of meat per capita per week in the 1880s to the 1890s in Britain.

It should be noted that the Plains Indians used the beef much the way they had the buffalo previously. Most evidently made good use of the fats, blood and offal that would normally be lost in the rendering process and hence typically unavailable to the non-farming White population (Anderson et al, 1971; CIA 1870-1880; Nurge, 1970; Prince, 1989; Seerley, 1965). The Plains Indians were able to continue this practice because until the early 1890s, most beef was issued as live cattle for each family. That American farmers and agricultural sector workers are known to exhibit taller mean statures during the 19th century is thought to be connected in part to their unique access to such 'extra edibles' (Komlos, 1987), or higher quality food (Margo and Steckel, 1983) when compared to their more urban contemporaries (Steckel, 1995). This pattern has also been observed in Europe (Floud et al, 1990; Harris, 1994; Komlos, 1994b).

Still, it can easily be shown that the rations as supplied and utilized by the Plains Indians did not provide for a broad spectrum diet. The non-beef components of the Indian ration were less than half of those of a soldier of the era (Berthrong, 1976; Hagan, 1976). Even if all these components (flour, corn meal, coffee, sugar, salt) of the ration were available in the specified quantities, the diet still would be deficient in grains and cereals even by the standards of the era (Bennett and Pierce, 1961; Oddy, 1970). Additionally, many Plains Indians had little idea of how to use flour when it was first issued to them. Many Indian agents also noted the 'improvident' nature of some of their charges. The Indians typically did not conserve their weekly or biweekly rations so that they would last for the entire time between issues. Much feasting was noted on issue day, and fasting upon the approach of the next cycle of ration issues. The actual consumption trends present in each tribe and reservation would have varied considerably and remains difficult to estimate. The very definition and composition of what constituted a household could also be quite fluid for many tribes (Taylor, 1989). Only when the Indian schools were firmly established by the mid to late 1880s is there a clear indication that a healthful and plentiful diet was being supplied to those Indians attending day schools (Prince, 1989, 1995; Putney, 1980). The school ration was in practice large and often supplemented with vegetables and fruit grown in school gardens, which frequently represented the only consistently successful farming operations on reservations (Pennington, 1979; Prince, 1989).

The subsistence ration was not the only source of food for at least some Plains Indians on the reservations, although typical statistics do indicate that better than 75% to 80% of these Indians were said to be wholly dependent upon the ration issue for any given year concerned (Nurge, 1970; CIA, 1876-1882). Other foodstuffs, principally the prairie turnip, were gathered by the Sioux on the reservations (CIA, 1885, 1893). Dogs were kept and eaten by the Sioux and Kiowa and other tribes (CIA, 1893; Snyder, 1988), and many tribes continued to trade and barter buffalo and cattle hides as well as stolen stock for foodstuffs (Berthrong, 1976; Fowler, 1996; Hagan, 1976; Moore, 1987). Indian wage labor remained rare, but was also present at this time.

Significant also, caloric demand for the Plains Indians on the reservations should not have approached levels seen for groups requiring large caloric inputs for undoubtedly greater levels of physical exertion, U.S. slaves, for example (Steckel, 1986, 1987), or perhaps even middle class White military cadets (Komlos, 1987). This is certainly reflected in a similar population sample of Sioux taken in 1906-1907 by agency physician Dr. James Walker, showing robust and modern weights for the Oglala Sioux at that time (Prince, 1989, 1995). Still, it is entirely possible that high disease rates, as reflected by elevated mortality rates, may have caused malnutrition even in the face of extraordinary diets (Fogel, 1986a, 1992). That government supplied rations were critical to the survival of these Plains Indians is not in doubt. Both the Assiniboin and the Blackfeet lost hundreds of members during the starvation winter of 1883-1884, due directly to a shortage of supplies on hand at their agencies, caused in part by transport problems.

If we can document the rather inconsistent, i.e. late, provision of rations to many (perhaps most) of these nomadic Plains tribes, a definitive answer to our paradox does not seem forthcoming. A good case in point may be the Cheyenne.

The Cheyenne in the sample utilized here seem to be all southerners. Their reservation with the Arapaho as well as the neighboring Comanche-Kiowa reservation in the Oklahoma Territory was within a deadly malarial belt that affected both Indians and

Whites (Berthrong, 1976; Campbell, 1989b; CIA, 1876-82; Hagan, 1976; Nespor, 1989). Despite inconsistent and short rations and documented high mortality (Campbell, 1989b), the Cheyenne and the Arapaho managed to sustain the tallest mean statures reported here, although not statistically significant secular trends (Tables 3 and 4, Chapter IV).

Could there have been any ameliorative economic device or institution that may have buffered these Plains Indians from the effects of these food shortages on the reservations? In England, a mechanism to supply grain to the poor during famines or times of scarcity was employed by governments as early as the mid to late 1500s (Fogel, 1986a, 1992). For these Plains Indians, already supplied with a regimen of rations on the reservations, their coping mechanisms may have been more familiar cultural ones (Minnis, 1985). All Plains tribal groups had in common a marked ethos of sharing and generosity and this particularly applied to foodstuffs. There were formal, institutionalized and well recognized customs where an individual or family could stake a claim to a buffalo carcass. For the Dakota, this included the hunka adoption ceremony, for the Blackfeet and other tribes there was tail-tieing or challenge sticks, all ways of assuring provision for the poor. As mentioned by Landes (1968: 36) of the Eastern Sioux in the years prior to 1862:

> ...no matter how a household feared destitution, it had to share meat with all the village when the man of the household had hunted successfully...Consequently, there might be a large number of feasts on a night when men had brought home game or rations, straining the favored person invited to two or three feasts who dared not offend by refusal. Distribution and feasts witnessed the solidarity of the village...

All members of the tribe were thus socially obligated and in turn entitled to the aid of fellow tribe members in times of trouble (Albers, 1992; Ewers, 1955, 1961, 1968; Isenberg, 1993; Hassrick, 1964; Klein, 1983, 1992). As noted by O'Shea and Halstead (1989:124):

> The structure of social relations between individuals and between communities is a …major point of articulation for risk buffering activities. Their important role in risk buffering is apparent in the universal use of food sharing and hospitality to define and confirm ties of kinship, partnership or patronage, and in the use of such relationships to establish rights to food resources.

As Whelan (1993:256-257) describes the Eastern Dakota Sioux:

> Reciprocity--mutual exchange between socially defined partners-- was the key to economic production, distribution, and consumption among the Dakota. Cycles of 'gift' and counter 'gift' were used to keep social ties strong…The exchange of these foodstuffs reinforced kinship bonds and also earned an individual prestige because she or he gained a reputation as hard working, kind, and generous.

For the Plains Indians, prior to their reservation experience, other types of responses to shortages would have included more of a reliance upon stored foodstuffs, enlarging social support networks, and movement to an area where the resources or buffalo herds were to be found (Ewers, 1955, 1968; Isenberg, 1993; Minnis, 1985; Moore, 1982, 1987; O'Shea and Halstead, 1989).

Some have claimed that this Plains Indian ethic of social cooperation where "customs mandating the communal redistribution of property mitigated the impact of scarcity" (Isenberg, 1993: 164) waned with the increasing influence of market integration

(Albers, 1992; Klein, 1983, 1992; Pickering, 1994). Still, it remains certain that portions of this ethos survived well into the 20th century, including an expansive kin recognition system of social obligations (DeMallie, 1994; Maynard and Twiss, 1969; Nurge, 1970; Seerley, 1965; Whelan, 1993). Further, it seems clear that traditional give-aways and feasts, communal methods of redistributing 'wealth' and food, remained a frequently remarked upon part of the Plains Indian culture during the early reservation years (CIA 1875-1900). So despite the rise in the commercialization of social relations with the increase of acquisition and accumulation of individual goods and wealth attendant to the meteoric rise of the fur trade of the 1860s and 1870s, the Plains Indians still practiced some aspects of an older communal ethic well into the present era (Ewers, 1955; Isenberg, 1993; Whelan, 1993).

This contention is important here for the implications these possible buffering mechanisms might have upon a mean height series. In studies of European historical height series, an increase in income inequality as measured by the Gini coefficient coincides with a decrease in mean heights over time (Floud, 1992; Floud et al, 1990; Komlos, 1994b). In a classic case study, Steckel (1983) examined a cross-sectional sample of 22 different contemporary societies and found that variation in inequality was an important determinant of mean heights. Thus the distribution of income or wealth are vital considerations in a mean height series, although this relationship "...was probably weaker in the mid 19th century compared with the modern period" (Steckel 1995: 1927). This is true in part because wealth probably conveyed little advantage for child survival in the mid to late 19th century United States and elsewhere (Davin, 1993; Floud, 1986; Preston and Haines, 1991; Steckel, 1988b). A similar case might be argued from the slow and sporadic improvements in adult life expectation during the mid to late 19th century "… with little overall improvement in mortality" (Pope, 1992: 293) seen for most of the century in the U.S. (Haines and Anderson, 1988; Smith, 1983). Currently, one of the principal theories on why despite growth in income, mean White heights lag or decline in 19th century America (from 1830 to about 1890) is the offset or nutritional costs of a worsening overall disease environment (Floud, 1992; Fogel, 1991, 1992; Steckel, 1994, 1995). This factor would be seen as operating in an environment of greater immigration, crowding in cities, mass migrations, and greater interregional trade; all opportunities for the more efficient spread of infectious disease (Steckel, 1994, 1995). Still, the predictive utility of real per capita income to sex and age specific heights has again been shown by Drukker and Van Meerten (1995) for several European countries from the early 1800s to the present.

So, how generally applicable are the above analyses and interpretations developed using national accounts for developed westernized economies when examining an aboriginal economy, or one that has just recently been integrated into the market? As I have argued here and elsewhere (Prince, 1989, 1995), unique insights can be gained into the history of the Plains Indians with such an analysis, however certain limitations are apparent. Per capita income will ever remain a difficult concept to apply to these Indians. Still, the Plains Indians were intimately bound to one identifiable commodity, the buffalo, from which they derived most of their subsistence. Class distinctions among these Indians, indicative of some type of inequality, have been noted (Ewers, 1955, 1968; Goldfrank, 1943; Klein, 1983, 1992; Mishkin, 1940), but the real operational meaning of such status differentials may have been greatly mitigated by social prescriptions to share the wealth, or at least the meat and foodstuffs. As applied in industrialized economies, income tracks the nutritional status (mean heights) of a population because of the food, housing, sanitation, and health care that can be purchased with greater monetary resources. Provisionment was ever more critical in the past, when considering that "...during the early phases of the industrial revolution...food consumption still accounted for as much as ¾ of total income among the laboring classes" (Komlos, 1994b:210). While this was more true of Europe than America (Steckel, 1995), one can see part of the futility of the concept of income when a couple of tons of readily available meat might graze within easy striking distance of your pony on the Plains (Ewers, 1955; Whelan, 1993).

As mentioned above, it remains easy to comprehend why the Plains Indians counted their wealth in horses (Ewers, 1955; Moore, 1987; Secoy, 1953; Sherow, 1992). Intriguingly, in this regard, Bamforth (1988: 123) provides us with a plot of "social categories against horse wealth" for the Plains tribes, showing Ewers' numbers (1955: 28) for estimates for horses per capita in 1874. In this proxy measure of wealth, the Kiowa and Comanche do indeed come out on top, at about 2.8 horses per person. The Sioux, however, seemingly fare poorly on this measure at 0.6 to 1.0 horse per person, with taller tribes occupying intermediate positions. The Arapaho and Cheyenne had horse ratios of 1.4, and the Crow had 1.9 horses per capita. This seems to indicate that no one simple factor (wealth) could account for either the absolute heights seen on the Plains, or the presence or absence of a secular trend.

The primacy of the relative availability and price of food as a determinant of nutritional status and height as noted by Cuff (1995) and Komlos (1987, 1994b), tends to indicate that an inconsistent and inefficient ration regime should certainly have caused a decline in per capita nutrient intake, and hence an overall decline in stature for these Plains Indians. And yet, there is little indication of this for our 1870 Plains male cohort, the most likely to have been born and raised on a reservation.

This claim, however, can not be made without reservation of the female tribal samples, as noted in Appendix A-2 and Table 5 (Chapter IV). It appears that there is a drop in mean heights, statistically significant or not, for some female Plains samples when moving from the 1860 birth cohort to the 1870 cohort. This effect may be most pronounced among the Kiowa, and to a much lesser extent the Comanche. This drop is undoubtedly affected by small cell numbers for these decades. T-tests, however, failed to confirm a statistically significant difference between the means for 1860 and 1870 for female max heights for these two tribes.

This brings up the point of the difference in behavior of the height trends in the female samples compared to the male Plains samples. As noted previously, only two female tribal samples showed any sort of statistically significant secular trends, where five of the eight Plains male samples show some change in one of the variables investigated. Previous studies of secular trends "...reveal that stature trends for the two sexes often do not move in concert" (Cuff, 1985: 7). As Komlos (1994b: 217) notes, "the evidence so far indicates that females began to experience nutritional stress earlier than men during a downturn and were less likely to show improvements in an upswing". This effect was noted for the historic Sioux in a previous study (Prince, 1989). Meadows Jantz (1996) has also confirmed this essential pattern noting greater secular change in stature among samples of American males than American females, as measured in long limb bones. A general greater environmental sensitivity has also been claimed for males (Stinson, 1985), although this concept has recently been challenged by Kuh and coworkers (1991) and others (Bielicki, 1986). That nutritional requirements, demands and utilization are typically different for males and females is well known (Adair, 1987; Malina, 1987). Less well defined are the operational and household consequences of sex differences in child and adult energy expenditure and how these and similar factors would impact nutritional status (Beaton, 1992; Payne, 1985; Strickland, 1990).

Possibly significant in this regard are Reinhard's and coworkers' (1994) findings from the analysis of skeletal remains from two historic Omaha cemeteries and one Ponca cemetery in Nebraska. Part of this analysis suggests the distinct negative impact of the fur trade on the Omaha and Ponca, particularly for women. More severe spinal degenerative disease was found among the Omaha and Ponca living during this trade era (ca. 1780s-1820s) than in a prehistoric control sample, and historic era females showed greater overall pathological involvement than did males. From this Reinhard's group concludes (1994) that there were heavier work demands attendant to the rise of the Omaha and Ponca involvement in the fur trade. This shift in subsistence activity, or more likely the addition of production of furs for market to the usual household demands on women's labor, is usually seen as a particularly stressful development for Indian women over the entire Plains during the 19th century (Jablow, 1950; Lewis, 1942; Klein, 1983; Pickering, 1994; Swagerty, 1988; Weist, 1983). Thus it is entirely possible that similar increasing demands on women's labor would have had a negative impact on their nutritional and health status, and hence statures on a Plains-wide basis from at least the 1820s on. This development was seen in conjunction with the increase in polygamy among the nomadic tribes, especially on the northern Plains. Age at first marriage also progressively declined among the nomadic Plains Indians during the 19th century, under the influence of the fur trade. A woman could experience her first pregnancy while still in her teens, with all the well known attendant health risks and growth costs associated with that condition (Adair, 1987; Fowler, 1996; Klein, 1983; Kardulias, 1990; Lewis, 1942; Moore, 1991; Pickering, 1994).

Yet another indication of declining nutritional status for historic Plains villager females during this time period comes from Owsley (1991). In examination of femoral cortical thickness in a sample of historic (1795-1832) Arikara, he noted that "Females seem to have been most affected by the stresses of this turbulent era" (Owsley, 1991:109). These historic females registered the lowest cortical values he recorded from a range of four samples grouped from late prehistoric (1600-1650) to the historic era. For the Arikara, the historic era was probably one of more intense military conflict with the Sioux than was seen for either the Ponca or Omaha, however.

DISEASE AND SANITARY ENVIRONMENT ON THE RESERVATIONS

The general hygienic and sanitary conditions that prevailed on all Plains reservations were easily recognized by perceptive agency physicians and reservation agents alike as clearly deplorable and promoting the spread of disease, particularly deadly tuberculosis. These conditions were seen as a direct outgrowth of the increased crowding and decreased group mobility as these formerly nomadic Indians adapted a more sedentary lifestyle (CIA, 1882-89; Walker, 1906). These factors are also frequently cited by modern researchers when investigating changing patterns of disease in acculturating groups (Garruto, 1981; Swedlund and Armelagos, 1990), with measures of household crowding seen as especially significant in elevated child mortality rates even well into the modern era (Kunitz, 1994; Preston and Haines, 1991). The small one-room shacks that gradually replaced the tipi by the late 1870s to mid 1890s were frequently very crowded, had poor or no ventilation, bedding that was rarely cleaned, and dirt floors upon which the expectorations of infected individuals fell--promoting ready infection and re-infection from the long-lived tuberculosis bacilli.

Where once the very mobility of these nomads served to protect them from some of the most severe effects of epidemics seen amongst the more sedentary village horticulturalists (Isenberg, 1993; Trimble, 1989, 1992, 1994), now this natural check on disease and poor sanitation was largely abandoned on the reservations. Dispersal and the fission of social units could no longer be practiced as a successful crisis strategy on the reservations (Taylor, 1977). The frequent visitations by neighbors and relatives now only served as an efficient vector for the dissemination of disease.

As noted previously, it is difficult to quantify the effects of the disease environment upon the early reservation Plains Indians. Most disease statistics are not only highly variable (Putney, 1980), but basic vital statistics may be unreliable as well (cf Campbell, 1989b; Stuart, 1987). The most reliable and dramatic case, however, can be made with some confidence for the Sioux after about a decade on their reservations (CIA, 1882-1892; Prince, 1989, 1995). Drawing from the Sioux experience we can surmise that for the decade of the 1880s, they experienced a crude mortality rate across all reservations, ranging from the mid to high 30s to the mid to high 40s per 1,000 living population. Better reservations might have clustered at the lower end of this spectrum (low 30s or slightly under), with larger ones occasionally spiking into the 50s per 1,000 of living population. This range is the most likely experience for the 1870s as well. There is also every indication that this is the situation that prevailed on most of the Plains reservations considered here during the 1870s (CIA 1875-82). For the Sioux, the essentially static nature of the health and living standards on their largest reservation, Pine Ridge, was reflected in the fact that by 1916 the aggregate mortality rate had changed very little, at 37 per 1,000 of population (Wissler, 1936a).

Comparable mortality statistics for the White population are difficult to come by (Condran and Crimmins, 1979). A conservative estimate would place the mortality rate for the Plains Indians at about 1.5 to 2.5 times the elevated rates known to prevail for Whites in urban areas in 1890 (Condran and Crimmins, 1980). Comparisons with more similar rural areas in eastern death registration states might attest to an even wider disparity from a rural White average of 18.2 deaths per 1,000 in 1890 (Condran and Crimmins, 1980). Similar levels of differential morbidity and mortality (1.5 to 2.0 times that of comparable Whites) were seen until fairly recently on many Indian reservations (Kunitz, 1994; U.S. Public Health Service, 1959).

Infant mortality rates are still rarer to come by, however Walker (CIA, 1907:18) provides estimates for average annual infant mortality rates from 1896-1907 being within a range of about 215.3 per 1,000 for the Oglala Sioux of Pine Ridge, South Dakota. Similar high rates of infant mortality have also been suggested for the Crow during the late 1880s and early 1890s (Hoxie, 1995). Again, this rate is elevated by similar amounts over comparable White figures for 1890, where the rural weighted average was 154.2 deaths per 1,000 (Condran and Crimmins, 1980). A still bleaker picture would place these rates at levels that were approaching three times those seen for comparable rural Whites in the West in 1890 (Bean et al, 1992; Lynch et al, 1985), although this is far from certain (Murray, 1995). Goldin and Margo (1989), for example, document infant mortality in a Philadelphia almshouse hospital as averaging about 60.6 deaths per 1,000 from 1848 to 1873.

After 1882, tuberculosis was increasingly cited by agency physicians as one of the greatest single causes of death across many of these Plains reservations. For the Sioux, it was regularly seen as responsible for upwards of 50% of all mortality in some years. Putney (1980) notes that tuberculosis became the largest single cause of death among the entire American Indian population in the United States at the turn of the century (1897-1928). This led to one of the first federal health surveys of Indian reservations in order to investigate the extent of the tuberculosis problem (Hrdlicka, 1908, 1909).

CRITIQUE AND ALTERNATIVE EXPLANATIONS FOR TRENDS SEEN

This study has been limited by the nature of the historical tribal samples within the Boas data set. Although the total number of individuals analyzed was reasonably robust (n=1,485), when broken down by sex and by tribe, some tribes included an insufficient number of individuals to make reliable inferences. This is especially evident for the female tribal samples, where only four of the eight Plains tribes (Table 2, Chapter III) can be said to provide a minimally respectable sample size ($n \geq 25$). The fact of low cell numbers for many of these tribes has significantly constrained our interpretations of data.

The relationship between various demographic events, in particular mortality and mean heights, is also a subject of some concern (Fogel, 1986a, 1986b; Malina, 1979; van Wieringen, 1986). The obvious question here is what fraction of the stature we see exhibited by these Indians is due to the possible effects of differential survival. Steckel

(1986a, 1986b, 1986c, 1987) has done extensive research into the heights, health and nutritional status of U.S. slaves; he is of the opinion that "No more than a small portion of the dramatic rise in slave heights relative to modern standards can be attributed to the selectivity of survival with respect to height" (1986a:734). This is critical, as antebellum U.S. slaves possibly experienced a more severe mortality regime than can be documented for most of the Plains Indian tribes described here; with the crucial infant mortality rate for slaves being about 350 deaths under one year of age per 1,000 population (Schmidt et al, 1995; Steckel, 1986a, 1986b). Friedman (1982: 500) actually studied the cumulative effect of mortality on slave heights in Trinidad, arriving at an estimate of the difference in average heights between survivors and nonsurvivors over a one-year period of about 1.6 centimeters among nonadults. Steckel (1986a:734) derives an equation to estimate the percentage of height gain seen in his data that could be accounted for by such selectivity in survivorship, and arrives at a figure under 1% (0.88%). He assumes the average annual mortality rate was no more than 10 per thousand for the seven-year period between adolescence and age 17.

Looking back upon Table 3 (Chapter IV), we can examine the Blackfeet, noting a 2.19 centimeter difference in the maximum height for the cohort of the 1860s (172.25) and the 1870s (174.44). Although this difference does not appear to be statistically significant, by making some conservative assumptions and using Steckel's (1986a:734) formula, we can arrive at a ballpark estimate of this putative culling effect. This is significant because of all the tribes documented, the Blackfeet are well known for having repeated and serious late epidemic episodes (1870 and 1879 smallpox), and well documented hundreds of deaths from starvation in 1879 and 1883-1884. These historic events are seen as producing a population bottleneck due to these extensive depopulation episodes, especially within 10-20 years of measurement. Genetic distances between the Blackfeet and other Plains tribes reflect this bottleneck, by showing the Blackfeet to be more homogenous than expected using an anthropometrically derived genetic Fst measure (Jantz, 1995c; Jantz and Meadows, 1995). The Blackfeet seem to be, in fact, the most internally homogenous group among the Plains nomads studied here (Jantz, 1995c).

Given these findings and taking the two Blackfeet mean max heights for the 1860s and 1870s at face value, we can arrive at a conservative estimate that differential survival should only be responsible for at most 22% to 25% of this 2.19 centimeter difference in means. This is assuming a worst case scenario of the operation of a 1.6 centimeter differential in nonadult heights over twenty years and given an elevated average annual mortality rate of 15 or 16 per thousand.[6] While this culling effect probably contributes to the results we see, even given the best test case available for its potency to prove itself, it still seemingly can not explain a great deal of the variation that can be documented. To be sure, this is a crude estimation utilizing the survivorship and height estimates of Trinidad and U.S. slaves. If accurate survivorship statistics were available for the Plains samples, we might be able to derive better estimates of this

[6] An estimate of 20%-25% would seemingly support a differential of up to 3 centimeters between survivors and nonsurvivors for periods up to a decade even given high (15/1000) average annual mortality rates (Friedman, 1982; Steckel, 1986a).

selective mortality effect, however the pedigree and family data that is available is limited in the Boas data set (Jantz, 1995b; Konigsberg and Ousley, 1995; Logan and Ousley, 1996). Here also the small tribal sample sizes hinder these prospects as well. With respect to the Blackfeet, however, it should be remembered that survivors (who are still growing) would have likely ended up shorter if the net nutritional regime deteriorated (Steckel, personal communication, 1996).

Severe population shifts and declines such as those experienced by the Blackfeet and other Plains tribes, especially during the famed Plains-wide smallpox epidemics of 1780-1781, 1800-1802, and 1837-1838, and the cholera epidemic of 1848-1850 are also no doubt reflected in the data presented here (Ewers, 1973; Jantz, 1995c; Ramenofsky, 1987; Taylor, 1977; Vehik, 1989). The magnitude of these disasters can only be guessed at due to widely differing interpretations of 19th century tribal population estimates (Decker, 1991; Flores, 1991; Taylor, 1989; Ubelaker, 1992). There does not seem to be a simple direct relationship between population loss and mean heights (Sandberg and Steckel, 1987; Steckel, personal communication, 1996) unless the net nutritional status of the population is impacted. Smallpox, in and of itself seemingly would have minimal impact here as it is only nominally influenced by a subject's nutritional status (Rotberg and Rabb, 1983). Cholera, as well as measles, tuberculosis, most respiratory infections, influenza, diarrheas, and most parasitic infections are highly sensitive to nutritional influences, and hence are much more likely to impact mean heights (Fogel, 1986a. 1986b; Rotberg and Rabb et al, 1983; Steckel, personal communication, 1996).

Still, it should be reasonably certain that epidemics would engender much more widespread and systemic social disruption in small isolated aboriginal populations than would be experienced in towns or cities in the 19th century. Hence provisionment could very well have been affected no matter what the cause or type of the epidemic (Dollar, 1977; Garruto, 1981; Jensen, 1972; McGrath, 1991; Taylor, 1977; Thornton et al, 1991; Trimble, 1989; Vehik, 1989; Wirsing, 1985). This may have been the case for Plains tribal populations whether or not any of the epidemics they endured from 1800 to the 1850s were virgin soil epidemics, with which they had little or no experience, and hence little or no immunity (Black, 1992; Crosby, 1994; Neel et al, 1970; Swedlund and Armelagos, 1990). Of related concern as well are the detrimental effects on fertility patterns known to occur with some severe epidemics of measles, influenza, tuberculosis, and smallpox. This possibility of reduced fertility and sub-fecundity must be considered as yet another pattern of depopulation within the overall impact of disease on aboriginal groups (Crosby, 1994; Decker, 1991; Stannard, 1990; Thornton et al, 1991).

Seemingly then we might have no easy single explanation for the concerted decline in heights for males seen in the 1830s through the 1850s for most the samples of Plains tribes studied here (Thornton et al, 1991). Possibly it was a combination of factors that led to this seeming common statural decline. Drought for various years has been suggested by many as a Plains-wide experience for sundry areas; most of the 1820s for the central and 1838-1841 for the northern Plains (Lewis, 1977); 1849-1852 for the central and southern Plains (Flores, 1991); 1845-1853 generally (Isenberg, 1993); 1849-

1850 for the northern Plains (Ewers, 1972); and 1846, 1851, 1854, and the 1850s generally on the south central Plains (Sherow, 1992). Some of these claims have been supported (Lawson, 1974) and others disputed as debate continues (Bamforth, 1988).

Still more vexing is the seeming common increase in stature for many of these tribes in the 1860s and 1870s. While an earlier study had argued for higher consistent levels of net nutrition for the Sioux (Prince, 1989, 1995), this contention for the remaining seven Plains tribes is difficult to sustain. This is true due in part to the inefficient ration regime that prevailed for most of the Plains reservations during the 1870s and 1880s. The youngest person included in the 1870 cohort is for the year 1872, however. This indicates that some children represented in this cohort could have lived for four or five years with their families still successfully practicing some hunting to supplement the government's inconsistent ration schedules. The inclusion of a child cohort in this study as in the earlier study would have directly addressed this issue, but time and space constraints have forestalled these efforts.

The possibility of some effect with increasing admixture is a subject of concern (Logan and Ousley, 1996; Moore and Campbell, 1995). As noted by others (Jantz, 1995b; Szathmary, 1995), it remains difficult to correct for the problems and biases in an historic sample. Again, as mentioned above, admixed individuals with less than a reported ¾ Indian 'blood' quantum were excluded from the present analysis. While this may not address the problem to the degree of thoroughness suggested by some (Moore and Campbell, 1995), it is the most economical and efficient way to proceed without a detailed examination of tribal rolls and censuses. It is noted that given the useful estimates provided by Moore and Campbell (1995:504-505) for percentage of intermarriage in the Boas data set, there does not seem to be any simple or obvious relationship with the results from the height data presented here. Further, most researchers who have worked with height data do not think that heterosis (hybrid vigor) can adequately explain most of the secular increase in height that has been documented for Europe and America over the last 200 years (Bielicki, 1986; Fogel, 1992; Martorell, 1985; van Wieringen, 1986).

At best, the government rations provided to most of the Plains Indians by the early 1870s could have represented a much needed supplement to a dwindling and inconsistent bison and game supply. The virulent disease and hygienic environment that is hypothesized for the early reservations might have extracted an even higher toll in mortality and stature had this critical support been unavailable. Here, the Assiniboin might be a case in point. They, like their northern neighbors the Blackfeet, received rations late, only by 1875. Hence the Assiniboin not only are the second shortest overall in the male sample, but also are the only tribe to show an apparent dramatic decline for male max heights for the 1870s (Table 3, Chapter IV). Again, however, this interpretation probably has been severely affected by the very small cell sample sizes here, and does not appear to be statistically significant.

The deeper paradox is that given a putative poor disease climate on the reservations, how was it possible for any level of supplementation to have kept up with the level of infection and disease known to exist in the 1880s and 1890s, and that we posit for the 1870s? There can be little doubt that disease stress and infection can cause malnutrition (Fogel, 1986a, 1992; Shell-Duncan, 1995), (see Chapter III above). In a similar light, the height disadvantage of about two centimeters of White northeastern U.S. residents when compared to southerners during the 1800s is thought to be due to a worse disease environment in the North. This was in the face of the northerners' clear advantage in per capita income and ample diets (McMahon, 1981; Steckel, 1994, 1995). As Steckel comments (1995:1930), "One possible explanation notes the dense settlement, high rate of commerce, industrialization, and substantial immigration into the area...reinforced the harmful aspects of this [northeastern] disease environment". Steckel (1988b) has also noted that earlier American White populations (1850-1860) facing an elevated mortality schedule likewise showed equivocal results in reduced mortality, even with rising living standards, but still remained relatively tall.

The genetic maintenance of tall stature has also been suggested by some (Tanner, 1981; van Wieringen, 1986). As noted by Steckel (1995: 1929), "Indeed prior to the late 19th century geographically isolated, preindustrial populations in sparsely settled regions were often tall, as discovered in Ireland, the interior American South, Australia, Hungary, Sweden, and Japan".

CHAPTER V: CONCLUSIONS

This dissertation has documented the occurrence of secular trends in height in an historic population of nomadic American Plains Indians. The samples used are a subset of the Boas North American Indian anthropometric data set (Jantz, 1995a, 1995b), and are thought to represent the largest historical American Indian data set ever examined for secular trends. The eight Plains tribes chosen for this study were selected largely because of their single unifying economic and subsistence focus on the buffalo. It was hoped that this Plains-wide similarity would help in an effort to attempt to better model some of the economic inputs into these societies (Flores, 1991), but this effort has proved to be more intractable than imagined (see Estimates of Historic Aboriginal Rate of Bison Utilization in Chapter II). These Indians, however, are among the best documented of Native American groups, which does provide us with historical records of sufficient detail to proceed with some reasonable interpretations of the secular trends that are seen.

A working hypothesis was constructed about the possible shape of any secular trends in the 19th century nomadic Plains Indians that posited a consistent negative secular trend over time, or at least from about 1850 through the 1870 cohort. That is, with the likely stresses seen from increasing White settlement, the related decline and/or retreat of game and buffalo from traditional hunting ranges, and the increased tempo of warfare and conflict with the Army and settlers, one would expect individuals born after 1850 to be shorter than adults born earlier in the 19th century. Additionally, one would expect those individuals born during or after the reservation period to also be shorter than adults born earlier in the 19^{th} century. These shorter statures, if seen in the younger Plains Indians, would be a reflection of a declining net nutritional status (the balance between nutrient intake and claims on that intake), as a direct reflection of a deterioration of living standards seen on the Indian reservations. The stresses of reservation life probably included worsening living conditions, inadequate nutrition levels, and dramatic changes in activity and subsistence patterns (from nomadic hunters to government dependents and would be sedentary farmers) (Hagen and Shaw, 1960; Hoover, 1983; Nespor, 1987; Pennington, 1978, 1979).

In the test for secular trends in mean heights over the period of 1800-1870, a cross-sectional design was used with tribes and sexes analyzed separately. To correct for aging effects over time, formulas developed by Cline et al (1989) (one male and one female) were utilized to adjust for age-related statural loss. The adjustment for each individual case was added to the observed standing height to become max height. Sitting heights were similarly adjusted to become max sitting heights. Ratio was created by max sitting heights /subischial lengths. The four variables or dimensions used to examine each of the Plains tribes for secular trends were max height, max sitting height, ratio, and subischial length. Each variable was then regressed onto decade of birth using a quadratic model for the regression equation. Tribal samples showing significant differences ($p \leq 0.05$) among the means of the birth cohorts, and hence secular change through time for any of the four variables examined, included five of eight male samples, but only two of eight female tribal samples. For male max heights there were significant regressions for the Comanche, Kiowa, and the Sioux. Near significant results were noted for this variable for the Arapaho and the Crow as well. The variable male max sitting height produced significant regressions ($p \leq 0.05$) for the Assiniboin, Comanche, Kiowa, and the Sioux. Crow and Sioux males showed significant trends for the variable ratio, and Crow males were the only tribal sample to show significant change for the subischial dimension.

For the female tribal samples, both Crow and Sioux showed secular trends in the variables max height and max sitting height. Only the Sioux females showed a significant change in the variable ratio.

There do seem to be common trends in heights seen for the majority of the tribes represented in the male Plains sample, with an early decline in heights through the 1830s to the 1850s and then a recovery in heights seen in the 1860s and 1870s. This pattern is also seen for Sioux and Crow females, the only female tribal samples to exhibit statistically significant secular trends.

These common trends are also apparent in an analysis of the entire male (n=1,123) and female (n=362) Plains sample for secular trends. Tests for significant trends for these samples yielded significant results for the variables max height, max sitting height and ratio for both the overall Plains male and female samples. This result, however, may be overly influenced by the larger Sioux numbers included in the analysis.

There does not seem to be any single factor or force that can be seen as responsible for the secular trends in height presented here, although particular historical circumstances can be seen to be broadly responsible for some of the shape of these trends. Morbidity, mortality, and disease trends are probably implicated in the decline of mean heights seen from about the 1820s through the 1850s for most of the male Plains tribal samples studied. While other Indian tribes examined for secular trends have exhibited declining statures throughout the 19th century (Stivers, 1990, for the Eastern Cherokee), this seemingly is not the case for the eight equestrian Plains tribes presented here. The maintenance of relatively tall statures for the majority of these tribes is fairly remarkable. For male max heights, most of the Plains tribes (seven of eight) exceeded the heights of contemporary 19th century U.S. Whites for the decade of the 1860s, with six of eight continuing to do so in the 1870 cohort (Table 3, Chapter IV). From the limited data there is to work with (Meadows Jantz, 1996), it appears that five of eight female tribal max heights exceed the U.S. White female standard for the decade of the 1870s (Table 5, Chapter IV), although this is far from a good national sample of Americans at this time.[7]

The government ration regime, inconsistent as it was in actual application, provided most of these eight Plains tribes with a much needed supplement to their diminishing buffalo diet until the buffalo were effectively hunted out sometime after 1875-1876 on the southern and central Plains. The Plains ration regime was seemingly unusual in that it was primarily meat based (Kelly, 1991:117), no doubt in consideration of these Indians' long-time dependence upon the buffalo as the staff of life (Prince, 1989). The relative abundance and availability of dietary protein is seen by many as a

[7] For a regional comparison of U.S. female heights see Wu, 1995.

key ingredient to the maintenance of an adequate nutritional status (Cuff, 1992, 1995; Fogel, 1986a, 1991; Komlos, 1987, 1994b; Landes, 1998; Ulizzi and Terrenato, 1982).

While the level of rations were eventually reduced from apparently high earlier levels, largely to account for more accurate (and generally lower) tribal census counts, most of these reductions occurred by the late 1870s (1877 for the Cheyenne) or afterward (mid 1880s for the Sioux). Hence it is entirely possible that many Plains Indian children born during the 1870s may have benefited from the unusual circumstance of an overlap in the dietary availability of some game animals being supplemented by government rations until about 1875-1876. This may have meant that a majority of those individuals in the 1870 reservation cohort would have been able to reach their critical third birthday (Martorell et al, 1992), while experiencing sustained and possibly relatively high levels of net nutrition. This would give further proof to the maxim that "food is medicine" (Floud, 1986), and may have helped these children overcome the handicap of a virulent reservation disease environment that was known to exist on most of the Plains reservations by the time of their adolescence (1882-1892).

This study has confirmed and expanded on an earlier study (Prince, 1989, 1995), and here documents the unique occurrence of consistent positive secular trends for both Sioux males and females reanalyzed here, with three variables (max height, max sitting height, and ratio) increasing through time. This strengthens the supposition that the Sioux, the most numerous tribe during the time of study, enjoyed some exceptionally favorable environmental, historical, and tactical advantages over most of their Plains neighbors and rivals (Bamforth, 1988; Prince, 1989; White, 1978).

BIBLIOGRAPHY

Adair, L.S.
1987 Nutrition in the reproductive years. In: Nutritional anthropology. New York: Alan R. Liss.

Albers, P.C.
1983 Sioux women in transition: A study of their changing status in a domestic and a capitalist sector of production. In: The hidden half: Studies of Plains Indian women, P.C. Albers and B. Medicine, eds. New York: University Press of America.

Albers, P.C.
1992 Symbiosis, merger, and war: Contrasting forms of intertribal relationship among historic Plains Indians. In: The political economy of North American Indians, John Moore, ed. Norman: University of Oklahoma Press.

Albers, P.C. and Kay, J.
1987 Sharing the land: A study in American Indian territoriality. In: A cultural geography of North American Indians, T.E. Ross and T.G. Moore, eds. Boulder, Colorado: Westview Press.

Albers, P.C. and Medicine, B. (eds.)
1983 The hidden half: Studies of Plains Indian women. New York: University Press of America.

Algier, K.
1986 Robert Meldrum and the Crow peltry trade. Montana. Summer. 36: 36-47.

Allen, V. R.
1975 Agency physicians to the southern Plains Indians, 1868-1900. Bulletin of the History of Medicine. 49: 318-331.

Anderson, J. A., Hamilton, H. W., and Hamilton, J.H.
1971 The Sioux of the Rosebud. Norman: University of Oklahoma.

Anderson, G.C.
1980 Early Dakota migration and intertribal war: A revision. Western Historical Quarterly. Jan: 17-36.

Anderson, G.C.
1984 Kinsmen of another kind: Dakota-White relations in the upper Mississippi valley, 1650-1862. Lincoln: University of Nebraska Press.

Anderson, H.H.
1972 Fur traders as fathers: The origins of the mixed-blooded community among the Rosebud Sioux. South Dakota History, 3: 3: 233-270.

Arthur, G.A.
1975 An introduction to the ecology of early historic communal bison hunting among the northern Plains tribes. Archeological survey of Canada, Paper 37. Ottawa: National Museums of Canada.

Bad Heart Bull, A.
1967 A pictographic history of the Oglala Sioux. Lincoln: University of Nebraska Press.

Balazs, R., Jordan, T., Lewis, P. D., and Patel, A. J.
1986 Undernutrition and brain development: In: Human growth, a comprehensive treatise, volume 3, second edition, F. Falkner and J. M. Tanner, eds. New York: Plenum Press.

Bamforth, D.B.
1987 Historical documents and bison ecology on the Great Plains. Plains Anthropologist. 32:115:1-16.

Bamforth, D.B.
1988 Ecology and human organization on the Great Plains: Interdisciplinary contributions to archaeology. New York: Plenum Press.

Barker, D.J.P., Osmond, C., and Golding, J.
1990 Height and mortality in the counties of England and Wales. Annals of Human Biology. 17: 2-6.

Barry, E.E.
1976 From buffalo to beef: Assimilation on Fort Belknap Reservation. Montana. Winter: 38-51.

Barsness, L.
1985 Heads, hides and horns: The compleat buffalo book. Fort Worth: Texas Christian University Press.

Bean, L.L., Mineau, G.P., and Anderton, D.L.
1992 High-risk childbearing: Fertility and infant mortality on the American frontier. Social Science History. 16: 3: 337-363.

Beaton, G.H.
1992 The Raymond Pearl Memorial Lecture, 1990: Nutrition research in human biology: Changing perspectives and interpretations. American Journal of Human Biology. 4:2: 159-177.

Bedford, D.R.
1975 The fight at "Mountains on Both Sides." Indian Historian. 8: 2: 13-23.

Bennett, M.K. and Pierce, R.H.
1961 Change in the American national diet, 1879-1959. Food Research Institute Studies. 2: 95-119.

Berthrong, D.J.
1963 The southern Cheyennes. Norman: University of Oklahoma Press.

Berthrong, D.J.
1976 The Cheyenne and Arapaho ordeal: Reservation and agency life in Indian Territory, 1875-1907. Norman: University of Oklahoma Press.

Berthrong, D.J.
1989 From buffalo days to classrooms: The southern Cheyennes and Arapahos and Kansas. Kansas History. 12:2:101-113.

Bielicki, T.
1986 Physical growth as a measure of the economic well-being of populations: The twentieth century. In: Human growth, a comprehensive treatise, volume 3, second edition. F. Falkner and J. M. Tanner, eds. New York: Plenum Press.

Biolsi, T.
1984 Ecological and cultural factors in Plains Indian warfare. In: Warfare, culture, and environment. Brian Ferguson, ed. Orlando, Florida: Academic Press.

Bittle, W.E.
1971 A brief history of the Kiowa Apache. University of Oklahoma Papers in Anthropology. 12: 1: 1-34.

Black, F.
1992 Why did they die? Science. 258:1739-1740.

Blakeslee, D.J.
1994 The archeological context of human skeletons in the northern and central Plains. In: Skeletal biology in the Great Plains. Douglas Owsley and Richard Jantz, eds. Washington, DC: Smithsonian Institution Press.

Blouet, B.W. and Luebke, F.C.
1977 The Great Plains: Environment and culture. Lincoln: University of Nebraska Press.

Boas, F.
1894a The anthropology of the North American Indian: Memoirs of the International Congress of Anthropology. In: The shaping of American anthropology, 1883-1911. G. W. Stocking, ed. New York: Basic Books.

Boas, F.
1894b The half-blood Indian, an anthropometric study. Popular Science Monthly. 45: 761-770 (October).

Boas, F.
1898 The growth of Toronto children. In: Annual report of the Commission of Education for 1896-97. Washington: U.S. G.P.O.

Boas, F.
1895 Zur Anthropologie der nordamerikanischen Indianer. Zeitshcrift pur Ethnologie. 27: 366-411.

Boas, F. and Putnam, F.W.
n.d. (1891-92) Worlds Columbian Exposition, Chicago, 1893. Department of Ethnology and Archaeology. Subdepartment of Physical Anthropology. "Instructions". Mimeograph on file at the Peabody Museum Archives, Harvard (Cambridge).

Boettcher, A.J.
1966 Groundwater Development in the High Plains of Colorado. U.S. Geological Survey Water Supply Paper No: 1819I. Washington, U.S.G.P.O.

Bogin, B.
1988a Patterns of human growth. Cambridge: Cambridge University Press.

Bogin, B.
1988b Rural to urban migration. In: Biological aspects of human migration. C.G.N. Massie-Taylor and G.W. Lasker, eds. New York: Cambridge University Press.

Bolus, M. (ed.)
1972 People and pelts: Selected papers of the second North American Fur Trade Conference. Winnipeg, Manitoba: Peguis Publishers.

Borkan, G.A., Hults, D.E., and Glynn, R.J.
1983 Role of longitudinal change and secular trend in age differences in male body dimensions. Human Biology. 55: 3: 629-641.

Bowler, M. J.
1944 The Sioux Indians and the United States Government, 1862-1878. St. Louis: Washington University.

Branch, E.D.
1962 The hunting of the buffalo. Lincoln: University of Nebraska Press.

Bray, K.M.
1985 Lone Horn's peace: a new view of Sioux-Crow relations, 1851-1858. Nebraska History. 66: 28-47.

Brooks, R.L.
1992 Southern Plains cultural complexes. In: Skeletal biology in the Great Plains. D.W. Owsley and R.L. Jantz, eds. Washington, DC: Smithsonian Institution Press.

Brown, J.S.H.
1994 Fur trade as centrifuge: familial dispersal and offspring identity in the company contexts. In: North American Indian anthropology: essays on society and culture. R.J. DeMallie and A. Ortiz, eds. Norman: University of Oklahoma Press.

Brown, W.R., Jr.
1986 Comancheria demography, 1805-1830. Panhandle Plains Historical Review. 59: 1-17.

Bruce-Chwatt, L. J.
1986 Health problems of the third world. In: Science, medicine and the community: the last hundred years. A. Briggs and J.H. Shelley, eds. Amsterdam and Princeton: Elsevier Science Publishing.

Buechler, J.
1989 Eastern Dakota social structure and the fur trade. South Dakota Archaeology. 13: 55-68.

Burlingame, M.G.
1929 The buffalo in trade and commerce. North Dakota History. 3:4: 262-291.

Butzer, K.W.
1990 The Indian legacy in the American landscape. In: The making of the American landscape. M. Conzen, ed. Boston: Unwin Hyman.

Callaway, D.G.
1978 Raiding and feuding among western North American Indians. Unpublished PhD dissertation. University of Michigan.

Calloway, C.G.
1982 The intertribal balance of power on the Great Plains, 1760-1850. Journal of American Studies (British) 16:1:25-48.

Calloway, C.G.
1986 The only way open to us: The Crow struggle for survival in the 19th century. North Dakota History. 53:3:25-34.

Calloway, C.G.
1997 New worlds for old: Indians, Europeans, and the remaking of early America. Baltimore: Johns Hopkins University Press.

Cameron, N.
1996 Antenatal and birth factors and their relationship to child growth. In: Long-term consequences of early environment: Growth, development and the lifespan developmental perspective. C.J.K. Henry and S.J. Ulijaszek, eds. New York: Cambridge University Press.

Campbell, G.R. (ed.)
1989a Plains Indian demography and health: Perspectives, interpretations, and critiques. Plains Anthropologist. 34: 124: part 2 (May).

Campbell, G.R.
1989b The epidemiological consequences of forced removal: The northern Cheyenne in Indian territory. Plains Anthropologist. 34: 124: 85-97.

Campbell, G.R.
1991 Changing patterns of health and effective fertility among the northern Cheyenne of Montana, 1886-1903. American Indian Quarterly. Summer: 339-358.

Carlson, G.G. and Jones, V.H.
1940 Some notes on the uses of plants by the Comanche Indians: Papers of the Michigan Academy of Science, Arts and Letters. 25: 517-542.

Carlson, P.H.
1992 Indian agriculture, changing subsistence patterns, and the environment on the southern Great Plains. Agricultural History. 66:2: 52-65.

Carmichael, A. G.
1983 Infection, hidden hunger, and history. In: Hunger and history. R. I. Rotberg and T. K. Rabb, eds. Cambridge: MIT.

Cassedy, J.H.
1991 Medicine in America: a short history. Baltimore: Johns Hopkins University Press.

Chen, C. and Scrimshaw, N. S. (eds.)
1983 Diarrhea and malnutrition. Interactions, mechanisms, and interventions. New York: Plenum Press.

Cline, M.G., Meredith, K.E., Boyer, J.T., and Burrows, B.
1989 Decline of height with age in adults in a general population sample: estimating maximum height and distinguishing birth cohort effects from actual loss of stature with aging. Human Biology. 61: 3: 415-425.

Coclanis, P,A. and Komlos, J.
1995 Nutrition and economic development in post-Reconstruction South Carolina. Social Science History. 19:1:93-115.

Coman, K.
1912 Economic beginnings of the Far West. 2 volumes. New York: Harper.

Comer, D.G.
1996 Ritual ground: Bent's old fort, world formation, and the annexation of the Southwest. Berkeley: University of California Press.

Commissioner of Indian Affairs (CIA)
1870-1901 Annual Reports of the Commissioner of Indian Affairs to the Secretary of the Interior, 1870-1900. Washington: U.S. G.P.O.

Condran, G. A. and Crimmins, E.
1979 A description and evaluation of mortality data in the federal census: 1850-1900. Historical Methods, 12: 1-23.

Condran, G. A. and Crimmins, E.
1980 Mortality differentials between rural and urban areas of states in the northeastern United States 1890-1900. Journal of Historical Geography. 6: 179-202.

Costa, D.L.
1993 Height, weight, wartime stress, and older age mortality: evidence from the Union Army records. Explorations in Economic History. 30: 424-449.

Crosby, A.W.
1994 Germs, seeds, and animals: Studies in ecological history. Armonk, New York: M.E. Sharpe.

Crow, J.M.
1978 Notes on Crow Indian buffalo jump traditions. In: Bison procurement and utilization: A symposium. L. Davis and M. Wilson, eds. Plains Anthropologist. 23:82:249-253.

Cuff, T.
1992 A weighty issue revisited: New evidence on commercial swine weights and pork production in mid 19th century America. Agricultural History. 66: 4: 55-74.

Cuff, T.
1995 Introduction: Historical anthropometrics--Theory, method, and the state of the field. In: The biological standard of living on three continents. J. Komlos, ed. Boulder: Westview Press.

Cunningham-Rundles, S.
1984 Nutritional factors in immune response. In: Malnutrition: determinants and consequences, P. L. White and N. Selvey, eds. New York: Alan R. Liss, Inc.

Danziger Jr., E.J.
1970 The Crow Creek experiment: an aftermath of the Sioux War of 1862. North Dakota History. 37: 2: 105-123.

Davin, E.L.
1993 The era of the common child: egalitarian death in antebellum America. Mid-America Historical Review. 75: 2: 134-163.

Davis, L. and Wilson, M. (eds.)
1978 Bison procurement and utilization: A symposium. Plains Anthropologist. 23:82: Part 2. (Memoir No.14).

Decker, J.F.
1991 Depopulation of the northern Plains natives. Social Science Medicine. 33: 4:381-393.

DeMallie, R. J.
1975 Joseph Nicollet's account of the Sioux and Assiniboin in 1839. South Dakota History. 5: 4: 75-92.

DeMallie, R. J.
1994 Kinship and biology in Sioux culture. In: North American Indian anthropology: Essays in society and culture. R.J. DeMallie and A. Ortiz, eds. Norman: University of Oklahoma Press.

Dempsey, H.A.
1965 A Blackfoot winter count. Occasional Paper Number 1. Calgary, Alberta: Glenbow Foundation.

Dobyns, H.F.
1992 Native American trade centers as contagious disease foci. In: Disease and Demography in the Americas. J.W. Verano and D.H. Ubelaker, eds. Washington, DC: Smithsonian Institution Press.

Dollar, C.D.
1977 The High Plains smallpox epidemic of 1837-38. The Western Historical Quarterly. Jan: 15-38.

Drass, R.R. and Flynn, P.
1990 Temporal and geographic variations in subsistence practices for Plains villagers in the southern Plains. Plains Anthropologist. 35:128:175-190.

Driver, H.E.
1969 Indians of North America. Second Edition, revised. Chicago: University of Chicago Press.

Driver, H.E., Kenny, J.A., Hudson, H.C., and Engle, O.M.
1972 Statistical classification of North American Indian ethnic units. Ethnology. 11: 311-39.

Driver, H.E. and Coffin, J.L.
1975 Classification and development of North American Indian cultures: A statistical analysis of the Driver-Massey sample. American Philosophical Society, Transactions. 65:3.

Drukker, J.W. and Van Meerten, M.A.
1995 Beyond Villerme and Quetelet: The quantitative relation between sex and age-specific height and real per capita income. In: The biological standard of living on three continents. J. Komlos, ed. Boulder, CO: Westview Press.

Eggan, F.
1966 The American Indian: perspectives for the study of social change. Chicago: Aldine Publishing Company.

Ehrich, R.W. and Henderson, G.M.
1968 Culture area. International encyclopedia of the social sciences. 3: 563-66.

Elo, I.T. and Preston, S.H.
1992 Effects of early life conditions on adult mortality: a review. Population Index. 58: 2: 186-212.

Eveleth, P. B.
1986 Population differences in growth: environmental and genetic factors. In: Human growth, a comprehensive treatise, volume 3, second edition. F. Falkner and J. M. Tanner, eds. New York: Plenum Press.

Eveleth, P. B. and Tanner, J. M.
1976 Worldwide variation in human growth. Cambridge: Cambridge University Press.

Eveleth, P. B. and Tanner, J. M.
1990 Worldwide variation in human growth, second edition. Cambridge: Cambridge University Press.

Ewers, J.C.
1955 The horse in Blackfoot Indian culture. Washington, DC: Smithsonian Institution Press. Reprinted in 1980.

Ewers, J.C. (ed.) and Denig, E.T. (author)
1961 Five Indian tribes of Upper Missouri: Sioux, Arickaras, Assiniboines, Crees, Crows. Norman: University of Oklahoma Press.

Ewers, J.C.
1967 The Blackfeet: Raiders on the northwestern Plains. Norman: University of Oklahoma Press.

Ewers, J.C.
1968 Indian life on the Upper Missouri. Norman: University of Oklahoma Press.

Ewers, J.C.
1972 The influence of the fur trade upon Indians of the northern Plains. In: People and pelts: Selected papers of the second North American Fur Trade Conference. M. Bolus, ed. Winnipeg, Manitoba: Peguis Publishers.

Ewers, J.C.
1973 The influence of epidemics on the Indian population and cultures of Texas. Plains Anthropologist. 18: 60: 104-115.

Ewers, J.C.
1975 Intertribal warfare as the precursor of Indian-White warfare on the northern Great Plains. Western Historical Quarterly. 6: 4: 397-410.

Ewers, J.C.
1994 Women's roles in Plains Indian warfare. In: Skeletal biology in the Great Plains. D.W. Owsley and R.L. Jantz, eds. Washington, DC: Smithsonian Institution Press.

Fehrenbach, T.R.
1974 Comanches: The destruction of a people. New York: Alfred A. Knopf.

Feraca, S. E. and Howard, J. H.
1963 The identity and demography of the Dakota or Sioux tribes. Plains Anthropologist. 8: 80-84.

Flores, D.
1991 Bison ecology and bison diplomacy: The southern Plains from 1800 to 1850. The Journal of American History. 78: 465-485.

Floud, R.
1984 The heights of Europeans since 1750: A new source for European economic history. National Bureau of Economic Research Working Paper Series, 1318.

Floud, R.
1986 Science, medicine and the community: a case of slow diffusion. In: Science, medicine and the community: The last hundred years. A. Briggs and J.H. Shelley, eds. Amsterdam and Princeton: Elsevier Science Publishing.

Floud, R.
1992 Anthropometric measures of nutritional status in industrialized societies: Europe and North America. In: Nutrition and poverty. S.R. Osmani, ed. New York: Oxford University Press.

Floud, R.
1994 The heights of Europeans since 1750: A new source for European economic history. In: Stature, living standards, and economic development. J. Komlos, ed. Chicago: University of Chicago Press.

Floud, R., Wachter, K., and Gregory, A.
1990 Height, health and history: Nutritional status in the United Kingdom, 1750-1980. New York: Cambridge University Press.

Fogel, R. W.
1986a Nutrition and the decline in mortality since 1700: Some additional preliminary findings. National Bureau of Economic Research Working Paper Series, 1802. Cambridge, MA: NBER.

Fogel, R. W.
1986b Nutrition and the decline in mortality since 1700: Some preliminary findings. In: Long-term factors in American economic growth. J.L. Engerman and R.E. Gallman, eds. Chicago: University of Chicago Press.

Fogel, R. W.
1991 The conquest of high mortality and hunger in Europe and America: Timing and mechanisms. In: Favorites of fortune: Technology, growth, and economic development since the Industrial Revolution. D. Landes, P. Higgonet, and H. Rosovsky, eds. Cambridge, MA: Harvard University Press.

Fogel, R. W.
1992 Second thoughts on the European escape from hunger: Famines, chronic malnutrition, and mortality rates. In: Nutrition and poverty. S. R. Osmani, ed. New York: Oxford University Press.

Fogel, R. W.
1994 Economic growth, population theory and physiology: The bearing of long-term processes on the making of economic policy. The American Economic Review. 84: 3: 369-395. The 1993 Nobel Memorial Prize in Economic Sciences Lecture.

Fogel, R. W., Engerman, S. L., and Trussell, J.
1982 Exploring the uses of data on height: The analysis of long-term trends in nutrition, labor, welfare, and labor productivity. Social Science History. 6: 401-421.

Fogel, R. W., Engerman, S. L., Floud, R. et al
1983 Secular changes in American and British stature and nutrition. Journal of Interdisciplinary History. 14: 445-481.

Forbes, A.
1972 The Plains AGON: A gross typology. Plains Anthropologist. 17: 56: 143-155.

Foster, M.W.
1991 Being Comanche: a social history of an American Indian community. Tuscon: University of Arizona Press.

Fowler, J.
1898 The journal of Jacob Fowler: Narrating an adventure from Arkansas through the Indian Territory, Oklahoma, Kansas, Colorado, and New Mexico, to the sources of the Rio Grande del Norte. E. Coues, ed. New York: Harper.

Fowler, L.
1982 Arapahoe politics, 1851-1978: Symbols in crises of authority. Lincoln: University of Nebraska Press.

Fowler, L.
1994 The civilization strategy: Gros Ventres, northern and southern Arapahoes compared. In: North American Indian anthropology. R.J. DeMallie and A. Ortiz, eds. Norman: University of Oklahoma Press.

Fowler, L.
1996 The Great Plains from the arrival of the horse to 1885. In: The Cambridge History of the native peoples of the Americas: Vol. I, Part 2: North America. B.G. Trigger and W.E. Washburn, eds. New York: Cambridge University Press.

Friedman, G.C.
1982 The heights of slaves in Trinidad. Social Science History. 6:4:482-515.

Frisancho, A. R.
1978 Nutritional influences on human growth and maturation. Yearbook of physical anthropology. 21: 174-191.

Frison, G.C.
1974 The Casper site. New York: Academic Press.

Frison, G.C.
1978 Prehistoric hunters of the High Plains. New York: Academic Press.

Gage, T.B., and O'Connor, K.
1994 Nutrition and the variation in level and age patterns of mortality. Human Biology. 66:77-103.

Gage, T.B., and Zansky, S.M.
1995 Anthropometric indicators of nutritional status and level of mortality. American Journal of Human Biology. 7: 679-691.

Gallman, R.E.
1996 Dietary change in antebellum America. Journal of Economic History. 56: 1: 193-201.

Garenne, M., Glasser, J., and Levins, R.
1994 Disease, population, and virulence: thoughts about measles mortality. In: Disease in evolution. M.E. Wilson, R. Lewis and A. Spielman, eds. Annals of the New York Academy of Sciences. Vol. 740.

Garn, S. M. and Clark, D. C.
1975 Nutrition, growth, development, and maturation: Findings from the ten-state nutrition survey of 1968-1970. Pediatrics. 56: 300-319.

Garn, S. M. and Bailey, S. M.
1978 Genetics of the maturational processes. In: Human growth, Volume 1. F. Falkner and J. M. Tanner, eds. New York: Plenum Press.

Garruto, R. M.
1981 Disease patterns of isolated groups: In Biocultural aspects of disease. H. Rothschild, ed. New York: Academic Press.

Geist, V.
1996 Bison nation: History and legend of the North American buffalo. Voyager Press.

Gilbert, B.M.
1980 The Plains setting. In: Anthropology on the Great Plains. W. R. Wood and M Liberty, eds. Lincoln: University of Nebraska Press.

Gilmore, M. R.
1919 Uses of plants by the Indians of the Missouri River region. Annual Report to the Bureau of American Ethnology. 33: 43-154.

Golden, M.H.N..
1996 Effect of early nutrition on later growth. In: Long-term consequences of early environment: growth, development and the lifespan developmental perspective. C.J.K. Henry and S.J. Ulijaszek, eds. New York: Cambridge University Press.

Goldin, C. and Margo, R.A.
1989 The poor at birth: birth weights and infant mortality at Philadelphia's Almshouse Hospital, 1848-1873. Exploration in Economic History. 26: 360-379.

Goldfrank, E.
1943 Historic change and social character: A study of the Teton Dakota. American Anthropologist. 45: 67-83.

Goldfrank, E.S.
1944 Changing configurations in the social organization of a Blackfoot tribe during the reserve period: The Blood of Alberta, Canada. Monographs of the American Ethnological Society. Number 8. Seattle: University of Washington Press.

Gopalan, C.
1992 Undernutrition: measurement and implications. In: Nutrition and poverty. S.R. Osmani, ed. New York: Oxford University Press.

Greene, L. S.
1980 Conclusions. In: Social and biological predictors of nutritional status, physical growth, and neurological development. L. S. Greene and F. E. Johnston, eds. New York: Academic Press.

Greene, L. S. and Johnston, F. E. (eds.)
1980 Social and biological predictors of nutritional status, physical growth, and neurological development. New York: Academic Press.

Grinnell, G.B.
1908 Blackfoot lodge tales: The story of a prairie people. New York: Charles Scribner.

Grinnell, G.B.
1910 Coup and scalp among the Plains Indians. American Anthropologist 12: 296-310.

Grinnell, G.B.
1923 The Cheyenne Indians: Their history and ways of life, 2 volumes. New Haven: Yale University Press.

Grinnell, G.B.
1956 The fighting Cheyennes. Norman: University of Oklahoma Press.

Gullason, L.
1994 No less than seven different nations: Ethnicity and culture contact at Fort George-Buckingham House. In: The fur trade revisited: Selected papers of the 6th North American Fur Trade Conference, 1991. J.S.H. Brown, W.J. Eccles, and K.P. Heldman, eds. Mackinac Island: Michigan State University Press.

Gussow, Z.
1974(1954) Cheyenne and Arapaho aboriginal occupation. In: Arapaho-Cheyenne Indians. Z. Gussow, L.R. Hafen, and A.A. Ekirch. New York: Garland Publishing.

Haas, J.D.
1990 Mortality and morbidity consequences of variation in early child growth. In: Disease in populations in transition: anthropological and epidemiological perspectives. A.C. Swedlund and G.J. Armelagos, eds. Westport, Connecticut: Bergin and Garvey.

Hagen, E. E. and Shaw, L. C.
1960 The Sioux on the reservations: The American colonial problem. Cambridge: MIT, unpublished.

Hagan, W.T.
1976 United States-Comanche relations: The reservation years. New Haven: Yale University Press.

Hagan, W.T.
1988 United States Indian policies, 1860-1900. In: The handbook of North American Indians, Volume 4. W.C. Sturtevant and W.W. Washburn, eds. Washington, DC: Smithsonian Institution Press.

Haines, F.
1976 The Plains Indians. New York: Thomas Crowell.

Haines, M.R. and Anderson, B.A.
1988 New demographic history of the late 19th century United States. Explorations in economic history. 25: 341-365.

Halstead, P. and O'Shea, J. (eds.)
1989 Bad year economics: cultural responses to risk and uncertainty. New Directions in Archeology. New York: Cambridge University Press.

Hanson, J.R.
1984 Bison ecology in the northern Plains and a reconstruction of bison patterns for the North Dakota region. Plains Anthropologist. 29: 104: 93-113.

Hanson, J.R.
1986 Adjustment and adaptation on the northern Plains: The case of equestrianism among the Hidatsa. Plains Anthropologist. 31: 112: 93-107.

Harris, B.
1994 Health, height and history: An overview of recent developments in anthropometric history. Social History of Medicine. 7:2: 297-320.

Hassrick, R. B.
1964 The Sioux: Life and customs of a warrior society. Norman: University of Oklahoma Press.

Hayden, F.V.
1862 Contributions to the ethnology and philology of the Indian tribes of the Missouri Valley. Transactions of the American Philosophical Society. 12: 231-461.

Heidenreich, C.A.
1985 The Native American's Yellowstone. Montana, Autumn. 35: 2-17.

Helleson, J.C. and Gadd, M.
1974 Ethnobotany of the Blackfoot Indians. Canadian Ethnology Service Paper 19, National Museum of Man Mercury Series. Ottawa: National Museums of Canada.

Henry, A. and Thompson, D.
1965 (1897) New light on the early history of the Great Northwest: The manuscript journals of Alexander Henry and David Thompson. Elliott Coues, ed. 2 vols. Minneapolis: Ross and Haines.

Henry, C.J.K. and Ulijaszek, S.J. (eds.)
1996 Long-term consequences of early environment: growth, development and the lifespan developmental perspective. Society for the Study of Human Biology Symposium 37. New York: Cambridge University Press.

Hester, J.
1972 Blackwater draw locality No. 1: A stratified early man site in eastern New Mexico. Fort Burgwin Research Center Publication No. 8. Southern Methodist University.

Hickerson, H.
1974 Sioux Indians, I: Mdewakanton Band of Sioux Indians. New York: Garland Publishing.

Higginbotham, N. A.
1981 The Wind-Roan winter count. Plains Anthropologist. 26: 1-42.

Higgs, R.
1973 Mortality in rural America, 1870-1920: Estimates and conjectures. Explorations in Economic History, 10: 177-195.

Himes, J. H. and Mueller, W. H.
1977 Aging and secular change in adult stature in rural Colombia. American Journal of Physical Anthropology. 46: 275-280.

Hoig, S.
1980 The Peace Chiefs of the Cheyennes. Norman: University of Oklahoma Press.

Holder, P.
1970 The hoe and the horse on the Plains: A study of cultural development among North American Indians. Lincoln: University of Nebraska Press.

Hollow, R.C. and Parks, D.R.
1980 Studies in Plains linguistics: A review. In: Anthropology on the Great Plains. W.R. Wood and M. Liberty, eds. Lincoln: University of Nebraska Press.

Holmes, G.K.
1907 Meat supply and surplus. U.S. Department of Agriculture, Bureau of Statistics, Bulletin 55. Washington, DC: U.S.G.P.O.

Holzkamm, T.E.
1983 Eastern Dakota population movements and the European fur trade: one more time. Plains Anthropologist. 28:101: 225-233.

Hoover, H. T.
1983 Arikara, Sioux, and government farmers: Three American Indian agricultural legacies. South Dakota History. 13: 22-48.

Howard, J. H.
1966 The Dakota or Sioux Indians: A study in human ecology. Vermillion: University of South Dakota.

Howard, J. H.
1972 Notes on the ethnogeography of the Yankton Dakota. Plains Anthropologist. 17: 281-307.

Howard, J.H.
1975 The culture area concept: Does it diffract anthropological light? Indian Historian. 8: 22-26.

Howard, J. H.
1976 Yanktonai ethnohistory and the John K. Bear winter count. Plains Anthropologist. 21: part 2, 1-45.

Howe, G. M.
1972 Man, environment and disease in Britain. New York: Barnes and Noble.

Hoxie, F.E.
1991 Searching for structure: reconstructing Crow family life during the reservation era. American Indian Quarterly. Summer. 15: 287-309.

Hoxie, F.E.
1995 Parading through history: The making of the Crow nation in America, 1805-1935. New York: Cambridge University Press.

Hrdlicka, A.
1908 Physiological and medical observations. Smithsonian Institution, Bureau of American Ethnology, 34: 172-219.

Hrdlicka, A.
1909 Tuberculosis among certain Indian tribes of the United States. Smithsonian Institution, Bureau of American Ethnology, 42: 1-48.

Hrdlicka, A.
1931 Fecundity of Sioux women. American Journal of Physical Anthropology. 16: 81-90.

Hurt, W. R.
1974 Dakota Sioux Indians. New York: Garland Publishers.

Hyde, G. E.
1956 A Sioux chronicle. Norman: University of Oklahoma Press.

Hyde, G.E.
1959 Indians of the High Plains: From the prehistoric period to the coming of the Europeans. Norman: University of Oklahoma Press.

Hyde, G. E.
1967 Red Cloud's folk. Norman: University of Oklahoma Press.

Isenberg, A.C.
1992 Toward a policy of destruction: Buffaloes, law and the market, 1803-1883. Great Plains Quarterly. 12: 227-241.

Isenberg, A.C.
1993 Indians, Whites and the buffalo: An ecological history of the Great Plains, 1750-1900. Evanston, Illinois: Northwestern University. unpublished PhD dissertation, Dept. of History.

Jablow, J.
1950 The Cheyenne in Plains Indian trade relations, 1795-1840. American Ethnological Society Monographs, No. 19. Seattle: University of Washington Press.

Jackson, A.A.
1985 Nutritional adaptation in disease and recovery. In: Nutritional adaptation in Man. K. Blaxter and J.C. Waterlow, eds. London: John Libbey.

Janke, R.A.
1987 The loss of Indian lands in Wisconsin, Montana and Arizona. In: A cultural geography of North American Indians. T.E. Ross and T.G. Moore, eds. Boulder: Westview Press.

Jantz, R.L. (ed.)
1995a Special issue on the population biology of late 19th century native North Americans and Siberians: Analyses of Boas data. Human Biology. 67: 3: 337-533.

Jantz, R.L.
1995b Franz Boas and Native American biological variability. Human Biology. 67: 3: 345-354.

Jantz, R.L.
1995c Comparative population structure of nomads and villagers. Paper presented at the 53rd Plains Anthropological Conference. October, 1995. Laramie, Wyoming.

Jantz, R.L., Hunt, D.R., Falsetti, A.B., and Key, P.J.
1992 Variation among North Amerindians: analysis of Boas' anthropometric data. Human Biology. 64: 435-461.

Jantz, R. L. and Key, P. J.
1987 Preservation of Boas' North American anthropometric data. Proposal to National Science Foundation.

Jantz, R. L. and Meadows, L.
1995 Population structure of Algonquian speakers. Human Biology. 67: 3: 375-386.

Jenness, D.
1977(1932) Indians of Canada. Seventh Edition. Toronto: University of Toronto Press and the National Museums of Canada.

Jensen, M.
1972 The Mandan tragedy. The Indian Historian. 5:18-21.

John, E.A.
1984 Nurturing the peace, Spanish and Comanche cooperation in the early nineteenth century. New Mexico Historical Review. 59: 4: 345-369.

John, E.A.
1985 An earlier chapter of Kiowa history. New Mexico Historical Review. 60: 4: 379-397.

Johnston, F.E. and MacVean, R.B.
1995 Growth faltering and catchup growth in relation to environmental change in children of a disadvantaged community from Guatemala City. American Journal of Human Biology. 7: 6: 731-740.

Johnston, M.A.
1948 Federal relations with the great Sioux Indians of South Dakota, 1887-1933. Washington: Catholic University of America Press.

Kappler, C.J. (comp.)
1971 (1904) Indian affairs: Laws and treaties, Vol. 1 and 2. Washington: U.S.G.P.O. (reprint).

Kardulias, P.N.
1990 Fur production as a specialized activity in a world system: Indians in the North American fur trade. American Indian Culture and Research Journal. 14: 1:25-60.

Kavanagh, T.W.
1989 Comanche population, organization and reorganization 1869-1901: A test of the continuity hypothesis. Plains Anthropologist. 34: 24: 99-111.

Kavanagh, T.W.
1996 Comanche political history: An ethnohistorical perspective, 1706-1875. Lincoln: University of Nebraska Press.

Kaye, B. and Moodie, D.W.
1978 The Psoralea food resource of the northern Plains. Plains Anthropologist. 23: 329-336.

Kearl, J.R. and Pope, C.
1986 Choices, rents, and luck: Economic mobility of nineteenth-century Utah households. In: Long term factors in American economic growth. S.L. Engerman and R.E. Gallman, eds. Chicago: The University of Chicago Press.

Keeley, L.
1996 War before civilization: The myth of the peaceful savage. New York: Oxford University Press.

Kelly, M.A.
1991 Ethnohistorical accounts as a method of assessing health, disease, and population decline among Native Americans. In: Human paleopathology: Current syntheses and future options. D.J. Ortner and A.C. Aufderheide, eds. Washington, DC: Smithsonian University Press.

Kennedy, M.S. (ed.)
1961 The Assiniboines: From the accounts of the old ones told to First Boy (James Larpenteur Long). Norman: University of Oklahoma Press.

Kielmann, A. A., DeSweemer, C., Chjernichovsky, D. et al
1983 Child and maternal health services in rural India: The Narangwal experiment. Vol. 1: Integrated nutrition and health. Baltimore: Johns Hopkins Press.

Kindscher, K.
1992 Medicinal wild plants of the prairie: An ethnobotanical guide. Lawrence: University Press of Kansas.

Klein, A.M.
1983 The political economy of gender: A 19th century Plains Indian case study. In: The hidden half: Studies of Plains Indian women, P. Albers and B. Medicine, eds. New York: University Press of America.

Klein, A.M.
1992 Political economy of the buffalo hide trade: Race and class on the Plains. In: The political economy of North American Indians, J.H. Moore, ed. Norman: University of Oklahoma Press.

Komlos, J.
1987 The height and weight of West Point cadets: Dietary change in antebellum America. Journal of Economic History. 47: 897-927.

Komlos, J. ed.
1994a Stature, living standards and economic development: Essays in anthropometric history. Chicago: University of Chicago Press.

Komlos, J.
1994b On the significance of anthropometric history. In: Stature, living standards and economic development. J. Komlos, ed. Chicago: University of Chicago Press.

Komlos, J. (ed.)
1995 The biological standard of living on three continents: Further explorations in anthropometric history. Boulder, Colorado: Westview Press.

Konigsberg, L.W. and Ousley, S.D.
1995 Multivariate quantitative genetics of anthropometric traits from Boas data. Human Biology. 67:3:481-498.

Krober, A.L.
1939 Cultural and natural areas of native North America. University of California Publications in American Archaeology and Ethnology. Vol. 38.

Kuh, D., Power, C., and Rogers, B.
1991 Secular trends in social class and sex differences in adult height. International Journal of Epidemiology. 20: 1001-9.

Kunitz, S.J.
1987 Making a long story short: a note on men's height and mortality in England from the first through the nineteenth centuries. Medical History. 31: 269-280.

Kunitz, S.J.
1994 Disease and social diversity: the European impact on the health of non-Europeans. Oxford: Oxford University Press.

Kurtz, W.M.
1989 Early Cheyenne migrations and cultural change. South Dakota Archaeology. 13: 69-88.

Lamar, H.R. and Truett, S.
1996 The greater Southwest and California from the beginning of European settlement to the 1880s. In: The Cambridge history of the native peoples of the Americas: Vol. I, Part 2: North America. B.G. Trigger and W.E. Washburn, eds. New Yor: Cambridge University Press.

Landes, R.
1968 The Mystic Lake Sioux. Madison: University of Wisconsin Press.

Landes, R.S.
1998 The wealth and poverty of nations: why some are so rich and some so poor. New York: Norton.

Larpenteur, C.
1898 Forty years a fur trader on the Upper Missouri (1833-1872). The personal narrative of Charles Larpenteur, 2 volumes. E. Coues, ed. New York: Harper.

Lawson, M.P.
1974 The climate of the Great American Desert: Reconstruction of the climate of the western interior U.S. 1800-1850. Lincoln: University of Nebraska Press.

Lee, C.
1997 Socioeconomic background, disease, and mortality among Union army recruits: Implications for economic and demographic history. Explorations in Economic History. 34: 27-55.

Lehmer, D.J.
1971 Introduction to Middle Missouri archaeology. National Park Service Anthropological Papers 1. U.S. Dept. of the Interior.

Lewis, G.M.
1977 The cognition and communication of former ideas about the Great Plains. In: The Great Plains: environmental and culture. B.W. Blouet and F.C. Luebke, eds. Lincoln: University of Nebraska Press.

Lewis, M. and Clark, W.
1904-05 Original journals of the Lewis and Clark expedition, 1804-1806. Ruben G. Thwiates, ed. 8 vols. New York: Dodd and Mead.

Lewis, O.
1942 The effects of White contact upon Blackfoot Indian culture. Monographs of the American Ethnolological Society, No.6. Seattle: University of Washington Press.

Liberty, M. and Wood, W.R.
1980 Introduction. In: Anthropology on the Great Plains, W. R. Wood and M. Liberty, eds. Lincoln: University of Nebraska Press.

Little, B.B. and Malina, R.M.
1986 Gene flow and variation in stature and craniofacial dimensions among indigenous populations of Southern Mexico, Guatemala, and Honduras. American Journal of Physical Anthropology. 70: 505-512.

Logan, M.H. and Ousley, S.D.
1996/n.d. Hypergamy, quantum and reproductive success: The lost Indian ancestor reconsidered. In: Anthropologists and Indians in the New South. J.A. Paredes and R. Bonney, eds. Birmingham: University of Alabama Press (in press).

Lowie, R.H.
1909 The Assiniboine. Anthropological Papers of the American Museum of Natural History. 4: 1: 1-57.

Lowie, R.H.
1954a Indians of the Plains. Anthropological handbook No. 1, The American Museum of Natural History. New York: McGraw Hill Publishing Company.

Lowie, R.H.
1954b Indians of the High Plains. New York: McGraw Hill Publishing Company.

Lowie, R.H.
1956 The Crow Indians. New York: Rinehart and Co. (reissue).

Luebke, F.C.
1977 Introduction In: The Great Plains environment and culture. B. Blouet and F. Luebke, eds. Lincoln, Nebraska: University of Nebraska Press.

Lynch, K.A., Mineau, G.P., and Anderton, D.L.
1985 Estimates of infant mortality on the western frontier: The use of genealogical data. Historical Methods. 18:4: 155-163.

Mails, T.E.
1985 (1973) Plains Indians: Dog Soldiers, bear men, and buffalo women. New York: Bonanza Books.

Malina, R. M.
1979 Secular changes in size and maturity: Causes and effects. Monograph. Society for Research in Child Development, 44: 59-192.

Malina, R. M.
1987 Nutrition and growth. In: Nutritional Anthropology. F. E. Johnston, ed. New York: Alan R. Liss, Inc.

Malone, P.M.
1993 The skulking way of war: Technology and tactics among the New England Indians. Baltimore: Johns Hopkins University Press.

Mandelbaum, D.G.
1940 The Plains Cree. Anthropological Papers of the American Museum of Natural History. Vol. 37, Part 2.

Margo, R. A. and Steckel, R. H.
1983 Heights of native-born whites during the antebellum period. Journal of Economic History. 43: 167-174.

Marmot, M.G., Shipley, M.J., and Rose, G.
1984 Inequalities in death—specific explanation of a general pattern? Lancet. 5 May: 8384: 1003-1006.

Martorell, R.
1980 Interrelationships between diet, infectious disease and nutritional status. In: Social and biological predictors of nutritional status, physical growth and neurological development. L. S. Greene and F. E. Johnston, eds. New York: Academic Press.

Martorell, R.
1985 Child growth retardation: A discussion of its causes and its relationship to health. In: Nutritional adaptation in man. K. Blaxter and J.C. Waterlow, eds. London: John Libbey.

Martorell, R., Rivera, J., Kaplowitz, H., and Pollitt, E.
1992 Long-term consequences of growth retardation in early childhood. In: Human growth: Basic and clinical aspects. M. Hernandez and J. Argente, eds. Amsterdam: Elsevier Publishing.

Martorell, R. and Habicht, J. P.
1986 Growth in early childhood in developing countries. In: Human growth, a comprehensive treatise, volume 3, second edition. F. Falkner and J. M. Tanner, eds. New York: Plenum Press.

Mayhall, M.P.
1971 The Kiowas, second edition. Norman: University of Oklahoma Press.

Maynard, E. and Twiss, G.
1969 That these people may live. Pine Ridge Reservation: U.S. Public Health Service.

McGinnis, A.
1980 Strike and retreat: Intertribal warfare and the Powder River War, 1865-1868. Montana. Autumn: 31-41.

McGinnis, A.
1990 Counting coup and cutting horses: Intertribal warfare on the northern Plains, 1738-1889. Evergreen, Colorado: Cordillera Press.

McGrath, J.W.
1991 Biological impact of social disruption resulting from epidemic disease. American Journal of Physical Anthropology. 84: 407-419.

McHugh, T.
1972 The time of the buffalo. New York: Alfred A. Knopf.

McMahon, S. F.
1981 Provisions laid up for the family. Historical Methods. 14: 4-21.

Meadows Jantz, L.
1996 Secular change and allometry in the long limb bones of Americans from the mid 1700s through the 1970s. The University of Tennessee, Knoxville. Unpublished PhD dissertation, Department of Anthropology.

Meadows Jantz, L., Jantz, R.L., and Prince, J.M.
1995 Secular change in body size in equestrian Plains Indians: 1800-1870. Paper presented at the 53rd Plains Anthropological Conference, October 1995, Laramie, Wyoming.

Meinig, D.W.
1993 The shaping of America: a geographical perspective on 500 years of history, volume 2: Continental America, 1800-1867. New Haven: Yale University Press.

Minnis, P.E.
1985 Social adaptation to food stress: a prehistoric Southwestern example. Chicago: University of Chicago Press.

Mishkin, B.
1940 Rank and warfare among the Plains Indians. American Ethnological Society Monograph, No.3. Seattle: University of Washington Press.

Monahan, F.D.
1971-72 Kiowa - Federal relations in Kansas, 1865-1868. The Chronicles of Oklahoma. 49: 4: 477-491.

Moodie, D.W.
1980 Agriculture and the fur trade. In: Old trails and new directions: Papers of the 3rd North American Fur Trade Conference, 1978, C.M. Judd and A.J. Ray, eds. Toronto: University of Toronto Press.

Moodie, D.W. and Ray, A.J.
1976 Buffalo migrations in the Canadian Plains. Plains Anthropologist. 21: 45-52.

Moon, N.B.
1995 Secular changes in Eastern and Western bands of the Cherokee Nation. Manuscript on file at the University of Tennessee, Knoxville (UTK), Department of Anthropology.

Mooney, J.
1892-93 The ghost dance religion and the Sioux outbreak of 1890. Annual Report to the Bureau of American Ethnology. 14: 641-1136.

Moore, J.H.
1974 Cheyenne political history, 1820-1894. Ethnohistory. 21:4: 329-359.

Moore, J.H.
1982 The dynamics of scale in Plains ethnohistory. University of Oklahoma Papers in Anthropology. 23: 2: 225-246.

Moore, J.H.
1987 The Cheyenne nation: A social and demographic history. Lincoln: University of Nebraska Press.

Moore, J.H.
1991 The developmental cycle of Cheyenne polygyny. American Indian Quarterly. Summer: 311-328.

Moore, J.H.
1992 The political economy of North American Indians. Norman: University of Oklahoma Press.

Moore, J.H. and Campbell, G.R.
1989 An ethnohistorical perspective on Cheyenne demography. Journal of Family History. 14: 1: 17-42.

Moore, J.H. and Campbell, J.E.
1995 Blood quantum and ethnic intermarriage in the Boas data set. Human Biology. 67: 3: 499-516.

Moses, L.G
1996 Wild West shows and the images of American Indians: 1883-1933. Albuquerque: University of New Mexico Press.

Murdock, G.P.
1967 Ethnographic atlas. Pittsburgh: University of Pittsburgh Press.

Murray, J.E.
1995 A new anthropometric look at the status of women and children in Oneida Community, 1848-1881. In: The Biological Standard of Living on Three Continents. J. Komlos, ed. Boulder, CO: Westview Press.

National Academy of Sciences
1980 Recommended dietary allowances, ninth edition. Washington, DC: National Academy of Sciences Press.

Needham, R.
1980 Reconnaissances. Toronto: University of Toronto Press.

Neel, J.V., Centerwall, W.R., Chagnon, N.A., and Casey, H.L.
1970 Notes on the effect of measles and measles vaccine in a virgin-soil population of South American Indians. American Journal of Epidemiology. 91: 418-429.

Nespor, R.P.
1987 From war lance to plow share: the Cheyenne Dog Soldiers as farmers, 1879-1930s. The Chronicles of Oklahoma. 65: 1: 42-75.

Nespor, R.P.
1989 The ecology of malaria and changes in settlement pattern on the Cheyenne and Arapaho Reservation, Indian Territory. Plains Anthropologist. 34: 124: 71-97.

Newcomb, W.W., Jr.
1950 A re-examination of the causes of Plains warfare. American Anthropologist. 52: 317-330.

Noyes, S.
1993 Los Comanches: The horse people, 1751-1845. Albuquerque: University of New Mexico Press.

Nurge, E.
1970 Dakota diet: Traditional and contemporary. In: The modern Sioux. E. Nurge, ed. Lincoln: University of Nebraska Press.

O'Connell, R.L.
1995 Ride of the second horseman: The birth and death of war. New York: Oxford University Press.

Oddy, D.J.
1970 Working class diets in late nineteenth century Britain. Economic History Review. 23: 314-323.

Oliver, S.C.
1962 Ecology and cultural continuity as contributing factors in the social organization of the Plains Indians. Berkeley: University of California Press.

Olsen, S.L. and Shipman, P.
1994 Cutmarks and perimortem treatment of skeletal remains on the northern Plains. In: Skeletal Biology in the Great Plains. D.W. Owsley and R.L. Jantz, eds. Washington, DC: Smithsonian Institution Press.

Olson, J. C.
1965 Red Cloud and the Sioux problem. Lincoln: University of Nebraska Press.

Osborn, A.J.
1983 Ecological aspects of equestrian adaptations in aboriginal North America. American Anthropologist. 85: 563-591.

O'Shea, J. and Halstead, P.
1989 Conclusions: Bad year economics. In: Bad year economics: cultural responses to risk and uncertainty. P. Halstead and J. O'Shea, eds. New York: Cambridge Unversity Press.

Osmani, S.R. (ed.)
1992a Nutrition and Poverty. WIDER studies in development economics. New York: Oxford University Press.

Osmani, S.R.
1992b On some controversies in the measurement of undernutrition. In: Nutrition and poverty. S.R. Osmani, ed. New York: Oxford University Press.

Owsley, D.W.
1991 Temporal variation in femoral cortical thickness of North American Plains Indians. In: Human paleopathology: current syntheses and future options. D.J. Ortner and A.C. Aufderheide, eds. Washington, DC: Smithsonian Institution Press.

Owsley, D.W.
1994 Warfare in coalescent tradition populations of the northern Plains. In: Skeletal biology in the Great Plains. D.W. Owsley and R.L. Jantz, eds. Washington, DC: Smithsonian Institution Press.

Owsley, D.W. and Jantz, R.L. (eds.)
1994 Skeletal biology in the Great Plains: Migration, warfare, health and subsistence. Washington, DC: Smithsonian Institution Press.

Parks, D.R. and DeMallie, R.J.
1992 Sioux, Assiniboine, and Stoney dialects: A classification. Anthropological Linguistics. 34:1-4:233-255.

Parks, D.R., Liberty, M., and Ferenci, A.
1980 Peoples of the Plains. In: Anthropology on the Great Plains. W.R. Wood and M. Liberty, eds. Lincoln: University of Nebraska Press.

Patterson, P.E.
1972 The Canadian Indians: A history since 1500. Don Mills, Ontario: Collier-Macmillan Canada, Limited.

Payne, P.
1985 Nutritional adaptation in man: Social adjustments and their nutritional implications. In: Nutritional adaptation in man. K. Blaxter and J.C. Waterlow, eds. London: John Libbey.

Payne, P.
1992 Assessing undernutrition: The need for a reconceptualization. In: Nutrition and poverty. S.R. Osmani, ed. New York: Oxford University Press.

Pennington, W.D.
1978 Government agricultural policy on the Kiowa Reservation, 1869-1901. The Indian Historian. 11: 1: 11-16.

Pennington, W.D.
1979 Government policy and Indian farming on the Cheyenne and Arapaho reservations: 1869-1880. The Chronicles of Oklahoma. 57: 2: 171-189.

Peterson, J. and Anfinson, J.
1984 The Indian and the fur trade: a review of recent literature. In: Scholars and the Indian experience: critical reviews of recent writing in the social sciences. W.R. Swagerty, ed. Bloomington: Indiana University Press.

Pickering, K.
1994 Articulation of the Lakota mode of productions and the Euro-American fur trade. In: The fur trade revisited: Selected papers of the 6th North American Fur Trade Conference, 1991. J.S.H. Brown, W.J. Eccles, and D.P. Heimand, eds. Mackinac Island: Michigan State University Press.

Plowden, D.
1972 Floor of the sky. New York: Charles Curtis.

Pope, C.L.
1992 Adult mortality in America before 1900: A view from family histories. In: Strategic factors in 19th century economic history. C. Goldin and H. Rockoff, eds. Chicago: The University of Chicago Press.

Powell, J.P.
1981 People of the Sacred Mountain: A history of the northern Cheyenne chiefs and warrior societies, 1830-1879. Volumes 1and 2. San Francisco: Harper and Row Publishers.

Preston, S.H. and Haines, M.R.
1991 Fatal years: Child mortality in late 19th century America. Princeton, NJ: Princeton University Press.

Price, C.
1985 The Comanche threat to Texas and New Mexico in the Eighteenth century and the development of Spanish-Indian policy. Journal of the West. 24: 34-45.

Priest, L. B.
1942 Uncle Sam's stepchildren: The reformation of United States Indian policy, 1865-1887. New Brunswick: Rutgers University Press.

Prince, J.M.
1989 Secular trends in stature in an historic Sioux population. The University of Tennessee, Knoxville, unpublished Masters Thesis, Department of Anthropology.

Prince, J.M.
1995 Intersection of economics, history and human biology: Secular trends in stature in 19th century Sioux Indians. Human Biology. 67:3:387-406.

Prucha, F. P.
1976 American Indian policy in crisis. Norman: University of Oklahoma Press.

Prucha, F. P.
1984 The Great Father: The United States government and the American Indians, Vol. I and II. Lincoln: University of Nebraska Press.

Prucha, F. P.
1994 American Indian Treaties: The history of a political anomaly. Berkeley: University of California Press.

Putney, D. T.
1980 Fighting the scourge: American Indian morbidity and federal policy, 1897-1928. Marquette University, Doctoral Dissertation, University Microfilms International.

Ramenofsky, A.F.
1987 Vectors of death: The archaeology of European contact. Albuquerque: University of New Mexico Press.

Ray, A.J.
1974 Indians of the fur trade: Their role as hunters, traders, and middlemen in the lands southwest of Hudson Bay, 1660-1870. Toronto: University of Toronto Press.

Ray, A.J.
1988 The Hudson's Bay Company and native people. In: Handbook of North American Indians: History of Indian-White relations. Vol. 4, W.C. Sturtevant and W.E. Washburn, eds. Washington, DC: Smithsonian Institution Press.

Reher, C.A. and Frison, G.C.
1980 The Vore site, 48CK302, a stratified buffalo jump in the Wyoming Black Hills. Plains Anthropologist. Memoir No.16: 1-190.

Reinhard, K.J., Tieszen, L., Sandness, K.L. et al
1994 Trade, contact and female health in northwest Nebraska. In: In the wake of contact: Biological responses to conquest. C.S. Larsen and G.R. Milner, eds. New York: Wiley-Liss.

Relethford, J. H.
1995 Re-examination of secular change in adult Irish stature. American Journal of Human Biology. 7: 2: 249-253.

Relethford, J. H. and Lees, F. C.
1981 The effects of aging and secular trend on adult stature in rural western Ireland. American Journal of Physical Anthropology. 55: 81-88.

Richardson, J.
1940 Law and status among the Kiowa Indians. Monographs of the American Ethnological Society, No. 1. Seattle: University of Washington Press.

Richardson, R.N. (K.R. Jacobs, ed.)
1991 The Comanche barrier to south Plains settlement. Abilene, Texas: Hardin-Simmons University.

Robarchek, C.A.
1994 Plains warfare and the anthropology of war. In: Skeletal biology in the Great Plains. D.W. Owsley and R.L. Jantz, eds. Washington, DC: Smithsonian Institution Press.

Roberts, D.F.
1985 Genetics and nutritional adaptation. In: Nutritional adaptation in Man. K. Blaxter and J.C. Waterlow, eds. London: John Libbey.

Roe, F.G.
1955 The Indian and the horse. Norman: University of Oklahoma Press.

Roe, F.G.
1970 The North American buffalo: A critical study of the species in its wild state, second edition. Toronto: University of Toronto Press.

Rogers, S.L.
1982 The aging skeleton. Springfield, Illinois: Charles C. Thomas.

Ross, T.E. and Moore, T.G. (eds.)
1987 A cultural geography of North American Indians. Boulder, CO: Westview Press.

Rossman, I.
1986 Clinical geriatrics. Philadelphia: Lippincott.

Rotberg, R. I. and Rabb, T. K. (eds.)
1983 Hunger and history: The impact of changing food production and consumption patterns on society. Cambridge: Cambridge University Press.

Rotberg, R. I., Rabb, T. K. and the Conferees of the Bellagio conference
1983 The relationship of nutrition, disease and social conditions: A graphical presentation. In: Hunger and history. R. I. Rotberg and T. K. Rabb, eds. Cambridge: Cambridge University Press.

Sandberg, L.G. and Steckel, R.H.
1987 Heights and economic history: The Swedish case. Annals of Human Biology. 14: 101-110.

SAS Institute, Inc.
1990 SAS/STAT user's guide, version 6, 4th edition. Cary, N.C.: SAS Institute, Inc.

SAS Institute, Inc.
1996 SAS for Windows, version 6.12. Cary, N.C.: SAS Institute, Inc.

Satterlee, J. L. and Malan, V. D.
1968 History and acculturation of the Dakota Indians. Brookings: South Dakota State University.

Scaglion, R.
1980 The Plains culture area concept. In: Anthropology on the Great Plains. W. Raymond Wood and Margot Liberty, eds. Lincoln: University of Nebraska Press.

Schaeffer, C.E.
1978 The bison drive of the Blackfeet Indians. In: Bison procurement and utilization: A symposium. Leslie Davis and Michael Wilson, eds. Plains Anthropologist. 23:82:243-248.

Schell, H. S.
1975 History of South Dakota, third edition. Lincoln: University of Nebraska Press.

Schilz, T.F.
1982 Ponies, pelts and pemmican: The Arapahoes and early western trade. Red River Valley Historical Review. 7:2: 28-38.

Schilz, T.F.
1984 Brandy and beaver pelts: Assiniboine-European trading patterns, 1695-1805. Saskatchewan History. 37: 3: 95-102.

Schilz, T.F. and Worcester, D.E.
1987 The spread of firearms among the Indian tribes on the northern frontier of New Spain. American Indian Quarterly. 11: 1: 1-10.

Schmeckebier, L. F.
1927 The Office of Indian Affairs: Its history, activities and organization. Baltimore: Johns Hopkins University Press.

Schmidt, I.M., Jorgensen, M.H., and Michaelsen, K.F.
1995 Height of conscripts in Europe: is postneonatal mortality a predictor? Annals of Human Biology. 22:1:57-67.

Schultz, D.
1992 Over the earth I come: The great Sioux uprising of 1862. New York: St. Martin's Press.

Scrimshaw, N. S.
1983 The value of contemporary food and nutrition studies for historians. In: Hunger and history. R. I. Rotberg and T. K. Rabb, eds. Cambridge: MIT.

Scrimshaw, N. S. and Young, V. R.
1976 The requirements of human nutrition: In: Human nutrition: Readings from Scientific American. San Francisco: W. H. Freeman and Company.

Secoy, F.
1953 Changing military patterns on the Great Plains: 17th century through early 19th century. American Ethnological Society Mongraph No. 21. Seattle: University of Washington Press.

Seerley, N. R.
1965 A social system analysis of the changing food practices of the Teton Dakota Indians, 1800-1900. South Dakota State University, Masters Thesis, unpublished.

Sharrock, S.R.
1974 Crees, Cree-Assiniboines, and Asiniboines: Interethnic social organization on the far northern Plains. Ethnohistory. 21:2: 95-122.

Shaw, J.H. and Lee, M.
1997 Relative abundance of bison, elk and pronghorn on the Southern Plains, 1806-1857. Plains Anthropologist. 42: 159: 163-172 Memoir #29.

Shaw, V.
1980 The end of the Cheyenne-Arapaho alliance. Red River Valley Historical Review. 5: 1: 56-73.

Shelford, V.E.
1963 The Ecology of North America. Urbana: University of Illinois Press.

Shell-Duncan, B.
1995 Impact of seasonal variation in food availability and disease stress on the health status of nomadic Turkana children: a longitudinal analysis of morbidity, immunity, and nutritional status. American Journal of Human Biology. 7: 3: 339-355.

Sherow, J.E.
1992 Workings of the Geodialectic: High Plains Indians and their horses in the region of the Arkansas River Valley, 1800-1870. Environmental History Review. Summer.

Shoemaker, N.
1992 The census as civilizer: American Indian household structure in the 1900 and 1910 U.S. Censuses. Historical Methods. 25: 1: 4-11.

Smith, B.M.
1986 Politics and the Crow Indian land cessions. Montana, Autumn. 36: 24-37.

Smith, D.S.
1983 Differential mortality in the United States before 1900. Journal of Interdisciplinary History. 8: 4: 735-759.

Smith, M.
1938 The war complex of the Plains Indians. Philadelphia: Proceedings of the American Philosophical Society. 78: 425-464.

Smith, R.A.
1985 The Comanches' foreign war: Fighting headhunters in the tropics. Great Plains Journal. 23: 21-44.

Snyder, L. M.
1988 Barking mutton: Ethnohistoric archaeology and nutritional evidence pertaining to the domestic dog as a Native American food resource on the plains. Abstracts from 46th Annual Plains Conference.

Sokoloff, K.L.
1995 The heights of Americans in three centuries: Some economic and demographic implications. In: The biological standard of living on three continents. J. Komlos, ed. Boulder, Colorado: Westview Press.

Sommerfeld, J.
1994 Emerging epidemic diseases: Anthropological perspectives. In: Disease in evolution: Global changes and emergence of infectious diseases. M.E. Wilson, R. Lewis, and A. Spielman, eds. Annals of the New York Academy of Sciences. Volume 740.

Speth, J.D.
1983 Bison kills and bone counts: Decision making by ancient hunters. Chicago: University of Chicago Press.

Stannard, D.E.
1990 Disease and infertility: a new look at the demographic collapse of native populations in the wake of western contact. Journal of American Studies. 24:3:325-350.

Stallings, V.A. and Zemel, B.S.
1996 Role of disease in energy balance in children. American Journal of Human Biology. 8: 2: 189-198.

Steckel, R. H.
1983 Heights and per capita income. Historical Methods. 16: 1: 1-7.

Steckel, R. H.
1986a A peculiar population: The nutrition, health and mortality of American slaves from childhood to maturity. Journal of Economic History. 46: 721-741.

Steckel, R. H.
1986b A dreadful childhood: The excess mortality of American slaves. Social Science History. 10:4:427-465.

Steckel, R. H.
1986c Birth weights and infant mortality among American slaves. Explorations in Economic History. 23:193-198.

Steckel, R. H.
1987 Growth depression and recovery: The remarkable case of American slaves. Annals of Human Biology. 14: 101-132.

Steckel, R. H.
1988a Heights and health in the United States, 1710-1950. Presentation at the Fifth International Auxology Congress, Exeter, July.

Steckel, R. H.
1988b The health and mortality of women and children, 1850-1860. Journal of Economic History. 48: 333-345.

Steckel, R. H.
1994 Heights and health in the United States, 1710-1950. In: Stature, living standards, and economic development. J. Komlos, ed. Chicago: University of Chicago Press.

Steckel, R. H.
1995 Stature and the standards of living. Journal of Economic Literature. 33: (December):1903-1940.

Steegmann, A.T.
1985 Eighteenth century British military stature: Growth cessation, selective recruiting, secular trends, nutrition at birth, cold and occupation. Human Biology. 57:77-95.

Stinson, S.
1985 Differences in environmental sensitivity during growth and development. Yearbook of physical anthropology. 28: 123-147.

Stivers, D.
1990 Changes in stature and health status as related to the emergence of diabetes among the Eastern Cherokee Indians in North Carolina. University of Tennessee, Knoxville (UTK), PhD Dissertation, Department of Anthropology.

Strickland, S.S.
1990 Traditional economies and nutritional disease. In: Diet and disease in traditional and developing societies. G.A. Harrison and J.C. Waterlow, eds. New York: Cambridge University Press.

Stuart, P.
1987 Nations within a nation: Historical statistics of American Indians. New York: Greenwood press.

Sturtevant, W.C. (ed.)
1978-96+ Handbook of North American Indians. Washington, DC: Smithsonian Institution Press. (20 vols. projected, 9 already published).

Sullivan, R.
1920 Anthropometry of the Siouan Tribes. Anthropological Papers of the American Museum of Natural History. 23: Pt. 3, 93-101.

Surtees, R.J.
1988 Canadian Indian treaties. In: Handbook of North American Indians: History of Indian White relations, vol. 4. W.C. Sturtevant and W.E. Washburn, eds. Washington, DC: Smithsonian Institution Press.

Susanne, C.
1980 Aging, continuous changes of adulthood. In: Human physical growth and maturation: Methodologies and factors. F. E. Johnston, A. F. Roche and C. Susanne, eds. New York: Plenum Press.

Swagerty, W.R.
1988 Indian trade in the Trans-Mississippi West to 1870. In: Handbook of North American Indians: History of Indian-White relations, vol. 4. W.C. Sturtevant and W.E. Washburn, eds. Washington, DC: Smithsonian Institution Press.

Swan, D.C. and Campbell, G.R.
1989 Reproduction differentials and Osage population dynamics. Plains Anthropologist. 34: 124: 61-70.

Swedlund, A.C. and Armelagos, G.J. (eds.)
1990 Disease in populations in transition: anthropological and epidemiological perspectives. New York: Bergin and Garvey.

Szathmary, E.J.E.
1995 Overview of the Boas anthropometric collection and its utility in understanding the biology of native North Americans. Human Biology. 64: 337-344.

Tanner, J. M.
1966 The secular trend towards earlier physical maturation. T. Soc. Geneesk, 44: 524-538.

Tanner, J. M.
1978 Fetus into man: Physical growth from conception to maturity. Cambridge: Harvard University Press.

Tanner, J. M.
1981 A history of the study of human growth. Cambridge: Cambridge University Press.

Tanner, J. M.
1982 The potential of auxological data for monitoring economic and social well being. Social Science History. 6: 571-581.

Tanner, J. M.
1986 Use and abuse of growth standards. In: Human growth, a comprehensive treatise, volume 3, second edition, F. Falkner and J. M. Tanner, eds. New York: Plenum Press.

Tanner, J. M.
1988 Human growth and constitution. In: Human biology: An introduction to human evolution, variation, growth, and adaptability, third edition, G. A. Harrison, J. M. Tanner et al, eds. Oxford: Oxford University Press.

Tanner, J. M.
1994 Introduction: Growth in height as a mirror of the standard of living. In: Stature, living standards, and economic development. J. Komlos, ed. Chicago: University of Chicago Press.

Tanner, J. M. and Preece, M.A. (eds.)
1989 The physiology of human growth. Society for the Study of Human Biology. Symposium No. 29. New York: Cambridge University Press.

Taylor, C. E.
1983 Synergy among mass infections, famines, and poverty. In: Hunger and history. R. I. Rotberg and T. K. Rabb, eds. Cambridge: MIT.

Taylor, J. F.
1977 Sociocultural effects of epidemics on the northern plains: 1734-1850. Western Canadian Journal of Anthropology. 7: 55-81.

Taylor, J. F.
1989 Counting: the utility of historic population estimates in the northwest Plains, 1800-1880. Plains Anthropologist. 34: 124 part 2: 17-30.

Textor, L.E.
1896 Official relations between the United States and the Sioux Indians. Palo Alto: Stanford University Publications.

Thornton, R.
1981 Demographic antecedents of a revitalization movement: Population change, population size, and the 1890 Ghost Dance. American Sociological Review. 46: 88-96.

Thornton, R.
1987 American Indian holocaust and survival: A population history since 1492. Norman: University of Oklahoma Press.

Thornton, R.
1997 Aboriginal North American population and rates of decline, ca. A.D. 1500-1900. Current Anthropology. 38: 2: 310-315.

Thornton, R., Miller, T., and Warren, J.
1991 American Indian population recovery following smallpox epidemics. American Anthropologist. 93: 28-45.

Thwaites, R.G. (ed.)
1896-1901 The Jesuit Relations and Allied Documents. 73 vols. Cleveland: Burrows Brothers.

Titley, B.
1991 The fate of the Sharphead Stoneys. Alberta History. 39:1:1-8.

Topinard, P.
1885 Elements d'Anthropologie Generale. Paris: Delahaye et Lecrosnier.,

Trenholm, V.C.
1970 The Arapahoes, our people. Norman: University of Oklahoma Press.

Trimble, M.K.
1989 Infectious disease and the northern Plains horticulturalists: A human behavior model. Plains Anthropologist. 34: 124: 41-60.

Trimble, M.K.
1992 The 1832 inoculation program on the Missouri River. In: Disease and Demography in the Americas. J.W. Verano and D.H. Ubelaker, eds. Washington, DC: Smithsonian Institution Press.

Trimble, M.K.
1994 The 1837-1838 smallpox epidemic on the Upper Missouri. In: Skeletal biology in the Great Plains. D.W. Owsley and R.L. Jantz, ed. Washington, DC: Smithsonian Institution Press.

Tuross, N. and Fogel, M.F.
1992 Stable isotope analysis and subsistence patterns at the Sully site. In: Skeletal biology in the Great Plains. D.W. Owsley and R.L.Jantz, eds. Washington, DC: Smithsonian Institution Press.

Ubelaker, D.H.
1992 The sources and methodology for Mooney's estimates of North American Indian populations. In: The native population of the Americas in 1492. W.M. Denevan, ed. Madison: University of Wisconsin Press.

Ulijaszek S.J.
1996 Long-term consequences of early environments on human growth: a developmental perspective. In: Long-term consequences of early environment: Growth, development, and the lifespan developmental perspective. C.J.K. Henry and S.J. Ulijaszek, eds. New York: Cambridge University Press.

Ulizzi, L. and Terrenato, L.
1982 A comparison between secular trends of stature and of some socio-economic factors in Italy. Journal of Human Evolution. 11:715-720.

U.S. Bureau of the Census, Department of Commerce
1910 Indian population in the United States and Alaska. Washington, D.C.: U.S. G.P.O.

U.S. Public Health Service
1959 Indians on federal reservations in the United States: A digest. Washington, D.C.: U.S. Dept. of HEW.

Utley, R. M.
1963 The last days of the Sioux nation. New Haven: Yale University Press.

Utley, R. M.
1973 Frontier regulars: The United States Army and the Indians, 1866-1890. New York: Macmillan Press.

Utley, R. M.
1984 The Indian frontier of the American West 1846-1890. Albuquerque: University of New Mexico Press.

Utley, R. M.
1988 Indian-United States military situation, 1848-1891. In: Handbook of North American Indians: History of Indian-White relations, vol. 4. W.C. Sturtevant and W.E. Washburn, eds. Washington, DC: Smithsonian Institution Press.

van Wieringen, J. C.
1986 Secular growth changes. In: Human growth, a comprehensive treatise, volume 3, Second edition. F. Falkner and J. M. Tanner, eds. New York: Plenum Press.

Vehik, S.C.
1989 Problems and potential in Plains Indian demography. Plains Anthropologist. 34:124 (2): 115-125.

Voght, W.P.
1993 Dictionary of statistics and methodology. Newbury Park, California: Sage Publications.

Waaler, H. T.
1984 Height, weight and mortality: The Norwegian experience. Acta Medica Scandinavica. Supplement 679.

Wachter, K.W.
1981 Graphical estimation of military heights. Historical Methods. 14: 31-42 (Winter).

Wachter, K.W. and Trussell, J.
1982 Estimating historical heights. Journal of the American Statistical Association. 77: 378: 279-303.

Waldman, C.
1985 Atlas of the North American Indian. New York: Facts on File Publications.

Waldman, C.
1990 Who was who in Native American history: Indians and non-Indians from early contacts through 1900. New York: Facts on File Publications.

Walker, J. R.
1906 Tuberculosis among the Oglala Sioux Indians. American Journal of the Medical Sciences. 132: 600-605.

Walker, J. R.
1982 Lakota society, R. J. DeMallie, ed. Lincoln: University of Nebraska Press.

Wallace, E. and Hoebel, E. A.
1952 The Comanches: Lords of the South Plains. Norman: University of Nebraska Press, 7th printing.

Weaver, J.E. and Albertson, F.W.
1956 Grasslands of the Great Plains. Lincoln, Nebraska: Johnson Publishing Company.

Webb, W.P.
1931 The Great Plains. Boston: Ginn.

Wedel, W. R.
1940 Culture sequence in the central Great Plains, Smithsonian miscellaneous collection, volume 100: Essays in historical anthropology of North America. Plains Anthropologist. 17: 291-353.

Wedel, W.R.
1961 Prehistoric man on the Great Plains. Norman: University of Oklahoma Press.

Wedel, W.R.
1963 The High Plains and their utilization by the Indian American Antiquity. 29: 1-16.

Wedel, W.R.
1977 Holocene cultural adaptations in the Republican River basin. In: The Great Plains: Environment and culture. B. Bouet and F.C. Luebke, eds. Lincoln: University of Nebraska Press.

Wedel, W.R.
1978 The Prehistoric Plains. In: Ancient Native Americans. J. D. Jennings, ed. San Francisco: W.H. Freeman and Company.

Wedel, W. R.
1986 Central Plains prehistory: Holocene environments and culture change in the Republican River Basin. Lincoln: University of Nebraska Press.

Weist, K.
1983 Beasts of burden and menial slaves: 19th century observations of northern Plains Indian women. In: The Hidden Half: Studies of Plains Indian Women. P. Albers and B. Medicine, eds. New York: University Press of America.

Weist, K. M. and Sharrock, S. R.
1985 An annotated bibliography of northern Plains ethnohistory. Missoula: University of Montana.

Wells, P.V.
1965 Scarp Woodlands, transported grassland soils, and concept of grassland climate in the Great Plains region. Science. 148: 246-249.

Wheat, J.B.
1972 The Olsen-Chubbuck site, a Paleo-Indian bison kill. Memoirs of the Society for American Archaeology. 26.

Whelan, M.K.
1993 Dakota Indian economics and the 19th century fur trade. Ethnohistory. 40: 2: 246-276.

White, R.
1978 The winning of the West: The expansion of the Western Sioux in the 18th and 19th centuries. The Journal of American History. 65: 319-343 (Sept.).

White, R.
1984 Native Americans and the environment. In: Scholars and the Indian Experience: critical reviews of recent writing in the social sciences. W.R. Swagerty, ed. Bloomington: Indiana University Press.

Willey, G.R.
1966 An introduction to American archaeology, vol. 1. Englewood Cliffs, New Jersey: Prentice Hall, Inc.

Willey, P.
1990 Prehistoric warfare on the Great Plains. New York: Garland Press.

Williams, J.
1994 Disease profiles of archaic and woodland populations in the northern Plains. In: Skeletal biology in the Great Plains. D.W. Owsley and R.L. Jantz, eds. Washington: Smithsonian Institution Press.

Winich, M. and Brasel, J.A.
1979 Nutrition and cell growth. In: Modern nutrition in health and disease. R.S. Goodhart and M.E. Shils, eds. Philadelphia. Lea and Febiger.

Winick, C.
1970 Dictionary of Anthropology. Totowa, New Jersey: Littlefield, Adams.

Wirsing, R.
1985 The health of traditional societies and the effects of acculturation. Current Anthropology. 26:3:303-322.

Wishart, D.J.
1979 The Fur Trade of the American West, 1807-1840: A geographical synthesis. Lincoln: University of Nebraska Press.

Wissler, C.
1910 The material culture of the Blackfoot Indian. American Anthropologist. 16: 1-25.

Wissler, C.
1911 Measurements of Dakota Indian children. Annals of the New York Academy of Science. 20: 355-364.

Wissler, C.
1912 North American Indians of the Plains. Handbook series No. 1. New York: American Museum of Natural History.

Wissler, C.
1936a Distribution of deaths among American Indians. Human Biology. 8: 223-231.

Wissler, C.
1936b Population changes among the northern Plains Indians. Yale University Publications in Anthropology No. 1. New Haven: Yale University Press.

Wissler, C.
1936c Changes in population profiles among the northern Plains Indians. Anthropological Papers of the American Museum of Natural History. Vol. 36, Part 1.

Wissler, C.
1971 (1926) The relation of nature to man in aboriginal America: Lectures on the distribution of American Indian traits, aboriginal geography and ecology. Reprint. New York: AMS Press, Inc.

Wood, C.S.
1983 Early childhood, the critical stage in human interactions with disease and culture. Social Science Medicine. 17: 2: 79-85.

Wood, W.R.
1974 Northern Plains village cultures: Internal stability and external relationships. Journal of Anthropological Research. 30:1: 1-16.

Wood, W.R.
1980 Plains trade in prehistoric and protohistoric intertribal relations. In: Anthropology of the Great Plains. W. R. Wood and M. Liberty, eds. Lincoln: University of Nebraska Press.

Wood, W. R. (ed.)
1986 Papers in northern Plains prehistory and ethnohistory. South Dakota Archaeological Society. 10.

Wood, W.R. and Downer, A.S.
1977 Notes on the Crow-Hidatsa schism. Plains Anthropologist. 22: 78: 83-100.

Wood, W. R. and Liberty, M.
1980 Anthropology on the Great Plains. Lincoln: University of Nebraska Press.

Wood, W. R. and Thiessen, T.D.
1985 Early fur trade on the northern Plains: Canadian traders among the Mandan and Hidatsa Indians, 1738-1818. The narratives of John Macdonell, David Thompson, Francois-Antoine Larocque, and Charles McKenzie. Norman: University of Oklahoma Press.

Woolworth, A. R. and Champe, J. L.
1974 Sioux Indians III: Ethnohistorical report on the Yankton Sioux and Yankton chronology. New York: Garland.

Wooster, R. A.
1988 The military and United States Indian policy 1865-1903. New Haven: Yale University Press.

Wooten, S.A. and Jackson, A.A.
1996 Influence of undernutrition in early life on growth, body composition and metabolic competence. In: Long-term consequences of early environment: Growth, development, and the lifespan developmental perspective. C.J.K. Henry and S.J. Ulijaszek, eds. New York: Cambridge University Press.

Worster, D.
1979 Dust Bowl: The southern Plains in the 1930s. New York: Oxford University Press.

Wozniak, J.S.
1978 Contact, negotiation and conflict: An ethnohistory of the Eastern Dakota, 1819-1839. Washington, DC: University Press of America.

Wright, G.A.
1978 The Shoshonean migration problem. Plains Anthropologist. 23: 80: 113-137.

Wu, J.
1994 How severe was the Great Depression? Evidence from the Pittsburgh region. In: Stature, living standards, and economic development. J. Komlos, ed. Chicago: University of Chicago Press.

Young, T.K.
1994 The health of Native Americans: Towards a biocultural epidemiology. New York: Oxford University Press.

Zwink, T.A.
1978-79 On the White man's road: Lawrie Tatum and the formative years of the Kiowa Agency, 1869-1873. Chronicles of Oklahoma. 56: 4: 431-441.

APPENDICES

APPENDIX A-1: SIMPLE SUMMARY STATISTICS FOR UNADJUSTED AND MAX VARIABLES, MALES

-------------------------- TRIBE=ARAPAHO DECADE=181 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	77.0000000	.	77.0000000	77.0000000
STANDHT	1	182.3000000	.	182.3000000	182.3000000
SITHT	1	95.7000000	.	95.7000000	95.7000000
SUBISCH	1	86.6000000	.	86.6000000	86.6000000
MAXHT	1	185.2315500	.	185.2315500	185.2315500
MAXSITHT	1	98.6315500	.	98.6315500	98.6315500
RATIO	1	1.1389324	.	1.1389324	1.1389324

-------------------------- TRIBE=ARAPAHO DECADE=182 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	68.0000000	.	68.0000000	68.0000000
STANDHT	1	181.6000000	.	181.6000000	181.6000000
SITHT	1	93.2000000	.	93.2000000	93.2000000
SUBISCH	1	88.4000000	.	88.4000000	88.4000000
MAXHT	1	183.2927900	.	183.2927900	183.2927900
MAXSITHT	1	94.8927900	.	94.8927900	94.8927900
RATIO	1	1.0734479	.	1.0734479	1.0734479

-------------------------- TRIBE=ARAPAHO DECADE=183 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	5	57.4000000	3.8470768	53.0000000	62.0000000
STANDHT	5	171.5200000	3.3506716	167.7000000	176.9000000
SITHT	5	88.4400000	5.0376582	80.5000000	93.1000000
SUBISCH	5	83.0800000	5.3499533	77.5000000	91.1000000
MAXHT	5	172.2127700	3.2395733	168.4134900	177.2805900
MAXSITHT	5	89.1327700	4.7685541	81.5550500	93.4805900
RATIO	5	1.0785892	0.1153901	0.8952256	1.1730773

-------------------------- TRIBE=ARAPAHO DECADE=184 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	6	46.0000000	2.0000000	43.0000000	48.0000000
STANDHT	6	170.4666667	7.7747454	160.6000000	183.2000000
SITHT	6	87.9833333	4.9893553	84.3000000	97.5000000
SUBISCH	6	82.4833333	4.2621200	76.2000000	87.1000000
MAXHT	6	170.5637233	7.7488185	160.6653100	183.2282900
MAXSITHT	6	88.0803900	4.9589899	84.4521900	97.5282900
RATIO	6	1.0691922	0.0611268	0.9915650	1.1380197

The SAS System

-------------------------- TRIBE=ARAPAHO DECADE=185 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	13	38.6923077	2.6578379	34.0000000	42.0000000
STANDHT	13	173.9846154	5.4605931	164.3000000	183.7000000
SITHT	13	90.5615385	3.2361341	83.3000000	95.5000000
SUBISCH	13	83.4230769	4.0249542	77.5000000	91.0000000
MAXHT	13	174.0035869	5.4641661	164.3088900	183.7044100
MAXSITHT	13	90.5805100	3.2432318	83.3088900	95.5686100
RATIO	13	1.0879115	0.0614811	0.9893449	1.1882598

-------------------------- TRIBE=ARAPAHO DECADE=186 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	19	26.8421053	2.1670040	24.0000000	31.0000000
STANDHT	19	173.3052632	6.2423708	160.2000000	183.5000000
SITHT	19	89.8000000	3.1508376	84.0000000	97.7000000
SUBISCH	19	83.5052632	4.6225863	74.7000000	93.0000000
MAXHT	19	173.6569605	6.2349519	160.3952100	183.8886900
MAXSITHT	19	90.1516974	3.1389647	84.4475100	98.0886900
RATIO	19	1.0821709	0.0601590	0.9408087	1.1636535

-------------------------- TRIBE=ARAPAHO DECADE=187 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	12	21.1666667	0.8348471	20.0000000	22.0000000
STANDHT	12	176.0500000	9.0826007	166.2000000	194.0000000
SITHT	12	90.8500000	3.3090784	86.5000000	96.2000000
SUBISCH	12	85.2000000	6.4265076	78.0000000	97.8000000
MAXHT	12	176.7630450	9.0870024	167.0043100	194.8043100
MAXSITHT	12	91.5630450	3.3200259	87.2245900	97.0043100
RATIO	12	1.0783229	0.0606538	0.9918641	1.2056745

-------------------------- TRIBE=ASSINIBO DECADE=179 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	100.0000000	.	100.0000000	100.0000000
STANDHT	1	174.2000000	.	174.2000000	174.2000000
SITHT	1	87.6000000	.	87.6000000	87.6000000
SUBISCH	1	86.6000000	.	86.6000000	86.6000000
MAXHT	1	181.8355100	.	181.8355100	181.8355100
MAXSITHT	1	95.2355100	.	95.2355100	95.2355100
RATIO	1	1.0997172	.	1.0997172	1.0997172

The SAS System

------------------------ TRIBE=ASSINIBO DECADE=181 ------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	75.0000000	.	75.0000000	75.0000000
STANDHT	1	167.2000000	.	167.2000000	167.2000000
SITHT	1	82.3000000	.	82.3000000	82.3000000
SUBISCH	1	84.9000000	.	84.9000000	84.9000000
MAXHT	1	169.8270100	.	169.8270100	169.8270100
MAXSITHT	1	84.9270100	.	84.9270100	84.9270100
RATIO	1	1.0003181	.	1.0003181	1.0003181

------------------------ TRIBE=ASSINIBO DECADE=183 ------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	61.0000000	.	61.0000000	61.0000000
STANDHT	1	167.3000000	.	167.3000000	167.3000000
SITHT	1	87.0000000	.	87.0000000	87.0000000
SUBISCH	1	80.3000000	.	80.3000000	80.3000000
MAXHT	1	168.2633900	.	168.2633900	168.2633900
MAXSITHT	1	87.9633900	.	87.9633900	87.9633900
RATIO	1	1.0954345	.	1.0954345	1.0954345

------------------------ TRIBE=ASSINIBO DECADE=184 ------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	6	48.8333333	2.0412415	45.0000000	50.0000000
STANDHT	6	167.0666667	5.2981758	160.7000000	175.0000000
SITHT	6	84.9000000	3.7635090	80.5000000	90.2000000
SUBISCH	6	82.1666667	5.6884679	74.7000000	90.3000000
MAXHT	6	167.2569233	5.3241745	160.8521900	175.2310100
MAXSITHT	6	85.0902567	3.7954041	80.7310100	90.4310100
RATIO	6	1.0409091	0.1019955	0.9405427	1.1878315

------------------------ TRIBE=ASSINIBO DECADE=185 ------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	38.5000000	4.9497475	35.0000000	42.0000000
STANDHT	2	164.1500000	8.6974134	158.0000000	170.3000000
SITHT	2	86.7000000	4.1012193	83.8000000	89.6000000
SUBISCH	2	77.4500000	4.5961941	74.2000000	80.7000000
MAXHT	2	164.1817300	8.7195883	158.0160500	170.3474100
MAXSITHT	2	86.7317300	4.1233942	83.8160500	89.6474100
RATIO	2	1.1202344	0.0132398	1.1108725	1.1295964

The SAS System

------------------------ TRIBE=ASSINIBO DECADE=186 ------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	5	27.8000000	3.0331502	24.0000000	30.0000000
STANDHT	5	173.9000000	4.7238755	169.3000000	180.9000000
SITHT	5	88.3800000	3.7472657	83.2000000	91.6000000
SUBISCH	5	85.5200000	2.3435017	83.3000000	89.3000000
MAXHT	5	174.2087300	4.6518490	169.8105100	181.0952100
MAXSITHT	5	88.6887300	3.6817543	83.7105100	91.7952100
RATIO	5	1.0375372	0.0482631	0.9722475	1.0954083

------------------------- TRIBE=ASSINIBO DECADE=187 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	6	20.3333333	0.5163978	20.0000000	21.0000000
STANDHT	6	167.2166667	4.3549589	163.0000000	172.3000000
SITHT	6	87.8833333	2.3928365	83.5000000	90.4000000
SUBISCH	6	79.3333333	3.6658787	74.4000000	83.2000000
MAXHT	6	167.9944033	4.3549094	163.8043100	173.1043100
MAXSITHT	6	88.6610700	2.3849597	84.3043100	91.2043100
RATIO	6	1.1196148	0.0610774	1.0538039	1.2059757

------------------------- TRIBE=CHEYENNE DECADE=183 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	55.0000000	2.8284271	53.0000000	57.0000000
STANDHT	2	175.6000000	0.4242641	175.3000000	175.9000000
SITHT	2	89.0000000	4.1012193	86.1000000	91.9000000
SUBISCH	2	86.6000000	4.5254834	83.4000000	89.8000000
MAXHT	2	176.1095700	0.2418588	175.9385500	176.2805900
MAXSITHT	2	89.5095700	4.2836246	86.4805900	92.5385500
RATIO	2	1.0363052	0.1036190	0.9630355	1.1095749

------------------------- TRIBE=CHEYENNE DECADE=184 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	49.0000000	.	49.0000000	49.0000000
STANDHT	1	174.3000000	.	174.3000000	174.3000000
SITHT	1	86.7000000	.	86.7000000	86.7000000
SUBISCH	1	87.6000000	.	87.6000000	87.6000000
MAXHT	1	174.4895100	.	174.4895100	174.4895100
MAXSITHT	1	86.8895100	.	86.8895100	86.8895100
RATIO	1	0.9918894	.	0.9918894	0.9918894

The SAS System

------------------------- TRIBE=CHEYENNE DECADE=185 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	6	37.3333333	3.4448028	33.0000000	42.0000000
STANDHT	6	175.9666667	8.3803739	165.2000000	183.4000000
SITHT	6	89.5500000	2.3304506	86.7000000	92.9000000
SUBISCH	6	86.4166667	7.8333688	77.3000000	94.6000000
MAXHT	6	176.0015333	8.3681362	165.2939900	183.4175500
MAXSITHT	6	89.5848667	2.3033087	86.7939900	92.9160500
RATIO	6	1.0436309	0.0954477	0.9267295	1.1527670

------------------------- TRIBE=CHEYENNE DECADE=186 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	13	24.6923077	1.6012815	23.0000000	28.0000000
STANDHT	13	176.9538462	5.1650452	168.4000000	185.5000000
SITHT	13	89.7384615	3.0590136	85.6000000	93.9000000
SUBISCH	13	87.2153846	4.1003752	81.7000000	92.4000000
MAXHT	13	177.4252423	5.1815678	168.9776900	186.0776900
MAXSITHT	13	90.2098577	3.0953411	85.9340500	94.3475100
RATIO	13	1.0364449	0.0601183	0.9479999	1.1242045

------------------------- TRIBE=CHEYENNE DECADE=187 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	7	20.8571429	0.6900656	20.0000000	22.0000000
STANDHT	7	175.5714286	5.4116277	167.9000000	184.4000000
SITHT	7	90.5428571	1.3721724	88.3000000	92.0000000
SUBISCH	7	85.0285714	4.6132831	78.9000000	93.3000000
MAXHT	7	176.3080043	5.4144113	168.6245900	185.1245900
MAXSITHT	7	91.2794329	1.3829918	89.0245900	92.8043100
RATIO	7	1.0757846	0.0505973	0.9841864	1.1371938

------------------------- TRIBE=COMANCHE DECADE=183 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	5	57.0000000	2.1213203	55.0000000	60.0000000
STANDHT	5	174.2000000	4.4738127	167.2000000	179.3000000
SITHT	5	91.3600000	1.9007893	88.5000000	93.8000000
SUBISCH	5	82.8400000	3.9055089	76.0000000	85.5000000
MAXHT	5	174.8460740	4.5005866	167.7012100	179.8012100
MAXSITHT	5	92.0060740	1.8542397	89.2134900	94.3012100
RATIO	5	1.1126523	0.0574572	1.0520459	1.2065949

The SAS System

------------------------- TRIBE=COMANCHE DECADE=184 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	9	46.1111111	1.9002924	44.0000000	50.0000000
STANDHT	9	167.9222222	8.2839872	155.9000000	179.6000000
SITHT	9	85.8444444	4.0358119	79.7000000	91.8000000
SUBISCH	9	82.0777778	5.1883952	76.2000000	90.4000000
MAXHT	9	168.0220322	8.2600046	156.0190500	179.6447100
MAXSITHT	9	85.9442544	4.0232763	79.8190500	91.9190500
RATIO	9	1.0490909	0.0517421	0.9523240	1.1150389

------------------------- TRIBE=COMANCHE DECADE=185 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	16	36.9375000	2.7681221	33.0000000	42.0000000
STANDHT	16	167.2812500	5.9324215	155.2000000	177.8000000
SITHT	16	86.6875000	3.8220195	77.9000000	92.5000000
SUBISCH	16	80.5937500	3.4636144	75.0000000	86.7000000
MAXHT	16	167.3144938	5.9305084	155.2041100	177.8041100
MAXSITHT	16	86.7207438	3.8182655	77.9041100	92.5175500
RATIO	16	1.0772585	0.0546990	0.9858538	1.1733881

---------------------- TRIBE=COMANCHE DECADE=186 ----------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	29	27.5517241	2.6265976	23.0000000	32.0000000
STANDHT	29	166.2103448	6.0545346	152.1000000	177.5000000
SITHT	29	87.3275862	3.3240355	78.7000000	94.0000000
SUBISCH	29	78.8827586	4.2962666	70.5000000	87.0000000
MAXHT	29	166.5299597	6.0665833	152.2235500	177.6952100
MAXSITHT	29	87.6472010	3.3204419	78.8235500	94.1952100
RATIO	29	1.1137653	0.0647646	0.9625150	1.2579233

---------------------- TRIBE=COMANCHE DECADE=187 ----------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	14	20.8571429	0.9492623	20.0000000	22.0000000
STANDHT	14	168.5857143	5.9429153	155.5000000	175.1000000
SITHT	14	87.1428571	3.0960805	79.9000000	91.7000000
SUBISCH	14	81.4428571	3.9420249	75.6000000	87.9000000
MAXHT	14	169.3231857	5.9560527	156.3043100	175.9043100
MAXSITHT	14	87.8803286	3.1045428	80.7043100	92.3490500
RATIO	14	1.0806305	0.0488324	0.9775266	1.1411425

The SAS System

------------------------ TRIBE=CROW DECADE=181 ------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	75.0000000	.	75.0000000	75.0000000
STANDHT	1	176.5000000	.	176.5000000	176.5000000
SITHT	1	92.4000000	.	92.4000000	92.4000000
SUBISCH	1	84.1000000	.	84.1000000	84.1000000
MAXHT	1	179.1270100	.	179.1270100	179.1270100
MAXSITHT	1	95.0270100	.	95.0270100	95.0270100
RATIO	1	1.1299288	.	1.1299288	1.1299288

------------------------ TRIBE=CROW DECADE=182 ------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	7	68.1428571	2.3401262	64.0000000	70.0000000
STANDHT	7	174.9428571	6.8041304	162.6000000	181.5000000
SITHT	7	88.0285714	4.1696180	83.2000000	93.1000000
SUBISCH	7	86.9142857	5.1304414	77.5000000	94.4000000
MAXHT	7	176.6624757	6.9006036	164.0634900	183.4388100
MAXSITHT	7	89.7481900	4.1605799	85.1388100	94.9137100
RATIO	7	1.0354678	0.0721451	0.9029535	1.1169483

TRIBE=CROW DECADE=183

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	25	57.8800000	2.8035692	53.0000000	62.0000000
STANDHT	25	173.3560000	7.6113446	157.5000000	186.7000000
SITHT	25	89.3760000	3.2725220	83.8000000	96.6000000
SUBISCH	25	83.9800000	6.2723600	71.4000000	97.7000000
MAXHT	25	174.0760468	7.6207058	158.3759100	187.7550500
MAXSITHT	25	90.0960468	3.2657354	84.3677900	97.1012100
RATIO	25	1.0780192	0.0804226	0.8820462	1.2181500

TRIBE=CROW DECADE=184

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	44	47.0681818	2.8886122	43.0000000	52.0000000
STANDHT	44	173.8136364	6.6691791	154.1000000	188.1000000
SITHT	44	90.0181818	4.0349792	77.6000000	99.7000000
SUBISCH	44	83.7954545	3.6435323	74.8000000	92.0000000
MAXHT	44	173.9518559	6.6654320	154.3310100	188.3310100
MAXSITHT	44	90.1564014	4.0127771	77.8310100	99.9766900
RATIO	44	1.0768795	0.0477696	0.9921017	1.1763831

The SAS System

TRIBE=CROW DECADE=185

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	55	37.7818182	2.8783413	33.0000000	42.0000000
STANDHT	55	171.9709091	6.6946820	152.3000000	188.4000000
SITHT	55	89.8254545	3.6190452	72.1000000	96.4000000
SUBISCH	55	82.1454545	4.6705071	73.8000000	92.2000000
MAXHT	55	171.9983325	6.6901360	152.3303900	188.4160500
MAXSITHT	55	89.8528780	3.6138495	72.1303900	96.4088900
RATIO	55	1.0966101	0.0657739	0.8993814	1.2575083

TRIBE=CROW DECADE=186

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	74	27.3243243	3.2228130	23.0000000	32.0000000
STANDHT	74	173.5364865	7.0754365	159.8000000	195.0000000
SITHT	74	90.4094595	3.5875801	81.1000000	102.0000000
SUBISCH	74	83.1270270	4.8982328	72.8000000	97.3000000
MAXHT	74	173.8751276	7.1071038	159.9235500	195.5776900
MAXSITHT	74	90.7481005	3.6046354	81.6776900	102.4475100
RATIO	74	1.0944486	0.0625584	0.9386531	1.2404394

TRIBE=CROW DECADE=187

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	21	20.7619048	0.8890873	20.0000000	22.0000000
STANDHT	21	173.3714286	3.9292675	166.7000000	180.3000000
SITHT	21	89.2714286	2.4938209	85.3000000	92.9000000
SUBISCH	21	84.1000000	3.0477861	79.1000000	89.9000000
MAXHT	21	174.1161938	3.9236279	167.4245900	181.0043100
MAXSITHT	21	90.0161938	2.4771979	86.1043100	93.5490500
RATIO	21	1.0716961	0.0492151	0.9811380	1.1826681

-------------------------- TRIBE=KIOWA DECADE=182 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	3	66.6666667	3.5118846	63.0000000	70.0000000
STANDHT	3	168.3333333	5.9281813	162.1000000	173.9000000
SITHT	3	88.3333333	3.2005208	86.1000000	92.0000000
SUBISCH	3	80.0000000	3.4655447	76.0000000	82.1000000
MAXHT	3	169.8885833	6.0856213	163.6760500	175.8388100
MAXSITHT	3	89.8885833	3.5126028	87.6760500	93.9388100
RATIO	3	1.1243699	0.0450574	1.0724834	1.1536322

The SAS System

-------------------------- TRIBE=KIOWA DECADE=183 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	55.0000000	.	55.0000000	55.0000000
STANDHT	1	167.6000000	.	167.6000000	167.6000000
SITHT	1	89.2000000	.	89.2000000	89.2000000
SUBISCH	1	78.4000000	.	78.4000000	78.4000000
MAXHT	1	168.1012100	.	168.1012100	168.1012100
MAXSITHT	1	89.7012100	.	89.7012100	89.7012100
RATIO	1	1.1441481	.	1.1441481	1.1441481

-------------------------- TRIBE=KIOWA DECADE=184 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	7	45.5714286	2.2253946	43.0000000	50.0000000
STANDHT	7	164.7285714	8.1875341	147.8000000	173.3000000
SITHT	7	87.1571429	4.8514112	80.4000000	95.4000000
SUBISCH	7	77.5714286	6.0947284	67.4000000	84.0000000
MAXHT	7	164.8164014	8.1919350	147.8653100	173.3900900
MAXSITHT	7	87.2449729	4.8383886	80.4653100	95.4282900
RATIO	7	1.1302812	0.1031172	1.0041581	1.2843646

-------------------------- TRIBE=KIOWA DECADE=185 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	20	37.2500000	3.1434979	33.0000000	42.0000000
STANDHT	20	169.3200000	6.0513243	161.9000000	184.6000000
SITHT	20	88.9150000	2.9414059	82.3000000	93.7000000
SUBISCH	20	80.4050000	4.8450164	72.8000000	93.3000000
MAXHT	20	169.3546130	6.0520757	161.9474100	184.6939900
MAXSITHT	20	88.9496130	2.9391294	82.3088900	93.7041100
RATIO	20	1.1096980	0.0706096	0.9795712	1.2300468

TRIBE=KIOWA DECADE=186

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	32	26.0000000	2.6027281	23.0000000	31.0000000
STANDHT	32	171.3156250	4.8816384	160.2000000	181.8000000
SITHT	32	90.1812500	2.3674455	84.8000000	94.8000000
SUBISCH	32	81.1343750	3.5972758	75.3000000	90.1000000
MAXHT	32	171.7180306	4.9303694	160.3572900	182.3105100
MAXSITHT	32	90.5836556	2.4159401	84.9572900	95.3105100
RATIO	32	1.1181459	0.0482820	0.9965448	1.2334355

The SAS System

TRIBE=KIOWA DECADE=187

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	10	21.2000000	0.6324555	20.0000000	22.0000000
STANDHT	10	171.7000000	3.3846057	166.1000000	175.5000000
SITHT	10	89.9500000	2.7346542	84.7000000	95.0000000
SUBISCH	10	81.7500000	3.1882597	74.9000000	86.4000000
MAXHT	10	172.4099000	3.3770007	166.7490500	176.2245900
MAXSITHT	10	90.6599000	2.7098359	85.5043100	95.7245900
RATIO	10	1.1109607	0.0640277	1.0164883	1.2262891

TRIBE=PIEGAN DECADE=180

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	85.0000000	.	85.0000000	85.0000000
STANDHT	1	165.5000000	.	165.5000000	165.5000000
SITHT	1	85.8000000	.	85.8000000	85.8000000
SUBISCH	1	79.7000000	.	79.7000000	79.7000000
MAXHT	1	169.8169100	.	169.8169100	169.8169100
MAXSITHT	1	90.1169100	.	90.1169100	90.1169100
RATIO	1	1.1307015	.	1.1307015	1.1307015

TRIBE=PIEGAN DECADE=181

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	80.0000000	.	80.0000000	80.0000000
STANDHT	1	171.7000000	.	171.7000000	171.7000000
SITHT	1	84.3000000	.	84.3000000	84.3000000
SUBISCH	1	87.4000000	.	87.4000000	87.4000000
MAXHT	1	175.1197100	.	175.1197100	175.1197100
MAXSITHT	1	87.7197100	.	87.7197100	87.7197100
RATIO	1	1.0036580	.	1.0036580	1.0036580

TRIBE=PIEGAN DECADE=182

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	67.5000000	0.7071068	67.0000000	68.0000000
STANDHT	2	165.0500000	1.4849242	164.0000000	166.1000000
SITHT	2	86.0500000	3.7476659	83.4000000	88.7000000
SUBISCH	2	79.0000000	2.2627417	77.4000000	80.6000000
MAXHT	2	166.6844200	1.4023766	165.6927900	167.6760500
MAXSITHT	2	87.6844200	3.6651183	85.0927900	90.2760500
RATIO	2	1.1110495	0.0782169	1.0557418	1.1663572

The SAS System

TRIBE=PIEGAN DECADE=183

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	55.5000000	3.5355339	53.0000000	58.0000000
STANDHT	2	165.8000000	1.9798990	164.4000000	167.2000000
SITHT	2	86.2500000	4.3133514	83.2000000	89.3000000
SUBISCH	2	79.5500000	2.3334524	77.9000000	81.2000000
MAXHT	2	166.3470400	1.7445031	165.1134900	167.5805900
MAXSITHT	2	86.7970400	4.0779555	83.9134900	89.6805900
RATIO	2	1.0923222	0.0833041	1.0334174	1.1512271

TRIBE=PIEGAN DECADE=184

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	5	47.6000000	2.5099801	45.0000000	50.0000000
STANDHT	5	174.2400000	8.8347609	166.9000000	186.4000000
SITHT	5	89.0800000	3.0094850	85.5000000	92.2000000
SUBISCH	5	85.1600000	6.1869217	78.7000000	94.2000000
MAXHT	5	174.3889660	8.8762940	166.9653100	186.5521900
MAXSITHT	5	89.2289660	3.0512979	85.5653100	92.4310100
RATIO	5	1.0504175	0.0500730	0.9803842	1.1215414

TRIBE=PIEGAN DECADE=185

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	12	37.0000000	2.8284271	34.0000000	42.0000000
STANDHT	12	170.3416667	5.4975132	157.9000000	178.3000000
SITHT	12	88.1416667	4.5155204	81.5000000	94.8000000
SUBISCH	12	82.2000000	3.9806349	76.2000000	87.5000000
MAXHT	12	170.3745433	5.5059055	157.9041100	178.3474100
MAXSITHT	12	88.1745433	4.5194566	81.5041100	94.8474100
RATIO	12	1.0754349	0.0828506	0.9833945	1.2224070

TRIBE=PIEGAN DECADE=186

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	27	27.6666667	2.6165156	23.0000000	32.0000000
STANDHT	27	171.9370370	4.6118700	162.8000000	180.9000000
SITHT	27	88.8333333	3.8841889	80.4000000	95.8000000
SUBISCH	27	83.1037037	4.2613181	77.2000000	92.4000000
MAXHT	27	172.2507611	4.6167970	162.9235500	181.1835900
MAXSITHT	27	89.1470574	3.8902348	80.6373100	95.9952100
RATIO	27	1.0761714	0.0825130	0.8966181	1.2434613

The SAS System

------------------------- TRIBE=PIEGAN DECADE=187 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	8	20.5000000	0.5345225	20.0000000	21.0000000
STANDHT	8	173.6750000	4.7436424	164.4000000	178.9000000
SITHT	8	87.5875000	3.8065498	80.0000000	91.3000000
SUBISCH	8	86.0875000	5.1187157	74.1000000	91.0000000
MAXHT	8	174.4394500	4.7248301	165.2043100	179.7043100
MAXSITHT	8	88.3519500	3.8033464	80.8043100	92.1043100
RATIO	8	1.0309995	0.0971070	0.9079136	1.2294779

------------------------- TRIBE=SIOUX DECADE=180 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	87.5000000	4.9497475	84.0000000	91.0000000
STANDHT	2	164.3000000	0	164.3000000	164.3000000
SITHT	2	81.4500000	1.2020815	80.6000000	82.3000000
SUBISCH	2	82.8500000	1.2020815	82.0000000	83.7000000
MAXHT	2	169.1303000	0.9916324	168.4291100	169.8314900
MAXSITHT	2	86.2803000	2.1937139	84.7291100	87.8314900
RATIO	2	1.0417055	0.0415924	1.0122952	1.0711157

------------------------- TRIBE=SIOUX DECADE=181 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	5	76.6000000	3.7815341	73.0000000	81.0000000
STANDHT	5	169.5600000	6.0620129	160.0000000	175.4000000
SITHT	5	85.3600000	4.0184574	78.7000000	89.3000000
SUBISCH	5	84.2000000	3.0331502	81.3000000	88.5000000
MAXHT	5	172.4532140	5.5841217	163.4197100	177.7391900
MAXSITHT	5	88.2532140	3.7158458	82.1197100	91.6391900
RATIO	5	1.0487353	0.0462088	0.9902733	1.0951256

------------------------- TRIBE=SIOUX DECADE=182 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	28	66.7142857	3.1955657	63.0000000	72.0000000
STANDHT	28	168.8857143	7.1294233	147.0000000	179.2000000
SITHT	28	85.8964286	3.9708645	75.0000000	91.6000000
SUBISCH	28	82.9892857	4.8516770	72.0000000	92.7000000
MAXHT	28	170.4497579	7.1216064	148.1508900	181.1388100
MAXSITHT	28	87.4604721	3.9588970	76.1508900	93.1760500
RATIO	28	1.0565597	0.0665390	0.9501192	1.2293763

The SAS System

------------------------- TRIBE=SIOUX DECADE=183 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	71	56.9859155	2.7851287	53.0000000	62.0000000
STANDHT	71	171.8746479	5.4759922	152.7000000	183.2000000
SITHT	71	87.0760563	3.5720128	76.8000000	96.5000000
SUBISCH	71	84.7985915	4.3564892	73.0000000	94.9000000
MAXHT	71	172.5281559	5.4986579	153.2677900	183.6388100
MAXSITHT	71	87.7295644	3.5562992	77.1805900	96.9388100
RATIO	71	1.0373934	0.0698417	0.9058755	1.2018695

------------------------- TRIBE=SIOUX DECADE=184 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	127	46.8188976	2.8239827	43.0000000	52.0000000
STANDHT	127	171.7606299	4.9958897	159.1000000	186.6000000
SITHT	127	87.9149606	3.4486961	73.5000000	94.8000000
SUBISCH	127	83.8456693	4.1810752	74.7000000	93.8000000
MAXHT	127	171.8906615	4.9867308	159.1447100	186.6282900
MAXSITHT	127	88.0449922	3.4433390	73.5900900	94.8282900
RATIO	127	1.0529625	0.0705445	0.7955685	1.2003950

------------------------- TRIBE=SIOUX DECADE=185 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	133	37.4135338	2.9184051	33.0000000	42.0000000
STANDHT	133	172.5458647	5.5992628	156.5000000	189.9000000
SITHT	133	88.9932331	3.7541330	80.0000000	97.5000000
SUBISCH	133	83.5526316	4.3911340	71.5000000	95.1000000
MAXHT	133	172.5769935	5.5971829	156.5939900	189.9303900
MAXSITHT	133	89.0243619	3.7521145	80.0041100	97.5303900
RATIO	133	1.0685653	0.0739155	0.8988602	1.2680901

------------------------- TRIBE=SIOUX DECADE=186 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	149	27.2550336	2.9250880	23.0000000	32.0000000
STANDHT	149	173.8939597	5.8224313	154.1000000	189.0000000
SITHT	149	89.1697987	3.2385913	81.7000000	97.2000000
SUBISCH	149	84.7241611	4.6628151	70.4000000	97.0000000
MAXHT	149	174.2325060	5.8202745	154.4886900	189.4475100
MAXSITHT	149	89.5083449	3.2313221	81.9835900	97.6475100
RATIO	149	1.0595650	0.0680868	0.8493679	1.2283253

The SAS System

------------------------- TRIBE=SIOUX DECADE=187 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	69	20.8695652	0.8028084	20.0000000	22.0000000
STANDHT	69	172.4304348	5.5140277	155.1000000	184.9000000
SITHT	69	88.9347826	2.8790228	79.4000000	93.3000000
SUBISCH	69	83.4956522	4.2591229	71.5000000	94.4000000
MAXHT	69	173.1665135	5.5086365	155.9043100	185.6245900
MAXSITHT	69	89.6708613	2.8655210	80.2043100	94.0245900
RATIO	69	1.0764376	0.0595163	0.8850535	1.2215260

APPENDIX A-2: SIMPLE SUMMARY STATISTICS FOR UNADJUSTED AND MAX VARIABLES, FEMALES

TRIBE=ARAPAHO DECADE=185

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	36.0000000	.	36.0000000	36.0000000
STANDHT	1	168.3000000	.	168.3000000	168.3000000
SITHT	1	88.1000000	.	88.1000000	88.1000000
SUBISCH	1	80.2000000	.	80.2000000	80.2000000
MAXHT	1	168.4546800	.	168.4546800	168.4546800
ADJ	1	0.1546800	.	0.1546800	0.1546800
MAXSITHT	1	88.2546800	.	88.2546800	88.2546800
RATIO	1	1.1004324	.	1.1004324	1.1004324
YOB	1	1856.00	.	1856.00	1856.00
YOB2	1	3444736.00	.	3444736.00	3444736.00

TRIBE=ARAPAHO DECADE=186

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	26.0000000	4.2426407	23.0000000	29.0000000
STANDHT	2	155.8500000	4.4547727	152.7000000	159.0000000
SITHT	2	82.1000000	1.4142136	81.1000000	83.1000000
SUBISCH	2	73.7500000	3.0405592	71.6000000	75.9000000
MAXHT	2	156.6959200	4.0549463	153.8286400	159.5632000
ADJ	2	0.8459200	0.3998265	0.5632000	1.1286400
MAXSITHT	2	82.9459200	1.0143871	82.2286400	83.6632000
RATIO	2	1.1253633	0.0326420	1.1022819	1.1484447
YOB	2	1866.00	4.2426407	1863.00	1869.00
YOB2	2	3481965.00	15833.54	3470769.00	3493161.00

TRIBE=ARAPAHO DECADE=187

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	20.0000000	.	20.0000000	20.0000000
STANDHT	1	163.7000000	.	163.7000000	163.7000000
SITHT	1	87.7000000	.	87.7000000	87.7000000
SUBISCH	1	76.0000000	.	76.0000000	76.0000000
MAXHT	1	165.1858800	.	165.1858800	165.1858800
ADJ	1	1.4858800	.	1.4858800	1.4858800
MAXSITHT	1	89.1858800	.	89.1858800	89.1858800
RATIO	1	1.1734984	.	1.1734984	1.1734984
YOB	1	1872.00	.	1872.00	1872.00
YOB2	1	3504384.00	.	3504384.00	3504384.00

The SAS System

------------------------- TRIBE=ASSINIBO DECADE=187 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	21.0000000	.	21.0000000	21.0000000
STANDHT	1	157.8000000	.	157.8000000	157.8000000
SITHT	1	82.5000000	.	82.5000000	82.5000000
SUBISCH	1	75.3000000	.	75.3000000	75.3000000
MAXHT	1	159.1612800	.	159.1612800	159.1612800
ADJ	1	1.3612800	.	1.3612800	1.3612800
MAXSITHT	1	83.8612800	.	83.8612800	83.8612800
RATIO	1	1.1136956	.	1.1136956	1.1136956
YOB	1	1871.00	.	1871.00	1871.00
YOB2	1	3500641.00	.	3500641.00	3500641.00

------------------------- TRIBE=CHEYENNE DECADE=185 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	36.5000000	4.9497475	33.0000000	40.0000000
STANDHT	2	161.3500000	2.4748737	159.6000000	163.1000000
SITHT	2	81.2500000	2.7577164	79.3000000	83.2000000
SUBISCH	2	80.1000000	0.2828427	79.9000000	80.3000000
MAXHT	2	161.5196600	2.6544506	159.6426800	163.3966400
ADJ	2	0.1696600	0.1795768	0.0426800	0.2966400
MAXSITHT	2	81.4196600	2.9372933	79.3426800	83.4966400
RATIO	2	1.0165462	0.0402599	0.9880782	1.0450143
YOB	2	1855.50	4.9497475	1852.00	1859.00
YOB2	2	3442892.50	18368.51	3429904.00	3455881.00

------------------------- TRIBE=COMANCHE DECADE=182 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	70.0000000	.	70.0000000	70.0000000
STANDHT	1	161.5000000	.	161.5000000	161.5000000
SITHT	1	85.9000000	.	85.9000000	85.9000000
SUBISCH	1	75.6000000	.	75.6000000	75.6000000
MAXHT	1	163.5178800	.	163.5178800	163.5178800
ADJ	1	2.0178800	.	2.0178800	2.0178800
MAXSITHT	1	87.9178800	.	87.9178800	87.9178800
RATIO	1	1.1629349	.	1.1629349	1.1629349
YOB	1	1822.00	.	1822.00	1822.00
YOB2	1	3319684.00	.	3319684.00	3319684.00

The SAS System

------------------------- TRIBE=COMANCHE DECADE=183 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	55.0000000	.	55.0000000	55.0000000
STANDHT	1	153.8000000	.	153.8000000	153.8000000
SITHT	1	82.5000000	.	82.5000000	82.5000000
SUBISCH	1	71.3000000	.	71.3000000	71.3000000
MAXHT	1	154.2092800	.	154.2092800	154.2092800
ADJ	1	0.4092800	.	0.4092800	0.4092800
MAXSITHT	1	82.9092800	.	82.9092800	82.9092800
RATIO	1	1.1628230	.	1.1628230	1.1628230
YOB	1	1837.00	.	1837.00	1837.00
YOB2	1	3374569.00	.	3374569.00	3374569.00

TRIBE=COMANCHE DECADE=184

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	5	47.0000000	2.8284271	44.0000000	50.0000000
STANDHT	5	155.6600000	4.0109849	151.2000000	161.6000000
SITHT	5	80.3000000	2.2226111	77.6000000	83.8000000
SUBISCH	5	75.3600000	2.5065913	71.2000000	77.8000000
MAXHT	5	155.7368640	3.9885953	151.3490800	161.6402800
ADJ	5	0.0768640	0.0663614	0.0190000	0.1490800
MAXSITHT	5	80.3768640	2.2208066	77.6268800	83.8402800
RATIO	5	1.0672225	0.0365279	1.0322723	1.1256893
YOB	5	1845.00	2.8284271	1842.00	1848.00
YOB2	5	3404031.40	10435.31	3392964.00	3415104.00

TRIBE=COMANCHE DECADE=185

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	4	37.2500000	2.6299556	35.0000000	40.0000000
STANDHT	4	157.8750000	5.1311954	150.7000000	162.8000000
SITHT	4	82.6750000	1.6459546	80.5000000	84.4000000
SUBISCH	4	75.2000000	4.2292631	70.2000000	80.3000000
MAXHT	4	157.9995100	5.1451444	150.7624000	162.8426800
ADJ	4	0.1245100	0.0834928	0.0426800	0.1964800
MAXSITHT	4	82.7995100	1.7112852	80.5624000	84.5964800
RATIO	4	1.1032638	0.0557278	1.0279288	1.1476125
YOB	4	1854.75	2.6299556	1852.00	1857.00
YOB2	4	3440102.75	9755.39	3429904.00	3448449.00

The SAS System

TRIBE=COMANCHE DECADE=186

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	16	28.3750000	2.9183329	23.0000000	32.0000000
STANDHT	16	155.9000000	4.1332796	151.8000000	168.3000000
SITHT	16	79.9437500	4.9739279	69.5000000	93.6000000
SUBISCH	16	75.9562500	3.8858665	70.2000000	83.4000000
MAXHT	16	156.5348650	4.0400564	152.6436400	168.7882800
ADJ	16	0.6348650	0.2565428	0.3550000	1.1286400
MAXSITHT	16	80.5786150	4.9357106	70.1436400	94.0882800
RATIO	16	1.0652316	0.1043716	0.8502259	1.2595486
YOB	16	1863.63	2.9183329	1860.00	1869.00
YOB2	16	3473106.13	10884.36	3459600.00	3493161.00

TRIBE=COMANCHE DECADE=187

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	4	21.5000000	1.0000000	20.0000000	22.0000000
STANDHT	4	154.6500000	7.1937473	145.4000000	162.9000000
SITHT	4	79.1000000	2.7215192	76.8000000	82.7000000
SUBISCH	4	75.5500000	4.9352474	68.6000000	80.2000000
MAXHT	4	155.9531200	7.2873236	146.6422000	164.3858800
ADJ	4	1.3031200	0.1218400	1.2422000	1.4858800
MAXSITHT	4	80.4031200	2.8295483	78.0422000	84.1858800
RATIO	4	1.0664162	0.0513246	1.0160907	1.1376414
YOB	4	1870.50	1.0000000	1870.00	1872.00
YOB2	4	3498771.00	3742.00	3496900.00	3504384.00

------------------------- TRIBE=CROW DECADE=182 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	67.0000000	.	67.0000000	67.0000000
STANDHT	1	154.1000000	.	154.1000000	154.1000000
SITHT	1	79.6000000	.	79.6000000	79.6000000
SUBISCH	1	74.5000000	.	74.5000000	74.5000000
MAXHT	1	155.6968000	.	155.6968000	155.6968000
ADJ	1	1.5968000	.	1.5968000	1.5968000
MAXSITHT	1	81.1968000	.	81.1968000	81.1968000
RATIO	1	1.0898899	.	1.0898899	1.0898899
YOB	1	1825.00	.	1825.00	1825.00
YOB2	1	3330625.00	.	3330625.00	3330625.00

The SAS System

------------------------- TRIBE=CROW DECADE=183 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	8	59.1250000	1.6420806	56.0000000	60.0000000
STANDHT	8	154.5500000	3.9666467	148.2000000	159.9000000
SITHT	8	78.9500000	2.8760091	75.1000000	85.0000000
SUBISCH	8	75.6000000	3.1080541	69.3000000	79.9000000
MAXHT	8	155.2843450	3.9776397	149.0074800	160.7074800
ADJ	8	0.7343450	0.1368609	0.4778800	0.8074800
MAXSITHT	8	79.6843450	2.9247525	75.5778800	85.8074800
RATIO	8	1.0558215	0.0628427	0.9828073	1.1501801
YOB	8	1832.88	1.6420806	1832.00	1836.00
YOB2	8	3359433.13	6022.60	3356224.00	3370896.00

------------------------- TRIBE=CROW DECADE=184 -------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	19	47.6842105	2.8490277	43.0000000	52.0000000
STANDHT	19	159.5315789	4.6160412	153.4000000	166.6000000
SITHT	19	83.3684211	2.3381029	79.3000000	87.4000000
SUBISCH	19	76.1631579	3.2280387	69.8000000	80.8000000
MAXHT	19	159.6281284	4.6303393	153.4402800	166.7490800
ADJ	19	0.0965495	0.0664176	0.0166400	0.2366000
MAXSITHT	19	83.4649705	2.3503199	79.4490800	87.5490800
RATIO	19	1.0973273	0.0465502	1.0257079	1.1982848
YOB	19	1844.32	2.8490277	1840.00	1849.00
YOB2	19	3401508.42	10512.04	3385600.00	3418801.00

------------------------------ TRIBE=CROW DECADE=185 ------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	21	39.2857143	2.3268618	34.0000000	42.0000000
STANDHT	21	157.5095238	4.5656221	148.5000000	165.2000000
SITHT	21	82.8190476	3.2595428	76.0000000	87.4000000
SUBISCH	21	74.6904762	4.2990586	68.0000000	85.5000000
MAXHT	21	157.5799581	4.5735001	148.5876400	165.3546800
ADJ	21	0.0704343	0.0664792	0.0198000	0.2438000
MAXSITHT	21	82.8894819	3.2678682	76.0426800	87.4426800
RATIO	21	1.1138733	0.0851283	0.8893881	1.2798306
YOB	21	1852.71	2.3268618	1850.00	1858.00
YOB2	21	3432555.38	8628.02	3422500.00	3452164.00

The SAS System

------------------------------ TRIBE=CROW DECADE=186 ------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	38	27.6052632	2.7757587	23.0000000	32.0000000
STANDHT	38	159.8184211	4.3639714	152.4000000	169.8000000
SITHT	38	82.8078947	2.9344535	76.8000000	89.7000000
SUBISCH	38	77.0105263	3.9264721	69.3000000	85.9000000
MAXHT	38	160.5160389	4.4542303	152.8188800	170.7180800
ADJ	38	0.6976179	0.2447067	0.3550000	1.1286400
MAXSITHT	38	83.5055126	2.9950025	77.2882800	90.8286400
RATIO	38	1.0874323	0.0724950	0.9225104	1.2170799
YOB	38	1864.39	2.7757587	1860.00	1869.00
YOB2	38	3475975.24	10352.73	3459600.00	3493161.00

------------------------------ TRIBE=CROW DECADE=187 ------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	9	20.6666667	1.0000000	20.0000000	22.0000000
STANDHT	9	157.8333333	5.1640585	151.2000000	165.5000000
SITHT	9	81.3333333	3.2003906	76.9000000	86.1000000
SUBISCH	9	76.5000000	2.9461840	73.0000000	80.4000000
MAXHT	9	159.2379867	5.1436311	152.6858800	166.9858800
ADJ	9	1.4046533	0.1218400	1.2422000	1.4858800
MAXSITHT	9	82.7379867	3.1286197	78.3858800	87.3422000
RATIO	9	1.0823750	0.0446375	1.0243339	1.1540027
YOB	9	1871.33	1.0000000	1870.00	1872.00
YOB2	9	3501889.33	3742.00	3496900.00	3504384.00

------------------------------ TRIBE=KIOWA DECADE=183 ------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	60.0000000	.	60.0000000	60.0000000
STANDHT	1	158.2000000	.	158.2000000	158.2000000
SITHT	1	80.4000000	.	80.4000000	80.4000000
SUBISCH	1	77.8000000	.	77.8000000	77.8000000
MAXHT	1	159.0074800	.	159.0074800	159.0074800
ADJ	1	0.8074800	.	0.8074800	0.8074800
MAXSITHT	1	81.2074800	.	81.2074800	81.2074800
RATIO	1	1.0437979	.	1.0437979	1.0437979
YOB	1	1832.00	.	1832.00	1832.00
YOB2	1	3356224.00	.	3356224.00	3356224.00

The SAS System

-------------------------- TRIBE=KIOWA DECADE=184 ----------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	5	47.6000000	2.6076810	44.0000000	50.0000000
STANDHT	5	156.6200000	3.9397969	151.4000000	161.5000000
SITHT	5	81.2800000	3.2018745	77.0000000	84.4000000
SUBISCH	5	75.3400000	4.4696756	71.6000000	82.4000000
MAXHT	5	156.7082160	3.9296861	151.5490800	161.6490800
ADJ	5	0.0882160	0.0602464	0.0190000	0.1490800
MAXSITHT	5	81.3682160	3.2221028	77.0190000	84.5490800
RATIO	5	1.0839073	0.0891102	0.9346966	1.1659726
YOB	5	1844.40	2.6076810	1842.00	1848.00
YOB2	5	3401816.80	9621.42	3392964.00	3415104.00

-------------------------- TRIBE=KIOWA DECADE=185 ----------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	7	36.1428571	1.7728105	35.0000000	40.0000000
STANDHT	7	157.4571429	3.5846232	151.5000000	161.6000000
SITHT	7	81.5285714	3.3762476	77.3000000	86.2000000
SUBISCH	7	75.9285714	1.7182494	73.5000000	78.4000000
MAXHT	7	157.6137371	3.6045492	151.6546800	161.7964800
ADJ	7	0.1565943	0.0544060	0.0426800	0.1964800
MAXSITHT	7	81.6851657	3.3933769	77.4964800	86.3964800
RATIO	7	1.0763868	0.0531233	0.9884755	1.1596843
YOB	7	1855.86	1.7728105	1852.00	1857.00
YOB2	7	3444208.43	6575.19	3429904.00	3448449.00

-------------------------- TRIBE=KIOWA DECADE=186 ----------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	16	27.1875000	2.7133927	23.0000000	32.0000000
STANDHT	16	159.8312500	4.4519237	154.4000000	168.7000000
SITHT	16	83.7437500	2.6477585	78.6000000	89.1000000
SUBISCH	16	76.0875000	3.9981454	67.3000000	83.4000000
MAXHT	16	160.5633625	4.4807300	155.4436400	169.4296000
ADJ	16	0.7321125	0.2394803	0.3550000	1.1286400
MAXSITHT	16	84.4758625	2.6539188	79.3296000	89.8296000
RATIO	16	1.1134621	0.0745805	0.9954566	1.3213908
YOB	16	1864.81	2.7133927	1860.00	1869.00
YOB2	16	3477532.56	10120.22	3459600.00	3493161.00

The SAS System

-------------------------- TRIBE=KIOWA DECADE=187 ----------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	3	20.6666667	1.1547005	20.0000000	22.0000000
STANDHT	3	150.8333333	7.3111787	142.9000000	157.3000000
SITHT	3	79.1666667	6.9291654	74.3000000	87.1000000
SUBISCH	3	71.6666667	5.7422411	66.8000000	78.0000000
MAXHT	3	152.2379867	7.4435423	144.1422000	158.7858800
ADJ	3	1.4046533	0.1406887	1.2422000	1.4858800
MAXSITHT	3	80.5713200	6.9842975	75.7858800	88.5858800
RATIO	3	1.1304461	0.1470695	0.9716138	1.2619071
YOB	3	1871.33	1.1547005	1870.00	1872.00
YOB2	3	3501889.33	4320.89	3496900.00	3504384.00

TRIBE=PIEGAN DECADE=182

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	67.5000000	0.7071068	67.0000000	68.0000000
STANDHT	2	155.6000000	2.8284271	153.6000000	157.6000000
SITHT	2	80.4500000	0.6363961	80.0000000	80.9000000
SUBISCH	2	75.1500000	3.4648232	72.7000000	77.6000000
MAXHT	2	157.2642200	2.9237734	155.1968000	159.3316400
ADJ	2	1.6642200	0.0953463	1.5968000	1.7316400
MAXSITHT	2	82.1142200	0.5410498	81.7316400	82.4968000
RATIO	2	1.0939997	0.0576389	1.0532428	1.1347565
YOB	2	1824.50	0.7071068	1824.00	1825.00
YOB2	2	3328800.50	2580.23	3326976.00	3330625.00

TRIBE=PIEGAN DECADE=183

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	1	60.0000000	.	60.0000000	60.0000000
STANDHT	1	161.3000000	.	161.3000000	161.3000000
SITHT	1	79.2000000	.	79.2000000	79.2000000
SUBISCH	1	82.1000000	.	82.1000000	82.1000000
MAXHT	1	162.1074800	.	162.1074800	162.1074800
ADJ	1	0.8074800	.	0.8074800	0.8074800
MAXSITHT	1	80.0074800	.	80.0074800	80.0074800
RATIO	1	0.9745125	.	0.9745125	0.9745125
YOB	1	1832.00	.	1832.00	1832.00
YOB2	1	3356224.00	.	3356224.00	3356224.00

TRIBE=PIEGAN DECADE=184

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	49.0000000	1.4142136	48.0000000	50.0000000
STANDHT	2	155.1000000	10.3237590	147.8000000	162.4000000
SITHT	2	76.5000000	7.3539105	71.3000000	81.7000000
SUBISCH	2	78.6000000	2.9698485	76.5000000	80.7000000
MAXHT	2	155.2163600	10.2774859	147.9490800	162.4836400
ADJ	2	0.1163600	0.0462731	0.0836400	0.1490800
MAXSITHT	2	76.6163600	7.3076375	71.4490800	81.7836400
RATIO	2	0.9737015	0.0561818	0.9339749	1.0134280
YOB	2	1843.00	1.4142136	1842.00	1844.00
YOB2	2	3396650.00	5212.79	3392964.00	3400336.00

TRIBE=PIEGAN DECADE=185

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	3	37.0000000	2.6457513	35.0000000	40.0000000
STANDHT	3	163.5666667	2.7790886	161.4000000	166.7000000
SITHT	3	82.7000000	4.7822589	77.3000000	86.4000000
SUBISCH	3	80.8666667	4.1404509	76.2000000	84.1000000
MAXHT	3	163.6979467	2.8163660	161.4426800	166.8546800
ADJ	3	0.1312800	0.0795253	0.0426800	0.1964800
MAXSITHT	3	82.8312800	4.8616648	77.3426800	86.5964800
RATIO	3	1.0278280	0.1083933	0.9196514	1.1364367
YOB	3	1855.00	2.6457513	1852.00	1857.00
YOB2	3	3441029.67	9812.34	3429904.00	3448449.00

TRIBE=PIEGAN DECADE=186

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	3	26.6666667	2.3094011	24.0000000	28.0000000
STANDHT	3	160.1333333	0.4932883	159.8000000	160.7000000
SITHT	3	80.8000000	2.1000000	78.4000000	82.3000000
SUBISCH	3	79.3333333	1.8823744	78.1000000	81.5000000
MAXHT	3	160.9026267	0.7101481	160.4436400	161.7206000
ADJ	3	0.7692933	0.2176380	0.6436400	1.0206000
MAXSITHT	3	81.5692933	2.2411618	79.0436400	83.3206000
RATIO	3	1.0289864	0.0513775	0.9698606	1.0627628
YOB	3	1865.33	2.3094011	1864.00	1868.00
YOB2	3	3479472.00	8618.68	3474496.00	3489424.00

The SAS System

TRIBE=PIEGAN DECADE=187

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	20.0000000	0	20.0000000	20.0000000
STANDHT	2	161.4500000	5.5861436	157.5000000	165.4000000
SITHT	2	84.2500000	0.0707107	84.2000000	84.3000000
SUBISCH	2	77.2000000	5.5154329	73.3000000	81.1000000
MAXHT	2	162.9358800	5.5861436	158.9858800	166.8858800
ADJ	2	1.4858800	0	1.4858800	1.4858800
MAXSITHT	2	85.7358800	0.0707107	85.6858800	85.7858800
RATIO	2	1.1133771	0.0786275	1.0577790	1.1689752
YOB	2	1872.00	0	1872.00	1872.00
YOB2	2	3504384.00	0	3504384.00	3504384.00

TRIBE=SIOUX DECADE=180

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	2	86.0000000	4.2426407	83.0000000	89.0000000
STANDHT	2	157.2500000	1.9091883	155.9000000	158.6000000
SITHT	2	80.6000000	3.3941125	78.2000000	83.0000000
SUBISCH	2	76.6500000	1.4849242	75.6000000	77.7000000
MAXHT	2	162.3775200	0.9038522	161.7384000	163.0166400
ADJ	2	5.1275200	1.0053361	4.4166400	5.8384000
MAXSITHT	2	85.7275200	2.3887764	84.0384000	87.4166400
RATIO	2	1.1189400	0.0528417	1.0815753	1.1563048
YOB	2	1806.00	4.2426407	1803.00	1809.00
YOB2	2	3261645.00	15324.42	3250809.00	3272481.00

TRIBE=SIOUX DECADE=181

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	8	78.1250000	1.9594095	75.0000000	80.0000000
STANDHT	8	159.1125000	4.9984105	154.7000000	169.9000000
SITHT	8	78.2000000	3.8582009	72.1000000	82.8000000
SUBISCH	8	80.9125000	5.4309793	72.5000000	91.3000000
MAXHT	8	162.5295550	5.1598830	157.5300800	173.6802800
ADJ	8	3.4170550	0.3749515	2.8300800	3.7802800
MAXSITHT	8	81.6170550	4.0438621	75.4836400	86.5802800
RATIO	8	1.0139707	0.1019229	0.8880428	1.1942108
YOB	8	1813.88	1.9594095	1812.00	1817.00
YOB2	8	3290145.88	7109.79	3283344.00	3301489.00

The SAS System

TRIBE=SIOUX DECADE=182

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	9	65.2222222	1.5634719	63.0000000	68.0000000
STANDHT	9	156.8555556	3.7450337	152.6000000	163.5000000
SITHT	9	78.6555556	2.6847305	75.4000000	83.3000000
SUBISCH	9	78.2000000	2.7919527	74.8000000	83.8000000
MAXHT	9	158.2322667	3.6740811	153.9436800	164.7254000
ADJ	9	1.3767111	0.1941164	1.1126400	1.7316400
MAXSITHT	9	80.0322667	2.6440704	76.6254000	84.7674800
RATIO	9	1.0246733	0.0521682	0.9656969	1.1080716
YOB	9	1826.78	1.5634719	1824.00	1829.00
YOB2	9	3337119.22	5711.20	3326976.00	3345241.00

TRIBE=SIOUX DECADE=183

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	24	56.4166667	2.5523504	53.0000000	62.0000000
STANDHT	24	158.8041667	5.0773563	151.7000000	168.8000000
SITHT	24	80.8583333	3.4088015	70.7000000	85.2000000
SUBISCH	24	77.9458333	4.7649061	69.1000000	86.3000000
MAXHT	24	159.3294900	5.0933536	152.1092800	169.3520000
ADJ	24	0.5253233	0.1983854	0.2886400	1.0054000
MAXSITHT	24	81.3836567	3.3483669	71.7054000	85.6074800
RATIO	24	1.0484764	0.0845804	0.8308853	1.2070808
YOB	24	1835.58	2.5523504	1830.00	1839.00
YOB2	24	3369372.42	9366.61	3348900.00	3381921.00

TRIBE=SIOUX DECADE=184

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	35	47.5714286	2.7038721	43.0000000	52.0000000
STANDHT	35	158.4342857	4.8817754	148.5000000	168.2000000
SITHT	35	81.2257143	3.0895786	74.9000000	87.0000000
SUBISCH	35	77.2085714	3.9495623	70.2000000	85.2000000
MAXHT	35	158.5263771	4.9039855	148.5166400	168.3490800
ADJ	35	0.0920914	0.0707985	0.0166400	0.2366000
MAXSITHT	35	81.3178057	3.1073692	74.9166400	87.1490800
RATIO	35	1.0559537	0.0679138	0.8941742	1.2082142
YOB	35	1844.43	2.7038721	1840.00	1849.00
YOB2	35	3401923.86	9973.66	3385600.00	3418801.00

The SAS System

TRIBE=SIOUX DECADE=185

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	45	37.4444444	2.9198035	33.0000000	42.0000000
STANDHT	45	160.8400000	5.7313492	146.8000000	172.1000000
SITHT	45	81.8933333	3.2948583	74.5000000	89.7000000
SUBISCH	45	78.9466667	3.7858348	71.9000000	88.8000000
MAXHT	45	160.9670542	5.7572069	146.8876400	172.3966400
ADJ	45	0.1270542	0.0948040	0.0198000	0.2966400
MAXSITHT	45	82.0203876	3.3204569	74.5876400	89.9966400
RATIO	45	1.0406597	0.0542395	0.9379239	1.1494114
YOB	45	1854.56	2.9198035	1850.00	1859.00
YOB2	45	3439384.64	10830.61	3422500.00	3455881.00

TRIBE=SIOUX DECADE=186

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	33	27.4848485	3.1733383	23.0000000	32.0000000
STANDHT	33	161.4575758	4.9732428	148.9000000	170.5000000
SITHT	33	82.7484848	4.1110462	66.6000000	88.6000000
SUBISCH	33	78.7090909	5.1133015	65.3000000	96.9000000
MAXHT	33	162.1717600	4.9638473	149.3882800	170.8550000
ADJ	33	0.7141842	0.2766940	0.3550000	1.1286400
MAXSITHT	33	83.4626691	4.1721262	66.9550000	89.1632000
RATIO	33	1.0658549	0.0959745	0.6909701	1.2877225
YOB	33	1864.52	3.1733383	1860.00	1869.00
YOB2	33	3476426.52	11834.43	3459600.00	3493161.00

TRIBE=SIOUX DECADE=187

Variable	N	Mean	Std Dev	Minimum	Maximum
AGE	27	20.8888889	0.8473185	20.0000000	22.0000000
STANDHT	27	160.6962963	4.2997747	149.7000000	167.2000000
SITHT	27	83.8481481	3.4616993	77.3000000	93.8000000
SUBISCH	27	76.8481481	4.3319360	66.2000000	85.0000000
MAXHT	27	162.0730563	4.3168847	150.9422000	168.6858800
ADJ	27	1.3767600	0.1033566	1.2422000	1.4858800
MAXSITHT	27	85.2249081	3.4926133	78.5422000	95.2858800
RATIO	27	1.1134849	0.0940264	0.9322612	1.4393637
YOB	27	1871.11	0.8473185	1870.00	1872.00
YOB2	27	3501057.48	3170.71	3496900.00	3504384.00

VITA

Joseph M. Prince was born in New Jersey on September 30, 1961. He grew up in northern New Jersey and attended Boston University in Boston, Massachusetts. He transferred to the University of Toronto, in Toronto, Canada. In November 1983 he received a bachelor of science degree with honors in anthropology.

Mr. Prince received his master of arts degree in anthropology at the University of Tennessee in 1989. He and his wife, Becky Carr, currently reside in Cartersville, Georgia.

He is a member of the American Association of Physical Anthropologists, as well as the following professional organizations:

Society for the Study of Human Biology,

Human Biology Council,

New York Academy of Sciences,

Cultural Survival,

Union of Concerned Scientists.