

CLOVIS HUNTING  
AND THE ORGANIZATION OF SUBSISTENCE LABOR

by

Nicole Marie Waguespack

---

Copyright © Nicole Marie Waguespack 2003

A Dissertation Submitted to the Faculty of the

DEPARTMENT OF ANTHROPOLOGY

In Partial Fulfillment of the Requirements  
For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

2003

UMI Number: 3107051

Copyright 2003 by  
Waguespack, Nicole Marie

All rights reserved.

#### INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

**UMI**<sup>®</sup>

---

UMI Microform 3107051

Copyright 2004 by ProQuest Information and Learning Company.

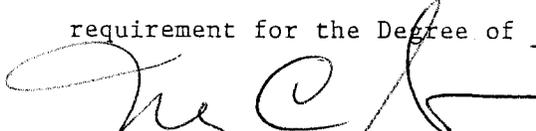
All rights reserved. This microform edition is protected against unauthorized copying under Title 17, United States Code.

ProQuest Information and Learning Company  
300 North Zeeb Road  
P.O. Box 1346  
Ann Arbor, MI 48106-1346

THE UNIVERSITY OF ARIZONA ®  
GRADUATE COLLEGE

As members of the Final Examination Committee, we certify that we have  
read the dissertation prepared by Nicole Marie Waguespack  
entitled Clovis Hunting and the Organization of Subsistence Labor

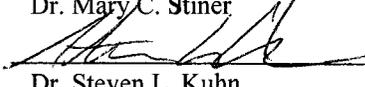
and recommend that it be accepted as fulfilling the dissertation  
requirement for the Degree of Doctor of Philosophy



Dr. Mary C. Stiner

11-8-03

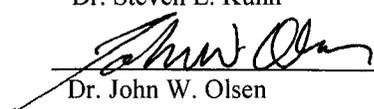
Date



Dr. Steven L. Kuhn

11-08-03

Date



Dr. John W. Olsen

11 AUGUST 2003

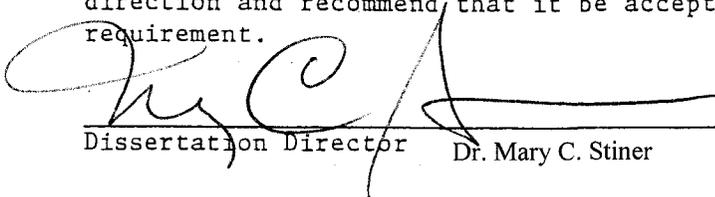
Date

Date

Date

Final approval and acceptance of this dissertation is contingent upon  
the candidate's submission of the final copy of the dissertation to the  
Graduate College.

I hereby certify that I have read this dissertation prepared under my  
direction and recommend that it be accepted as fulfilling the dissertation  
requirement.



Dissertation Director Dr. Mary C. Stiner

11-8-03

Date

## STATEMENT BY AUTHOR

This dissertation has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this dissertation are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the copyright holder.

SIGNED:  \_\_\_\_\_

## ACKNOWLEDGEMENTS

It is a privilege to thank my advisors, colleagues, friends, and family who have made the completion of this dissertation possible. I have been fortunate to have had the opportunity to work and learn from many individuals, whose insight and wisdom have been integral to my education. The members of my committee, Mary Stiner, Steve Kuhn, and John Olsen, have gone above and beyond the call of duty to help me see this through to the end. Mary Stiner's guidance and encouragement, her knowledge of predatory adaptations, and enthusiasm for pushing the limits of zooarchaeological analyses provided a deep source of inspiration. Her attention to detail and support of my interests has been a valuable and enduring component of my graduate education. Steve Kuhn always provided a willing ear to discuss all things hunter-gatherer. His ability to clarify what often seemed to me, very complex issues of optimal foraging theory and human behavior, provided me with a much needed "voice of reason" from which to organize my ideas. I am grateful and inspired by John Olsen's confidence in my ability to complete this work, and excitement about Pleistocene fauna and Clovis peoples.

As an undergraduate at Colorado State University I initially signed up for "Introduction to Archaeology" for two reasons: it was offered at a convenient time and in a convenient location. This "course of convenience" quickly developed into genuine interest and eventually a chosen career, and has led me to pursue many rather inconvenient, yet rewarding, tasks such as dissertation writing. I thank Larry Todd for providing me with such an inspiring introduction to archaeology, and for developing my interests in zooarchaeology. Later at the University of Wyoming, Robert Kelly's vast knowledge of hunter-gatherer lifeways greatly expanded these interests. His thoughtful reasoning, and willingness to share his thoughts and experiences enabled me to realize the connection between zooarchaeology and forager ecology. Mary Lou Larson and Marcel Kornfeld, also at the University of Wyoming, provided me with countless research and field opportunities, and have become great friends and mentors.

The support and humor of my friends Stacey Lengyel, Chris Widga, and Amy Margaris are greatly appreciated—our "coffee breaks" were always enlightening. Cherie Freeman generously volunteered her time to help with various tasks, primarily data collection, for which I am grateful. My parents, Faye and Lanny Waguespack, have provided both financial and emotional support throughout my education and I could not have completed this degree without them. The unflinching support and assistance provided by my husband, Todd Surovell, has been astounding. He has patiently listened to my ideas and enthusiastically read countless drafts of this work, instilling a degree of confidence and motivation I could never have mustered alone. I consider the completion of my degree as a true collaborative effort—and I would not have wanted it any other way. Finally, I need to thank Kaya T. Dog for keeping me company during many hours of typing, and for being my favorite terrestrial carnivore.

## TABLE OF CONTENTS

LIST OF FIGURES.....	7
LIST OF TABLES.....	9
ABSTRACT.....	10
CHAPTER I: INTRODUCTION.....	12
<u>The Application of Optimal Foraging Models</u> .....	15
<u>The Clovis Archaeological Record</u> .....	19
<u>Data &amp; Methodological Caveats</u> .....	22
CHAPTER II: HUMAN PREDATORY BEHAVIOR.....	25
<u>Predator Body Size and Population Density</u> .....	29
<u>Prey Selection</u> .....	32
<u>Human Resource Use</u> .....	39
<u>Capture Success</u> .....	45
<u>Human Hunting in Context</u> .....	51
CHAPTER III: HUMAN PREY SELECTION STRATEGIES.....	54
<u>The Diet Breadth Model</u> .....	55
<u>The Benefits of Large Prey</u> .....	58
<u>Risk, Variance and the Benefits of Small Prey</u> .....	63
<u>Handling Costs and the Benefits of Gatherable Prey</u> .....	69
<u>Strategies of Prey Selection</u> .....	71
<u>Prey Utilized by Recent Subsistence Hunters</u> .....	77
<u>Specialization Past &amp; Present</u> .....	89
CHAPTER IV: CLOVIS HUNTING STRATEGY.....	91
<u>Clovis as Generalists</u> .....	92
<u>Estimating Clovis Diet Breadth</u> .....	97
<u>Clovis as Specialists</u> .....	106
CHAPTER V: THE ORGANIZATION OF SUBSISTENCE LABOR.....	109
<u>Hunted &amp; Gathered Resources</u> .....	111
<u>Approaches to the Division of Labor</u> .....	119
<u>Task Differentiation and Gender</u> .....	122
<u>Gathered Foods &amp; Labor Relative to Hunting</u> .....	124
CHAPTER VI: CLOVIS LABOR ORGANIZATION.....	138
<u>The Incredible Shrinking Woman</u> .....	140
<u>Women, Men &amp; Technology</u> .....	146

TABLE OF CONTENTS – *Continued*

<u>Identifying Multiple Agents in Lithic Production</u> .....	150
<u>Hunter-Gatherer Mobility and Raw Material Access</u> .....	153
CHAPTER VII: CONCLUSIONS.....	159
<u>Clovis Hunters and Their Prey</u> .....	161
<u>Men Hunt, Women Gather (Make Tools, Move Camp, and Build Houses)</u> .....	164
<u>Closing Thoughts</u> .....	170
APPENDIX A: BODY SIZE AND POPULATION DENSITY DATA FOR A SAMPLE OF TERRESTRIAL ANIMALS.....	173
APPENDIX B: A GLOBAL SAMPLE OF HUNTER-GATHERERS.....	175
APPENDIX C: SUBSISTENCE HUNTER PREY INVENTORIES.....	182
REFERENCES.....	193

## LIST OF FIGURES

Figure 1.1: Representation of a typical Clovis hunting scene.....	12
Figure 1.2: Distribution map of Clovis sites.....	20
Figure 2.1: Plot of animal body mass and population density.....	29
Figure 2.2: Plot of hunter-gatherer population density .....	31
Figure 2.3: Average size of most common prey for 42 carnivore species .....	34
Figure 2.4: Graphical model of predator and prey size relationship.....	35
Figure 2.5: Plot of predator and prey mass for 6 carnivorous species.....	38
Figure 2.6: Plot of population density and dietary contribution for 92 hunter-gatherer societies.....	40
Figure 2.7: Average size of most common prey for 8 foraging societies.....	42
Figure 2.8: Scatterplot of predator and prey mass for non-human carnivorous species and human foragers.....	43
Figure 3.1: Plot of animals killed versus meat procured for 3 hypothetical prey.....	60
Figure 3.2: Plot of prey return rate relative to kill interval.....	63
Figure 3.3: Plot of average daily returns for 3 hypothetical prey.....	68
Figure 3.4: Modeled relationship between selective and encounter based prey strategies.....	74
Figure 3.5: Plot of population density, prey mass, and encounter rate of prey species hunted by the Ache.....	76
Figure 3.6: Plot of the total number of animals killed, and number of species represented relative to observation length for a sample of subsistence hunters.....	79
Figure 3.7: Plot of prey mass and number killed for a sample of subsistence hunters.....	81
Figure 3.8: Plot of the three most common prey relative to their mass for “generalists” and “specialists”.....	85
Figure 3.9: Plot of the number of prey species utilized relative to the mass of the most commonly hunted prey.....	88
Figure 4.1: Percent of Clovis sites containing various taxa.....	101
Figure 4.2: Total MNI by taxonomic group for Clovis sites.....	101
Figure 4.3: Plot of prey size class, total MNI, and number of sites per taxa for Clovis assemblages.....	105
Figure 4.4: Percentage of large game in the diet relative to population density for a sample of hunter-gatherers.....	107
Figure 5.1: Plot of average kilocalorie yield for 100 grams of four general resource classes.....	114
Figure 5.2: Plot of average post-encounter returns of four general resource classes.....	116
Figure 5.3: Staple plant foods relative to the degree of dependence on hunted and gathered resources in a sample of hunter-gatherer societies.....	126
Figure 5.4: Plot of average female foraging hours relative to the amount of meat in the diet.....	130

LIST OF FIGURES – *Continued*

Figure 5.5: Plot of female participation non-procurement tasks relative to the amount of meat in the diet.....	133
Figure 5.6: Plot of task differentiation by sex relative to the amount of meat in the diet.....	134
Figure 5.7: Graph of female participation in three common tasks relative to the amount of meat in the diet.....	135
Figure 7.1: An alternative depiction of Clovis subsistence and labor organization.....	168

## LIST OF TABLES

Table 2.1: Hunting success rates for 6 subsistence hunting societies.....	47
Table 3.1: Average daily returns for 3 hypothetical prey .....	60
Table 3.2: Average daily returns for 3 hypothetical prey with altered kill intervals.....	67
Table 3.3: Summary of prey data for 12 subsistence hunting groups.....	78
Table 4.1: Summary of Clovis faunal data.....	98
Table 4.2: Summary of Clovis faunal data by size class.....	103
Table 5.1: Average caloric returns reported for the Hadza.....	118
Table 5.2: Summary of time spent in the procurement of food resources for 8 hunter-gatherer societies.....	128

## ABSTRACT

I examine Clovis subsistence strategies within the broader context of predatory adaptations in cross-cultural and cross-species frameworks. To derive implications for labor activities of Clovis men and women, I also address the relationship between subsistence variation and the organization of labor for a sample of recent hunting and gathering populations.

I begin by placing humans within a broad zoological context. Examining variation in hunter-gatherer subsistence in relation to predatory-prey relationships reveals how humans are both subject to and alter the constraints governing other terrestrial carnivorous species. It is concluded that human populations often utilize an inordinately broad size range of prey relative to other predators.

I then explore human prey selection within an optimal foraging framework with respect to variance and risk. Based on predicted relationships between prey encounter rate and body size, I develop a model for differentiating between large-game hunting specialization and encounter-based hunting. The model is first tested with ethnographically documented prey inventories for a sample of recent subsistence hunting populations, and is found to reveal distinct faunal signatures typical of each strategy.

The model is then applied to the Clovis faunal record using faunal data from 33 Clovis sites. I find strong support for the hypothesis that Clovis hunter-gatherers used a large-game focused hunting strategy, although some use of small game is apparent. Furthermore, I employ data from modern hunter-gatherers to support the theoretical

plausibility of specialized large mammal hunting across North America during the Late Pleistocene.

Finally, I examine how subsistence choices affect the gendered division of labor in ethnographically documented populations. I examine the relationship between male and female subsistence efforts in terms of resource procurement, time allocation, and task differentiation. It is established that as male dietary contribution increases, female plant gathering focuses on high post-encounter return/low risk resources, the amount of time women spend procuring food decreases, and female participation in non-subsistence activities increases. An interpretation of Clovis labor organization is developed that emphasizes female labor in the production of material goods and the procurement of low risk resources.

## CHAPTER I: INTRODUCTION

Few images of North American Pleistocene hunter-gatherers capture the imagination like that of a small group of male hunters in the process of killing a mammoth. How frequently has this image been rendered in textbooks and museum displays for evoking awe at the skill and bravery of prehistoric hunter-gatherers? While captivating, serious thought to this image (Figure 1.1) raises some problematic questions. Namely, is it possible that this scene actually occurred—and how frequently? What would compel Clovis hunters to attempt such a feat, and how would they have done so? And, where are all the Clovis women? For lack of a better term, the notion of prehistoric

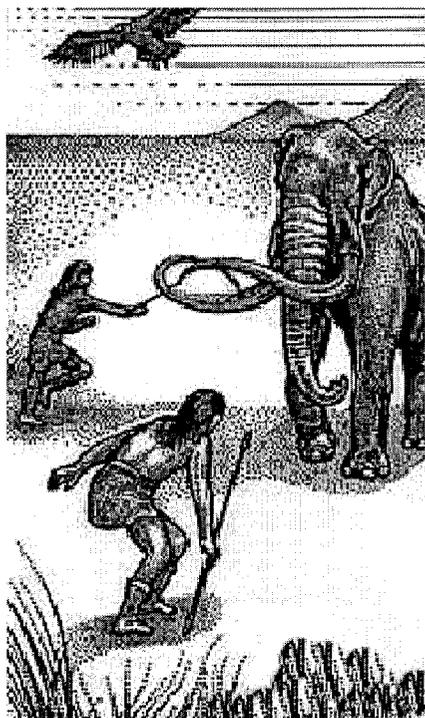


Figure 1.1: A typical rendering of Clovis hunters confronting a mammoth.

humans killing an animal the size of a Pleistocene mammoth is odd. A woolly mammoth (*Mammuthus primigenius*) is estimated to have weighed over six metric tons (Kurtén and Anderson 1980), roughly 100 times the weight of an average human. The magnitude of this size difference is unprecedented among predatory mammals. Even a wolf capturing an adult moose is killing an animal only 11 times its body weight. Among ethnographically documented peoples (except those in arctic regions) few

are known to frequently hunt the largest prey available to them.

We know from the archaeological record that Clovis projectile points are found in association with the remains of mammoth and other large Pleistocene species (reviewed in Frison 1993; Haynes 1966; Haynes 1991, 2002), and actualistic studies show that these weapons could have been suitable for killing extremely large prey (Frison 1989). There are also ethnographic accounts documenting the predation of modern elephant species by hunting and gathering peoples without the benefit of modern weapons such as firearms (Duffy 1984; Johnson et al. 1980; Marks 1976). Yet none of this adds up to an accepted view regarding the interaction between Clovis hunters and mammoths (Grayson and Meltzer 2003; Meltzer 1993). While the image of mammoth killing hunters is compelling, it presents something of an anomaly in accounts of North American prehistory and challenges the limits of hunter-gatherer diversity as it is ethnographically known. It thus remains difficult to conceive of mammoth hunting as a habitual component of the food quest.

I will not attempt to address all of the potential “oddities” associated with human procurement of extremely large prey, but throughout the following chapters I explore Clovis hunting practices by evaluating their subsistence strategy within the broader context of predatory adaptations in cross-cultural and cross-species contexts. Two questions form the basis of my analysis: 1) how do foraging peoples make decisions regarding which animals to hunt and how are these decisions reflected in the archaeological record; and 2) how does the degree of dependence on hunted resources affect the organization of labor in foraging populations including its implications for

labor investments of Clovis men and women? To address these questions, I begin by examining human predation in relation to other terrestrial carnivores. The interactions between predators and their prey are first compared with regards to population density and body mass. Human prey selection strategies are then examined in greater detail based on optimal foraging theory and ethnographically documented hunting behaviors for a sample of recent foraging populations. A model of two prey selection strategies and their effects on faunal assemblage attributes is developed and then applied to the Clovis faunal record. Finally, the relationship between the dependence on hunted resources and the sexual division of labor is examined ethnographically and the results applied to an interpretation of the Clovis archaeological record. My goal is to establish not only whether Clovis peoples were hunters of megafauna or not, but also to investigate the implications for the organization of subsistence labor as they relate to the predation strategies of foraging peoples.

Recent zooarchaeological work has established the great potential for utilizing faunal data to address issues above and beyond the most basic aspects of human subsistence. Studies relating the types and frequency of prey captured to larger scale issues concerning population level interactions between prehistoric humans and faunal communities (Broughton 1994, 1997, 2002; Stiner 2001; Stiner et al. 1999, 2000) have highlighted the utility of zooarchaeological data for identifying how prehistoric hunting behaviors impacted the organization of human populations and their ecological interaction with other species. Such work has significantly broadened the scope of zooarchaeological research and is the inspiration for the current study. Coupled with

insights into forager hunting strategies derived from evolutionary ecological theory (e.g. Smith and Winterhalder 1992; Winterhalder and Smith 1991), solid methodological and theoretical foundations exist for establishing not only what Clovis peoples are likely to have hunted but also for deriving interpretations of their subsistence and labor organization. Optimal foraging models are used throughout this study, and my analysis is essentially geared towards a behavioral ecological approach to human hunting. While only certain concepts and ideas from this theoretical paradigm are utilized, it warrants a brief introduction, followed by a general overview of Clovis archaeology and a description of the datasets employed.

### The Application of Optimal Foraging Models

Behavioral ecology provides theoretically informed models for the interpretation of a host of human behaviors, and the utility of optimality models in archaeology has been well substantiated (e.g., Barton and Clark 1997; Broughton and O'Connell 1999; Kelly 2000). Optimality models have been employed to address a wide variety of issues, ranging from the use of public architecture as a means of gaining social power (e.g., Neiman 1997) to the decisions underlying such private issues as infanticide (e.g., Smith and Smith 1994). Behavioral ecology provides a robust theoretical foundation for examining the adaptive strategies of past and present human populations by offering substantial insight into the costs and benefits of behavioral decisions. Importantly, it provides a body of decision-making models and empirical predictions suited to exploring behaviors of different subsets of a population within the same framework. So while my

interest in Clovis hunting strategy and labor organization may initially seem incongruous, they are interrelated components of a subsistence economy.

The foundation of optimal foraging models derived from behavioral ecology rests on two basic principles. Foragers have options, and strategically behave in ways that maximize their fitness goals in relation to those available options (reviewed in Krebs and Davies 1984; Smith and Winterhalder 1992; Stephens and Krebs 1986). Options consist of the complete inventory of physiological, behavioral, and cognitive abilities any given organism has at its disposal in a given environment. Options are not endless, but are constrained by the environmental context (including social and cultural factors) in which organisms live and interact, and by genetically-derived physiological constraints of the organism itself. “Goals” can be structured in terms of currencies, usually time or energy— which if utilized optimally contributes to an organism’s fitness. The ultimate fitness goal is to maximize the production of viable offspring, but a variety of more proximate goals contribute to this larger cause such as maintaining ones health and nutritional well being. The interplay between options, constraints, currencies, and goals are integral to optimal foraging models and has relevance to the behavioral strategies of a remarkably wide range of organisms.

Use of optimality models can be highly problematic, and many critics deny the very notion that animals can and do behave optimally (Pierce and Ollason 1987; Sih and Christensen 2001). Applications to humans have been especially controversial as many researchers question the validity of models applicable to both human and non-human behavior (as reviewed in Alcock 2001). While it is true that optimality models generally

require considerable simplification for application and are further limited by the ambiguities of prehistoric behavioral contexts, I do not consider the difficulties to be insurmountable. Many of the problems in the application of formal optimality models to archaeological data sets involve the degree of quantitative rigor employed. However adapting complex models to accommodate coarse grained archaeological data is clearly possible (e.g. Bird 1997; Jochim 1976; Kelly 2000; Schmitt and Lupo 1995; Surovell 2003). It is often suggested that the inability to test the mathematically derived optimum identified by any particular model in an archaeological context is a critical flaw (e.g. Lyman and O'Brian 1998a)— an error so fundamental that application of formal models from behavioral ecology to archaeology is wholly ineffective. On the other hand, model *testing* and model *application* are two very different epistemological endeavors. Only the latter is undertaken here.

It is not my intent to determine if hunter-gatherers of the past and present were/are optimal beings, or if optimality models “work” for Clovis populations. I assume the answer to both of these questions is yes. My use of behavioral ecological theory and models is to provide insight into the decisions and contexts in which optimality is expressed. It can be argued that optimality models are not designed to be tested, in the sense of evaluating the logical soundness of a models assumptions and premises, with archaeological data. The archaeological record simply does not provide fertile ground for the testing of an optimality model's validity. In fact, formal models by their very nature are necessarily valid, although they may apply to only a narrow range of situations. All models formulate general rules governing the relationship between various properties and

variables. In a sense, they provide a basic formula for how a particular aspect of the world might operate by extracting the key components of a complex system into a common language (usually a mathematical one). Models distill the complex interaction between *causes* and *effects* into a systematic and predictable framework. Optimal solutions merely reflect the most economically and/or reproductively positive outcome in a particular set of circumstances. Consequently, models may be theoretically derived, but must be tested in contexts where both causes, effects, and modeled constraints are present if the implications are to be empirically verified. Situations where causes and their potential behavioral effects can be tested include living populations, historically documented populations, or simulated populations based on known or realistic parameters.

The archaeological record is comprised of evidence of behavioral effects, the material residues of past human decisions and activities. The causes of these effects must be inferred, and preferably, from reliable, logically grounded interpretative frameworks. Whether construed as middle-range theory or frames of reference linking the statics and dynamics of the archaeological record in the classic Binfordian sense (1977, 1987) or as reconstruction theory (Schiffer 1988), the larger goal is the same; connecting the material residues of behavior to explanatory, and ultimately causal behavioral decisions of past peoples. Optimality models provide just such a means for archaeological interpretation. Behavioral ecology assumes that agents operate rationally, that behavioral decisions provide the means necessary for attaining a specific goal by maximizing or minimizing a specific currency within a set of constraints. As such, defining attributes of an

archaeological assemblage as optimal solutions, without regard to the circumstances in which optimality is expressed provides little, if any, interpretive insight. At issue is the context in which optimality is expressed- what goals, currencies, and constraints are causally related to the material record. The application of optimality models to archaeological data is to determine if past behavior does or does not conform to the modeled predictions for specific goals, constraints, and currencies.

### The Clovis Archaeological Record

The nearly ubiquitous distribution of Clovis projectile points throughout the United States provides the earliest and least controversial evidence of late Pleistocene human occupation of the New World (Figure 1.2). Found throughout North America from southern Canada to northern Mexico within a limited temporal span (c.11,600-10,800 B.P.), Clovis material culture suggests a rapid colonization of North America by a culturally distinct population of colonists (Haynes 1992; Haynes et al. 1984; Kelly and Todd 1988; Taylor et al. 1996). Diagnostic artifacts include fluted, bifacial projectile points, polyhedral blade cores and macroblades (Collins 1999a), and worked bone/ivory rods (Lyman and O'Brien 1998b). Less morphologically distinct artifacts often associated with Clovis lithic assemblages include a wide range of cutting and scraping tools. With the exception of isolated point finds, Clovis-aged sites from the United States and Canada generally fall into three distinct, as commonly defined, categories: kill sites, caches, and residential camps.

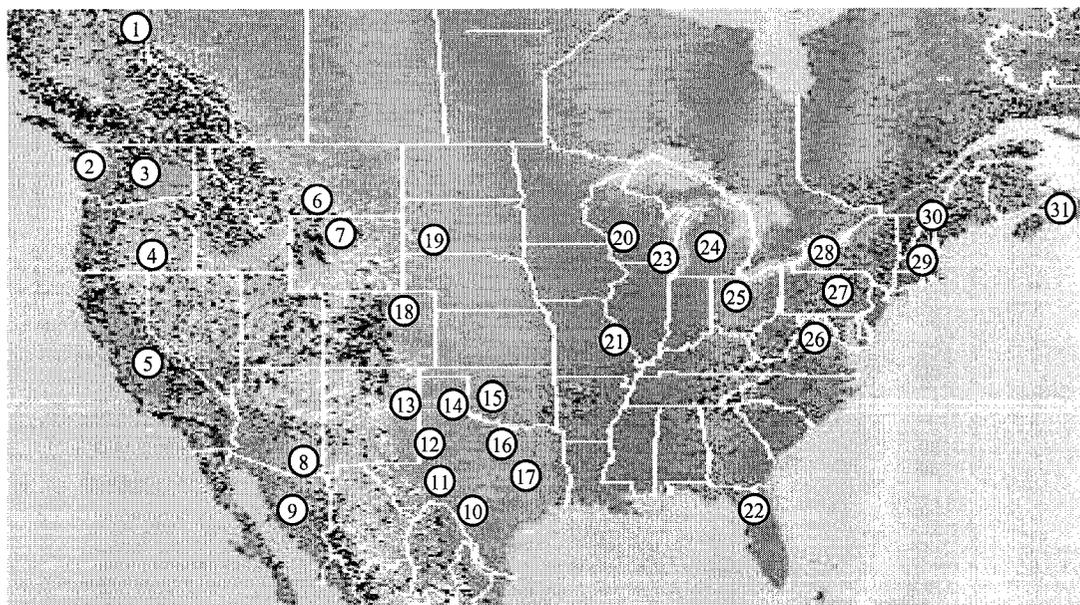


Figure 1.2: Representative map of the distribution of Clovis archaeological sites in North America\*: 1. *Charlie Lake Cave*; 2. *Mannis* 3. *East Wenatchee*; 4. *Dietz*; 5. *Tulare Lake*; 6. *Anzick*; 7. *Colby*; 8. *Murray Springs, Naco, Lehner, Escapule, Leikem*; 9. *El Bajio*; 10. *Kincaid*; 11. *Kincaid*; 12. *Lubbock Lake* 13. *Blackwater Draw*; 14. *Miami*; 15. *Domebo*; 16. *Aubrey, Lewisville*; 17. *Gault*; 18. *Dent*; 19. *Lange Ferguson*; 20. *Boaz*; 21. *Kimmswick*; 22. *Silver Spring, Guest*; 23. *Schaefer, Hebior*; 24. *Holcombe Beach*; 25. *Martins Creek, Sheridan Cave*; 26. *Thunderbird*; 27. *Shawnee-Minnisink* 28. *Lamb, Hiscock, Arc*; 29. *Bull Brook*, 30. *Adkins, Whipple*; 31. *Debert*.

\* Note: Faunal assemblages from the sites in italics comprise the sample discussed in subsequent chapters.

Kill sites are typified by a relatively narrow range of artifacts, primarily projectile points and modified flakes, in association with the remains of Pleistocene fauna, and they currently dominate the inventory of excavated Clovis localities. A more detailed documentation of these sites is presented in Chapter IV. Clovis caches, such as Fenn (Frison and Bradley 1999), Anzick (Wilke et al. 1991), and East Wenatchee (Mehringer 1988), generally contain bifaces at various stages of production, a variety of flake tools, and beveled bone rods, and artifacts are occasionally coated in

red ochre. The purpose of these isolated caches remains an open question, although the presence of human skeletal remains at Anzick suggests some caches may represent burials (Lahren and Bonnichsen 1974), only some of which contain preserved bone. The most diverse and largest inventories of Clovis technological remains are associated with campsites. However very few such sites have been excavated and published. Aubrey (Ferring 1995, 2001), Murray Springs (Haynes n.d.; Hemmings 1970), and Gault (Collins 1999a; Collins et al. 1992) are the best-known examples. All contain relatively large inventories of lithic tools and debitage, very different from the small assemblages typical of kills and caches.

The high frequency of Clovis projectile points manufactured on lithic raw materials from distant source locations suggests that these human populations were highly mobile (Goodyear 1989; Hester and Grady 1977). The consistency of point morphology suggests some degree of cultural homogeneity among North American Late Pleistocene populations (Storck 1991). These are perhaps the only two issues on which the majority of Paleoindian archaeologists can agree. Whether Clovis represents the initial colonizing population of the Americas or instead represents in-situ cultural development from earlier colonizing groups remains hotly debated (Adovasio and Pedler 1997; Bonnichsen and Sneider 1999; Dincauze 1984; Dixon 1999; Roosevelt et al. 2002; Surovell 2000; Whitley and Dorn 1993). How the colonization process proceeded (Beaton 1991; Kelly and Todd 1988; Meltzer 2002; Steele et al. 1998), from where the colonizers originated (Stanford and Bradley 2002; Strauss 2000), and the route they took (Gruhn 1994; Dixon 1999; Surovell in press) all remain open to

question. I will not attempt to resolve these issues, as my analysis of Clovis zooarchaeological material and hypotheses regarding labor organization do not hinge on geographic origins or how Clovis peoples first came into North America. I will however weigh-in on the controversial topics of Clovis big-game hunting and the role of women in Clovis society.

#### Data & Methodological Caveats

My analysis is primarily comparative in nature, relying extensively on previously published data concerning terrestrial carnivores and human foraging populations. Large datasets, which play a prominent role in the analysis, are included as appendices, and smaller datasets are summarized in tables throughout the text and/or referenced to their original source. I have purposefully included as much raw data as possible to provide opportunities for future analysis. Compiling data from numerous original sources presents unique problems, which I attempt to offset by utilizing the largest sample possible for each analysis, and by focusing on general trends as opposed to absolute values. Discussion of some specific limitations of the data nonetheless is warranted.

The variables for a sample of non-human terrestrial carnivores includes population density (individuals per 100 km<sup>2</sup>), average body mass (kg), and average prey mass (kg), and are drawn from literature concerning animal population biology (Gittleman 1989; Nowak 1999) (Appendix A). The data establish basic trends in predation and the similarities and differences between human and non-human hunting behaviors in Chapter II. It is important to note however, that studies of non-human

carnivores are generally conducted with very different research goals and methodologies than anthropological studies of human subsistence activities. Population density estimates for human and non-human groups and patterns regarding the type and frequency with which prey are hunted for example, may not be directly equivalent. Non-human population densities are often based on well-defined sampling procedures, often involving tracking specific individuals and detailed censuses (reviewed in Boitani and Fuller 2000), while hunter-gatherer densities are more often based on informant interviews and second-hand accounts. While acknowledging these discrepancies, I consider the data to be sufficient for outlining general patterns among carnivorous species.

The cross-cultural sample of foraging and subsistence hunting societies includes a wide range of variables relating to subsistence and labor (Appendices B and C). Most of the data are from G. P. Murdock's *Atlas of World Cultures* (1981), and R. Kelly's *The Foraging Spectrum* (1995). Additional material is taken from the works of Keeley (1988, 1995) and Binford (2002), or has been compiled directly from culture specific ethnographies. My methods for standardizing and recording variables from multiple sources certainly results in some inconsistency. The sample is quite large however, comprised of over 160 societies. While all variables recorded were not available for each society, large samples should overwhelm many of the discrepancies between individual data points. By relying in large part on previously published and widely available data, my analyses compliment and expand upon previous work while remaining replicable.

My use of ethnographic data is not intended as a means of generating direct ethnographic analogies for the interpretation of Clovis lifeways. Rather, the point is to identify the fundamental attributes of human prey selection strategies, the relationship between hunting and the division of labor, and to identify more clearly any consistencies or anomalies in Clovis lifeways relative to other foraging peoples. In subsequent chapters I approach human predation from an initially very broad scope to an increasingly narrow range of issues. Comparisons between and among ethnological and ethological data provides a means for exploring Clovis subsistence behaviors within the larger context of predation as an economic subsistence strategy. The apparent “oddity” of Clovis mammoth hunting is a topic whose implications extend well beyond the Pleistocene archaeological record. Factors influencing the hunting strategies of foraging populations of the past and present, and their impact on the organization of labor merely provide the foundation from which Clovis subsistence can be addressed.

## CHAPTER II: HUMAN PREDATORY BEHAVIOR

Humans are unique predators in many ways. Perhaps our most obvious distinction from other carnivorous animals is our reliance on technology to capture, handle, and process prey. Without the somatic ability to outrun, overpower, and kill large prey, humans lack many of the defining physiological characteristics typical of other terrestrial carnivores. If examined from the perspective of species-specific trait comparisons, humans will undoubtedly stand out as unique. We lack the sharp teeth, claws, highly erosive digestive system, agility, and speed of species comparable to our own size or who utilize similar kinds of prey. Our brains are exceptionally large, our offspring inordinately helpless, and we walk on only two limbs. These differences are well known and much touted. But to what extent do these features exempt humans from the ecological constraints governing carnivore behavior? I would argue that although human dependence on tools enables us to overcome, to some degree, our physiological limitations as a predatory species, this does not mean that we are necessarily immune to the effects of the basic ecological constraints that condition predatory behavior.

Viewed from an “us” versus “them” perspective, humans are undoubtedly rather exceptional. It can be argued that it is our ability to circumvent our physical limitations through intellectual means that has led to our success as a carnivore. But explanations of human predatory behavior that rely solely on arguments of human intellect potentially mask the general ecological and physiological parameters that make a carnivorous lifestyle fundamentally possible. Here I refer to the larger scale population level interactions between predators and prey. How predators and their respective prey are

distributed within landscapes, their densities, body sizes, and life history attributes all impose general limitations on the character of both predator and prey populations, and how they interact.

Although research on human carnivory has benefited significantly from the comparative study of humans and other predatory species with regard to the early modern and ancestral human position within past predatory guilds and ecological niches (e.g. Blumenschine et al. 1994; Brantingham 1998; Stiner 1990, 1991), fully modern foraging populations are rarely subjected to cross-species comparisons (but see Tanaka 1980). Perhaps because carnivory exists in all human foraging societies, examination of the broader role of humans as predators is largely abandoned in favor of a more anthropocentric view of hunting. Emphasizing variation in hunting behaviors among ethnographically documented foragers has revealed consistent patterns of variation which broadly correspond to environmental attributes. Variation in technological organization (Oswalt 1973; Torrence 1983, 2001), mobility regimes, (Kelly 1983; Shott 1986), dependence on game resources (Hayden 1981; Keeley 1995), and social organization (Arnold 1993; Cohen 1985; Murdock and Provost 1973), all show that human subsistence hunting, like that of other species, is generally bounded by ecological constraints. However it remains unclear how the carnivorous strategies of modern human foragers of the recent past and present diverge from the broad patterns of non-human predatory species.

The minimal requirements of a predator are to locate, kill, and process/consume prey. As straightforward as these may seem, hunting involves a complex interaction

between predators and their respective prey that far exceeds the difference between using one's claws or a spear to deliver a fatal blow. Unfortunately, investigations of human hunting behaviors that focus on specific technological/cognitive aspects usually give short shrift to the more fundamental characteristics of *how* humans hunt. The ethnographic record is filled with event focused accounts of hunting activities, for instance:

“I will kill the elephant!’ he exclaimed, jumping up to demonstrate how he would preform this mighty feat. Picking up a stick, he crept forward and thrust it violently into an imaginary animal while everybody laughed appreciatively. ‘You don’t even own a spear,’ Asumali told him sarcastically, ‘and besides, you’ve never killed an elephant before’...Arumba finally looked up and glanced from face to face before replying. ‘Today I saw the tracks of a big elephant,’ he said quietly. ‘Tomorrow I will follow the tracks and kill that elephant with my spear’” (Duffy 1984:142-3).

Could it possibly be so simple— have spear, will kill elephant? Arumba is talking about an animal roughly 80 times larger than himself, an animal easily capable of both eluding his capture and literally stomping him to death. Intrinsicly we know hunting is not so simple. But the reasons it is not are not wholly exclusive to human predators.

Hunting requires organization at multiple scales. The ecological relationship between predators and their respective prey evolve at the population level, and factors such as predator body size and population density relative to prey size display systematic relationship to the dynamics of energy flow through an ecosystem (Cohen 1993; Colinvaux 1978; Peters 1983). The distribution and abundance of predators and the prey they target (Sunquist and Sunquist 1989; Lotka 1932; Pianka 1974), their spatial organization (Davies and Houston 1984; Kelt and Van Vuren 2001), life history attributes

(Bekoff et al. 1984), metabolic rate (McNab 1989), and social structures (Bekoff 1989; Gittleman 1989; Nudds 1978) are neither randomly arrayed among carnivorous taxa nor randomly dispersed within any given environment.

In order to determine the manner in which human predators are, or are not unique, they must be placed within the larger context of carnivorous species. If humans are like other carnivores, an important aspect of *how* human populations successfully hunt is embedded in our ecological relationship with our potential prey (Gittleman 1989; Stiner 2002). An interspecific view of predators provides a somewhat objective approach to identifying the fundamental attributes of human predation and its variation among foraging societies. This is not only a matter of simply determining how humans “stack up” against other predators, but also a means of identifying the role of humans within the predatory realm of animals. If for instance, humans have managed to eliminate or stretch the fundamental constraints placed on other predatory populations such that we are wholly unlike any other species, the question of *which* constraints have been relaxed and how we have done so must be addressed.

The following inter-species comparisons are designed with two goals in mind. The first is to establish how human foraging populations conform to predictable relationships of carnivorous taxa regarding population density, prey size, and predation success. The second goal is to isolate some of the attributes most relevant to understanding the variability in hunting behaviors expressed in human foraging populations.

### Predator Body Size and Population Density

All animals, regardless of their feeding habits, exhibit an inverse relationship between body size and population density. Allometric scaling, the relationship between animal body size and population ecology, is commonly considered the most reliable predictor of animal population density (Blackburn et al. 1990; Cohen et al. 1993; Silva et al. 2001). A sample of terrestrial mammals (37 herbivore and 31 carnivore species) substantiates the significance of this relationship (Figure 2.1) (Appendix A). The negative correlation between body size and density is a result of the physiological requirements required to support life independent of ecosystem. Animals with similar metabolic processes, in this case terrestrial homeotherms, existing at the same trophic level (e.g., herbivores), require the consumption of biomass proportional to their size.

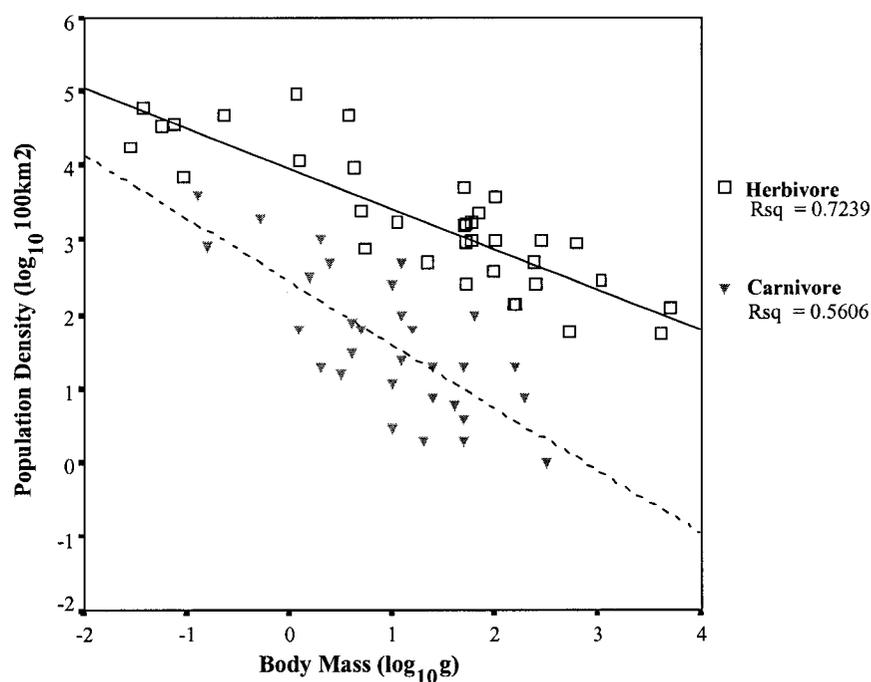


Figure 2.1: Scatterplot of average animal body mass against population density (data from Nowak 1999 and Gittleman 1989; presented in Appendix A).

Regardless of the variation in ecosystem productivity characteristic of different ecosystems (e.g., tundra, temperate grassland, etc.), large animals always require more food and consequently more space to obtain resources than do smaller animals (Eisenberg 1981; Kelt and Van Vuren 2001). Trophic level is a mitigating factor, as carnivores exist higher in the food web and thus at lower population densities than herbivores of comparable body size (Figure 2.1). Due to the inevitable energy losses that occur at higher trophic levels, biomass requirements increase more rapidly for species which do not rely exclusively on primary productivity (Case 1978; Colinvaux 1978; McNab 1989). Primary productivity (the amount of plant biomass per unit area) greatly exceeds the rate of secondary productivity (biomass produced by heterotrophs, or animals), so that there is generally more food available to herbivores than carnivores. The decrease in population density with increasing body size, particularly for carnivores, is apparent across a broad range of ecological contexts and has been established with samples far more complete than the data presented in Figure 2.1 (see for example Burness et al. 2001; Peters 1983; Carbone and Gittleman 2002).

In general then, larger animals exist at lower population densities than do small animals, and carnivores exist at lower population densities than comparably sized herbivores. Based on this relationship, and considering that human body size can be held constant, it is not surprising that hunter-gatherer population densities exhibit an inverse relationship to the degree of dependence on hunted resources (Binford 2001; Keeley 1987; Kelly 1995). The more a foraging group relies on game, and hence the more carnivorous they are, the lower their population density. But are human population

densities comparable to other terrestrial mammals of similar size? Human foraging populations have recorded densities ranging between 0.2 per/100km<sup>2</sup> (Caribou Eskimo) to 842 per/100km<sup>2</sup> (Chumash) (Appendix B) (Kelly 1995). Although there is some variation in the average human body mass of 63kg (Nowak 1999), the range of forager population densities is most closely aligned with those of other carnivores (Figure 2.2). That hunter-gatherer population densities exhibit such a broad range of variation is not surprising, since unlike other most carnivorous species, all human foragers are omnivores with variable degrees of reliance on animal resources. In light of this economic

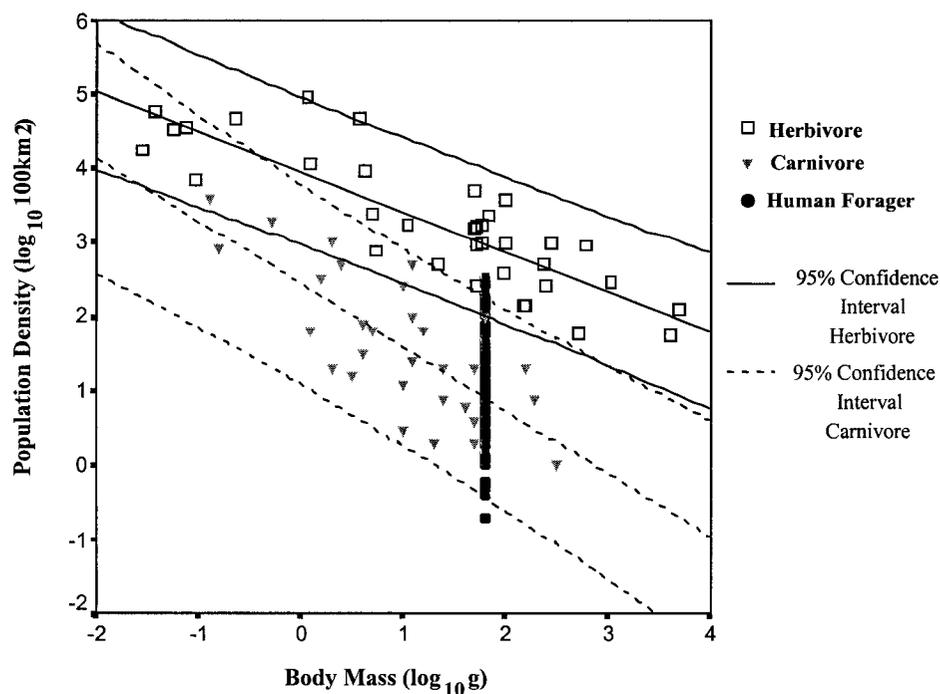


Figure 2.2: Scatterplot of forager population density (162 societies) relative to average human body size in comparison to the distribution of other species (data from Binford 2002: Table 5.01; Kelly 1995: Table 6-4; presented in Appendix B).

variation, it is to be expected that the sample of hunter-gatherer populations would generally fall below the 95% confidence intervals of herbivore population densities and within the predicted range for carnivores of comparable body size. Only the most herbivorous human foragers, as well as some coastal groups, exhibit population densities within the herbivore range. This pattern suggests that by and large, hunter-gatherer population densities are consistent with the basic trophic level constraints imposed by carnivory. Such that, even comparatively low levels of dependence on hunted resources effectively limit maximum human forager population densities.

#### Prey Selection

Non-human predators seldom target prey that exceeds their own body size (Bekoff et al. 1984; Cohen et al. 1993). Based on optimal foraging theory, the larger the prey captured the greater the potential caloric gain. But the costs and risks associated with capturing and processing prey can dramatically alter the overall return rate of a given prey item. The caloric costs of prey larger than oneself are often prohibitive, since larger prey are more likely to resist and elude capture (reviewed in Alexander 1996; Begon et al. 1996). Even the successful capture of a large prey animal can yield only minimal caloric reward if pursuit costs exceed the overall return rate. In such cases somewhat smaller prey may be more profitable. Lengthy, high speed chases or prolonged struggles are costly to a predator, especially when they are often unsuccessful. Costs can be minimized by targeting prey with the highest overall return rate as opposed to targeting prey based only on maximum body size. Like caloric costs, other risks often increase with prey size

including the probability of wasted time and energy and the risk of suffering injury or death.

The relationship between caloric gains, costs, and risks lead to predictable patterns between predators and the prey they target. Maximum and minimum constraints are placed on optimal prey size. Pursuit of too large a prey item results in diminished return rates due to high predation costs, whereas going after too small a prey item may yield to few calories to be worthy of the effort (Alexander 1996). Within the diet-breadth model of resource selection (Charnov 1976; Stephens and Krebs 1986), optimal prey size is commonly the largest that an animal can efficiently procure, taking into account procurement costs and risks. The ranking of prey based on caloric returns is then linked to prey size. Not unexpectedly, predator size generally increases in concordance with the average body size of their prey species (Rosenzweig 1966). A sample of average prey sizes for 42 terrestrial carnivore species, originally compiled by Gittleman (1989), yields a positive correlation between predator mass and average prey size (Figure 2.3). The larger a prey species is, the larger its potential predators are.

There is an upper threshold to this relationship since no terrestrial carnivores exceed the mass of the largest herbivores. Extremely large-bodied herbivores (e.g., elephants and giraffes) are seldom preyed upon by non-human carnivores. Metabolic rate is inversely proportional to body size. This, coupled with the fact that much energy is lost in transfers to higher trophic levels, makes extremely large terrestrial mammalian carnivores energetically impossible (Burness et al. 2001; Lovegrove 2000). Below this threshold however, prey size is an accurate predictor of predator size (Cohen et al. 1993).

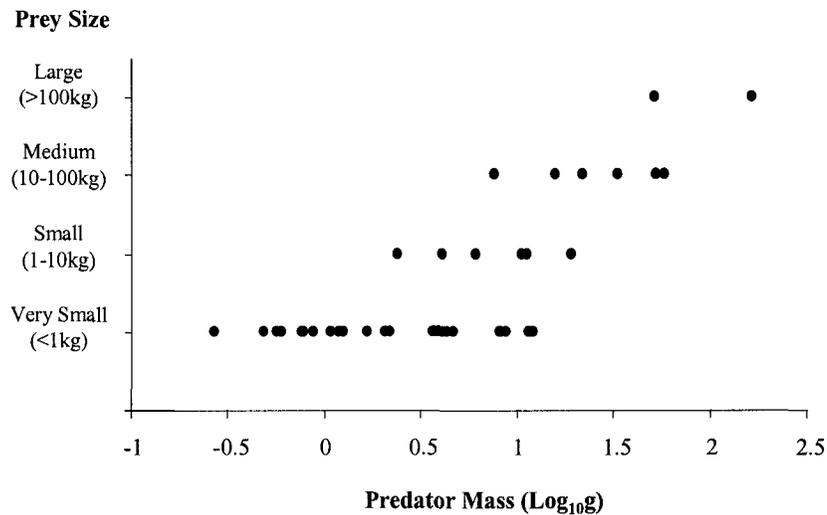


Figure 2.3: Average size of the most frequently consumed prey (grouped into four classes) utilized by 42 terrestrial carnivore species (data from Gittleman 1989:Table 7.1).

Other empirical observations confirm that predators can and often do target prey comparable to, but not exceeding, their own size. In a comprehensive study of the relationship between predator and prey body size, only 45 out of 354 predators (including aquatic species) regularly outweighed their prey (Cohen et al. 1993). While it may be feasible to maximize prey size, terrestrial carnivores on average capture animals that weigh just ten (Peters 1993) to twelve (Cohen et al. 1993) percent of their own body mass. For a carnivore of any given size, the typical body weight its potential prey can be fairly accurately predicted. While average prey size among carnivorous taxa is generally low, average prey size increases disproportionately with predator size (Cohen et al. 1993; Peters 1993), such that small carnivores take inordinately small prey and large carnivores take proportionally larger prey. As shown in Figure 2.4, the general relationship between predator and prey mass has a slope less than 1, predicting that as predators become extremely large prey mass could actually exceed predator mass. While in fact large terrestrial carnivores such as lions, wolves, and tigers, can target prey comparable to and

exceeding their own body size it is relatively rare for carnivorous species to consistently prey upon animals larger than themselves. The bifurcated relation of increasingly small and increasingly large prey has been attributed to the difference between small predators, which generally consume their prey whole— limiting maximum prey size to those which they can swallow, and larger predators which rend their prey (Peters 1993).

As average prey size increases with predator size, the range of *potential* prey increases as well (Peters 1993; Schoener 1969). Carnivores can and frequently do prey

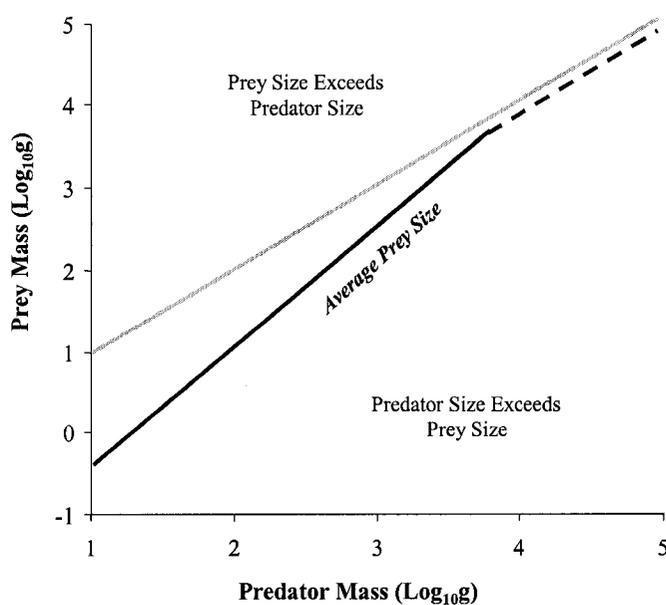


Figure 2.4: Modeled relationship between average predator and prey size. Grey line shows where predator mass equals prey mass, dotted line represents where predator mass approaches but rarely exceeds prey mass, based on data presented in Peters 1993.

upon species much smaller than themselves. Relatively small prey may still be worthwhile especially if they are more frequently encountered and are associated with lower failure rates and injury risk (Schoener 1969). The diet breadth model does not

preclude the use of lower ranked resources, only predicting that the highest ranked of available resources will always be utilized upon encounter regardless of their encounter frequency. Extremely small sized prey are commonly low ranked if capture costs are high, and thus are often avoided since minimal gains do not offset their procurement costs. However, when small prey items are extremely abundant, encountered in favorable circumstances, or when other situational variables serve to increase their value, their ranking may be temporarily elevated and may be taken upon encounter.

Some terrestrial predators consistently prey upon species larger than themselves. Among terrestrial carnivores, predation upon animals larger than oneself occurs among a few species of medium to large sized animals. For the capture of prey larger than the predator to be an economically viable strategy, the costs associated with capturing large prey must be offset. Carnivores commonly reduce the costs and risks associated with over-sized prey in two ways, hunting cooperatively and selecting only the most advantageous contexts for pursuit (Gittleman 1989). These strategies are often used in tandem. Hunting in groups allows predation costs and gains to be shared among group members. Although this reduces individual return rates, this strategy may render the hunting of over-sized game more feasible and energetically efficient where it would be nearly impossible if a predator hunted solo.

Studies of cooperative hunting in lions (Caraco and Wolf 1975; Sheel and Packer 1991), wolves (Nudds 1978), coyotes, and jackals (Bekoff 1978; Lamprecht 1978) have shown the benefits of group hunting by distributing costs and providing gains beyond those procured by any individual. By pooling their labor these carnivores can

successfully prey upon larger prey species than they could individually subdue (Giraldeau and Caraco 2000; Moehlman 1986). Communally, the predatory group might outweigh or at least approach that of their respective prey, in a sense using an aggregate of individuals to artificially inflate their ability to “outweigh” and over-power very large prey (Thompson 1981). Such strategies place limits on group size however, because the costs of cooperation must not exceed potential gains to group members (reviewed in Giraldeau and Caraco 2000:35-49).

Some solitary predators (such as leopards, mountain lions, tigers, jaguars, and some Mustelids) also target prey larger than themselves, but only in contexts in which they have a distinct advantage (Connolly 1978; Sandell 1989). Advantages can take a variety of forms. Both physiological and behavioral attributes of the predator, such as stealth and surprise tactics, can reduce pursuit and/or capture costs. When a lion (hunting solo) is confronted with a herd of potential prey such as African buffaloes- which outweigh the average lion by 300% percent— its choice of an animal to pursue is not altogether random. Prey selection is much closer to random when smaller prey items are involved (Stiner 1990). By focusing its energy on the capture of the youngest, oldest, or most debilitated buffalo, the lion selects prey that may be unable to engage in a lengthy chase, struggle or inflict bodily harm. In a study of wolf predation of white-tailed deer, young and old deer were preferentially targeted with prime-age adults being hunted only when deer population densities were unusually low (Potvin and Jolicoeur 1988).

In sum, predation upon animals larger than oneself is often limited to a few prey species and in some cases to only a select portion of those prey populations. Large animal predation often requires greater selectivity in the choice of prey targeted and/or some degree of cooperation among predators. In Figure 2.5 the size of the most common large prey taken by a sample of carnivores that do hunt very large prey is plotted against body size. Non-human predators are distinguished by their reliance on a group or a solitary hunting strategy. Solitary hunters (e.g. cheetahs, mountain lions, and leopards) tend to procure prey closer to their own body size than the group hunters (e.g. coyotes, wolves, hyenas) of similar body size (Bekoff et al. 1984).

Prey size limitations are apparent in Figure 2.5. Even group hunters exhibit a consistent relationship between prey and predator body mass, and in no case does prey

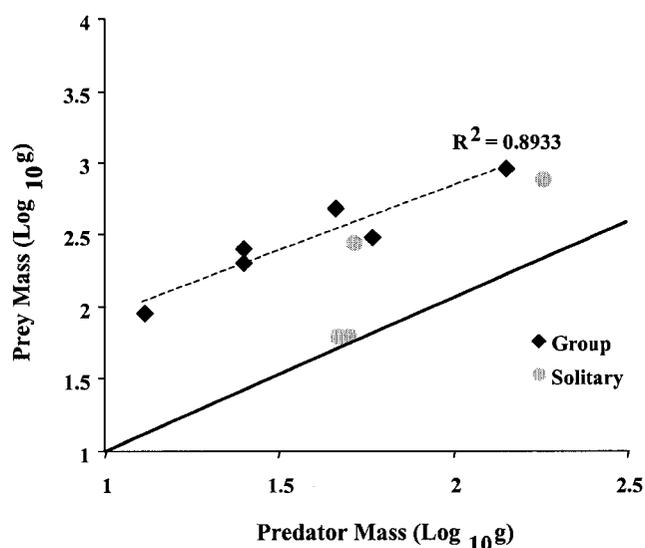


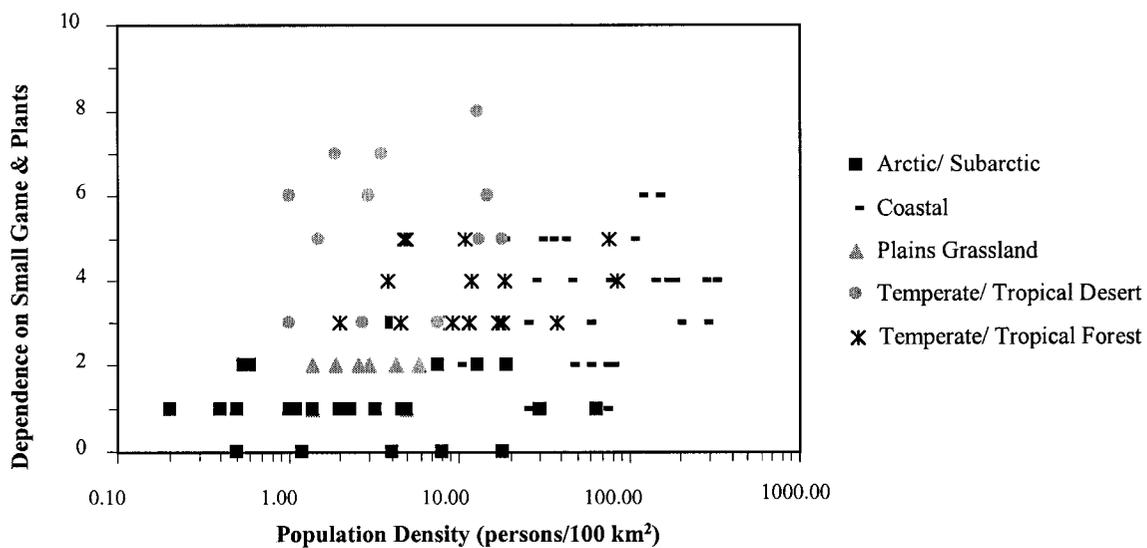
Figure 2.5: Scatterplot of six species of cooperative predators (wolf, coyote, dhole, spotted hyena, wild dog, and lion) and four solitary predators (tiger, cheetah, leopard, mountain lion) relative to their most commonly taken large-bodied prey. Dark black line shows predator mass equal to prey mass (data from Thompson 1981: Table 1).

size exceed twice the weight of the individual predator. The majority of species that hunt cooperatively target prey approximately one and a half times their mass, with solitary predators taking relatively smaller prey overall; although some carnivores such as wolves will occasionally target prey well beyond these size limits. While based on a small sample, the correlation between predator body mass and their prey is statistically significant ( $r= 0.945$ ,  $p= <0.01$ ) for cooperative predators.

### Human Resource Use

The degree of dependence on both large and small game is highly variable among ethnographically documented foraging groups but generally follows variation in environmental parameters such as latitude and primary productivity. Among hunter-gatherer societies there is a negative correlation between the dependence on large game resources and population density if environmental context is taken into account (Keeley 1988; Kelly 1995; Murdock 1981; Waguespack and Surovell 2003). Segregated by broad differences in environment, the dependence on small game and plants is positively correlated with population density in all regions except for arctic/subarctic and plains grasslands (Figure 2.6a), while dependence on the hunting of larger game is negatively correlated (Figure 2.6b). Dependence on small game/plants is calculated as the percent contribution to the diet based on ethnographic data compiled by Murdock (1967; 1981). In grassland and high latitude environments, the bulk of all edible food sources available to humans is in the form of secondary (heterotrophic) biomass, severely limiting the

a.



b.

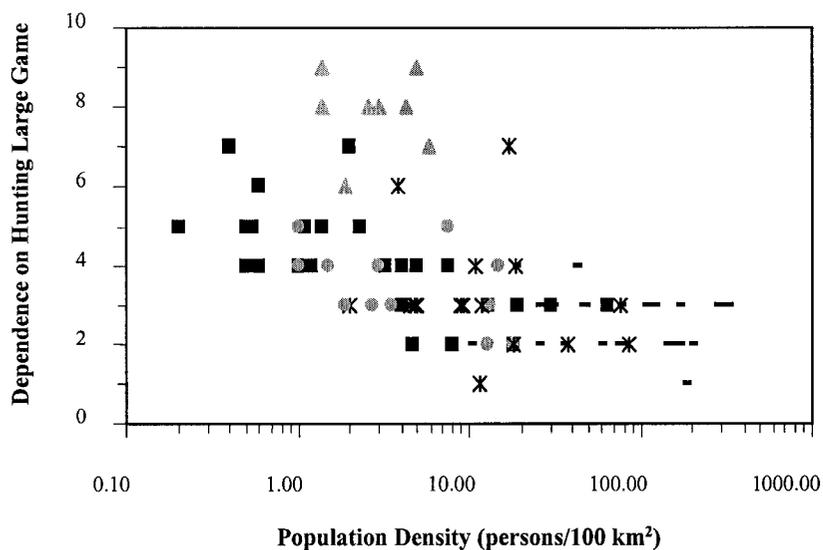


Figure 2.6: (a) (top) Proportion of plants and small game in the diet versus population density for a global sample of hunter-gatherers ( $n=92$ ); (b) (bottom) proportion of large game in the diet versus population density for the same sample.

the potential dietary contribution derived from plant resources. Consequently, foragers occupying grassland and arctic regions may have little choice but to focus their subsistence efforts on hunting. The environment occupied, associated patterns of primary productivity, latitude, and rainfall, generally determine the availability of animal and plant resources (Binford 2001; Kelly 1995). In temperate and tropical regions where both floral and faunal resources are available, plant use increases relative to population density (Keeley 1988).

Within the limits established by available resources, reliance on hunting, particularly large game use, is inversely correlated with population density (Figure 2.6b), consistent with observed trophic level relationships between population density and resource use among other carnivorous species. With greater emphasis on the procurement of game, larger procurement areas are needed to support a carnivorous population; a given land area can support a larger population of herbivores than carnivores. All other things being equal then, variation in hunter-gatherer population densities is a product of environmental constraints on resource availability and the extent to which animal and plant resources contribute to the diet. While this trend is certainly commensurate with those of other terrestrial mammals, it does not directly imply the size of prey taken by human hunters.

The size of the most frequently captured prey for eight hunter-gatherer populations is plotted in relation to non-human carnivores in Figure 2.7. The most common prey is defined from ethnographic documentation of the species of animals hunted and the quantities of each species procured. With the exception of the Blackfoot,

the data and their source material are presented in greater detail later (see Table 3.3, Appendix C). For the Blackfoot, numerous accounts identify bison as the primary prey item (Dempsey 2001; Ewers 1955, 1989). While problematic in the sense that I am comparing individual carnivore species to culturally defined human populations, and as such direct comparison is inherently flawed, it is clear that human foraging populations exhibit wide variation in the size of their most common prey. Unlike other carnivores, humans may not have an “average” prey size that can be reliably predicted based on body size since both extremely small and large animals (relative to the average human body) may be the most common prey items. While based on an extremely small sample, humans’ common use of and reliance on relatively small prey items is fairly unique among carnivores.

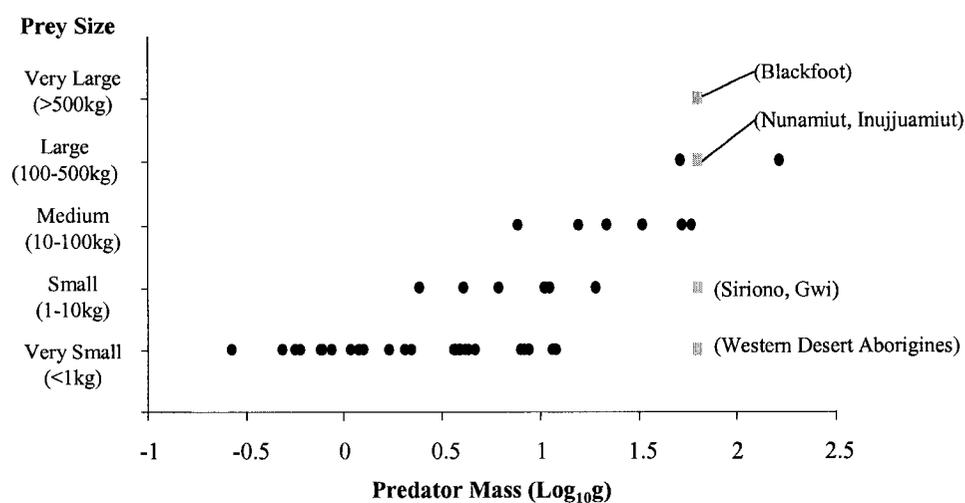


Figure 2.7: Average size of the most frequently consumed prey (grouped into four classes) utilized by 42 terrestrial carnivore species, and 8 hunter-gatherer populations. The most common prey for each human group are as follows: Blackfoot= bison, Nunamiut and Inujjuamiut= caribou, Siriono= nine-banded armadillo, Gwi= springhare, Western Desert Aborigine= mouse sp. (data and source material presented in Appendix C).

Human dependence on large prey is also distinctive. Reliance of some cultures on animals the size of bison exceeds the relative size of prey commonly taken by other large carnivores. While some species of large carnivores do capture extremely large prey, they do not do so consistently, whereas the hunting of bison and other large prey are well known components of recent and past forager hunting economies. If hunter-gatherer populations of the past relied upon prey the size of mammoth and mastodon, the size of their most common prey would literally be off the carnivore chart. Of course, proboscidean hunting remains a contentious issue in Paleoindian and other Pleistocene cultural contexts.

For the sake of comparison, seven species of large prey hunted by human foraging populations are plotted in relation to the average prey size of other carnivore species which hunt prey in excess of their own mass (Figure 2.8). While the prey species plotted

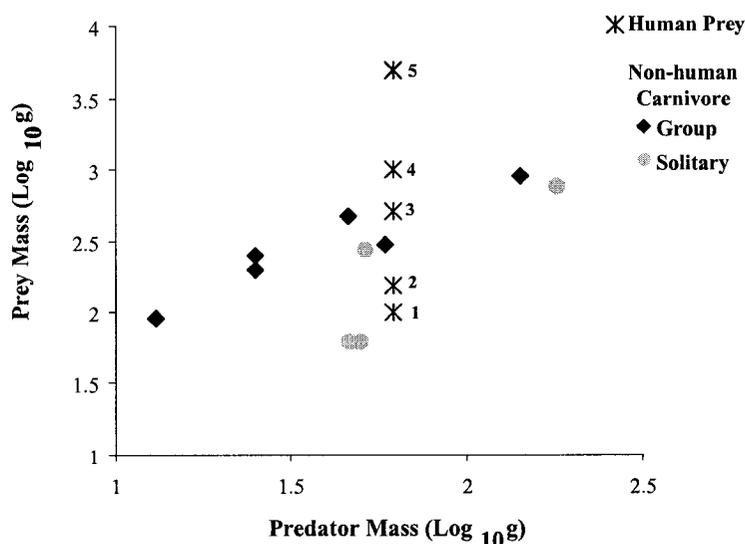


Figure 2.8: Scatterplot of six species of cooperative predators and four solitary predators relative to their most commonly taken large-bodied prey. For comparison, seven large prey species hunted by human foragers are plotted; species include 1) kangaroo, white-tailed deer, 2) gemsbok, caribou, 3) moose, 4) bison, 5) African elephant, body mass from Nowak 1999.

for humans may not represent the most common prey for any particular hunter-gatherer population, although bison and caribou are certainly the primary prey for many Plains and arctic populations, some distinctions of degree between human and other predators can be made based on these and other observations. First, humans hunt these animals both individually and in groups. So while other solitary carnivores may take relatively “less large” prey than cooperative predators, this may not always be the case for humans. For instance returning to the anecdote cited earlier, the elephant Arumba set out to kill was successfully brought down (Duffy 1984:156-7) — by Arumba himself with no help from other hunters. So for humans, reliance on extremely large-bodied prey may not require cooperative hunting strategies as it does in other species. Second, and megafauna aside, human groups often focus predatory efforts not only on relatively large game, but also often target the largest individuals within prey populations, prime-aged adults (Driver 1990; Speth 1983; Stiner 1990). Focus on prime adult animals can result in higher net return rates per animal procured but may also entail increased predation costs and risks (Griffiths 1980).

Third, in addition to large prey human foragers take a variety of small prey items, resources which might often be neglected by other carnivores. Thus, human foragers are able to efficiently procure and utilize an extremely *broad range* of prey resources, and in this sense we may not neatly conform to the predictive relationship between body mass and prey size seen in other carnivorous species. Human prey selection with regards to prey size is examined in greater detail in the next chapter.

### Capture Success

It is tempting to assume that human subsistence hunters are simply more successful at hunting than other carnivores since we rely on technological assistance and because human hunters most commonly provision both children (like other carnivores) *and* other meat dependent adults. Both humans and other carnivores provision their young, so population density values include some proportion of individuals who are *consuming* but not actively *pursuing* prey. The number of dependents who rely solely or partially on the predation efforts of others varies considerably among carnivorous and omnivorous taxa. General cross-species comparisons suggest that larger predators have increasingly altricial young, requiring greater post-partum parental investment (Geffen et al. 1996; Oftedal and Gittleman 1989; Moehlman 1986). Although influenced by life history patterns, prey availability, and predation tactics/skill, the balance between active hunters and consumers changes relative to body size.

For human foragers the proportion of active hunters within a group or population maybe far lower than those in other predatory species. Adult male and female hunter-gatherers seldom actively hunt comparable quantities or types of game. Differences in the type and quantity of prey procured by males and female non-human carnivores have been documented, particularly among social species such as lions (where females actually do the majority of hunting) (Funston et al. 1998) and coyotes (Landre and Hernandez 2003), but these differences are not as pronounced as the sexual division of labor typical of human foraging societies. Although some hunter-gather women do hunt game of a size comparable to their male counterparts (Estioko and Griffin 1981), the majority of females

either do not actively hunt or target only small-bodied species (Brumbach and Jarvenpa 1997; Goodale 1971; Jochim 1981; Kelly 1995). Certainly most women facilitate the task by providing labor and skill to the production of hunting technology and by transforming fresh game into consumable products (Brightman 1996; Halperin 1980; Leacock 1978), but actual procurement is predominately preformed by males (Kelly 1995:262-270; Ember 1978; Sanday 1981). The proportion of adults within human foraging populations acting as predators relative to the total number of consumers is thus arguably lower for than humans than for other carnivorous species.

The need to provision others with meat requires that a predator procures game in quantities beyond his or her own caloric needs. Considering that the number of non-hunting dependents may be quite high for human hunters, it is tempting to assume that individual humans are in a sense “super carnivores”— essentially procuring prey in quantities unparalleled by other predators of comparable body mass. If such is the case, it can also be argued that, given a comparable number of prey encounters human hunters will either succeed at capturing their prey more frequently than other predators, or will capture larger prey on average. As previously demonstrated, it is certainly not the case that all hunter-gatherers procure game larger than other comparably sized predators. Predation success rates, the percentage of encounters in which an animal pursued is subsequently captured, are estimated to be below 50% for most terrestrial carnivores (Vermeij 1982). Based on observations of a variety of species, including hyenas, wolves, and tigers, success rates are generally between 20-50% (Eaton 1974; Kruuk 1972; Rudnai 1973; Schaller 1972) , although rates of capture as high as 72% in a population of

lions (Funston et al. 1998) and 70% for African hunting dogs (Moehlman 1988) have been reported. The percentage of prey captured varies among species, as well as between individuals within a population, and in response to seasonal fluctuations in prey abundance (Alexander 1996). The question remains, do human subsistence hunters fare any better?

Based on a limited sample of human populations for whom the majority of meat in the diet is derived through subsistence hunting, human hunters fare little, if any better than non-human hunters at successfully capturing prey (Table 2.1). Although the sample of populations with reliable measures of hunting success is extremely small, it seems

<u>Group</u>	<u>Success Rate</u>	
<b>Bisa</b>		implausible to assume that those
Impala Hunts	2.78%	sampled are inordinately poor hunters.
Zebra Hunts	9.09%	Most values indicate that human
Waterbuck Hunts	10.34%	hunters capture game in well under
Warthog Hunts	18.42%	50% of pursuits. The only instance of
Buffalo Hunts	26.03%	extremely high hunting success rate
<b>Ju/'hoansi (!Kung)</b>	23%	(100%) is for BaMbuti net hunters.
<b>G/wi</b>		Hunting with nets essentially allows
Snare Hunting	20.00%	human hunters to engage in a
Bow and Arrow	16.00%	“continuous pursuit” while expending
<b>Kutse</b>	38.00%	relatively little to moderate amounts of
<b>Efe</b>		time and energy during the hunt. Once
Monkey Hunts	30.00%	the net is in place, game animals need
Ambush Hunts	11.00%	
<b>BaMbuti</b>		
Bow and Arrow	52.00%	
Nets	100.00%	

Table 2.1: Hunting success rate (percent of prey pursuits resulting in successful captures) for 6 subsistence hunting groups. Data for the Bisa from Marks 1976:229, and from Kelly 1995:103 for remaining groups.

not be individually pursued but are entangled or trapped upon encounter.

Although efficient in terms of successful captures, net hunting also requires large inputs of time, labor, and resources to set-up, manufacture, and maintain the nets (Bailey 1989; Bailey and Aunger 1989; Hart 1978; Satterthwait 1987). But net hunting can be an efficient means of procuring relatively small game resources in bulk. By reducing the costs associated with individually pursuing small game animals, nets enable humans to pursue small game that otherwise would have prohibitively low return rates (Bailey and Aunger 1989; Smith 1991; Winterhalder 1981). For these reasons net hunting has been connected to major prehistoric changes in human subsistence (Hayden 1981; Janetski 1997; Soffer et al. 1998). Nets are just one example of how technology may significantly contribute to the success rate of human game capture.

Yet even with technology, the success rates for large game are generally no higher for humans than they are for other carnivores. The Bisa (Table 2.1) for example consistently target large ungulates but have success rates below 30% (Marks 1976). However, success as measured only by the frequency of animal pursuits leading to capture does not adequately reflect other potential measures of hunting success. Considering that optimal prey size is largely dependent on the costs and risks associated with predation, lowering these associated variables is another means of enhancing overall rates of return. For example, two predators of equal size may both have 25% success rates for capturing a particular prey item. Each failed attempt is costly, resulting in wasted time and energy which ultimately detracts from the net gain received when pursuit is successful. If the costs of failure are lower for one predator it may be able to pursue the

targeted game more frequently, because it has more time and/or energy to do so. Even if both fail three out of four attempts, the predator with lower pursuit costs may end up capturing a greater number of prey- not because it is more successful at capture, but because it is able to make more pursuits attempts with its available energy budget.

Pursuit and capture costs of very large prey are prohibitively high for most carnivores (Griffiths 1980). Targeting weak animals is one method of lowering these costs, but even without this advantage human hunters still manage to hunt prey far larger than themselves at fairly comparable success rates to other carnivores. Perhaps by relying on projectile technology (e.g., bow and arrow, spears, blow guns, bolas) for the procurement of large game (Churchill 1993; Oswalt 1976), hunter-gatherers have a distinct advantage— the ability to fail and fail frequently at little cost, or at least at less cost (in terms of energy and perhaps bodily harm) than experienced by other predators. The manufacture and use of projectile weapons is not without cost, as they require time, labor, and resource investment for manufacture and maintenance. However once made and propelled, prey capture costs may be essentially identical regardless of the size of animal at which they are directed. Whether utilized on large or small game resources, the potential for loss of an arrow or spear is similar. Accounts of hunter-gatherer hunting techniques frequently document the loss of numerous projectiles per animal killed. For example, the Efe shoot an average of 37 arrows for every monkey killed, and only 12% of their arrows shot at duikers successfully hit their target (Bailey 1991:80-81). However, technological costs may still be lower than the energetic costs associated with the pursuit and capture of prey by other carnivorous species.

Assuming the manufacture of a spear or arrow is energetically less expensive than chasing and capturing an animal on foot and by hand, humans may thus be able to absorb failure costs more easily than other predators which depend on non or semi-renewable weapons such as teeth and claws. By incurring smaller losses human hunters may be able to focus their attention on relatively larger game. Even though their capture success rates are quite low, technology allows more capture attempts to be made given a fixed and/or predictable energy budget. Multiple predation attempts are only possible if humans are willing to search for prey relatively longer than other predators or can otherwise enhance their encounter rates with targeted prey. When failure is less expensive and occasional success can produce returns well above the investment in technology, it may be worthwhile to pursue very large healthy animals, something many hunter-gatherers evidently do.

Thus far, hunting failure rates have been discussed in terms of costs that can be recouped through capture success, but the option to fail is not limitless, since some risk of starvation always exists. Forager investment in hunting technology increases with latitude (Bamforth and Bleed 1997; Torrence 1983), in conjunction with the dependence on hunted large game resources and/or fishing. Interpreted as a means of maximizing the reliability of hunting technology to ensure procurement success, this trend suggests it is more cost effective to increase investment in technology the more reliant one is on meat of any sort. This highlights the importance of minimizing risk in foraging, particularly hunting.

The procurement of any resource involves risk, or the probability of an unwanted outcome which in this case is failing to secure prey. The risk of failing to secure a needed type, quantity or quality of food, or of failing to do so within a fixed amount of time or with a limited expenditure of energy are concerns faced by all animals. Some resources are inherently more risky than others, and for humans and other predators, large bodied game generally associates with greater risk (Alcock 1993; Kelly 1995). Large prey can certainly provide great economic (Marks 1976) or social benefits (Hawkes 1991; Testart 1986) to the foragers who procure them, but these benefits cannot be accrued over the long term unless they outweigh the potential risks of hunger or injury to oneself and dependents. As discussed previously, non-human carnivores offset failure/injury risks associated with large prey by hunting in groups, or pursuing prey only in advantageous contexts where the likelihood of success is greater. Human subsistence foragers utilize these risk minimizing strategies as well. Hunter-gatherers, except those inhabiting environments where other subsistence options are not available, have the additional advantage of procuring less risky or more reliable foodstuffs such as plant resources and/or smaller prey at greater relative cost but reduced risk of starvation.

### Human Hunting in Context

Much has been written about the significance of human hunting, from its veneration as a God-bestowed privilege, to an adaptive strategy with a long-standing evolutionary history. However, we are one of many carnivorous species, and our predatory behaviors imply some degree of affinity with other meat-eating animals. Like

other animals human population density is related to the extent of carnivory, in that greater reliance on meat requires more land per person to support a population.

Compared to other predators, human foragers display comparable population densities even though most hunter-gatherer societies are truly omnivorous.

The use of a broad range of prey sizes is also relatively extreme in humans, in that humans efficiently hunt both large and small prey. Overall hunter-gatherer success rates at prey procurement are not inordinately high. Alternatively, it has been suggested that lowering pursuit costs through technology, and reducing risk of starvation through the division of subsistence labor enables human hunters to more easily absorb the costs associated with the pursuit and capture of game. In this sense, human hunters may have greater success at making efficient use of risky and costly resources.

The implication that successful subsistence hunting for humans is, at least in part due to our species' ability to reduce the costs of failing to capturing prey (by relying on technological assistance) by relying on the labor and products procured by non-hunting individuals runs somewhat contrary to more traditional views of hunting. In contrast to overtly androcentric accounts, emphasizing the bravery and "sport" of subsistence hunting, the comparison of humans to other carnivores above presents a more moderating perspective of the human predatory niche. The roles of prey size, social, and technological organization have thus far been identified as important attributes of forager hunting strategies. These provide the foundation for later analyses. In subsequent chapters prey size selection criteria, the role of plants, and the division of labor among foragers will be examined in greater detail. These issues will be considered in relation to

hunting strategies of modern and ethnographically documented foragers in order to develop testable predictions and interpretations of Early Paleoindian predatory behavior.

### CHAPTER III: HUMAN PREY SELECTION STRATEGIES

Non-human carnivores tend to focus on a relatively narrow range of prey species. I do not mean to imply that they necessarily have limited diets consisting of only a few prey types. Except perhaps for a few highly specialized predators, the majority of carnivores pursue and consume a variety of available prey. However, prey inventories are unlikely to represent the complete repertoire of species co-existing within the environment. While the size range of prey can often be predicted based on a predators' body mass, factors such as locomotor ability, strength, habitat preferences, and escape/pursuit tactics, often restrict predators to specific types and species of prey. Lacking specialized carnivore morphological characteristics but possessing an extremely flexible behavioral repertoire, recent human hunters may be less limited in the types of prey they hunt. If, as suggested previously, reliance on technology fundamentally lowers the costs associated with the pursuit and capture of prey, then hunter-gatherers likely have a greater range of potential prey species available to them than do other carnivores.

Given their options, how do hunter-gatherers choose which prey to pursue? Models and concepts derived from optimal foraging theory, such as diet breadth ranking systems and predation risk and variance, provide one means for exploring prey choice. In this chapter, the costs and benefits associated with different general categories of prey are first explored, and discussion centers on the basic relationship between animal body size and population density. A series of hypothetical prey situations are created and likely return rates calculated. These models are extremely simplistic and are generated to establish some basic constraints relevant to human prey selection decisions. Then, environmental

and other subsistence factors that may alter the cost effectiveness of reliance on different prey types are discussed, and two general strategies of prey choice developed. The purpose is to explore which prey characteristics might exert the greatest influence on hunting return rates, which strategies of prey selection maximize different procurement goals, and how these attributes may be identified in faunal assemblages. A sample of prey taken by thirteen groups of subsistence hunters is then examined in order to address how different prey selection strategies alter the formation of faunal assemblages. The ethnographic assemblages provide an important data set for developing methods for differentiating between prey use strategies that can be applied to an archaeological case in the following chapters.

### The Diet Breadth Model

According to the diet breadth model, a hunter can maximize net return rates by focusing on taxa whose post-encounter return rates exceed the average environmental return rate (Charnov 1976; Stephens and Krebs 1986). Individual prey species are ranked according to their potential caloric returns relative to other prey. In its simplest form, optimal diet is comprised of the highest ranked resources. Taking lower ranked taxa only serves to lower overall return rates, an unproductive activity from an evolutionary standpoint. Focusing one's subsistence efforts on high ranked items ensures worthwhile expenditure of a forager's time and energy. High ranked prey are often larger than lower ranked species because they provide greater caloric returns per unit of resource (Lacher et al. 1982; Simms 1987; Winterhalder 1983; Winterhalder et al. 1988). As previously

shown, most carnivores target prey which are relatively large— though rarely exceeding their own body size. Although roughly comparable, prey rank and prey size are not necessarily the same. For instance, a mule deer and giant tortoise may be similar in weight but fundamental differences in how these animals are captured may result in disparate procurement costs and hence alter their caloric returns and relative rank. Excessively large- and small-bodied prey (relative to predator size) may provide so little caloric return due to the difficulty involved in their capture that their rank is far lower than predicted by body size alone (Begon et al. 1996). Also, small prey may in some circumstances be unusually high ranked due to low handling costs, a situation that will be addressed separately.

The classic diet breadth model predicts that a species will either always be taken or always be ignored, the “zero-one rule” (Stephens and Krebs 1986:20-21). From an optimality standpoint an individual predator should always pursue high ranked prey upon encounter and never pursue low ranked items, assuming that the ranking of resources remains constant relative to a fixed average environmental return rate. For as long as high ranked prey species are available, low ranked prey are not profitable. Rarely, if ever, can the rank of available prey be considered constant, however. If environmental and species-specific return rates are allowed to vary, as in a “risk-sensitive” model (e.g. Winterhalder et al. 1999), the optimal diet will consist of a more diverse mix of high and low ranked prey. For example, if a forager encounters a low-ranked prey item in circumstances in which handling costs are minimal, the effective return rate for that animal is enhanced, and it should be exploited (e.g. Madsen and Schmitt 1988). Also, if

high-ranked items are temporally scarce the average environmental return rate effectively drops, bringing low-ranked prey types into the diet (Krebs and McCleerly 1984). In addition, optimal diet breadth should vary for different segments of a foraging population with respect to age, skill, mobility patterns, time constraints, and for humans, access to hunting technology (reviewed for non-human carnivores in Stephens and Krebs 1986; and for humans in Kelly 1995). By allowing for contingencies such as fluctuations in prey encounter rate, capture efficiency, and capture success rate, variation in the relative ranking of available prey more realistically accounts for the diversity of prey likely to be pursued and captured over a period of time.

Thus, although the diet breadth model would generally predict use of the largest encountered prey, it does not imply that the highest ranked resources are necessarily the largest available or that small prey are universally low ranked. Other factors, particularly the risk, variance, and handling costs associated with hunting must also be considered with regard to prey choice. Studies of diet breadth in both ethnographic and prehistoric human contexts do commonly indicate that large prey are high ranked and pursued when encountered (Hawkes 1991; Hill et al. 1985; Smith 1991; Winterhalder 1981). However what constitutes “large” prey depends on the species available within the hunting environment and the inherent behavioral/physiological properties of the hunter (Bailey 1991; Bird and Bird 2000; Hill et al. 1985; Walker et al. 2002). Although subject to ecological, individual forager, and cultural conditions, prey size remains an important attribute of non-human and human predation strategies. The issue of prey size is examined below. Issues of variance, risk, and handling costs are examined separately.

### The Benefits of Large Prey

Large prey can provide great economic payoffs, whether these are measured in total weight, calories, or nutrients procured. Given the choice between procuring a 100 kg animal and a 20 kg animal, why not choose the larger? All other things being equal, the larger an animal is, the lower its population density (Figure 2.1). So it must be kept in mind that if the frequency with which prey are encountered is directly related to their density, it can be expected that a hunter would have lower encounter rates and fewer opportunities to capture a large prey item. The frequency of encounter, however, should have no impact upon prey rank. In general, large prey will remain high ranked simply because even when rarely encountered they still provide relatively enormous caloric benefit which exceed the environmental average.

A straightforward model of prey size and return rate demonstrates this relationship. In its simplest formulation, return rate is equal to the mass (or calories) procured relative to the frequency with which a resource is taken. Other currencies could be substituted for total calories, such as protein or fat, but this example will use energy as monitored by body mass. Based on three hypothetical prey resources, one large (100kg), one medium (50kg), and one small (20kg), average daily post-encounter return rates for each prey over a period of time can be estimated from their relative encounter rates as a function of their population density (Table 3.1). Population density is derived from the mathematical relationship between terrestrial mammal body size and density discussed in the previous chapter (see Figure 2.1). Prey population density can then be converted in a relative sense to a “kill interval”, the number of days between prey capture events; kill

intervals are then scaled relative to density and prey mass. The smallest prey taken is arbitrarily set at one kill per day, and the remaining prey intervals are scaled accordingly (Table 3.1). Annual return rates can then be calculated by dividing the kilograms of meat procured for each prey type by the kill interval and multiplying by 365 consecutive “hunting” days.

The average kilogram returns for the large prey is approximately double that of the small prey. Presented graphically (Figure 3.1), it is easy to see why even though large prey may be encountered and procured far less frequently than smaller resources they simply provide greater overall returns than smaller prey. While prey rank is a function of returns per encounter, encounter is at least in part a function of prey density. It can be expected that the number of prey captured may not be directly representative of prey rank, as it is unlikely that all prey encountered would be captured. However, the basic relationship between prey size and prey rank would remain positive, while the number encountered and captured might negatively reflect prey rank. It is not surprising then that many subsistence hunters seek out large game, and commonly lament their inability to procure as many large animals as they would like (e.g., Kensinger 1995).

The potential caloric benefits of large animals are frequently matched by social (Condon 1995; Marks 1976; Riches 1984; Testart 1986) and/or reproductive benefits (Hawkes 1991; Kaplan 2000; Marlowe 2001) enjoyed by hunters capable of procuring large game in many hunter-gatherer societies. The ability to reliably procure large-bodied game, animals with returns which exceed the immediate caloric needs of the

Prey Size	Large	Medium	Small
Mass (kg)	100	50	20
Density*	758.58	1102.95	1809.02
Kill Interval**	2.38	1.64	1.00
<hr/>			
Average			
Return Rate	41.03	30.04	20.00

\* $\log(\text{population density}) = \log(\text{mass})(-0.54)+1.96$   
 \*\*kill interval = density of smallest prey/ prey density

Table 3.1: Average daily return rates derived for three hypothetical prey species.

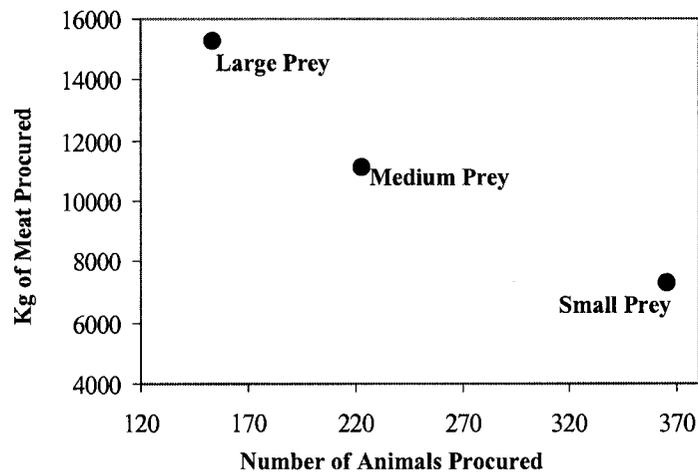


Figure 3.1: Plot of animals killed and meat procured for a 365 day period, based on prey types presented in Table 3.1

procurer and their dependents requires successfully capturing prey which are likely to be encountered far less frequently than smaller prey resources.

In the preceding example a forager simply procures all three prey when encountered regardless of its return rate. But perhaps a more realistic scenario is to assume that a forager must obtain some minimum quantity of meat within a given period of time. In order to fulfill the meat “quota”, procuring prey in the frequencies with which they are encountered may not be the best strategy to meet the caloric needs of the hunter and their dependents. In some situations it may be worth “gambling” on the probability one will encounter a large prey item and avoid procuring smaller prey (Alexander 1996). By passing up the opportunity to procure low ranked prey, a forager may in many circumstances conserve predation time and energy that can be directed at other resources and activities.

Assume, for instance, that a forager needs to procure 50 grams of protein per day and can only work for 8 hours per day. Two resources are available: resource “A” yields 25 grams but generally takes two hours to locate and capture and is only successfully procured in 50% of attempts; resource “B” consistently provides 10 grams of protein for every hour of time spent in its procurement. Failure to secure all 50 grams of protein will result in malnutrition, and repeated failures will eventually lead to death. Excess protein can be used to increase a forager’s social standing and reproductive opportunities. At the beginning of the day there is plenty of time to pursue resource “A” with a good chance of meeting one’s resource goal, plus the potential to secure 50 excess grams of protein. Choosing resource “B” secures the forager’s goal, and a chance at procuring 25 excess

grams. Option “A” is riskier but has higher potential benefits if the hunter is successful. Gambling on resource “A” while there is still plenty of time to ensure success or switch strategies may be worthwhile. It may also be worth the gamble in more dire situations. By 3:00, if no protein has been procured yet, there is little chance to secure excess grams and focusing on resource “B” is the only option to reliably meet one’s goal. But at 6:00, with only two hours left to work, if a forager has only 25 grams of protein their only chance to meet their goal is to gamble on the riskier resource. This simple scenario has numerous outcomes, and based on the amount of resource procured at any given time the optional strategy may be “A”, “B”, or a combination of the two.

Generally speaking, large prey are equivalent to the hypothetical resource “A”. They have high potential payoffs but are also less predictable. They are “worth the gamble” only when a forager has the time to pursue the riskier strategy, has the potential to switch strategies, or has so little time that taking chances on a high potential payoff resource is the only option available. When these conditions are met, large prey may always be worth pursuing since they can potentially increase the quantity of meat procured far more rapidly than smaller resources.

Varying the encounter rates of the three hypothetical prey examined previously demonstrates this point (Figure 3.2). The effect of shorter kill intervals, which in this case can be considered equivalent to increasing the percentage of successful captures, preferentially increases the average per day return rate of large prey. A forager can obviously increase return rates more rapidly by capturing large resources more frequently than small ones.

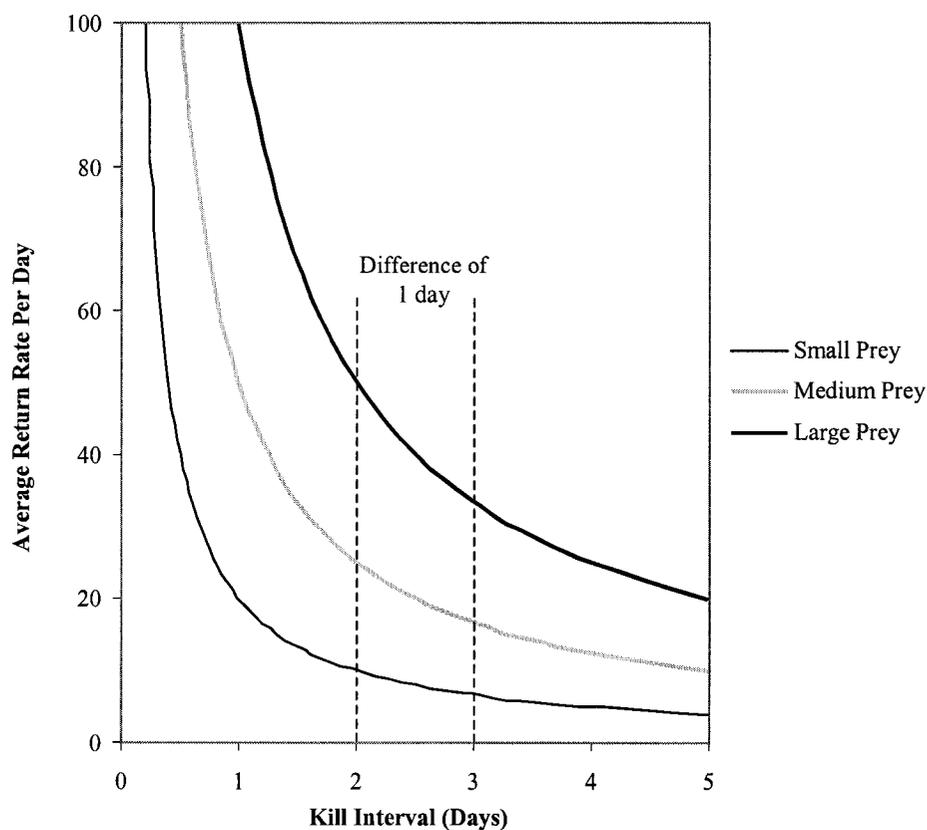


Figure 3.2: Plot of prey return rate by kill interval, based on prey types presented in Table 3.1 Dashed lines show the effect of modifying the kill interval by one day for the three hypothetical prey types on average return rate.

### Risk, Variance and the Benefits of Small Prey

Because hunting is an inherently more variable and risky procurement endeavor than plant collecting, a high degree of variance among the success rates of hunters can be expected. Even if multiple hunters target the same species for a comparable period of time, they are unlikely to locate and procure equal quantities of prey and will likely exhibit some degree of variance in their post-encounter return rates (e.g. Bailey 1991; Hill 1987). Variance in return rate and the risk of failure are similar yet distinct features

of procurement. While variance is a function of an individual's hunting returns over a period of time or among multiple individuals within a given time period, risk is simply the probability of an unwanted outcome resulting from one's procurement efforts. As used here, risk is primarily the probability of failing to capture prey, but risk can also encompass the probability of injury or other detrimental events which may occur while hunting. The risk of failure is not necessarily, and in fact rarely is, a direct function of return rate variance. Unless variance is normally distributed around the mean average post-encounter return rate (which is seldom the case), the risk of failure will not be directly related to variance (Stephens and Krebs 1986). For instance, salmon runs for example, may provide a low risk resource source because they are highly predictable in both space and time, whereas elephants may be typified by higher risk since their movements and behavior may be less well known. But individual fishers and elephant hunters are still likely to exhibit some degree of variance in their take.

Because hunted resources exhibit a great degree of variance in return rate, they may provide a less predictable source of nutrients than more reliable resources such as plants. Both the variance and risk associated with the procurement of large prey results in an unequal distribution of these high ranked resources between members of a group at any given time. Hunter-gatherers, particularly those whose subsistence depends heavily on hunted resources, must offset this variance to alleviate the fluctuations in the number of calories procured by individuals or through time (e.g., on a daily or seasonal basis). Numerous mechanisms can alleviate intra-group variance. Practices such as food sharing (Cashdan 1985; Damas 1982; Hawkes 1992), food storage (Hayden 1994; Testart 1982),

and cooperative hunting (Smith 1991) have been identified as successful means of redistributing resources among an aggregate of consumers by minimizing the variance in returns between procurers. The extent to which these “pre-” and “post-kill” mechanisms are employed is associated with the size of prey utilized and the degree of dependence on hunted resources (reviewed in Kelly 1995).

Another way to reduce variance is by selecting prey that provides less variable and more predictable return rates. Both risk and variance increase with prey size, such that these potentially negative consequences of hunting are only exacerbated by relying on large prey (Alcock 1993; Griffiths 1980; Jochim 1981). However, a certain degree of risk is always associated with hunting regardless of the prey being pursued. Assuming equal search times, you are just as likely to be bitten by a snake or have your house burn down while hunting rabbits as you are hunting bison. Search times are not likely to be equivalent among prey species, depending on their frequency of encounter, habitat preferences and predator avoidance behaviors (Begon et al. 1996). The longer a predator spends searching for prey the longer it is susceptible to ancillary hunting risks. Fatal attacks on human foragers by other animals such as jaguars and snakes occur more commonly while hunting than engaging in other activities (Hill and Hurtado 1996; Treves and Naughton-Treves 1999), suggesting that time spent hunting is also time a hunter is at higher risk for personal injury.

In addition to this basic level of risk associated with time spent hunting, it must also be acknowledged that there is a greater probability of being injured or killed by a bison than by a rabbit. Likewise, the hunting of large prey is subject to a more

pronounced “boom and bust” cycle (Jochim 1981; Winterhalder 1981). Unless large prey are spatially aggregated (as occurs for some ungulate species during annual migrations), their populations are generally thinly spread across the landscape, making it unlikely that a hunter can reliably predict their chances of encountering one within a given spatial area or period of search time. Species may congregate around resources such as water or around fixed territories or occupation sites, but the fewer individuals there are within a given area, the more unlikely it may be that a hunter will locate them. Consider the probability of finding an African buffalo (average population density is 9.1 animals per sq/km) versus a jackrabbit (average density 93.3 animals per sq/km) within any given one square kilometer area (Norwak 1999)— buffalo may be bigger and easier to see but you are still likely to spot 10 rabbits for every buffalo. This has nothing to do with the fact that large prey are necessarily harder to kill (a subject dealt with in a later section with regards to handling costs), only that encounter rates may become increasingly unpredictable in relation to prey size.

Selecting prey that minimize risk and variance, as opposed to maximizing caloric returns, may favor the procurement of small prey (Krebs and McCleery 1984; Stephens 1981). Opportunities to kill large animals may not be ignored, but a broadening of the diet to include more frequently encountered prey might be expected in contexts where large prey are encountered or captured too infrequently to provide returns of sufficient regularity. Consider the three hypothetical prey discussed earlier. By altering the kill intervals such that large and medium sized prey have considerably longer intervals between kills than small prey (Table 3.2), the smaller resource may have a higher average

return rate per unit time. The frequency of large animal kills was increased to one every ten days, medium prey to one every five, and small to one every two days. These arbitrary kill intervals are not derived from their expected population densities, but they are not wholly unrealistic. In this situation large prey are not captured frequently enough for their size to compensate for the long durations of time that pass without a kill, lowering their average return per day. When large prey are not available or captured in sufficient quantities per unit of time spent to offset their large but infrequent payoffs, a more productive strategy may be to focus one's effort on smaller prey.

<b>Prey Size</b>	<b>Large</b>	<b>Medium</b>	<b>Small</b>
<b>Mass (kg)</b>	100	50	20
<b>Density*</b>	758.58	1102.95	1809.02
<b>Kill Interval**</b>	10	5	2
<b>Average</b>			
<b>Return Rate</b>	9.33	9.66	9.90

\* $\log(\text{population density}) = \log(\text{mass})(-0.54)+1.96$

\*\*kill interval = arbitrary values

Table 3.2: Average daily return rates derived for three hypothetical prey species (c.f. Table 3.1).

A related situation in which small prey may be beneficial is when a reliable source of calories is more important than the overall quantity of calories procured within a given amount of time. Fluctuations in average return rate for the prey in Table 3.2 are plotted for a 50 day period in Figure 3.3. The degree of variance is apparent in the rise and fall of average returns. Assuming that meat procured by a forager cannot be stored and must be eaten within 2 days of its capture and 10 kg of meat provides sufficient

nutrition for a group of consumers, the hunter who procures small prey will always be fed. A hunter procuring large prey will capture more kilograms, many of which will go to waste, and will suffer many days of hunger. In this situation a reliable meat income should be favored over a quantity based strategy, and small prey by exhibiting less variance present the more attractive prey choice. Securing a consistent source of calories is certainly important, especially when children are being provisioned— consumers which may not be able to cope with a highly fluctuating food supply (Hawkes et al. 1995; 1997). Predation then, may focus on small prey although larger prey would not necessarily be avoided.

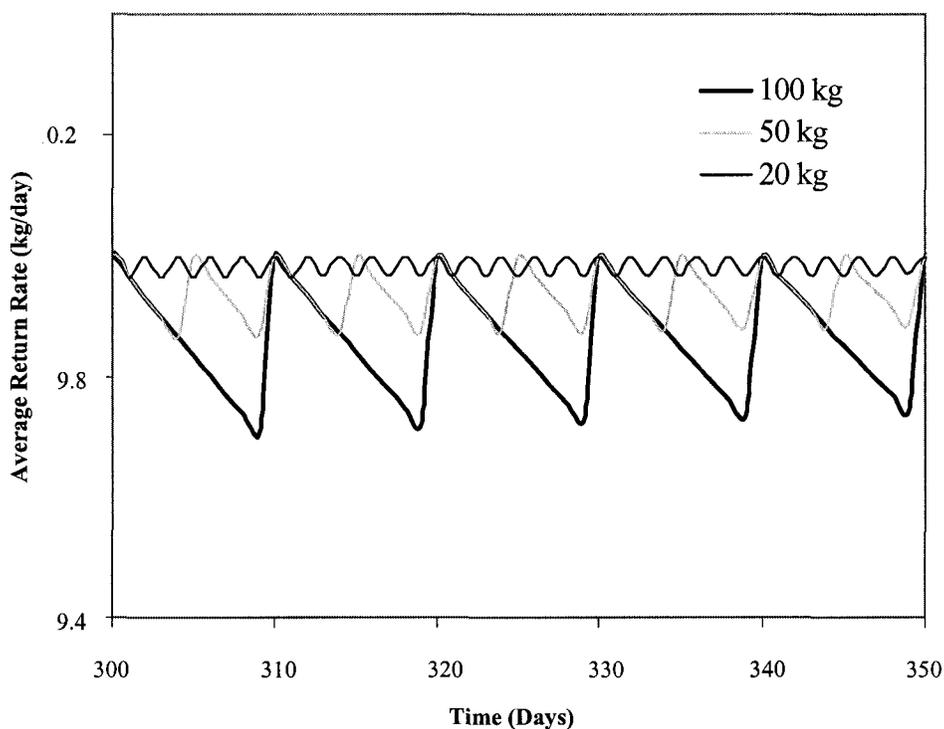


Figure 3.3: Daily return rates for prey types presented in Table 3.2, plotted through time for a 50 day period, note the increase in variance for large prey.

### Handling Costs and the Benefits of Gatherable Prey

So far, prey size has been discussed in light of potential costs and benefits associated with encounter and capture rates. It has been assumed that the only difference between available prey species are how frequently a forager has the opportunity to procure them and the benefits (in terms of quantity) they provide. However, one extremely important variable has so far been overlooked— handling costs. The amount of time and energy needed to pursue, capture, consume, and prepare oneself for another search together constitute handling costs (Begon et al. 1996; Stephens and Krebs 1986). Handling costs consume time and energy which cannot be spent on other activities and can dramatically alter the post-encounter return rates of available prey. Derived from optimal foraging theory the ratio of handling costs to search costs can dramatically alter a predator's prey selection strategy (MacArthur and Pianka 1996). As noted in the previous chapter, because of the potential benefits technology provides, handling costs for human predators are extremely difficult to quantify (Kaplan and Hill 1992). Humans, unlike other predators, rely almost exclusively on technological assistance to capture and render their prey suitable for consumption so their handling costs are not limited so much by evolved somatic characteristics as they are for other carnivores. The maximum prey size limits for non-human predators (see Figure 2. 6) are due in part to the prohibitively high handling costs associated with extremely large prey, costs which may be reduced by technology among human hunters. The costs of technology can be closely controlled and distributed, unlike cursorial ability, dental characteristics, gut morphology, and other

factors which influence the prey handling ability of other predators (Taylor 1989; Van Valkenburgh 1989).

The distance, speed, and duration an animal is pursued, the tools or actions used to capture it, and the manner it is prepared (butchered and processed) for consumption are to some extent related to the size of prey, but must also be largely attributed to the abilities, goals, and situation of the predator. But the costs of handling particular resources must also take into account the behavior and other attributes of the prey involved. For simplicity's sake, I will limit discussion of handling costs only to particular attributes of prey as opposed to predator behavior. This boils the issue down to a simple question, which types of prey are relatively inexpensive to procure? Animals that are slow moving, highly visible, and lack predator defense mechanisms that make it difficult for humans to capture them are obviously cheap to procure. Slow moving prey, for which handling costs may only entail approaching them and picking them up, can be expected to always be high ranked (see Stiner et al. 2000 on tortoise and shellfish harvesting). Likewise, animals that are highly visible, do not rapidly flee or attack upon encounter, are non-aggressive, and/or require minimal processing may have such low handling costs that they are always worth capturing when encountered. Predator defense mechanisms may require specialized technologies or capture strategies. "Naïve prey", populations which lack avoidance mechanisms for specific predators, could substantially decrease handling costs (Berger et al. 2001). The presence of naïve prey, although not an issue for modern hunter-gatherers, may have been a factor concerning prey selection decisions of prehistoric humans when colonizing new habitats (Berger et al. 2001; Kelly

and Todd 1988; Martin 1984). Which, of all available prey species can be considered the “easiest” or least costly to pursue and capture, is contingent upon the characteristics of both predator and prey and are not necessarily directly related to prey size.

### Strategies of Prey Selection

Considering size, risk, variance, and handling costs, the optimal choice depends on: 1) the types of prey available, 2) the quantity or density of prey, and 3) the currency with which potential prey are ranked. The array of available prey will vary depending on environmental context. In environments such as Plains grasslands where the vast majority of primary biomass is accessible to large ungulates, a greater number of large-bodied animals can be supported compared with other ecological contexts where more energy is devoted to inedible biomass. Foragers who occupy these environments may have more large prey options than others.

Obviously the population densities of particular prey types or species is largely environmentally controlled, though it is also prone to the effects of hunting “pressure” or other human induced impacts on the environment (Berger 1999; Robinson and Bennett 2000). However, what is most important from a human subsistence perspective is the relationship between the numbers of prey animals relative to the number of hunters and consumers. The absolute number of prey available is important in that it affects the frequency of prey encounter rates. How frequently high ranked prey are encountered will ultimately control the use of lower ranked prey, which in turn determines diet breadth. Prey encounter rates can, to some extent, be manipulated to increase encounters beyond

the number expected from average population density. Hunter mobility is perhaps the most direct method of increasing the probability of encountering high ranked prey. Covering large distances and/or spending more time searching for certain types of prey provide more opportunities for encounter (Binford 1980; Kelly 1985, 1995). Focusing one's search effort in portions of the landscape where prey animals are predictably encountered, such as water sources or known migration paths, serves the same purpose. Modification of the landscape can also alter prey encounter frequencies in both positive (e.g., intentional burns and drive lines) and negative ways (e.g., habitat reduction) (Blackburn and Anderson 1993; Kay and Simmons 2002).

When encounters with high ranked prey can be maintained at levels which provide sufficient caloric returns, low ranked prey should be used infrequently. In such situations a forager can afford to be choosy, and by selecting only large items with low handling costs would have a narrow diet breadth. In general, when human populations focus their hunting efforts on high ranked prey to the exclusion of low ranked animals, it implies that human population densities are low and/or prey densities are relatively high. However once high ranked prey became scarce relative to the number of hunters pursuing them, diet breadth will expand to include more low ranked resources (Kaplan and Hill 1992). The broadening of diet is likely inevitable for many human populations. Unless human population density increases at a slower rate than that of their high ranked prey, the ratio of human predators to high ranked prey will eventually reach a point at which people must resort to less preferred resources.

When large or low handling cost prey no longer provide sufficient caloric returns, the selection of prey based on other currency considerations may take precedence. In an effort to minimize variance and risk, small game could preferentially be targeted. Based on encounter frequencies, which generally relate to population density and body size, two generalized prey selection strategies can be predicted:

1) Selective Strategy: In contexts where large high ranked prey are abundant relative to the number of human hunters, large prey should be hunted preferentially. Small prey may not be altogether excluded, due largely to situational contingencies, but should be used less frequently than they are encountered. Prey species hunted and the frequency of their capture would not be consistent with prey population density. Large high ranked species with low population densities would be preferentially sought, and such situations may actually present a negative correlation between prey size and frequency of capture since high ranked prey are generally large bodied animals which also tend to have low population densities.

2) Encounter Strategy: Large prey will always be high ranked, but if hunters cannot afford to be overly selective in the animals they choose to pursue and capture, then a greater number of low ranked (i.e. smaller) prey will be utilized. Expected when large animals are rare, prey may be taken in quantities comparable to their encounter frequency, resulting in a predictable relationship between prey body size and capture frequency.

The degree to which high and low ranked taxa are used is the critical distinction between how selective a hunter is when choosing prey. Relating prey selectivity to the natural abundance of available prey species creates a simple framework for examining the types of prey utilized by hunter-gatherers of the past and present (Figure 3.4). The two generalized strategies, selective and encounter based, developed here do not make explicit which species of prey should be used. Only general categories of prey, based on body size and the relative frequency of their encounter, are predicted to be used in different proportions by each strategy.

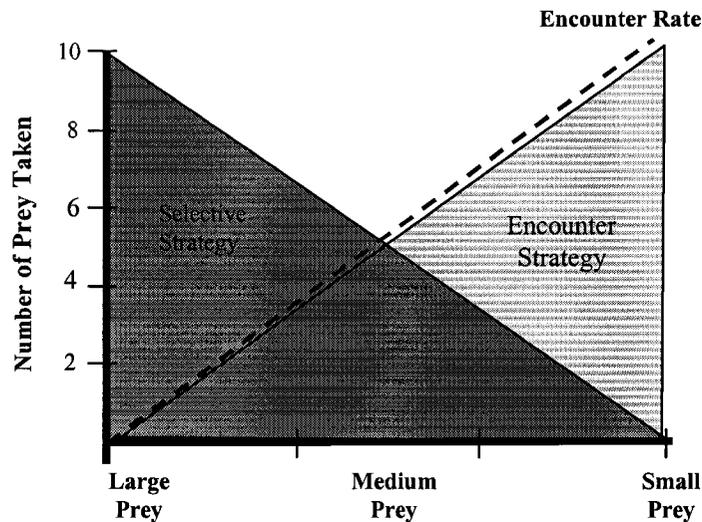


Figure 3.4: Modeled relationship between prey size, encounter rate, and predicted use by “selective” and “encounter” based prey use strategies.

Although the terms selective and encounter could imply two pure strategies, that is not their intended meaning in this discussion. As used here they refer to ends of an idealized continuum and concern decisions regarding which prey, among those available, a forager will target for predation. Holding environment constant, generalists should utilize a broad range of species, while specialists should exploit a more narrow range. More important, however, is whether taxa are or are not exploited when encountered. In this light, the most critical variable is *selectivity*, i.e., the degree to which certain taxa are *not* exploited upon discovery. Ultimately, encounter strategists as defined here, tend to utilize a broad range of taxa as they come across them, while specialists tend to ignore many of the species they encounter in favor of pursuing a more limited suite of high ranked taxa. Specialized subsistence strategies should be present in environments where return rates for highly ranked prey species far exceed those of low ranked items, and high

ranked taxa are encountered frequently. A more generalized encounter based strategy would be expected in environments where high ranked taxa are infrequently encountered, are seldom successfully captured, or where little variability exists in return rates among prey items. Various contingencies and biogeography can alter the relative ranking of available prey, so it follows that the number of taxa utilized is not in itself a good measure of subsistence specialization.

Because encounter rate is primarily a function of prey population density, estimated population densities based on body size provide a reasonable approximation of prey encounter rates for specific environments. Actual encounter rates are difficult to establish in real world settings and deriving comparable values in prehistoric contexts is exceedingly difficult. Population density must then be considered only a proxy measure of encounter rate. A comparison of actual encounter rates and population densities of eight prey species used by the Ache of Paraguay in the Mbaracayu Reserve (Figure 3.5) shows the disparity between these two measures. In this case, encounter rates equal the number of animals seen in over 2,000 km of transects walked by Ache informants and anthropologists (Hill and Padwe 2000). Plots of mass and population density (Figure 3.5a) and corresponding encounter rates (Figure 3.5b) are somewhat different. Importantly however, the overall trend between body size and encounter rate is approximated by population density. So although density does not provide an exact measure of encounter rate it does reasonably approximate prey encounters.

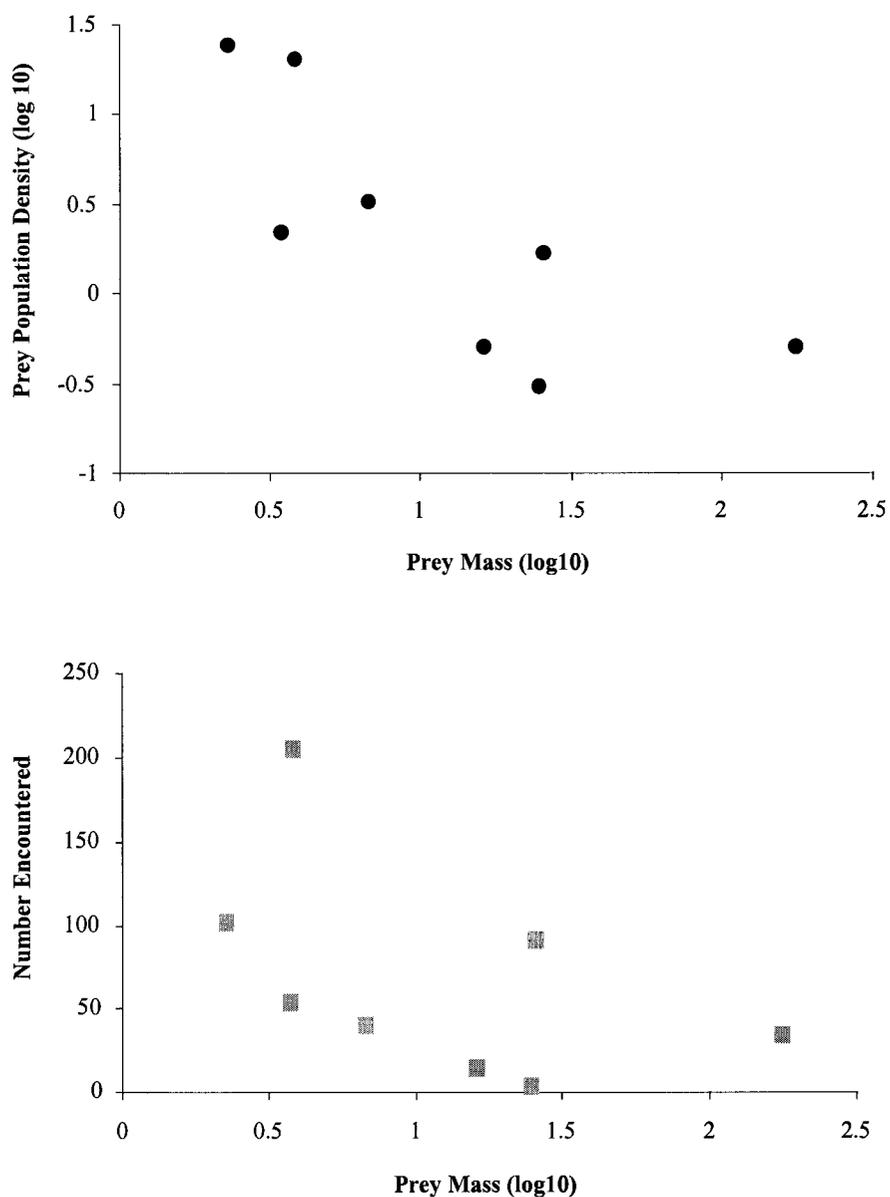


Figure 3.5: (a) (top) Scatterplot of population density and prey mass (log scaled) of eight species commonly hunted by Ache foragers; prey includes nine banded armadillo, capuchin monkey, paca, white-lipped peccary, collard peccary, coati, and brocket deer. (b) (bottom) Scatterplot of species encountered (during controlled transect walks) and prey mass. (Data from Hill and Padwe 2000: Table 5-4)

Comparing prey density to capture frequency provides a means of addressing prey selectivity in both ethnographic and archaeological assemblages, since the basic negative relationship between animal body mass and population density holds regardless of the environmental circumstance. So while the slope of the relationship will change across habitats, the relationship will always remain negative.

#### Prey Utilized by Recent Subsistence Hunters

In relation to prey population density or encounter rate, which prey do human subsistence hunters target? If prey selection strategies can be characterized as either encounter based or specialized based on the size of prey as an indicator of their population density, then clear trends should be apparent in the accumulated prey assemblages of hunting peoples. Comprehensive prey species data derived from ethnographic observation were compiled for 12 societies of subsistence hunters from published literature (Appendix C). The data include a range of observation periods from approximately one month (Ju/'hoansi [or !Kung]) to upwards of two years (Ache) and includes observations of societies in a diverse array of ecological settings (Table 3.3). The sample for each group includes the total number and average weight of each prey species captured during the observation period. For many groups the number of hunters represented in each sample was not clearly specified in the original source material. Differences in the number of kills and/or the species of prey captured by individual hunters within each group cannot be controlled. However, with the exception of the Ju/'hoansi, each sample includes well over 100 individual kills over two months or more.

<b>Group</b>	<b>Location</b>	<b>Length of Sample</b>	<b>Number of People</b>	<b>Number of Kills</b>	<b>Reference</b>
Gidra	New Guinea	80 days	20+	207	Ohtsuki and Suzuki 1990:42, Table 1
Pume	Venezuela	60+ days	10+	155	Greaves 1997:293, Table 2
Yanomamo	Venezuela	30+ days	10+	171	Hames 1979:234, Table II
Ye'kwana	Venezuela	30+ days	10+	716	Hames 1979:234, Table II
Inujjamiut	Quebec	1 year	?	317	Smith 1991:197-227
Siriono	Bolivia	1 year	?	2,300	Townsend 2000:272, Table 13-1
Ju/'hoansi	Botswana	26 days	5	18	Lee 1979:266, Table 9.6
Gwi	Botswana	1 year	50	171	Tanaka 1980:68, Table 11
W. Desert	W. Australia	90 days	10	468+	Gould 1980:65, Table 5
Aborigine		51 days	40	337+	Gould 1980:66, Table 6
Bisa	Zambia	1 year	8	101	Marks 1976:206, Table 38
Ache	Paraguay	multiple years	?	3,503	Hill and Padwe 2000:95, Table 5.2
Nunamiut	Alaska	1 year	20+	745	Binford 1991:107, Table 39

Table3.3: Summary data for 12 groups of subsistence hunters, the complete inventory of prey species taken is provided in Appendix C.

Although assemblage size differences can dramatically affect the proportion and diversity of species represented (reviewed in Grayson 1984), the sample used here is considered to be generally representative of the frequency with which different prey species are captured. The total numbers of kills does increase relative to the length of the observation period (Figure 3.6a), but the diversity of prey does not (Figure 3.6b). Since prey species representation cannot be attributed solely to differences in observation length, I am assuming the sample provides a reasonable approximation of the frequency with which different species are captured by each group.

To standardize the sample, the number of animals per species for each group was converted to percent values based on the total number of animals killed. All non-

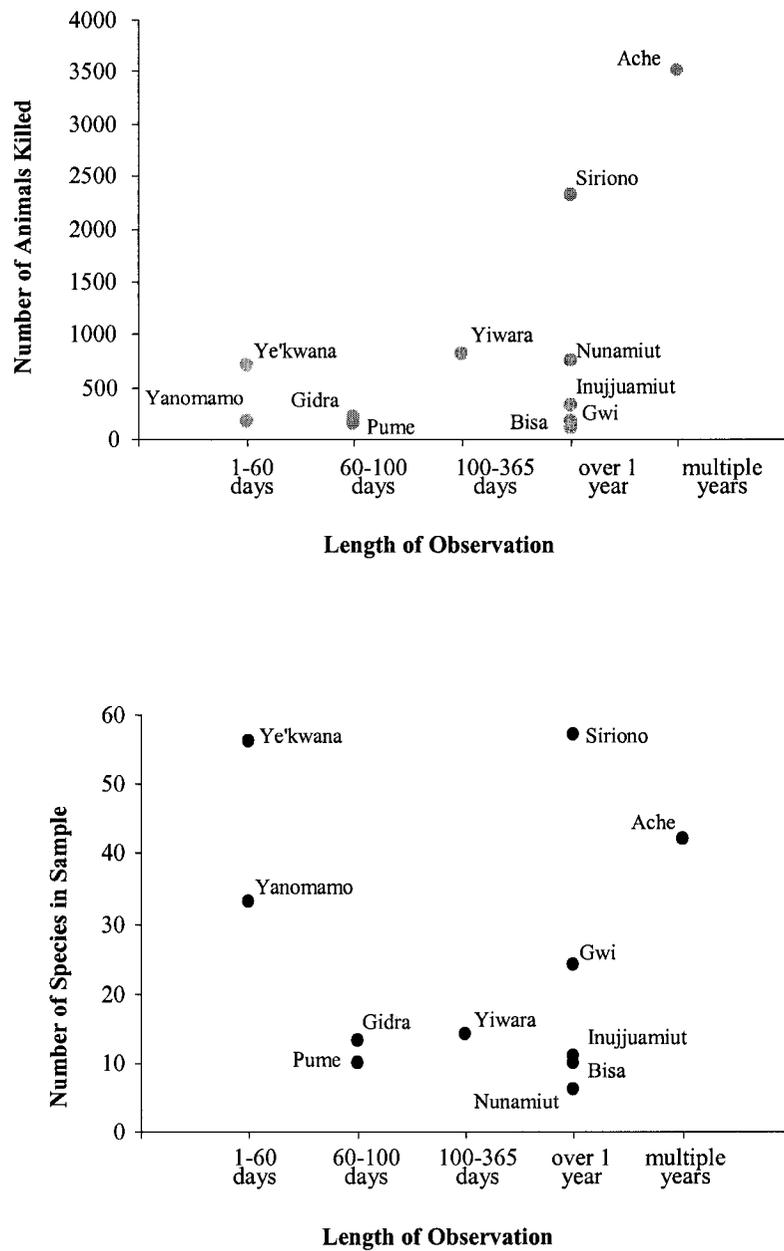


Figure 3.6: (a) (top) Total number of animals killed relative to observation length. (b) (bottom) Number of species present in the kill assemblage relative to observation length.

terrestrial mammalian species were also removed. Avian, reptilian, and aquatic prey species are subject to the same general relationship between body size and population density as terrestrial mammals. However the fundamental ecological differences between the habitats and the metabolisms of these species may dramatically alter the scale of the relationship between mass and density (Peters 1983). The distribution of species plotted by body size is presented for each group in Figure 3.7. Average mass for each species is arranged from smallest to largest and prey encounter rates can be expected to decrease accordingly.

Based only on the terrestrial mammalian species utilized, all groups, with three notable exceptions, exhibit a predominately negative trend in the percentage of animals killed relative to animal body size. The largest animal hunted consistently contributes the least in terms of the total number of individuals captured. The use of small game is highly variable, suggesting that all small prey available are not consistently utilized in proportion to their expected population densities. Groups such as the Ache, Gwi, and Siriono (Figure 3.7), which utilize a large diversity of small fauna capture many species less frequently than expected. Which suggests some degree of selectivity is expressed in the use of small game, since many small species are not used in proportion to their expected population density. In fact the distribution of species utilized relative to body size can more appropriately be described as “L-shaped” for groups such as the Yanomamo, Ache, Pume and Siriono, with greater variation in the number of individuals procured among the inventory of small fauna than compared to larger game species.

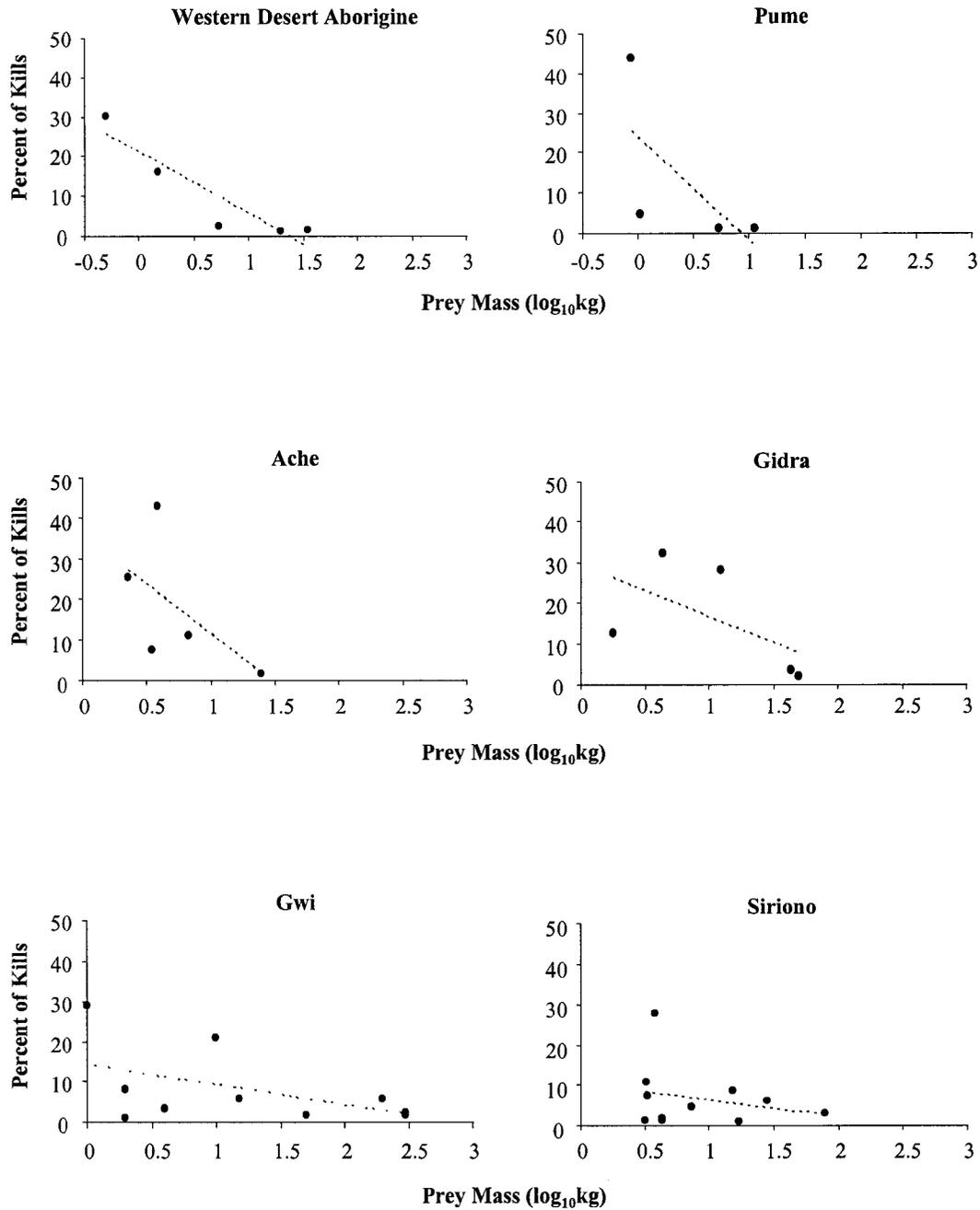


Figure 3.7: Scatterplots of all terrestrial prey species by mass and percent contribution (MNI percent) to the total number of kills made. Species which contributed less than 1% to the total kill assemblage are not plotted; scales are not consistent between graphs.

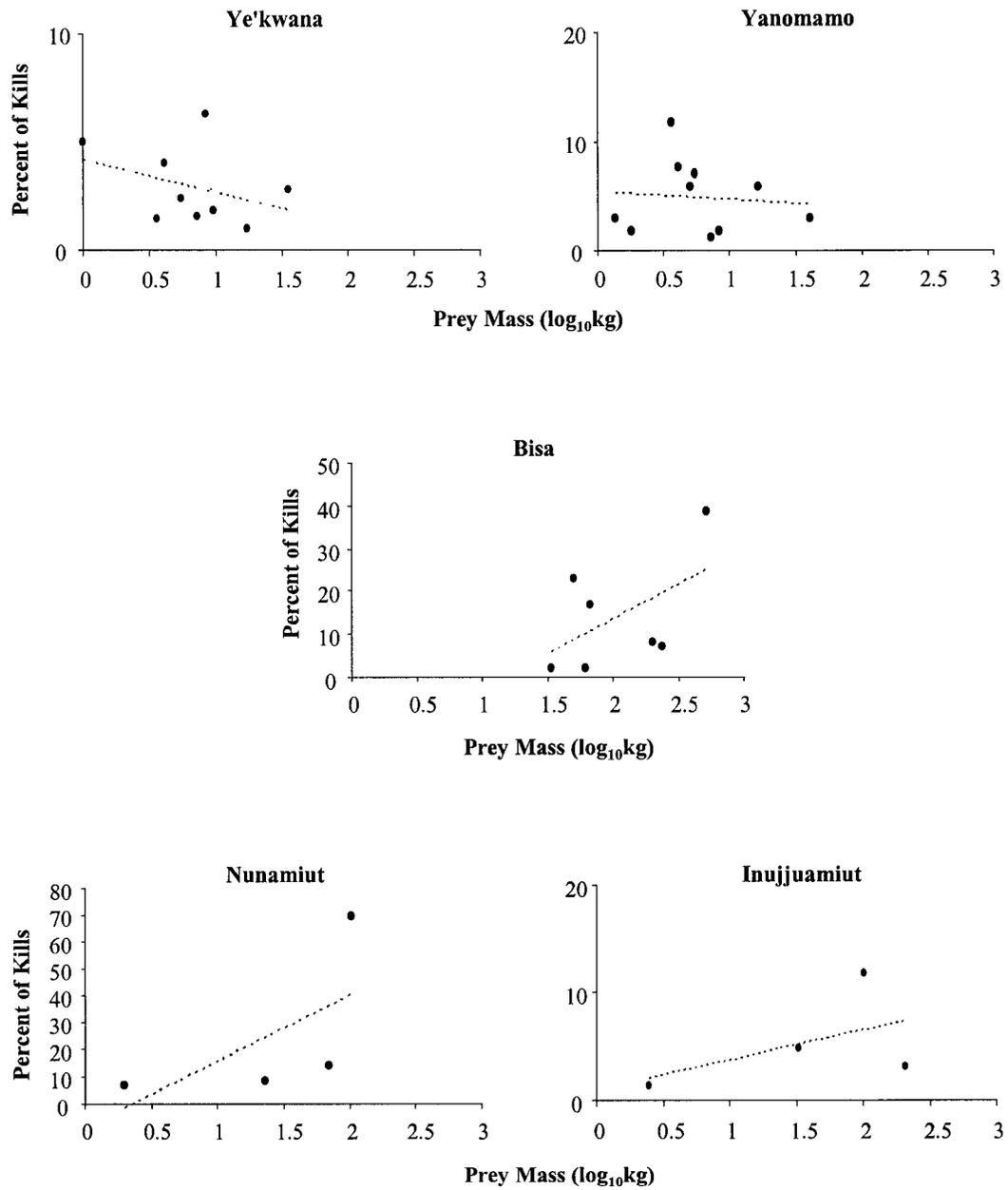


Figure 3.7 continued: : Scatterplots of all terrestrial prey species by weight and percent contribution (MNI percent) to the total number of kills made. Species which contributed less than 1% to the total kill assemblage are not plotted; scales are not consistent between graphs.

Overall, the majority of the groups sampled have prey assemblages which generally conform to the predicted distributions of an encounter based or generalized prey selection strategy. Selectivity in such groups is only expressed in the species of small prey utilized, not in the frequency of game procured relative to body size.

Only three groups, the Nunamiut, Inujjamiut and Bisa appear to utilize large game species more frequently than smaller prey. Both the Nunamiut and Inujjamiut occupy arctic environments and their prey frequencies deviate primarily due to the inordinate proportion of caribou in their assemblages. High latitude environments are associated with lower levels of primary productivity (Begon et al. 1996), generally support a lower density and diversity of mammalian species (Andrewartha and Birch 1961), and often maintain populations of larger animals than more temperate or tropical ecosystems. While arctic environments may be characterized by a more limited diversity of potential prey, there are small prey species available. These arctic hunters are the only groups sampled which display clear indications of a specialized prey selection strategy and rely almost exclusively on faunal resources for subsistence. Both groups are well known ethnographically to purposefully elevate their encounter frequencies with large game, particularly caribou, by maintaining high levels of mobility and concentrating their hunting efforts along ungulate migration routes (Binford 1978; Gubser 1965; Smith 1991). Although for both groups caribou are primarily hunted only seasonally, the quantity taken far outnumbers the smaller species utilized.

The Bisa are sedentary horticulturalists occupying a tropical desert/savannah environment. Their primary food source is sorghum supplemented with other cultivated

and wild vegetables and hunted game (Marks 1976:46-47). Hunting is explicitly focused on the procurement of ungulates such as water buffalo, impala, and warthog, and large species are taken more frequently than smaller game. The area is renowned for its density of large mammals which frequent the numerous permanent water sources (Marks 1976). The unique availability of large game, coupled with the steady source of calories provided by their sorghum crops, may provide a context where “gambling” on large prey is worthwhile.

Due to the considerable variation among the use of small fauna, the relationship between prey body size and prey selection strategy can be clarified by focusing analysis on only the three most frequently utilized species (Figure 3.8). The three most common species for all groups (based on the total number killed) with an encounter based prey selection strategy consistently exhibit a negative trend in relation to species body size, with those of specialist hunters exhibiting the opposite relationship. It also appears that within each strategy the relative contribution of the most commonly hunted mammalian species to the total inventory of prey varies considerably (Figure 3.8). These differences are due in part to the omission of various avian, reptilian, and aquatic taxa. For groups such as the Pume who procure a large number of reptiles (Greaves 1997) and the Inujuamiut who hunt a variety of aquatic mammals and fish (Smith 1991), mammals collectively contribute less than 30% of their faunal assemblage. Importantly, specialized large-game predation as defined here, does not necessarily imply exclusive hunting of a single species of large prey. In zooarchaeological contexts assemblage dominance by a single prey species, particularly caribou (e.g. Grayson and Delpeche 2001; Enloe 1999;

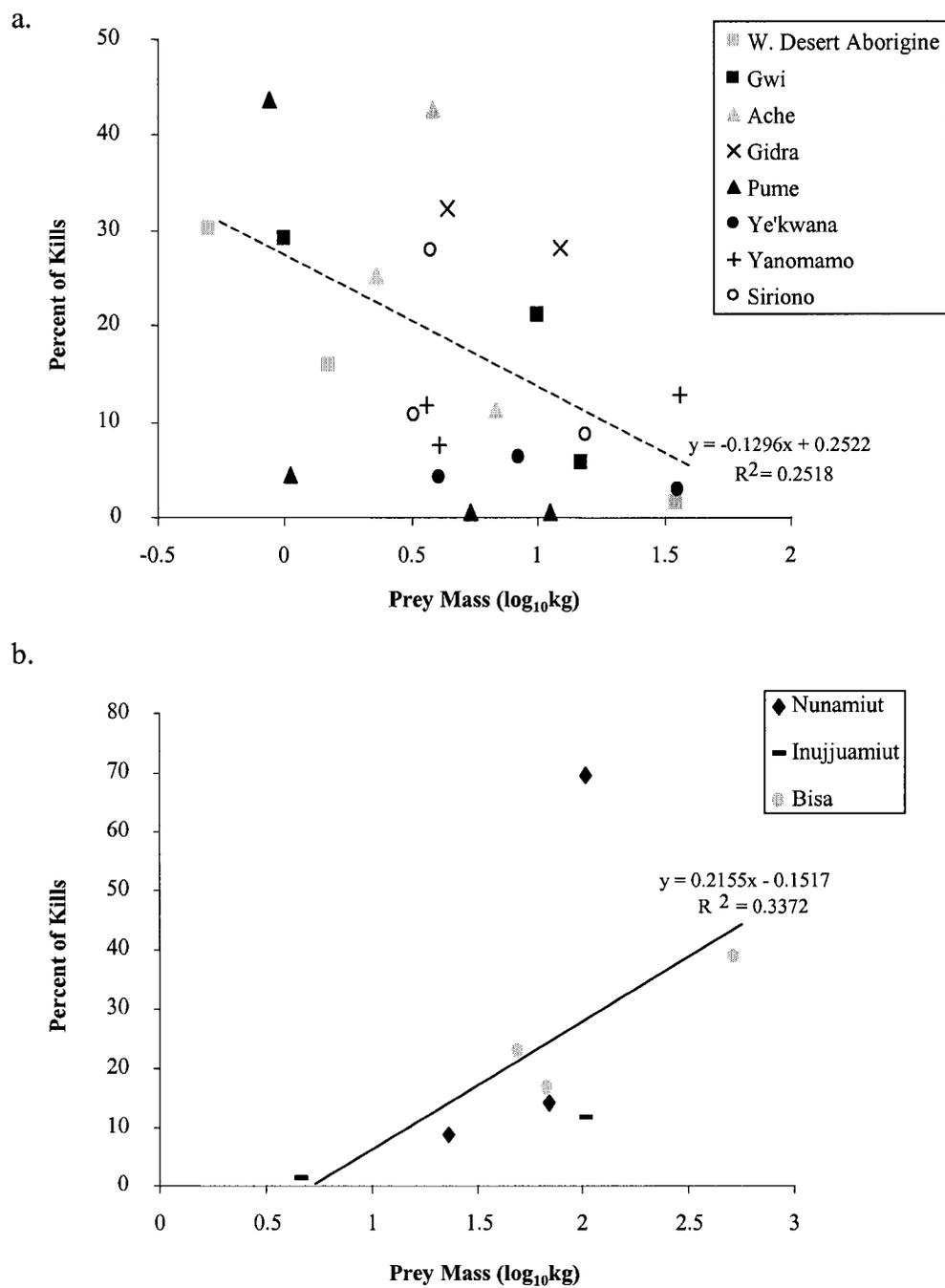


Figure 3.8: (a) (top) Scatterplot of the three most common terrestrial prey species by weight and percent contribution (MNI percent) to the total number of kills made for groups identified as “generalists”, ( $p < 0.05$ ); (b) (bottom) Scatterplot for groups identified as “specialists” ( $p < 0.05$ ).

White 1982) and bison (e.g. Brugal et al. 1999; Frison 1991; Todd 1987), is often presented as the only defining characteristic of a specialized hunting economy. While dominance may accurately identify large-game hunting in particular contexts, as it would for the Nunamiut where nearly 70% of their game intake is comprised of caribou, it may not be appropriate for hunting societies which utilize a suite of large species more frequently than smaller taxa. Neither the Bisa nor Inujjuamiut total faunal inventories are “dominated” (i.e. high MNI percent values) by a single large taxon, but both utilize large game relatively more frequently than would be predicted by an encounter based strategy.

As specialization is defined here, it assumes that smaller prey species are available but are relatively underutilized. It is difficult to establish whether the three groups identified as specialists are regularly passing up the opportunity to capture smaller animals. There is evidence for the Nunamiut and Inujjuamiut which suggests they do:

*Nunamiut (Gubser 1965)*

“The Nunamiut regard the shrew as a pesky, active little animal...Nunamiut have little use for shrews but nowadays trap them for biologists...” (260).

“The Nunamiut had little to say about red squirrels. They know the animal occurs in the timber, but apparently have never utilized them” (263)

“The snowshoe hare occurs rarely in the Brooks Range...The arctic hare is perhaps a bit more common. Nunamiut have reported the presence of both hares...in occasional years...Neither hare is significant as a food source” (Gubser 1965:276).

“The marmot occurs throughout the Brooks Range, usually in small, localized colonies...Summer may be a hungry time, and the fat meat of marmots is a welcome supplement...They are easy to catch as far as skill is concerned but difficult in the amount of labor required...” (Gubser 1965:279)

*Inujuamiut (Smith 1991)*

“Although the expressed purpose of the hunts was to locate and capture caribou...While hunting inland potential prey included fox, ptarmigan, and lake trout; the fish were never pursued, but the first two prey types were *taken on occasion*...In the case of ptarmigan, it appears they were sometimes ignored when encountered...The matter of fox trapping is more complicated. For one thing, foxes are harvested primarily for their pelts, which have exchange-value (as trade items) and use-value (as parka ruffs); food consumption is incidental to this...It is probably enough to say that the small loss in foraging efficiency entailed by trapping effort on these hunts was more than offset by the monetary return...” (220-2 emphasis added).

With regard to the Nunamiut, Gubser’s anecdotal observations suggest that some small prey species are ignored. While it is certainly possible that prey the size of shrews and squirrels cannot be efficiently captured in the quantities necessary to support the Nunamiut population, they are available and rarely if ever hunted which implies they are to some extent ignored in favor of caribou. For the Inujuamiut, it seems clear that ptarmigan are overlooked in favor of larger mammals. And the occasional capture of foxes is, at least in part, a direct result of the hunting for money rather than food. In both of these cases there is at least limited evidence to suggest that smaller prey are encountered more frequently than they are pursued and/or captured.

In addition to the general relationships between prey body size and assemblage frequency it can also be expected that because specialists choose not to pursue some proportion of the prey they encounter, the numbers of species represented may also differ among assemblages independent of assemblage size. Passing up predation opportunities would not necessarily impact the total number of species utilized if a hunter elects not to pursue a certain percentage of all species encountered. If however some species are

ignored more frequently than others, then the total number of species utilized would narrow with increased large prey specialization. The total number of species hunted (including non-mammalian taxa) and the size of the most commonly (highest MNI) utilized prey are plotted in Figure 3.9. The specialized hunters in the sample have a markedly low diversity of species represented relative to the size of their most common prey. For the remaining groups plotted the number species present increases relative to the size of the most frequently captured species. This relationship is not statistically significant but may imply that as the most common prey utilized by encounter based hunters becomes larger, a more diverse array of prey are taken, but only if the diversity of potential prey available in each specific environmental context is accounted for.

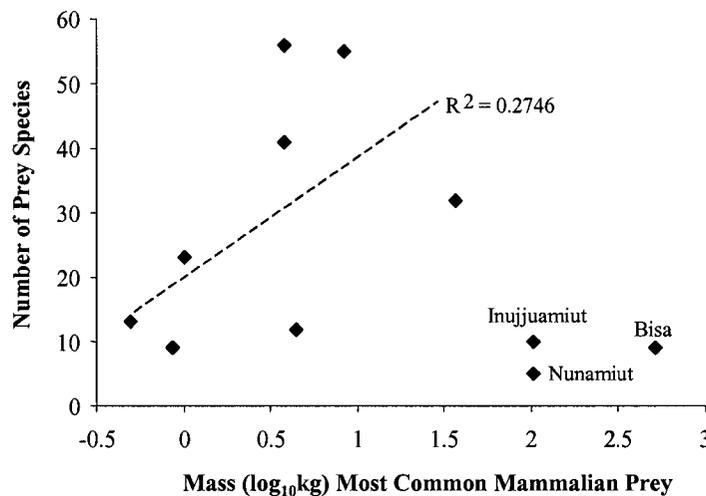


Figure 3.9: Scatterplot of the number of prey species utilized and the mass of the most common mammalian prey hunted, trend line excludes the Inujuamiut, Nunamiut, and Bisa.

### Specialization Past & Present

Outside of arctic environments and the unique case of Bisa farmers, none of the societies sampled expressed a prey selectivity strategy biased towards exceptionally large game. Why not? Assuming that a specialized prey strategy is viable only when large game are available in sufficient quantities, the environmental conditions present in the majority of societies examined may not be capable of supporting a selective strategy. Subsistence hunters documented in the modern era occupy ecosystems that have been inhabited by humans for thousands of years, and human populations likely exist at relatively high density levels. Also, most recent subsistence hunters occupy primarily “marginal” environments; consequently their subsistence options are likely more constrained than those of hunter-gatherers of the past. In some non-arctic contexts that are no longer represented in the ethnographic record large mammals may have been much more predictable and/or relatively easy to procure. For instance, the risks associated with hunting them could be minimal when large prey are abundant relative to human population sizes and/or are naïve to human predation. These prey characteristics are not present in modern foraging environments, but may have contributed to prey selection criteria among prehistoric foragers. As such, the patterns are drawn from modern subsistence hunting groups do not necessarily reflect the range of prey selection strategies of past human hunting populations. However, comparison of prey use frequency relative to body size and the predicted relationships outlined here, regarding encounter rates and natural prey abundance provides another method for evaluating prehistoric prey use strategies. Analysis of ethnographically documented subsistence

hunters provides validity to more general expectations about relationships between specialized and generalized hunting strategies and their faunal assemblage attributes.

Perhaps the most quintessential big-game hunters of the past are the Early Paleoindian, or Clovis, populations of North America. Preying upon large game animals the sizes of which are unparalleled in the modern world, except for a handful of species in Africa and Asia, Paleoindians hunted not only *big* game, but they are believed to have hunted Pleistocene *mammoth sized* game. To what extent they relied on such huge animals remains open to question, but based on the analysis of modern specialized large game hunters, predictions regarding the assemblage attributes produced by Clovis hunters can be evaluated. If archaeological interpretations of Clovis peoples as big-game specialists are correct, then Clovis hunters stand in stark contrast to the majority of modern subsistence hunters and non-human carnivores. In acknowledgement of this apparent “oddity” of Clovis subsistence, a generalized hunting strategy has been offered as a more plausible interpretation of Clovis subsistence economy by numerous Paleoindian archaeologists (Dillehay 2000; Dixon 1999; Johnson 1991; Meltzer 1993). But is Clovis hunting truly an “oddity”, as it surely seems relative to the survey of subsistence hunters, or does it represent a subsistence strategy that is simply poorly represented in the modern record of hunter-gatherers? The following chapter examines Clovis subsistence based on ideas concerning prey selection strategies developed here.

## CHAPTER IV: CLOVIS HUNTING STRATEGY

The characterization of Clovis peoples as specialized big game hunters began with the discovery of numerous sites across North America containing mammoth remains in association with Clovis projectile points in the early- to mid- 20<sup>th</sup> century (Cotter 1937; Figgins 1933; Haury 1953, Haury et al.1959; Howard 1935; Sellards 1952). Once this co-occurrence was firmly established, deposits throughout North America and Mexico containing *any* lithic tools in association with Pleistocene megafaunal remains were often, but not always, attributed to Clovis hunting activities. The frequently questionable relationship between artifacts and faunal remains at many reported proboscidean localities, such as Boaz (Palmer and Stoltman 1975), McLean (Ray 1942), Deuwall-Nuberry (Steele and Carlson 1989), and Lamb Spring (Stanford 1981), has led many researchers to doubt the consistency with which Clovis technology occurs in association with megafauna. However, it must be acknowledged that nearly all generally accepted Clovis sites containing well-preserved faunal remains, include in their assemblages species of large body size such as mammoth, mastodon, camel, and/or bison (e.g., Frison and Todd 1986; Haynes 1966, 1993; Haury 1953; Johnson 1987; Laub et al. 1988; Leonhardy 1966; Lundelius 1972). Lingering doubts regarding the cultural association with numerous megafauna deposits renders the quantification and comparison of Clovis kill site faunal assemblages difficult. Despite the many ambiguous associations, the fact that Clovis projectile points are not consistently found in archaeological deposits associated with *only* medium to small body sized prey has convinced many archaeologists that Clovis peoples were big-game specialists.

In addition to the faunal record, the interpretation of Clovis peoples as big-game hunters has been inferred from ancillary evidence. First, the age of Clovis is roughly coincident with the extinction of over 35 genera of large mammalian species, although the exact timing of extinction of numerous taxa remains questionable (Meltzer and Mead 1985). Despite only a handful of these taxa having been recovered from Clovis sites in clear association with artifacts (Grayson 1984b), some researchers accept this temporal coincidence as evidence that the extinction of Pleistocene megafauna was due to over-harvesting by Clovis populations (Alroy 1998; 2001; Martin 1984; Mosimann and Martin 1975). Second, the most defining characteristic of Clovis lithic technology is the manufacture of large bifacial projectile points. Actualistic studies have established that these weapons are suitable for wounding/killing large prey such as modern elephants (Frison 1989). The extensive use of exotic lithic raw materials and an emphasis on biface production (Goodyear 1989; Kelly and Todd 1988) have been interpreted as evidence of very high levels of mobility, a strategy consistent with the dependence on large game.

### Clovis as Generalists

Recently, the notion of Clovis as big-game hunters has been the subject of revisionist critique. Arguments have ranged from accusations that Clovis hunting behaviors provide a medium for perpetuating androcentric bias (Gero 1995; Hudecek-Cuffe 1998), to theoretical concerns regarding the likelihood that big-game hunting was an economically feasible strategy for Clovis peoples (Meltzer 1993; Meltzer and Smith 1996). Some authors note that there is little or no evidence for large game hunting in

regions such as the Great Basin (Heizer and Baumhoff 1970) or some portions of eastern North America (Meltzer 1988). The majority of critics allow that Clovis peoples killed large game at least occasionally, but they argue that the bulk of their diet was comprised of small and medium sized game and plant resources. The most common points of contention between the two positions are the claimed ubiquity of Clovis point/megafauna associations and whether big-game hunting was a viable subsistence strategy for a colonizing population in Pleistocene North America. It is argued that the archaeological record of Clovis suffers from unsystematic sampling, with an overwhelming bias toward the discovery of large game kill sites due to the greater archaeological visibility of large faunal remains. This argument implies that if more campsites, or at least “nonkill” sites, were discovered, they would likely present evidence attesting to the consistent utilization of a diversity of faunal and floral species (Gero 1995; Johnson 1977; Meltzer 1988, 1993, 1995).

Studies of elephant populations in Africa have led to some troubling observations concerning archaeological associations between proboscideans and humans (Haynes 1988, 1991, 1995). Notably, African elephants tend to die near sources of water, particularly during drought years when catastrophic die-offs can occur. As many Clovis sites are located in or near springs, draws and playas, the potential for fortuitous associations between mammoths and artifacts is high. Also, age and sex profiles of catastrophic elephant die-offs at water holes can resemble those of mass kills (Haynes 1988, 1995). The few Clovis kill sites with age and sex data for mammoths show various patterns, as both catastrophic and isolated individual males, females, juveniles and adult

kills are represented (Haynes 1991; Saunders 1977, 1980, 1992). Observations of weak and dying elephants during drought years have led to the conclusion that Clovis elephant hunting activities may have been “moribund scavenging” (Fisher 1986), the killing of animals already severely weakened by drought or illness, rather than the result of specialized selection of healthy animals.

There is evidence from a number of sites that Clovis hunter-gatherers did utilize a diverse set of resources, utilizing plants, small mammals, birds, fish, and reptiles (e.g., Ferring 1995; Johnson 1987; Graham and Kay 1988; Haynes and Haury 1982; McNett et al. 1977). For example, in addition to large game found at the Lehner site, the assemblage contained various small game animals including jackrabbit, tortoise, and snake (Haynes and Haury 1982). The Aubrey site also yielded a range of small animals, including clear evidence for the exploitation of tortoises (Ferring 1995). Other sites such as Blackwater Draw (Lundelius 1972) and Lubbock Lake (Johnson 1987), contain small game in their faunal assemblages. The presence of small game has led some researchers to conclude that: “Paleoindian subsistence data indicate an economic system rooted in general foraging” (Dixon 1999:255), and “Opportunistic hunting appears as a broad-spectrum meat-related subsistence base, utilizing a variety of animal food from a wide array of vertebrates both large and small” (Johnson 1991:229). Critics of the Clovis specialist model are quick to point out that the presence of megafauna does not necessarily imply selective hunting (Bryan 1991; Dillehay 2000:28-34; Dixon 1999:247-250; Johnson 1991; Meltzer 1988, 1989, 1993; Meltzer and Smith 1986). However, it seems reasonable to question whether the presence of small game alone provides an

adequate indicator of a generalized foraging strategy. The generalist (or encounter based) versus specialist prey selection strategies as I have previously defined them depends on the frequency of capture relative to body size and population density. The presence or absence of particular species in itself provides no indication of prey selectivity.

The most straightforward critiques point to the fact that few historically known and extant foraging groups prey exclusively upon big-game outside of arctic environments (Johnson 1977; Meltzer and Smith 1986; Meltzer 1988, 1993), a point also documented in the previous chapter. It has also been suggested on these grounds, that specialized big-game hunting would not have provided a sustainable or reliable strategy for Clovis peoples (Meltzer 1993). Although they lack reliable estimates for population densities of either Pleistocene megafauna or Clovis peoples, critics argue that large game were too infrequently encountered by Clovis peoples to provide a reliable nutritional source. Certainly smaller mammals could have been more abundant in the environments occupied by Clovis peoples, but it is not known whether large game populations were at densities too low to be consistently preyed upon. Another possibility is that Pleistocene megafauna, such as mammoths and mastodons, posed such a threat to human life that they would only be hunted when chance greatly favored a human advantage. Although there are ethnographically documented examples of hunters being wounded (sometimes mortally) by elephants, this does not appear to have universally deterred all modern hunter-gatherers from pursuing them (Duffy 1984; Marks 1976). On the other hand however, elephant hunting is not the mainstay of any recent hunter-gatherer diets.

Clovis big-game hunting is then construed as an unviable subsistence strategy for a colonizing, or any other, foraging population. Considered too inflexible to cope with the environmental diversity encountered by migrating Clovis populations, it is argued that a generalized “take what you can” subsistence approach facilitated their rapid expansion into new landscapes. Contrary to this position, Kelly and Todd (1988) argue that large game hunting is one way foragers *can* successfully cross-cut environments.

What means of adapting to local resource stress would be available if Paleoindians could not have depended on another group’s knowledge of the features of a new region because that other group did not exist? Entering an unpopulated continent, early Paleoindians needed a system which allowed them to utilize unoccupied, ‘unmapped’ tracts of land. A lifeway suitable for this task is one that placed primary reliance on faunal rather than plant resources...Unlike much information on plant resources, an understanding of animal behavior, though by no means perfectly transferable, can be generalized and accommodated to new territories (Kelly and Todd 1988:234).

In sum, opponents of the Clovis as specialized big-game hunter interpretation base their arguments on: 1) the presence of small game taxa in archaeological assemblages; 2) negative evidence, focusing especially on site recognition criteria, which they suggest would attest to the more frequent exploitation of small game, and 3) theoretical concerns regarding the plausibility of a specialized hunting strategy focusing on animals the size of Pleistocene mammoths and ungulates. Appeals to negative evidence, can only be resolved if the many hypothetical missing Clovis sites with abundant small game are found. However, the faunal assemblages of known Clovis sites and the conditions which permit specialized hunting strategies can be addressed with the currently available evidence.

### Estimating Clovis Diet Breadth

Assuming that a highly selective subsistence strategy favoring large terrestrial game was the basis of Clovis subsistence economy, it is predicted that either a negative correlation or no correlation will exist between archaeological species abundance and their natural abundance based on body size. If Clovis hunter-gatherers were generalists or encounter based hunters, the archaeological abundance of prey taxa should be positively correlated with natural abundance and thus negatively correlated with body size. Although some have argued that the record is unduly biased by an overrepresentation of megafauna kill sites, the archaeological record is the only direct source information regarding Clovis hunting behaviors.

The faunal assemblages of 33 archaeological sites were tabulated by species presence/absence and when possible minimum number of individuals (MNI) (Table 4.1). Sites were included in the sample if they contained diagnostic Clovis artifacts, or in a few cases, lack fluted points but show evidence of human interaction with extinct fauna. Due to inconsistencies in the literature with regards to the quantification of fauna, reliable MNI values for all taxa present could only be obtained for 15 site assemblages, and even the data from some of these sites are problematic. For example, MNI's may be reported for some taxa, while only "presence" is noted for others. In these cases, MNI's are based on the number of species present within a given taxonomic group. Faunal data for the remaining sites were recorded simply as present/absent for each taxon. For simplicity, certain species were aggregated into general taxonomic groupings (e.g., mammoth/mastodon, lagomorphs, rodents, turtles/tortoises, and carnivores). To

Site (State or Province)	Proboscidean	Bison	Equid	Camelid	Tapir	Pecary	Other Ungulate	Sloth	Glyptodont	Bear	Other Carnivore	Lagomorphs	Armadillo	Muskrat	Other Rodent	Insectivore	Turtle/Tortoise	Snake	Alligator	Fish	Bird	Amphibian	References:
Aubrey (TX)	✓	✓					✓	✓				✓		✓	✓		✓			✓	✓		Ferring 1995
Blackwater Draw (NM)	16	15	15	15		3	2				4			2	5		6				2		Lundelius 1972
Charlie Lake Cave (BC)		✓										✓		✓	✓					✓	✓		Driver 1999; Fladmark et al. 1988
Boaz Mastodon (WI)	1																						Palmer and Stoltman 1975
Bull Brook (MA)							✓								✓								Byers 1955; Spiess et al. 1985
Colby (WY)	7	3	1	1			1					1											Frison and Todd 1986; Walker and Frison 1980
Dent (CO)	13																						Figgins 1933, Brunswig and Fisher 1993
Domebo (OK)	1	1												1	5		1	2				4	Force 1997; Leonhardy 1966; Slaughter 1966, Leonhardy and Anderson 1966
Escapule (AZ)	1		✓																				Hemming and Haynes 1969; Saunders in press
Gault (TX)	✓	✓	✓																				Collins 1999
Guest (FL)	2	1					1										✓						Hoffman 1983; Rayl 1974
Hebior (WI) †	1																						Overstreet 1995, 1996; Overstreet and Stafford 1997
Hiscock (NY)	8						2								✓						2	3	Laub et al. 1988; Tankersley et al. 1998; Steadman 1988
Holcombe Beach (MI)							✓																Cleland 1965; Fitting et al. 1966; Spiess et al. 1985
Kimmswick (MO)	✓					✓	✓	✓			✓			✓	13	✓	✓			✓	✓	✓	Graham and Kay 1988; Graham et al. 1981

Table 4.1: Summary of Clovis faunal data.

Site (State or Province)	Proboscidean	Bison	Equid	Camelid	Tapir	Pecary	Other Ummatile	Sloth	Glyptodont	Bear	Other Carnivore	Lagomorpha	Armadillo	Muskrat	Other Rodent	Insectivore	Turtle/Tortoise	Snake	Alligator	Fish	Bird	Amphibian	References:
Kincaid Shelter (TX)	✓		✓								2		✓		✓		2		✓				Collins et al. 1989
Lange-Ferguson (SD)	2	✓					✓					✓		✓	9	3		2		✓	2	3	Hannus 1989, 1990; J. Martin 1984
Lehner (AZ)	13	4	2	4	1					3	3	3		1	3			4			1	1	Haynes and Haurly 1982; Haurly et al. 1959; Lance 1959; Saunders in press
Leikem (AZ)	2																						Saunders 1980; Saunders in press
Lewisville (TX)	2	2	8	2		1	9		1	1	9	13	1		23	1	24	5		1	2	1	Crook and Harris 1957
Little Salt Spring (FL)†	1	1						1				1					6	1			1		Clausen et al. 1979
Lubbock Lake (TX)	3	1	2	2		1	1			1	3	1	1	1	13	1	24	12		6	16	9	Johnson 1987
Manis (WA) †	1	✓												✓									Gustafson et al. 1979
Martins Creek (OH)	1						✓																Brush and Smith 1994; Brush et al. 1994
McLean (TX)	1																						Ray 1930, 1942; Ray and Bryan 1938
Miami (TX)	5																						Holliday et al. 1994; Sellards 1952
Murray Springs (AZ)	4	11	3	2		1					3				✓								Haynes 1993; Saunders 1980, in press
Naco (AZ)	1	✓																					Haurly 1953; Lance 1959; Saunders in press
Schaefer (WI) †	1																						Overstreet 1995, 1996; Overstreet and Stafford 1997
Shawnee-Minnisink (PN)																					✓		Eisenberg 1978; Dent and Kauffman 1985
Sheaman (WY)		2					1																Frison 1982
Wacissa River (FL)*		1		2			✓										✓		1				Webb et al. 1984
Whipple (NH)							✓																Spieß et al. 1985
<b>TOTAL SITES</b>	26	17	9	7	1	5	15	3	1	3	7	8	3	9	13	4	10	6	2	8	10	6	
<b>TOTAL MNI</b>	91	48	34	28	1	7	25	3	1	5	25	22	3	10	77	6	67	26	2	14	30	19	

**Table 4.1 continued: Summary of Clovis faunal data**

Notes: ✓ = Taxa present; † Sites lacking fluted points; \* Site contains a projectile point of uncertain typology.

maximize the number of taxa included, an extremely lenient measure of cultural association- simple presence in the assemblage- was used to tabulate the number and quantity of *all* taxa in each assemblage. Although the inclusion of both the presence/absence and MNI data of species with questionable cultural association skews the distribution of taxa, no preference was given to the recording of large or small body-sized animals. In fact by counting the presence of numerous small species that are less likely to have been utilized as food sources and are more likely to represent background fauna (e.g. amphibians, rodents, and insectivores), the sample is probably preferentially skewed in favor of small game.

Presence/absence of taxa across all 33 sites (Figure 4.1) shows that mammoth and mastodon are the most ubiquitous species, present in 79 percent of all assemblages. Bison occur in 52 percent of bone bearing sites, followed by other ungulates (45 percent), other rodents, turtle/tortoise and birds (30 percent), and equids, muskrats, and lagomorphs (27 percent). Very rare species include sloth, glyptodont, tapir, and alligator. Either mammoth/mastodon or bison are found in 88 percent of assemblages, and 42 percent of sites contain both. The relatively high frequency of rodents, and perhaps carnivores as well, is likely artificial since little clear evidence of their use as food sources has been documented for Clovis peoples.

Based on presence/absence data alone, two general conclusions can be drawn. First, as is widely assumed the most consistent component of Clovis faunal assemblages are the mammoth/mastodon group. Second, small game species are present in most but not all cases, and a broad diversity of species are present (Table 4.1). Alongside typical

mammalian faunas, birds, fish, and reptiles are not uncommon in of Clovis sites. These findings are also apparent from MNI data (Figure 4.2). Mammoths and mastodon are most common, represented by at least 91 individuals. Interestingly, “other rodents”

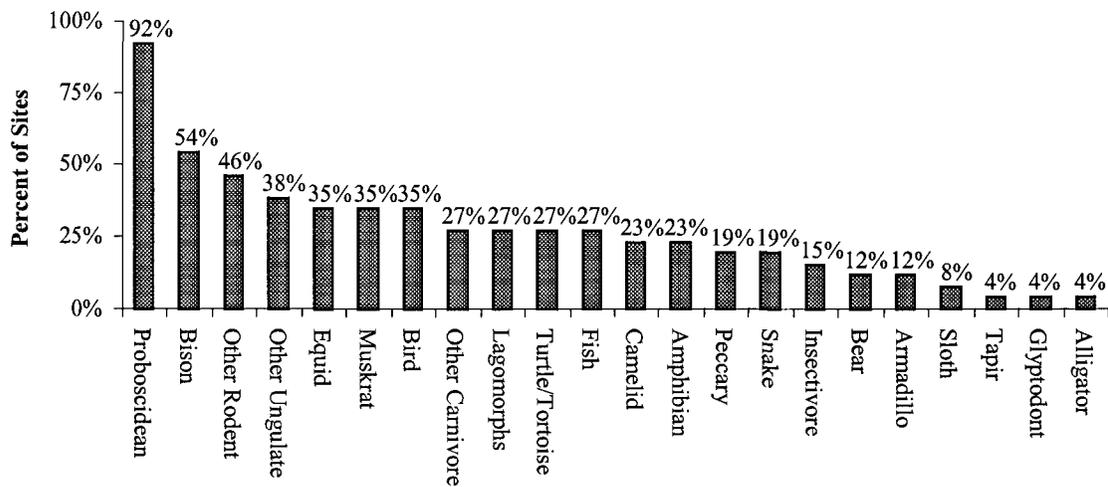


Figure 4.1: Percent of Clovis sites containing various taxa (based on presence/absence).

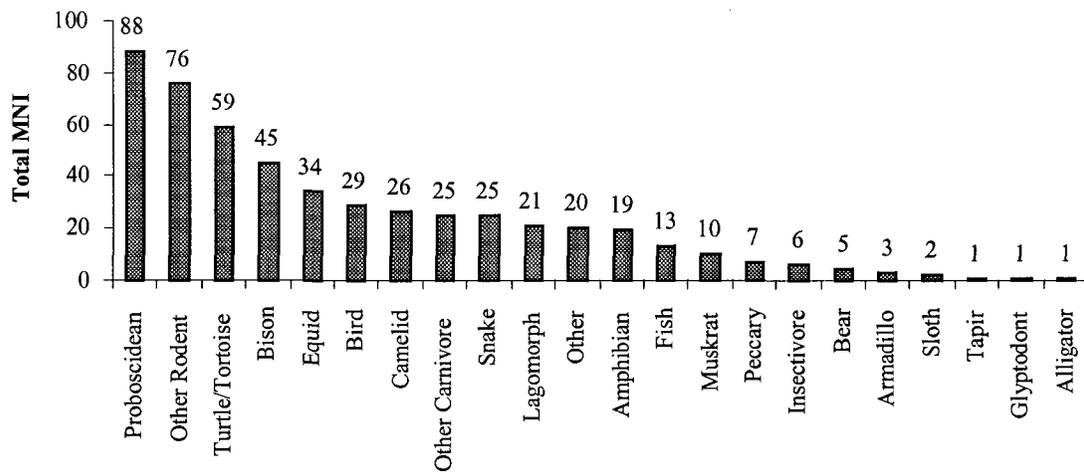


Figure 4.2: Total MNI by taxonomic grouping for 26 Clovis sites.

(MNI=77) and turtles and tortoises (MNI=67) are the next most common taxa, followed by bison, equids, birds, and camelids, respectively.

In order to analyze the data with regard to prey specialization and diet breadth, taxa were further aggregated by general body-size classes. Unlike the ethnographic data examined previously, the Clovis record includes prey that cannot be attributed to particular species. Thus, to maximize the data set available, prey are grouped into general categories. Excluding all non-mammalian species (birds, fish, amphibians, and reptiles) and carnivores since these taxa are subject to their own unique relationships between body size and density, species are ranked from largest to smallest into the following categories: Proboscideans (Size Class 1), Bison/Equid/Camelid (Size Class 2), Other ungulates, sloths, and glyptodonts (Size Class 3), Lagomorphs and Armadillos (Size Class 4), and Rodents and Insectivores (Size Class 5) (Table 4.2). The number of sites in which species of each of these five categories is represented and total MNI values were tabulated. In order to include the presence/absence data for analysis, the presence of a species was assigned an arbitrary MNI value of one. To standardize for varying numbers of taxa in each group, the total MNI for each taxonomic grouping was divided by the total number of species included in each size class (Table 4.2). On average, the largest types occur in the greatest numbers (Table 4.2). Three species of proboscideans, the largest size group, are represented by an average of 30.33 individuals each. This is followed by an average of 12.22 individuals for 9 species of bison, equids, and camelids. Four species of lagomorphs and armadillos are represented by an average of 6.25 individuals. Other ungulates, sloths and glyptodonts are represented 4.11 individuals per

species. Least abundant are the remaining size classes of “rodents and insectivores” with 3.10 individuals per species. The relationship between body size class and MNI values shows a strong, statistically significant negative correlation (*Spearman's*  $r = -0.9$ ; two-tailed significance,  $p = 0.037$ ), providing strong support for the Clovis hunters as large game specialists.

	Proboscideans	Bison, equids, & camelids	Other ungulates, sloths, & glyptodonts	Lagomorphs & armadillos	Rodents & insectivores
Size Class	1	2	3	4	5
N Taxa	3	9	9	4	30
Total MNI	91	110	37	25	93
<i>MNI per taxon</i>	<i>30.33</i>	<i>12.22</i>	<i>4.11</i>	<i>6.25</i>	<i>3.10</i>
Expected # sites †	3.3	9.9	9.9	4.4	33
Actual # sites	26	19	18	9	14
<i>Act. - Exp. # sites</i>	<i>22.7</i>	<i>9.1</i>	<i>8.1</i>	<i>4.6</i>	<i>-19</i>

Note: † see text for explanation of calculation

Table 4.2: Clovis assemblage faunal data summarized by size class.

To investigate the relationship between body size and taxon presence, a slightly different approach was taken to avoid problems of autocorrelation. For each size class, the expected number of sites in which each group should be present was calculated, assuming a generalist “take what you encounter” strategy. The expected number of sites for each size class was standardized to the most taxonomically abundant group (rodents and insectivores,  $n = 30$  species), as groups with more taxa should have more opportunities to enter archaeological sites. The expected value for rodents and insectivores was set to 33 sites (the total sample), and the expected value for the remaining taxa were set proportionately. For example, for proboscideans, consisting of 3 species, or  $1/10^{\text{th}}$  the diversity of rodents and insectivores, the expected value is 3.3 sites.

Since this method only takes into account numbers of species and not numbers of individuals in each taxonomic grouping, it is biased toward smaller, more abundant species. Comparing the observed number of sites to the expected number shows that the largest taxa are overrepresented in Clovis sites (Figure 4.3). Proboscideans appear in 22.7 more sites than expected, bison, equids, and camelids appear in 9.1 more sites, and other ungulates, sloths, and glyptodonts are present in 8.1 more sites than expected. Lagomorphs and armadillos are present in 4.6 more sites than expected, while rodents and insectivores are present in 19 fewer sites than expected. Using a Spearman's rho correlation ( $r = -1.0$ ;  $p = 0$ ), this pattern is highly statistically significant. Therefore, the presence/absence data also provide strong support for the Clovis as specialist model based on currently available faunal evidence. A strong negative correlation with body size and presence in Clovis assemblages is suggested, and the largest, least diverse, and least abundant taxa are the most consistent members of Clovis faunal assemblages based on the present sample.

One of the non-mammalian small game categories not examined in relation to natural abundance are turtles and tortoises, for which there is clear evidence of Clovis utilization (e.g. Lubbock Lake, Aubrey, and Lehner). In the sample, a minimum of 67 individual turtles or tortoises is represented. In other archaeological contexts, high frequencies of terrestrial chelonians have been linked to the harvesting behaviors of human groups with low population densities (Stiner et al. 2000). Since turtles and tortoises are easily captured with low handling costs, they are likely to be high ranked

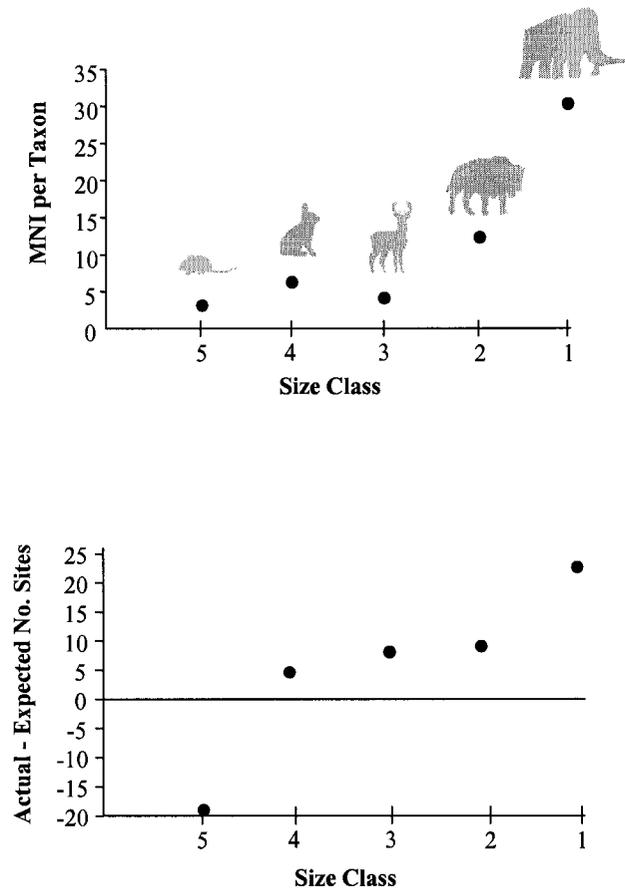


Figure 4.3: (a) (top) Prey size class versus total MNI per taxon, calculated as the sum of MNI's for all taxa in each size class grouping, divided by the total number of species in that group. (Spearman's  $\rho = -0.7$ ;  $p = 0.094$ ). (b) (bottom) Prey size class versus the number of sites per taxon, calculated as the number of sites containing each taxonomic grouping divided by the number of species within that group. (Spearman's  $\rho = -0.7$ ;  $p = 0.094$ )

resources, despite being relatively small compared to many other species of available prey.

### Clovis as Specialists

Based on the relative abundance of both large and small prey taxa, Clovis hunters appear to have used a highly selective prey strategy. This interpretation does not imply that Clovis peoples only hunted mammoth, bison, and other large animals. There is clear evidence that they exploited small mammals and reptiles on occasion. However estimated encounter rates based on body size and species abundances and the sample of known sites, Clovis hunter-gatherers often ignored opportunities to harvest smaller game species, apparently in favor of obtaining a higher ranked resource. Turtles and tortoises are one clear exception of game taxa that Clovis foragers may have regularly taken upon encounter, perhaps because handling costs are quite low for these slow-footed prey.

Regardless of whether Clovis represents the colonization of an uninhabited landscape or slightly postdates that event, early Paleoindian population densities were undoubtedly low. Low population densities coupled with frequent residential mobility over large distances provide a context where large game specialization is not only possible but also perhaps quite likely. As discussed previously, hunter-gatherer population densities are negatively correlated with the degree of dependence on hunted resources (Figure 2.2), and in the ethnographic sample two of the three specialized hunting societies are arctic dwellers with extremely low population densities. Although specialized prey selection strategies must be considered a relatively rare subsistence

strategy among recent and modern foraging populations, trends within the ethnographic record do support a global-scale relationship between low human population densities and dependence on large game (Figure 4.4).

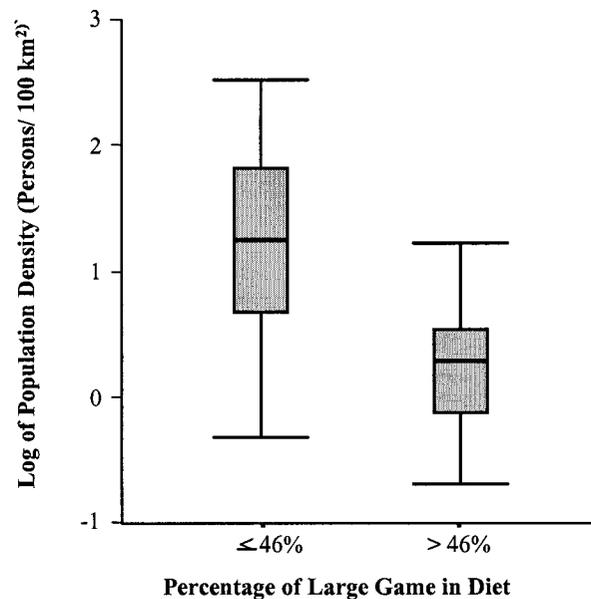


Figure 4.4: Percentage of large game in the diet versus population density for a worldwide sample of hunter-gatherers (N=92) (same data as presented in Figure 2.2). The sample is divided at 46% to accommodate the data as originally recorded in Murdock (1981).

It is difficult to make direct comparisons of Clovis prey inventories to those of other specialized hunting societies discussed in the previous chapter. The magnitude of difference between what constitutes “large” prey in past Pleistocene and present Holocene environments are enormous. Mammoths, mastodons, and Pleistocene bison (*Bison antiquus*) far exceed the size of their modern counterparts, and proboscideans have disappeared from most Holocene environments. The general trend of utilizing the

largest and consequently least frequently encountered prey nonetheless holds. Available faunal evidence has been explored to its limits under the methodology used here, and results in an interpretation of Clovis prey selection clearly aligned with a specialist strategy which is congruent with low population densities and high mobility. If such is the case, what is to be expected regarding other dimensions of predation such, as the roles of women in such societies? Since large game hunting is predominately a male activity ethnographically, it must be considered what the consequences of a specialized hunting economy has on the subsistence activities of non-hunting portions of a forager population. In relation to other carnivores, it was previously suggested that reliance on technology and labor provided by non-hunting individuals are distinguishing characteristics of human predation. The following chapter will explore the subsistence and technological activities of female foragers in relation hunting.

## CHAPTER V: THE ORGANIZATION OF FORAGER SUBSISTENCE LABOR

So far I have focused on hunting behaviors and the role of prey size as a distinguishing characteristic of predation strategy. However hunting is a multi-dimensional phenomenon, and it does not occur in isolation of other subsistence activities. While it may be more visible, especially archaeologically due to the accumulation of bone refuse, hunting is not necessarily the most important component of forager economies. One of the more significant conclusions reached at the influential *Man the Hunter* conference of 1966 was the recognition that plant foods gathered by women can be important and even dominant resource in the diets of hunter-gatherers (Lee and DeVore 1968). It has also been recognized that women's subsistence labor not only contributes plant foods to the diet, but may also be directly involved in the procurement of game or indirectly involved by facilitating the hunting behaviors of men. As the following quotes suggest, the actual killing of large animals may be a predominately male activity, but the efforts of women and other "non-hunters" may play major roles in hunting as well.

"The fact that men actually do the killing of large game should not lead us to overlook the fact that in many cases it is women (and even children) who make the killing possible" (Halperin 1990:395).

"In a sense, it is the dependable efforts of women in gathering that free the men for more chancy hunting activities" (Gould 1980:62).

That multiple economic strategies exist within a foraging group is a conclusion which can be reached from even casual perusal of the ethnographic literature on hunter-gatherer populations. Yet how the roles of female and male subsistence labor are integrated

remains under-explored. There is considerable variation in how sub-groups or individuals within a group procure particular resources, manufacture particular technological items, and engage in other behaviors related to subsistence. The fact that modern and historically known hunter-gatherers engage in a wide variety of food sharing (Gurven et al. 2000; Hawkes 1992; Peterson 1993), tool sharing (Condon et al. 1995), and economic provisioning (Bell 1995; Cashden 1985; Gurven et al. 2000; Hawkes et al. 1997; Wenzel 1995) suggests the interplay between multiple economic strategies is a key contributor to the diversity of hunter-gatherer lifeways, and that individual behaviors can impact the decisions and activities of others.

Optimality models are beginning to examine the degree to which individual foraging strategies influence or constrain each other, as well as the contexts that contribute to or facilitate the use of multiple strategies (e.g. Giraldeau and Caraco 2000). Multiple strategies can have complex interactions, and alter the costs and benefits associated with individual strategies considered in isolation. Studies of modern hunter-gatherers indicate considerable variation among individuals of a group in terms of skill (Bailey 1991; Kent 1993), access to technology (Hames 1979; Johnson 1977; Mena et al. 2000), mobility (Brumbach and Javenpa 1997; Jochim 1981; Kelly 1983), time constraints (Hill et al. 1985; Hurtado et al. 1985), age (Bird and Bird 2000; Walker et al. 2002) and reproductive goals (Hawkes 1991; Hawkes et al. 1997) exert considerable influence on the economic strategies of different individuals and groups of individuals within a foraging population. Whether viewed in terms of resource acquisition, the manufacture of goods, or the amount of time and energy allocated to particular activities,

the strategy of any given foraging population likely requires multiple strategies implemented by different segments of a group that collectively maintain and sustain the economic system. Anthropological investigations of inter-group variation in economic and social realms largely fall under the rubric of social organization, and more specifically, the division of labor. Unfortunately studies concerning male and female foraging activities are commonly viewed in relative isolation of the other (e.g. Bailey 1995; Dahlberg 1981; Klein and Ackerman 1995) and as such, do little to advance an understanding of how multiple strategies act in concert. Only recently has work among a select few groups of hunter-gatherers (primarily the Ache, Hadza, Hiwi) begun to explore how male and female economic activities operate in concert.

The following chapter is designed to address a relatively straightforward, but poorly documented, question regarding foraging lifeways: how does the degree to which a group relies on hunted resources affect the organization of subsistence labor? This question is inspired by a far more mundane issue which arises from the previous two chapters- namely, if men are the predominant providers what do women *do* in large game hunting societies?

### Hunted & Gathered Resources

It is tempting, particularly from a zooarchaeological perspective, to approach hunting behaviors in isolation of other aspects of forager subsistence economies. But clearly different subsistence roles may not be mutually independent strategies. To examine hunting strategies in isolation of other resource procurement and processing

activities risks not only ignoring the significant number of “non-hunters” within any given foraging population but also of overlooking how non-hunting behaviors contribute to hunting success. By cooperating in their subsistence efforts individual hunters or gatherers can mutually facilitate each others subsistence roles, such that the time, energy, and labor channeled into one activity may directly influence the success or profitability of the other. Who hunts and who does not involves, to some extent, the division of labor by age, sex, skill, and health. However, throughout the following discussion I will focus on the division and organization of subsistence labor with regard to gender only and draw an admittedly artificial distinction between male hunting and female plant gathering subsistence roles.

I assume that because of the high failure rates associated with hunting and consequentially the variance and risk associated with the procurement of large prey, omnivory may provide one way to ensure a predictable and consistent source of calories. This assumption has at least two consequences for how the amount of prey procured by men would influence the subsistence activities of women. First, the more calories that can be derived from hunting, the fewer that must be obtained through other activities such as gathering and fishing, so that the types of resources targeted by women and/or the amount of time spent by women can be expected vary relative to the amount of meat procured. I am assuming that vegetable foods are secondary to meat based on their lower average post-encounter rates, discussed later in greater detail. If this is the case, we should find predictable relationships between the amounts of hunted and gathered food resources utilized by different foraging populations and the time allocated to different

resource procurement activities by the male and female members of a foraging group. A strategy for minimizing the periodic shortfalls that may be associated with a reliance on hunted resources would be to increase hunting success rates through increased investment in technology, labor, and/or capture strategy. If hunting is rendered a more predictable and reliable procurement endeavor, variance in overall return rates could be reduced. Instead of focusing their subsistence efforts on the procurement of plants, non-hunters could participate in activities which facilitate and enhance hunting. As suggested by a number of ethnographic observations, women may allocate their labor to activities which provide ancillary support to male hunting behaviors in lieu of gathering.

Before examining the basic relationship between the labor requirements of hunted versus gathered resources, it is important to review the basic attributes of hunted and gathered foods and how their contribution to the diet is generally interpreted with regard to the division of labor. Assuming that animal products are derived only through hunting and plants from gathering (a somewhat artificial distinction since some slow-moving and sessile animals can essentially be collected like plants), some basic features of hunted versus gathered resources can be established. Obviously the nutritional content of animal and plant resources varies widely. Meat is an important source of proteins and fats that can be difficult to obtain from plant products, while plants may provide sugars and other nutrients lacking in meat. Setting aside these basic nutritional issues and focusing only on caloric value highlights attributes of different food sources which may be particularly relevant to foraging peoples. Weight, processing costs, and procurement/processing time dramatically alter average return rates for different resources classes. Based on a sample

of 212 foodstuffs (from Pennington 1989), the Kilocalorie returns for 100g of four general resource classes (nuts, grains/seeds, meat, and fruits/vegetables) are plotted in Figure 5.1. The four resource types represent the basic categories of food commonly utilized by hunter-gatherers. Based solely on caloric value per gram, nuts generally provide the greatest number of calories, followed by grains, meat, and fruits/vegetables respectively. If calories per unit food weight were the only criteria by which foragers selected resources it can be expected, that when nuts are available, hunter-gatherers would have specialized nut based economies. More importantly, except in environments and seasons where nuts are unavailable, why bother hunting?

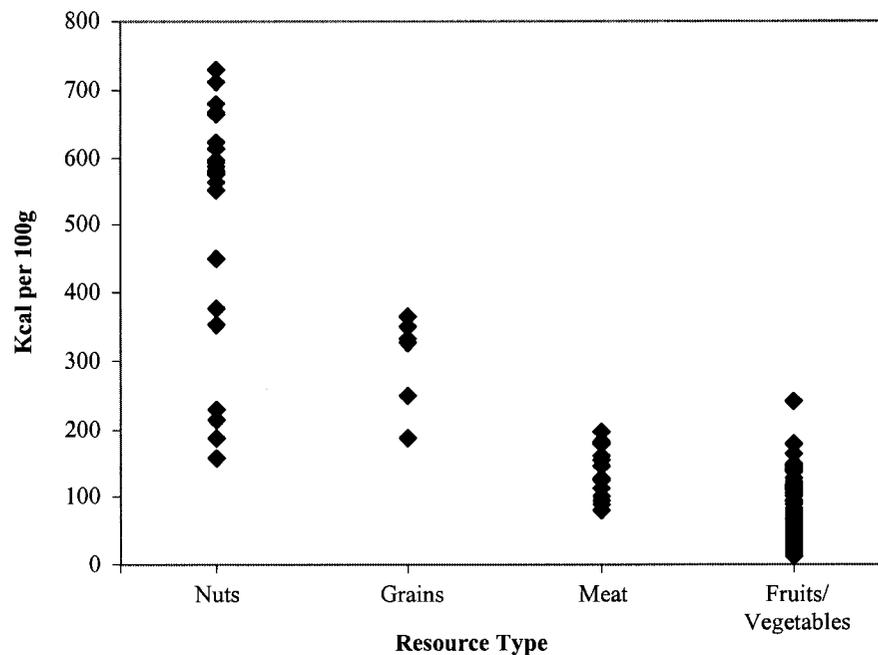


Figure 5.1: Average kilocalorie yield for 100 grams of 212 plant foods grouped into four general resource classes (data from Pennington 1989).

Although they may be very rich in essential nutrients, plant foods such as nuts and grains come in very small package sizes and often require extensive labor intensive, processing to be rendered edible (Hawkes and O'Connell 1985; Layton et al. 1991; O'Connell and Hawkes 1981; Simms 1987). So even though many of these plant products have more calories per gram than meat, high handling costs mean they are not necessarily the most economically advantageous resources. It is only when resources can be processed efficiently, which for small plant items such as seeds and grains often requires harvesting them in bulk and additional investment in specialized technologies (Richerson et al. 2001) that such resources can be economically utilized. Plus, considering the average size of single nut, seed or grain versus even the smallest of terrestrial mammals makes clear the enormous numbers of seeds and small nuts that must be procured to obtain even a modest sized meal. However it must also be kept in mind that the quantity of food procured and the labor expended in its capture vary widely across resource classes.

To accommodate differential procurement costs, post-encounter resource return rates for 94 resources utilized by foraging populations are shown in Figure 5.2. Originally presented in Kelly 1995 (Table 3-3), resources are divided into the same four resource types as in Figure 5.1, and clearly illustrate why hunting is an important component of nearly all hunter-gatherer subsistence economies. Based on the average post-encounter kilocalorie return rate (per hour) recorded for a variety of hunter-gatherer populations, the returns on hunted resources far exceed those of all plant products. Keeping in mind that post-encounter returns calculated as caloric gain minus handling

costs do not account for search costs (Stephens and Krebs 1986), the average returns for faunal resources is 8,501 Kcal per hour based on 25 species of terrestrial mammals ranging in size from squirrel to moose. The high return rates for meat are due to a number of factors, primarily the relatively large package sizes and minimal processing requirements of hunted game relative to plant products. Fruits and vegetables (including tubers) make up the next highest return rate class (1,533 Kcal), followed by nuts (1,366 Kcal) and grains/seeds (511 Kcal). In comparison to Figure 5.1, one noticeable difference is the increased value of fruits and vegetables relative to nuts and grains, highlighting the impact of processing costs on caloric yields. From this perspective

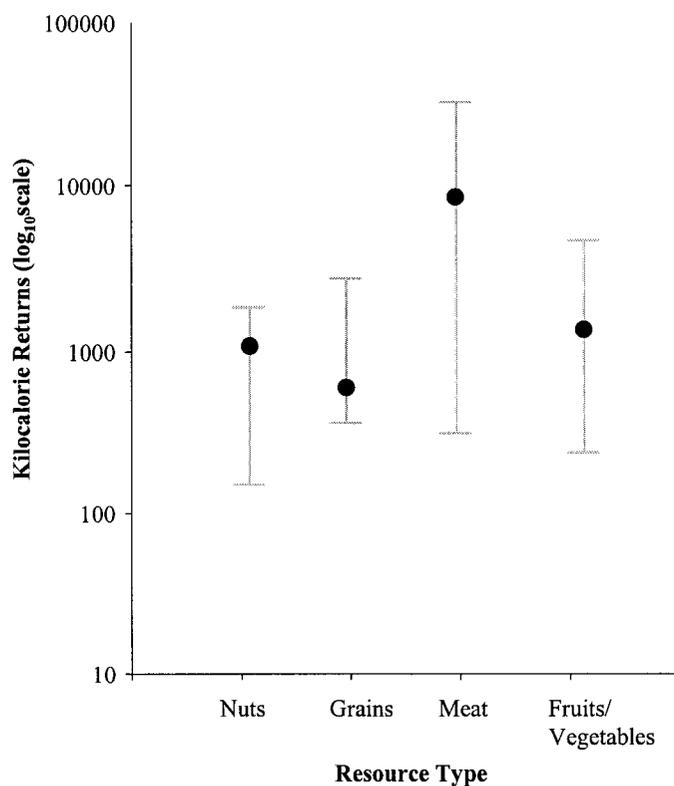


Figure 5.2: Plot of post-encounter return rates (average and range) for 94 resources utilized by a global sample of hunter-gatherers (data from Kelly 1995:Table 3-3).

it seems reasonable to question why plant products, particularly small package items that require intensive processing would be utilized at all as long as sufficient quantities of animals are available. Comparison of the range in post-encounter return values for each food type also reveals considerable variation among resource classes. It is clear that although average returns may be higher for meat relative to plants, and for fruits/vegetables relative to other plants products, post encounter returns can vary widely depending on the specific types of resources available.

Assuming a procurement goal of 2,000 Kcal and taking processing costs into account (Figure 5.2), a forager's caloric needs could be met more quickly by procuring meat than plant products. Hypothetically one's caloric needs could be met in about half an hour by procuring meat, around an hour for fruits/vegetables and nuts, and well over 3 hours for nuts. However, while this may hold true *on average*, faunal resources are associated with a greater degree of variance than plants. The frequency and quantity of captured prey is subject to considerable variation between individual hunters over a given time period. So while the average post-encounter returns may be greatest for meat average returns per day (factoring in encounter rates and search costs) are not likely to be as consistent (i.e. predictable) for game as the yields for plant products. Average acquisition rates (calories procured per hour spent foraging) for large game and plants procured by the Hadza (Table 5.1) exemplify the degree of variance in the degree of success in gathering or hunting forays. While large game brings in more calories per hour, kills are extremely infrequent. Considering that plant gathering is likely to result in the acquisition of food 100% of the time while hunting success is more unpredictable, it

	<b>Acquisition Rate (Calories/Hour)</b>	<b>Average Number of Days Between Successes</b>
<i>Large Game</i>	1,650	45
<i>Plants</i>	<<1,000	0

Table 5.1: Average returns for hunting (men) and gathering (women) reported for the Hadza based on 256 days of observation. Large game weighs an average of 180 kg in the sample (data from Hawkes et al. 2001: Table 5).

is easy to see why gathered foods are not only an important but perhaps a necessary stabilizing component of most hunter-gatherer diets.

In sum, hunted resources may be typified by high post-encounter return rates but variance in the frequency with which game is captured may render them an unreliable source of calories on a daily basis, a problem exacerbated as prey size increases. As for plants, nuts and grains/seeds have high caloric values per gram but must be collected in large numbers and often require extensive processing prior to consumption, which greatly lowers their post-encounter return rates relative to meat. There are good reasons to argue for the procurement for each class of resources, depending on whether a forager seeks to minimize time spent and/or variation in foraging returns, or seeks to maximize total caloric return (Hames 1992; Smith 1987). A mixed subsistence economy consisting of both risky but potentially high yielding meat resources and lower return, but predictable, plant foods is typical of all non-arctic dwelling ethnographically documented hunter-gatherer populations. This basic dichotomy between the role of plants and meat in the diet is generally associated with the division of labor. Differences between foraging strategies are such that women (Bailey and Aunger 1989; Lee 1979), children (Bird 2000; Blurton Jones et al. 1996), and older adults (Hawkes et al. 1997) often focus their

subsistence activities on resources that are relatively low risk, while adult males frequently target higher risk hunted prey.

### Approaches to the Division of Labor

Overall, the sexual division of labor among foraging peoples is generally characterized by women procuring small resources that have relatively high processing costs but are low risk in terms of pursuit failure and low variance. Explanations for this common division of subsistence labor fall into two general categories. The first can be called the “do what you can approach” and is based on the simple assumption that men hunt because they can, and women gather because they cannot hunt. Multiple reasons have been offered for why women in foraging societies are not able or proficient hunters. Suggested female hunting “deficits” include a lack of physical strength (Murdock and Provost 1973), lack of acquired skill/training (Brightman 1996), and a lack of time/energy due to the physical demands of pregnancy, childcare, and breastfeeding (Brown 1970; Quinn 1982). Additional factors may represent “deficits” on the behalf of anthropologists, including an overly simplistic notion of the behaviors that constitute “hunting” (Halperin 1980; Hudecek-Cuffe 1998), or a biased perpetuation of modern gender roles (Kehoe 1983; Leacock 1979).

The question of androcentrism aside, the “do what you can” approach implies that female foragers are restricted, either completely or partially, from pursuing large faunal resources to the extent males do. Women, either by not hunting or by hunting a limited suite of small less risky prey items, contribute by procuring the bulk of gatherable

resources included in the diet. This division of labor along resource lines is then interpreted to result in a system of cooperative provisioning; whereby a greater quantity and diversity of foodstuffs are collectively acquired by an economic group (i.e. family or household) than would be possible by an individual forager of either sex (Lee and DeVore 1968; Zihlman 1989). By acting cooperatively foragers can ensure that their dependents are better fed than they would be if individuals did not pool their resources. However the idea that gender related resource specialization results in some form of dietary benefit assumes a considerable degree of altruistic behavior between individuals of different sexes. If distributing resources equally among a cooperative group of male and female foragers and enables individuals to consume more calories than they could provide themselves, then the division of labor by sex based on the subsistence activities one can best perform conveniently provides a line of labor partitioning which would likely exist anyway. As succinct an explanation as this view may provide, recent studies of male and female foraging and provisioning behaviors do not support its assumptions.

Studies of contemporary foragers indicate that men frequently share their hunted game with individuals who do not reciprocate with comparable quantities of other food resources (Bailey 1991; Hawkes 1991; Hawkes et al. 2001; Kaplan and Hill 1985). In fact, Ache (Hill and Kaplan 1993; Kaplan and Hill 1985), Hadza (Hawkes et al. 1991, 1996), and Hiwi (Gurven et al. 2000) hunters often provide caloric benefits to individuals outside of their families in excess of what they provide to their wives and children. Furthermore, in at least some ecologic contexts, it has been shown that males could provide greater quantities of food, in terms of calories, to their families if they gathered

more plant foods and spent less time and energy hunting (Hawkes 1991; Hawkes et al. 1995, 2001; Hurtado and Hill 1990). These findings are not compatible with the “do what you can” approach to the division of labor. An alternative explanation is that female foraging practices focusing primarily on the procurement of plant resources are designed to maximize the consistency with which food is procured (Bird 1999; Hawkes et al. 1997; Hurtado et al. 1985), as part of women’s reproductive strategies. Ensuring that their children’s caloric and parenting needs are provided for is more compatible with a subsistence strategy based on gathered resources. While adults may be able to tolerate considerable fluctuation in daily caloric consumption, children and pregnant or nursing women are more prone to the detrimental effects of periodic shortfalls (Frisancho 1993). Consequently, for these groups a reliable source of calories is more important than the average number of calories over the long term.

Male reproductive strategies in contrast may seek to maximize mating opportunities, and would benefit from activities that increase their social visibility and prestige. Hunting is then construed not only as a purely economic endeavor, but it is also a way of showcasing prowess in order to increase a male’s attractiveness to potential mates (Hawkes 1991, 1992). The risks and variance associated with hunting are more compatible with, even integral to, the male reproductive strategy (Bird 1999; Hawkes et al. 2001). This perspective does not imply that males and females do not cooperate, or that male hunters do not procure game in order to feed their own children, only that differences in the types of resources targeted are at least in part due to reproductive goals. Resource specialization by sex then becomes not simply a means of providing greater

good to individuals within a cooperative group, but the result of sex specific reproductive strategies which may conflict. The conflict arises between foraging to procure goods to provision one's children and family, or foraging to procure goods which can be widely distributed and enhance ones status, and consequently mating opportunities, among the group.

Whether construed as the de facto result of different physical capabilities of men and women or the product of reproductive goals, the division of labor exists as an empirical fact in almost all hunter-gatherer societies and can be expected to differ depending on the types of resources available and how labor is allocated to procure them.

As recently summarized:

“Sex differences are predicted to be weaker or more cooperative where both males and females gain greater benefit from investing in offspring and their common goals are likely to result in cooperative foraging on resources that provide high consumption benefits. This might occur where large game is not available, where resources are captured more synchronously and predictably or are more narrowly shared (e.g. among net hunters and desert small game hunters), and where men gain more benefits from provisioning and fewer from competition...” (Bird 1999:72-73).

### Task Differentiation and Gender

When confronted with a variety of tasks, decisions must be made regarding how to allot ones time and labor to each specific activity. Time Allocation theory rests on the founding principle that time expenditure is not random, but is optimally partitioned in relation to the constraints, costs, and benefits associated with each task in the repertoire of activities performed by an agent or group (Hames 1992; Juster and Stafford 1991;

Grass 1984). Questions of “who does what” and for “how long” can be addressed as labor decisions and divisions reflect rational strategies adopted by the agents involved. Age, gender, social status, and related factors such as skill, strength, knowledge, and ability can then be examined without relying exclusively on culturally specific concepts such as “social norms” and “work attitudes”. The basic premise of Time Allocation, namely that the amount of time engaged in specific activities is the product of rational decision making, provides a useful construct for examining the preceding analysis.

Constraints, costs, and benefits manifest at multiple temporal scales, as optimal task allotment can be configured on the basis of hourly, daily, seasonal, or larger units of activity time. The costs and benefits of a necessary and/or potential task must be configured relative to other possible activities and the gains per unit of time spent. Time allocation studies frequently focus on two currency optimizing strategies by individual agents; time minimization and energy maximization (reviewed in Hames 1992). The amount of time spent engaged in procurement activities is designed to either maximize the amount of resources accumulated per time unit spent, or to minimize the amount of time spent per unit of resource. When multiple agents comprise the economic unit (such as a family, band, or tribe), time allotment will likely involve the additional variable of task partitioning.

By dividing tasks among cooperative members of a group, allotment involves both the optimal use of an individual’s time, and the optimal use of the available labor pool. Completion of various tasks may entail differential constraints for possible task participants due to differing reproductive goals, abilities, and skills, because all members

of the labor pool may not be created equal. While sounding dangerously close to some form of group selection, what I am suggesting is that while male and female labor strategies may be structured by their own reproductive goals the manner by which these goals are fulfilled may not be mutually independent. The relationships between the types of plant foods procured, the time spent foraging, and participation in other activities identified in relation to meat use could then be construed as differences in the way male and female goals are met through their time and labor allocation. As a result, the patterns documented below need not result from the altruistic intentions underlying the “do what you can” approach to the division of labor.

#### Gathered Foods & Labor Relative to Hunting

In light of the general dichotomy between male and female foraging goals and the attributes of different resources classes, some basic predictions regarding which resources should be targeted can be generated. First, if the types of plants utilized are wholly independent of the amount of meat procured, then gatherers should always target the most high ranked plant foods available. Regardless of the quantity of prey taken, gatherers would be expected to procure plants which satisfy the subsistence needs of themselves and their dependents in the shortest amount of time with the least amount of effort, maximizing time for other activities. Alternatively, if plant foods serve to minimize the risk and variance associated with hunting, then the predominate type of plants used should respond to the subsistence needs of both gatherers and hunters. As hunting becomes increasingly less reliable and contributes less to the overall diet

maximization of the total plant caloric yield could then be expected. As the dependence on or availability of meat decreases, lower ranked plant resources can be expected to enter the diet.

So what plants do hunter-gatherers predominately eat? Based on the staple plants utilized by a sample of 71 hunter-gatherer populations analyzed by L. Keeley (1995:Table 9), plant food type and dependence on hunting show some consistent relationships (see also Figure 3.4). Plant foods divided into eight classes, and as arranged on the x-axis represent categories of increasing caloric value per gram and increasing processing costs. A distinct wedge-shaped distribution is apparent in Figure 5.3a. When less than 50% of the diet is derived from terrestrial game, a broad diversity of staple plant types is represented. Greater dependence on hunting is associated with a narrower range of plants, and these are predominately fruits and vegetables. Of the forager groups that derive over 50% of their subsistence from meat, none have staples of nuts and seeds. Adding aquatic meat sources to the comparison presents a somewhat different distribution in Figure 5.3b. As the percentage of meat in the diet decreases, the range of plant staples utilized increases. With little to moderate use of hunted or fished resources, the majority societies sampled have predominately nut- and seed-based plant economies. The use of fruits, vegetables, and roots is highly variable but these are the most common staple plant foods utilized in hunting dominated foraging societies.

Although these trends suggest of broad scale relationships between hunting and the types of foods gathered, it is important to determine if they are the sole result of differential availability of plant types due to environmental variability. While the

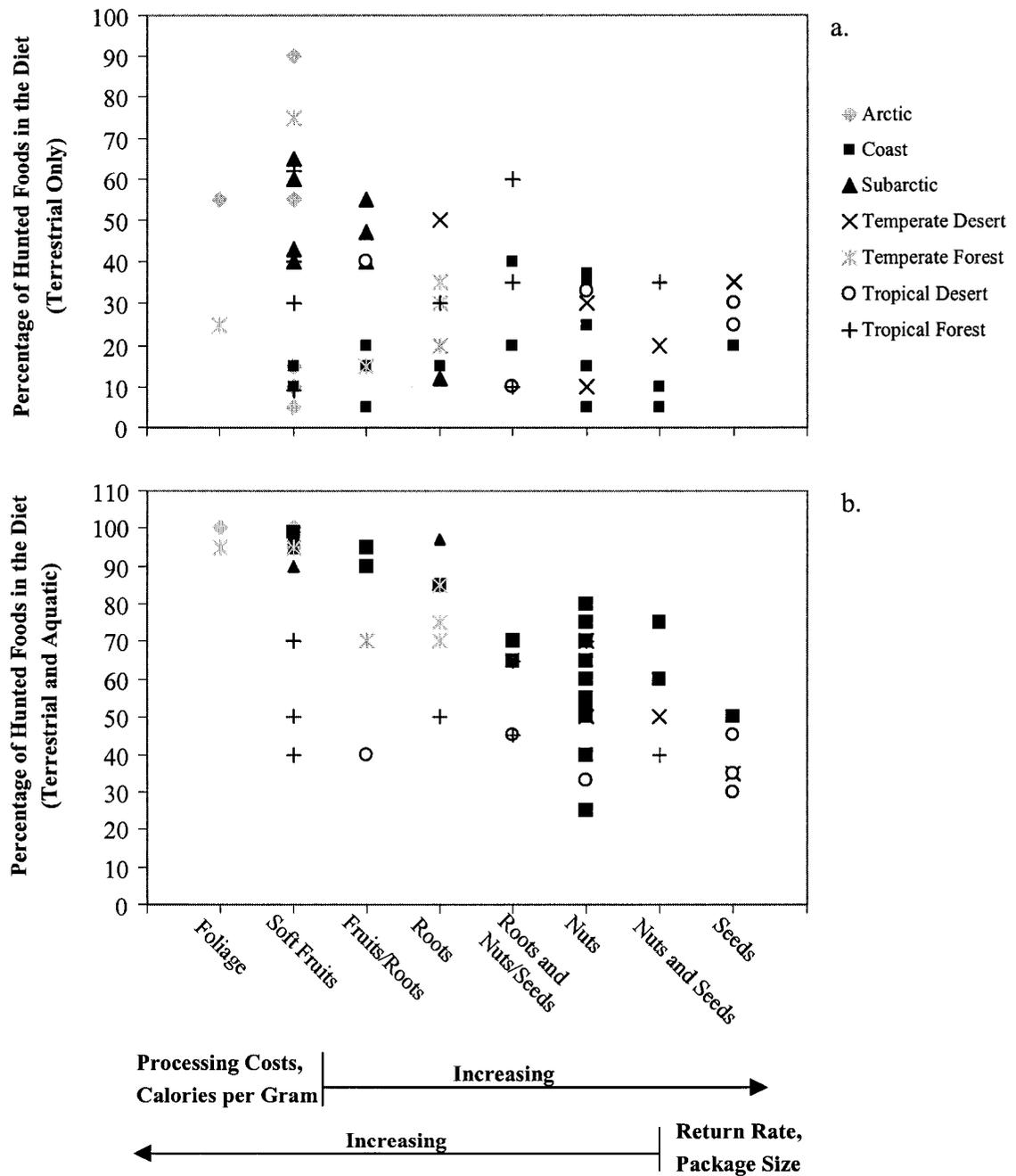


Figure 5.3: (a) (top) Staple plant use relative to dietary dependence on terrestrial meat. (b) (bottom) Staple plant use relative to dietary dependence on terrestrial and aquatic sources of meat. Processing costs increase from left to right along the x-axis, and return rates decrease, for each plant type (data from Keeley 1995: Table 9).

possibility that some plant types are unavailable or occur too infrequently to be regularly exploited, it remains difficult to attribute the overall pattern to environmental factors.

With the exception of arctic and subarctic groups (which have few plant types available and are poorly represented in the sample), hunter-gatherers in the remaining environmental categories (coastal, temperate, and tropical regions) display a wide range of variation in staple plant use and have a relatively wide range of plants available to them. This point was first made by Keeley (1988, 1995) with regard to environment among other factors. He shows that plant use generally decreases with latitude, and finds that staple foods are increasingly dominated by nuts and seeds as reliance on hunting and fishing declines. So although the specific plants being utilized as staples varies between environments, the fact that nuts and seeds as a resource class are not utilized as staple foods unless hunting contributes relatively little to the diet suggests this relationship is not entirely due to the environmental availability. If it were, the availability of meat and nuts/seeds would be negatively correlated. As Keeley notes, the explanation for the negative relationship between hunting and dependence on seeds/nuts is the high processing costs of the latter. Foods with processing costs are commonly interpreted as the last resources to enter the hunter-gatherer diet prehistorically (Keeley 1995; Edwards and O'Connell 1995), and at least among the Alyawara seeds were the first resources abandoned when other foods became available (O'Connell and Hawkes 1981).

If women in societies that have a less than 50% dependence on meat primarily collect relatively costly resources, then they are also likely devoting considerably more time to gathering and processing plants than their counterparts in societies with more hunting based economies. Do these women work longer hours? Unfortunately, forager time allocation data differentiated by gender is not widely available. A small sample of data for eight foraging populations is assembled in Table 5.2. The average number of minutes spent foraging per day represents primarily the amount of time women were engaged in plant procurement activities. The average time spent does not include processing collected resources, only the amount of time spent away from their residences while foraging. For all groups, the data represent the mean values for a minimum of 6 women over a 3 month period, and all are considered representative samples of female labor in the societies studied by the original researchers. The proportion of the diet derived from meat represents the estimated value for each group as presented by the

Society	Minutes Spent Foraging (Daily Average)		Percent of the Diet from Meat	Reference
	Male	Female		
<b>Kung</b>	249.0	152.0	<b>33%</b>	Lee 1979
<b>Ache</b>	417.0	79.0	<b>80%</b>	Hill et al. 1986; Hurtado et al. 1985
<b>Hadza</b>	249.0	240.0	<b>20%</b>	Hawkes et al. 1997; Woodburn 1968
<b>Hiwi</b>	108.0	106.0	<b>57%</b>	Hurtado et al 1990
<b>Kade</b>	489.7	284.1	<b>20%</b>	Tanaka 1980
<b>Batak</b>	246.0	174.0	<b>30%</b>	Kelly 1995
<b>Gunwingu</b>	174.0	138.0	<b>40%</b>	Altman 1987
<b>Agta</b>	359.0	100.0	<b>23%</b>	Rai 1990

Table 5.2: Summary of time spent in the procurement of food resources for 8 hunter-gatherer societies. The percent meat in the diet is based on absolute values or estimates provided in the referenced source material from which the time allocation values were collected, the Hadza meat estimate is taken from Woodburn 1968.

original researchers. The data are problematic in the sense that observation and recording procedures varied among the researchers, as well as how strictly they defined subsistence “work”. For the Gunwingu and the Agta, the data certainly represent time spent gathering plants along with activities such as fishing (and for the Agta women, hunting). While data on the Hadza, Ache, and Hiwi, were all collected by researchers using similar methods. The data be must be considered only a rough approximation of women’s subsistence labor, and comparisons between the eight societies must be considered somewhat tenuous.

Women’s subsistence work is negatively correlated with dietary importance of meat, based on the amount of the diet comprised of hunted game and the average number of minutes women spent per day engaged in subsistence activities ( $p = <0.001$ ) (Figure 5.4a). The data, excluding the Agta, present a clear non-linear trend, as meat contributes less to the diet women work increasingly longer hours. If the constituents of the diet are transformed to a ratio, the amount of “other” food (which includes plants, aquatic resources, and store bought and traded food) relative to meat, the relationship is linear (Figure 5.4b). With the exception of the Agta, women in societies where the majority of food is derived from hunting, or primarily male labor, work significantly fewer hours out of camp procuring food than women in societies with more plant based economies. Why the Agta deviate from the pattern is unclear. The fact that nearly 50% of their diet was derived through trading hunted game for agricultural products (Rai 1990:85-96) would suggest that the amount of meat in their diet is considerably less than the amount of meat actually procured. As such, Agta women’s foraging hours may reflect the amount of

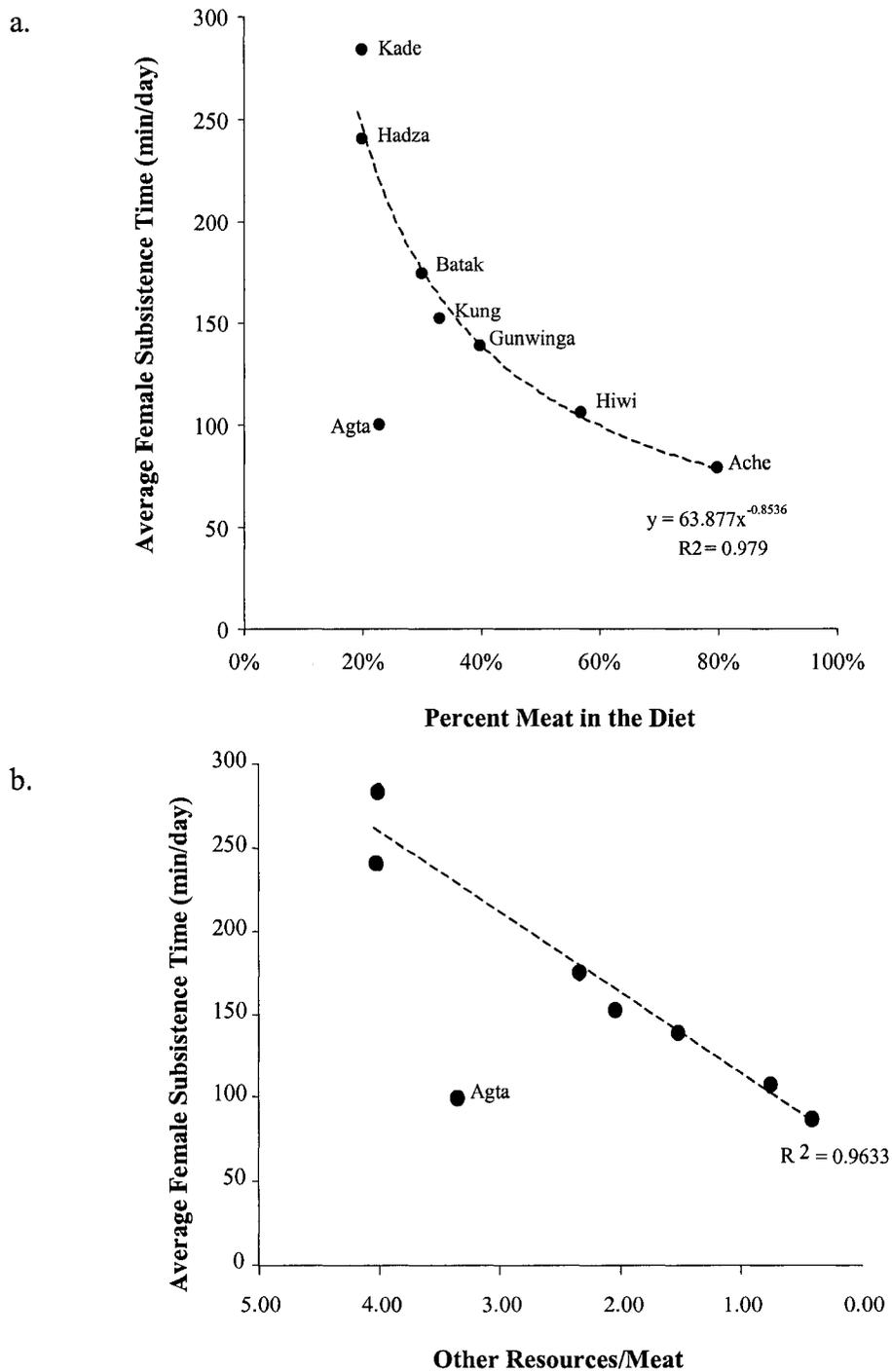


Figure 5.4: (a) (top) Scatterplot of average female foraging hours and percent meat in the diet, regression excludes the Agta. (b) (bottom) Average female foraging hours plotted against the ratio of other resources to meat in the diet, (calculated as the percent non-meat/percent meat), meat contribution increases as the ratio approaches zero, regression excludes the Agta.

meat hunted but not necessarily available for consumption. It must also be noted that the Agta are the only group in which women actively hunt fairly large size game (Estioko-Griffin and Griffin 1981), so their average foraging minutes includes hunting as well. Based on both the types of resources gathered and the amount of time spent

It is difficult to make direct comparisons of the trends presented in Figures 5.3 and 5.4 due to inherent differences in the data. However, it can be expected that women who target high ranked plant resources should have correspondingly shorter subsistence work hours. Analysis of Hadza foraging patterns by Hawkes, O'Connell and Blurton Jones (2001) has established that the wives of better hunters (those who bring in more game than the average male) actually work longer hours than the wives of less successful hunters. They interpret this positive relation in male and female work effort to mean that better hunters attract better wives. While male and female work effort may be positively related among the Hadza, and perhaps in some other societies as well, cross-cultural comparison generally indicate a decrease in the amount of time allocated to food resource procurement relative to meat dependence.

Conversely, women may spend relatively little time engaged in subsistence activities in societies where meat constitutes a major percentage of the total diet. It can then be asked: how are these women spending their time? Women's subsistence efforts may differ in relation to the amount of meat in the diet in two ways: the types of plants utilized and the time spent procuring them, and/or in their participation in activities that facilitate the hunting success of others (i.e. men). Some obvious facilitating activities would include participation in locating and aggregating prey (e.g. involvement in game

drives) and the manufacture of hunting related technology including clothing, weaponry, and transportation equipment. Women are well documented ethnographically to participate in these roles. Among Plains bison hunting (Ewers 1949; Kehoe 1995; Peters 1995), high latitude reindeer hunting societies (Binford 1991; Giffen 1930; Halperin 1990), and tropical net hunters (Bailey and Auger 1989; Hart 1978) women often played a critical role in surrounding and driving game animals towards male hunters. It must also be considered that the more tasks women perform the more time and energy males can potentially devote to actual hunting.

To explore how task differentiation between the sexes relates to hunting, data on the predominant gender that performs eight common activities was assembled for a sample of 35 hunter-gatherer societies. Activities include weaving, pottery making, butchery, house building, rope making, leather working, basketry, and burden carrying, and are drawn from data published by Murdock (1973, 1986). As originally tabulated the data included the presence/absence of each task and whether each activity was performed exclusively or predominately by a single gender, performed equally by both, or performed by both but with one gender predominating (described in Murdock 1976:203-204). I have simplified the data further by assigning each task as either preformed predominately by males, females, or as performed by both. Since the total number of these tasks preformed varies by society (few produce pottery for instance), the total number of activities performed in each society was used to create the percentage of activities performed predominately by men, by women, or by both genders. This

measure of task differentiation is compared to the percentage of the diet comprised of meat.

If women in foraging societies with hunting based economies are using the time they are not spending procuring food resources to carry out other activities, a positive relationship can be expected between my measure of task differentiation and the amount of meat in the diet. A significant positive relationship does exist between these two variables ( $p < 0.05$ ) (Figure 5.5). Although considerable variation is present, there tends to be a greater degree of female-dominated tasks as meat dependence increases. Aggregating the data into four groups with differing amounts of meat in the diet (0-25%, 25-50%, 51-75%, and 76-100%) makes the differences even clearer (Figure 5.6); setting

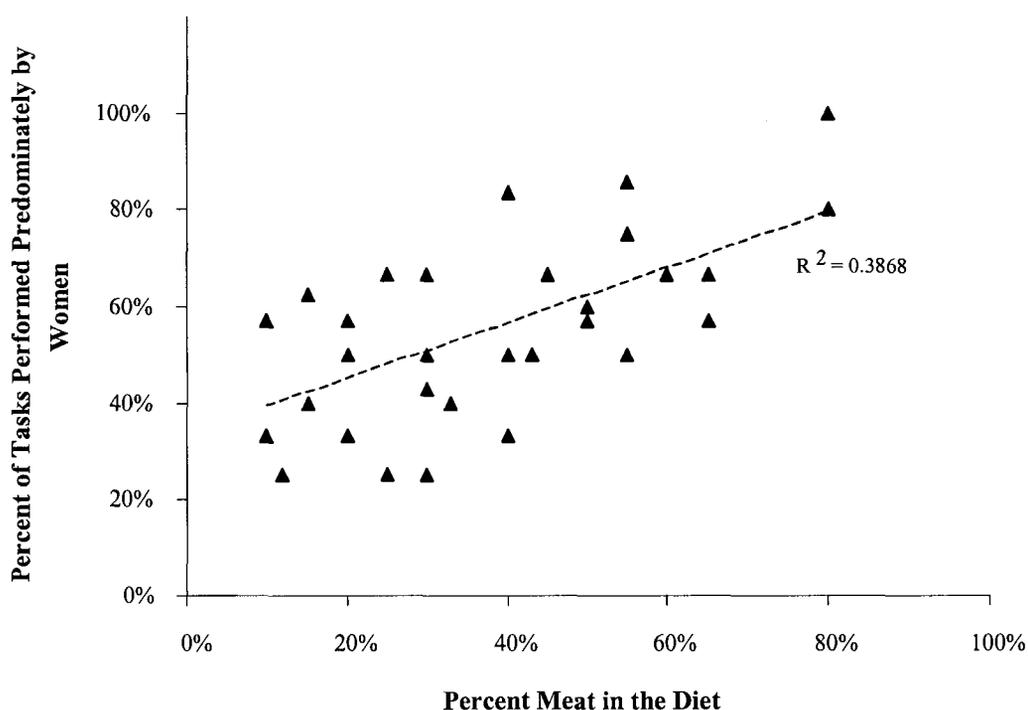


Figure 5.5: Scatterplot of the percent of female non-food procurement tasks relative to the amount of meat in the diet.

the 76-100% group particularly apart. The percentage of tasks performed by each diet subset represents the sum of all activities performed by the groups in each sample segregated by sex. The number of tasks performed by women is dramatically greater than those performed by men in the most meat dependent group, but some difference is present once the diet exceeds 50% meat (Figure 5.6). A chi-square test of the four diet sub-groups and the activity data (including female, male, and equal sex participation) is not statistically significant, or is at least not statistically robust ( $\chi^2 = 11.55, p < 0.073$ ). However the overall trend suggests that women's participation in the eight tasks recorded increases relative to the amount of meat in the diet, with the greatest difference between the sexes present in the most meat dependent societies. The extreme set is arguably the most relevant to Clovis peoples.

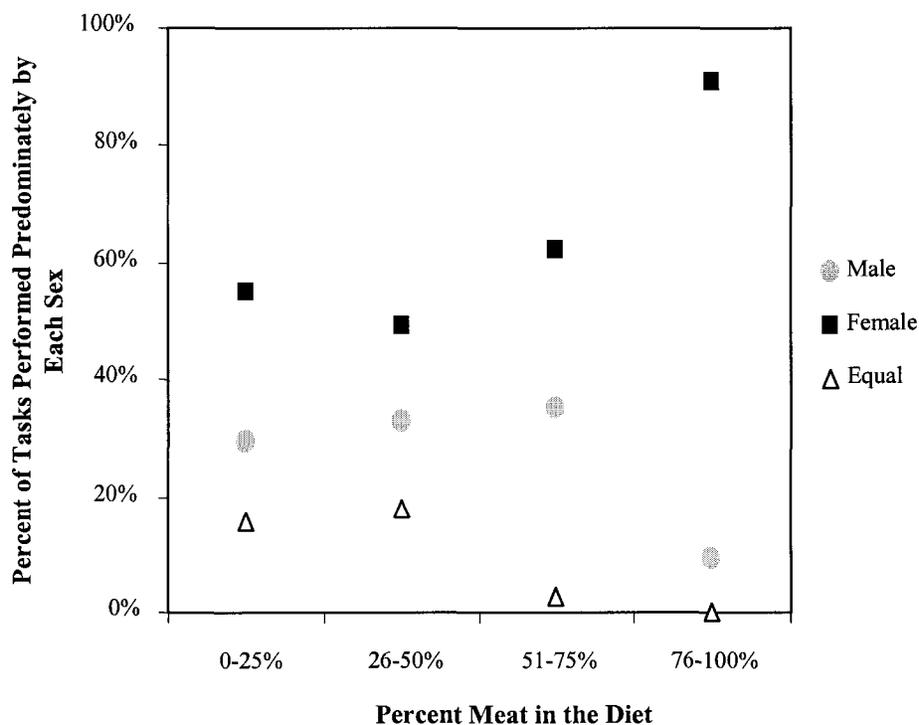


Figure 5.6: The percent of all tasks performed by each sex, or performed equally by each sex, relative to the percent of meat in the diet.

Specific tasks that become increasingly dominated by female labor as meat dependence increases include house building, leather working, and burden carrying. All three of these tasks are performed by nearly all groups in the sample (in nine cases leather working, and in three cases burden carrying were not recorded by Murdock) and are presented relative to hunting in Figure 5.7. The increased involvement in house building and burden carrying suggests women's labor is linked to moving and establishing new residential camps. Measures of hunter-gatherer mobility, both in terms of the number of residential camps established and the distances between moves, are known to be positively associated with reliance on hunting (Binford 2001:269-280; Kelly 1995:111-160). Women not only perform these roles more commonly than men when the majority of the diet is derived through hunting, but also likely perform these tasks more frequently

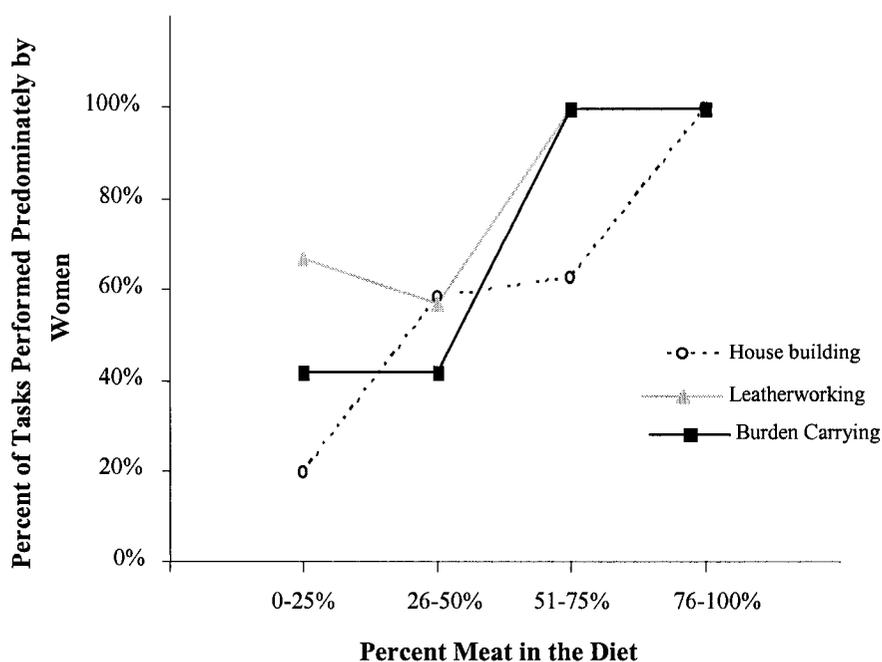


Figure 5.7: Percentage of house building, leatherworking, and burden carrying performed predominately by women relative to the amount of meat in the diet.

as well. Chi-square statistics on these three activities, segregated into four categories of meat use and including activities preformed predominately by women, men, and both sex, are not statistically significant for each individual task. However, if these tasks are combined and the total number performed by each gender within each diet category, the relationship is highly significant ( $\chi^2 = 17.37, p < 0.008$ ).

What has been established so far is that as the percent of meat in the diet increases, (1) plant gathering activities tend to focus on high post-encounter returns from items such as fruits, roots, and vegetables, and processing intensive plants foods like seeds and nuts are generally avoided; (2) the average amount of female time spent in the procurement of food decreases with the proportion of meat in the diet; and (3) female participation in non-subsistence activities increases in societies with hunting dominated subsistence economies. I interpret these general relationships to reflect a substantial difference in the organization of labor between predominately hunting- versus predominately gathering-based forager economies. As female labor is increasingly oriented to tasks other than direct food procurement and especially activities that facilitate hunting, male hunters may have potentially more time and energy to devote to resource acquisition. So what are women doing when male hunting provides the majority of food? Quite a bit: foraging for high return plant foods and/or performing a variety of material production tasks, hauling goods around, and constructing shelters.

The ethnographic record of large-game hunting foraging peoples of arctic and plains regions of North American provides a rich source of documentation regarding the importance of women's labor to the subsistence economy:

#### Inuit (group unspecified)

“The less important animals, birds, reindeer fawns, foxes, marmots, squirrels, are often taken by the women, presumably while the men are engaged in the more arduous hunting of big game...” (Giffen 1930:7) “In the transportation of goods, when there is neither snow for sledging nor waterway for the use of boats, recourse is had to carrying on the back. Both sexes engage in this, but the men seem sometimes to have been more lightly burdened in order to pursue game, should any be sighted” (Giffen 1930:24).

#### Nunamiut

“It should be noted that most of the daily tasks are performed by the women in the proximity of the house. The women play a major role in their daily maintenance of the household; they provide a base from which the men are able to search the countryside for game and the highly valued fur-bearing animals” (Gubser 1965:76).

#### Assinboine

“In camp, women dressed the skins and cut up the dried meat... They made the family’s clothing as well as the tepee cover, cared for young children, gathered wood and hauled water, and were responsible for packing, unpacking, and setting up the tepee when the camp moved” (DeMallie and Miller 2001:575-6).

#### Gros Ventre

“Women’s activities varied seasonally... In the spring they collected roots and berries... During the summer the women moved camp six or seven times to allow the hunters to follow smaller herds of buffalo” (Fowler and Flannery 2001:679-80).

#### Lipan Apache

“Because the antelope was not considered a dangerous quarry, the event was treated as a festive occasion and as an opportunity for women to demonstrate their riding and roping skills. Etiquette required that a man should not overtake and pass a woman who was chasing an antelope... Another event in which the women participated as equals was the rabbit surround... (Opler 2001:946).

The relationships between women’s food procurement of low risk resources, technological production, and other tasks should have consequences for the formation and character of the archaeological records produced by foragers of the past.

## CHAPTER VI: CLOVIS LABOR ORGANIZATION

The assumption that a hunting-based subsistence economy necessarily implies some degree of male dominance remains prevalent in archaeological interpretations of prehistoric foragers (Conkey and Spector 1984; Dobres 1995; Gero and Scattolin 2002; Kehoe 1983; Sanday 1981). When hunting, especially of large prey, is the primary means of subsistence the archaeological record is often implicitly assumed to be the result of male agents. Rarely however is the exact manner and context in which the presumed “dominance” is exerted formally expressed, whether it extends beyond the subsistence realm into control of social, political, or ideological dimensions remains unclear. What is clear is that, because the act of hunting is a predominately male activity, inferences about other attributes of prehistoric foraging societies such as mobility regimes, technological strategies, and mating systems are (whether purposefully or by default) structured largely around male activities (but see Surovell 2000). Consequently, our perspectives of prehistoric hunter-gatherers are often skewed towards what are traditionally considered male concerns such as hunting and the production of weaponry. As recently summarized:

“It is all very well to establish where the first Americans came from and how they got here and when, but a far more important question in the long run is surely this: How did they go about the business of living and succeeding in a new land? For a century in New World studies and more than twice as long in the Old World, the lifestyles question has been focused on what males did....In the Clovis scenarios, they (females) are largely ignored, except to be imagined as something of a drag, slowing down the great intercontinental bloodbath (Adovasio and Page 2002:286).

In fact, Paleoindian archaeology is often singled out as a research arena with a particularly egregious use of gender stereotyping (Adovasio et al. 2001; Gero 1995). Portrayed in a limited array of roles, primarily as plant gatherers, hide scrapers, and breast feeders, women's activities are often presented as unimportant to the primary Clovis occupation—killing megafauna. While the activities mentioned are generally associated with females in recent hunter-gatherer societies, arguments drawn strictly from analogy leave little room to identify behaviors of prehistoric female foragers that may not be well represented in the ethnographic record. Given the economic evidence of Clovis subsistence, perhaps most closely aligned with only the most meat dependent foragers, their division of labor may be not be well represented ethnographically.

There is some element of truth to the characterization of women as plant gatherers, hideworkers, and certainly breast feeders. However the assumption that these roles are peripheral to male activities and/or are the only activities hunter-gatherer women perform is based on naïve interpretation of the ethnographic record. Unfortunately, studies that have attempted to clarify the role of female labor in Clovis economies tend to gravitate almost exclusively to the roles of providing plant products, manufacturing perishable technological items from plant products, or processing the animals killed by men (e.g. Gero 1995; Hudecek-Cuffe 1998). By emphasizing their role as plant gatherers, and perhaps the procurers of small game (Adovasio et al. 2001) it is further assumed that these activities provided a substantial component of Clovis subsistence and technology (Adovasio and Page 2002; Dillehay 2000; Dillehay and Rossen 2002; Johnson 1991; Meltzer 1993; 2002). Due to the current lack of empirical

evidence attesting to frequent or widespread use of plant resources as a food or raw materials (with the notable exception of Monte Verde [Dillehay 1997]), arguments concerning women's labor in this area remain largely conjectural. It cannot be denied that plant resources were utilized (see for instance Dent and Kaufman 1985; Tankersley 1994), but it seems unlikely that plant products, given their apparently specialized hunting strategy, would have provided a significant source of calories to Clovis foragers. Their presumed exclusive role of women as plant gatherers, coupled with the lack of clear archaeological evidence attesting to any widespread use of plant resources, has led to considerable disagreement regarding both female and male economic roles among Paleoindian populations. Clovis peoples did appear to utilize small game animals (Grayson and Meltzer 2002; Meltzer 1993) to a modest degree, and many of them, if not most, were easily collected types with low procurement costs (e.g. turtles and tortoises) which may not have been hunted exclusively by males. This is all the more reason to expect that women's labor may have been consumed with tasks other than plant gathering.

### The Incredible Shrinking Women

In the movie *The Incredible Shrinking Woman*, Lily Tomlin slowly diminishes in size over the course of the film. Clovis women are often interpreted much like thousands of little Lily Tomlin's. Their archaeological presence slowly diminishing as artifacts and evidence of their labor literally pass unnoticed under our trowels, slip through our sediment screens, and even our models. There is much agreement that until adequate

attention, through more detailed excavation and collection techniques (i.e. flotation and the collection of macro-botanicals), is paid to establishing the presence and extent of plant gathering activities the role of women will remain ambiguous (Dillehay and Rossen 2002; Johnson 1991; Meltzer 1998; Meltzer and Smith 1986). But equating women with plants, and perhaps small game alone, may not provide as much insight into the issue as we would be like. Instead, dichotomy has emerged among Paleoindian archaeologists; proponents of the interpretation that Clovis subsistence focused on the hunting of big-game are accused of ignoring women by advocates of an “engendered” view, which posits that subsistence was more generalized and included a substantial proportion of plant foods procured by women (Adovasio and Page 2002; Dillehay 2000; Gero 1995). Clovis peoples were either big-game hunting male dominated societies, or they were generalized foragers with women playing a prominent role in subsistence. As such, arguments concerning the role of male and female labor are reduced to establishing who provided the majority of food. Since the evidence for plant use is so scant, those favoring the latter are free to interpret the role of female labor essentially any way they want. While appealing, this position is ultimately based on appeals to negative evidence and denial of the faunal record as we currently know it.

I clearly favor the interpretation of Clovis peoples as specialized hunters, but I see no reason to view women as peripheral economic players in Clovis society. I have no magic solution to transform the paucity of plant evidence to its rightful place, if it has indeed been significantly underestimated. Alternatively it is worth exploring how a hunting based economy, which can be investigated archaeologically, may impact

women's labor in other ways. The implications, in terms of the types of food women procure and their role in other activities as outlined in the preceding chapter provides a useful starting point or at least a potential way out of the current stalemate.

Following out the assumption that women's labor is only manifest in either the procurement of plant foods and/or the manufacture of material goods from plant products, the archaeological signature of female labor could potentially "shrink" in three ways. First, direct evidence attesting to the frequent use of gathered food resources (i.e. botanical remains) could become overwhelmed due to the better preservation of faunal remains. Reliance on hunting could then be construed as significantly over-represented in the Clovis archaeological record, a position many researchers advocate (Dillehay 2000; Meltzer 1988, 1993, 1995). Similarly, indirect evidence of gathered foods such as the technology used to process or procure plants could be underrepresented in Clovis technological assemblages. One small grinding stone from Blackwater Draw (Hester 1972) and two "cobbles" possibly used for pounding/grinding plant products from the Michaud site (Spiess and Wilson 1987), while often mentioned as confirmation for plant use, these certainly do not indicate that such tools were common implements in the Clovis technological inventory. In fact, their functions remain ambiguous. On the other hand, high yield-low cost plant foods require less equipment. The lack of gathering related tools could also occur because plant procurement/processing tools were preferentially manufactured using perishable materials (Dincauze 1993; Adovasio et al. 2002). because we do not yet have a representative sample of Clovis residential sites where such technologies were presumably manufactured, deposited, and/or utilized

(Meltzer 1993, 1995), or because components of the tool kit that may have served plant processing functions have not been identified as such from microwear or experimental evidence.

The first two issues, the extent to which plants contributed to the diet and the visibility of plant processing and procurement technologies, are certainly related. The more plants contribute to the overall diet the greater the reliance on processing intensive resources such as nuts and seeds (Keeley 1988, 1995). Investment in specialized plant processing technologies is often associated with these particular resources (Edwards and O'Connell 1995; Hayden 1981; Wright 1994). In addition, specialized features related to plant processing, such as cooking and storage facilities are also typically associated with bulk harvesting and processing of resources (Smith et al. 2001; Wandsnider 1997). Procurement of resources such as fruits, vegetables, and some tubers may involve nothing more than a digging stick and carrying device and need little, if any, specialized processing technology, but these are generally not staple foods. In short, archaeological evidence of plant use is contingent upon the type and quantity of plants utilized, and might only become visible when plant products comprise a significant proportion of the diet. Investment in artifacts such as grinding slabs, mortar/pestles, and features like roasting pits is likely to occur only when plant resources become a significant source of calories to the total diet. Whether evidenced by a reliance on processing intensive plant foods or by bulk harvesting strategies, both imply that relatively large quantities of plant products are being utilized. It is difficult to establish just *how much* of a dietary contribution plants must provide before these material signatures become commonplace

within a foraging group's technological inventory, but conversely, without specialized technologies plants are unlikely to have been important contributors to subsistence.

Two basic attributes of Clovis plant use can be tentatively surmised based on their apparent hunting strategy: 1) plant resources likely contributed substantially less to the overall diet than hunted animals, and 2) the plants utilized were likely high post-encounter return rate items requiring little processing. Their specialized hunting strategy as documented in Chapter IV strongly suggests a predominately meat-based subsistence economy (see also Haynes 2002; Kelly and Todd 1998; West 1983). That the selection of prey documented in Clovis sites was geared towards the procurement of extremely large animals implies the preferred prey were available in sufficient quantities to meet, and perhaps exceed, their caloric needs. In contexts where population densities are low and large prey are available, specializing hunting and minimal plant use can be expected since fauna simply provide higher post-encounter returns than plant resources (Haynes 2002; Ugan and Bright 2001).

It can further be speculated that the types of plants utilized by Clovis peoples did not require intensive harvesting/processing procedures and technologies. The general trend documented in the previous chapter, and by others (e.g. Keeley 1998; O'Connell and Hawkes 1981), relating the types of plants procured and the proportion of plant foods in the diet suggests that only with substantial reliance on resources such as nuts and seeds would durable technological goods and features be evident archaeologically. The "negative" evidence on Clovis plant use may not be solely the product of preservation and/or site bias, but simply reflects the minimal use of plant resources. Rather than

assume the record is hopelessly biased towards the preservation of male activities and that the role of women will remain wholly conjectural until more evidence of plant use is found, why not entertain the hypothesis that plants probably played a minimal role in the Clovis diet and that women's activities were concentrated elsewhere?

There is a good chance that women's economic contributions will never be detected as long as the efforts of women's labor in Clovis societies are equated solely with plant gathering and are only evidenced archaeologically through plant materials and related technologies. If, as has been shown for ethnographically documented hunter-gatherers, women in the most meat-dependent foraging societies spend less time procuring food and more time engaged in the production of technology and performing non-subsistence tasks, then Clovis women likely spent the majority of their time *not* gathering plants. In this sense equating women solely with plant gathering is reducing their role in prehistoric societies to activities in which they may have spent little time and effort. The "shrinking" phenomenon may not be entirely the effect of preservational bias, but the inherent bias of archaeologists limiting female labor to the plant realm. The same can be said for Clovis use of small game. The dichotomy between the procurement of extremely large high risk prey such as mammoths and mastodons and the diversity of small prey documented in some Clovis faunal assemblages does not necessarily reflect the range of prey hunted by Clovis men. It must be considered that since there is proportionately a lot of easy collectables in the small game fraction, such prey may be representative of the procurement efforts of women or other non-big-game hunters.

### Women, Men & Technology

It has long been recognized that women in foraging societies often produce more perishable forms of technology. By preferentially manufacturing goods out of “soft” organic raw materials (i.e. plant products, leather, and sinew) as opposed to harder materials (i.e. stone, bone, antler, and wood), technological items manufactured by women are unlikely to be preserved in most contexts (Adovasio et al. 2000; Colley 2000; Gilchrist 1999; Murdock and Provost 1973; Soffer et al. 1998). This does not mean that women did not make and use tools made of “hard” materials. The pattern of female involvement in the production of goods manufactured out of perishable raw materials is drawn primarily from the recent ethnographic record wherein many items once made of chipped stone, bone, and antler/ivory had long since been replaced by metal. It is reasonable to question whether flintknapping would have been exclusively male activity where chipped stone figured prominently in hunter-gatherer technology. Archaeologically the technological inventory of Clovis consists almost entirely of items manufactured out of stone, and to a lesser extent bone and ivory. Thus there is no a priori reason to exclude women’s labor from their production, and it remains likely that both men and women also worked softer more perishable materials as well.

Observations among peoples who still manufacture chipped stone tools, such as the Konso hide workers of Ethiopia (Brandt and Weedman 2002), and among peoples who until recently knapped stone (Colley 2000; Gero 1991; Hamilton 1980), indicate that women often are or at least were actively involved in stone tool production. The

following ethnographic observations attest to the diversity of tools knapped by female hunter-gatherers:

Tiwi (axe)

“One old lady told me that the ground ax was a ‘proper good one and a proper old one’ ... The same informant said, ‘In old days, I can’t make proper ax so my auntie make me good one. She makes lots of good ax. Ax belong women, no more men’ ... We had several of our collected axes hafted, and the women who did this work showed no hesitation in preparation” (Goodale 1971: 155-6).

Central Australian Aborigine (woodworking tool)

“The dish measured 2 feet by 3 inches in length and by 11 inches in width and was cut from a hollowed tree. Several stones weighing about 6 lb. each were collected and one or two not less than 10 lb. in weight. The size of the dish was to be cut was worked out on the green bark with a rather light stone. Heavier stones were then used; they were lifted with both hands and stout blows struck until the whole outline of the dish had been cut through... The tools were simple sharp-edged natural stones which, after use, were re-sharpened by striking off rough flakes from their edges. The dish was hollowed out and finished by means of a stone adze” (Mitchell 1949: 13).

Cheyenne (scraping tool)

“The adze-like flesher was used to chip off thin flakes from the flesh side of the hide... In ancient times the cutting edge of this implement was of flint, bound to the horn with strings of rawhide, or sometimes of sinew. These elk-horn fleshers did not wear out, and were handed down from mother to daughter or niece, perhaps for several generations. It was a matter of pride for a woman to possess a flesher made by her grandmother or her grandmother’s mother... Women kept the metal blades of their fleshers sharp by whetting them, usually with a smooth quartzite pebble” (Grinnell 1972:214-5).

Crow (scraping tools)

“Women were the primary processors of raw materials for domestic use. Moistened hides were staked on the ground, and a buffalo foreleg fitted with a serrated bone chisel was used to chip off the flesh. Hair was removed with an elkhorn adze...” (Voget 2001:699).

Andamanese (cutting tool)

“In former times quartz flakes were used by the Andamanese for the two purposes of shaving and scarifying the skin...For shaving, flakes with a sharp blade-like edge are required; for scarifying, flakes with a fine point are preferred. A flake is used till its fine edge is lost and is then thrown away and another made. Thus a woman who is shaving some one’s head may use as many as twenty flakes one after another, and to obtain twenty suitable flakes she probably makes as many as forty or even more” (Radcliffe-Brown 1922:444-5).

Pitjandjara (woodworking tool)

“Women are expected to make digging sticks by chopping off a suitable length of mulga wood from a living tree, using the sharp edge of a large core or block of stone. They then sharpen the working end by half burying it in the fire hearth...The differential charring process is controlled by rubbing and scraping off unwanted wood, using the aforesaid sharp edged block as a tool...a crude stone implement of the type used by the women resembles the so-called ‘horesehoof core’ of the archaeologists” (Tindale 1972:245-6).

Native North American (group unspecified, multiple tools)

“The turning of the blocked-out material into knives for skinning animals, scaling fish and opening them, carving meat, preparing hides, cutting leather and fur skins. This work was frequently done in exquisite fashion, and the only implement the women used was a bit of hard bone or antler pointed at the end...” (Mason 1893:141).

Native North American (group unspecified, arrowhead)

“Mr. Peale said he had seen squaws chipping flakes into small arrow points, holding the flake in their left hand, grasped between a piece of bent leather, and chipping off small flakes by pressure, using a small pointed bone in the right hand for that purpose” (quoted in Holmes 1919:316).

Why flintknapping is frequently portrayed as an explicitly male activity has been reviewed elsewhere (Gero 1991, 2002). Few discussions of Clovis lithic technology explicitly refer to men as the sole flintknappers, but it is not difficult to conclude that this is the underlying presumption.

While ethnographic examples do not provide evidence that Clovis women necessarily knapped stone, they certainly do provide reason to doubt that they did not. Clovis and other large-game hunting peoples of the past provide what may seem the worst possible contexts for exploring gender roles, but it is worth considering that these might have been the contexts where female labor was most involved in the production of technology. As shown previously, women take on a greater share of the manufacturing and other activities as the contribution of meat in the diet increases. Large-game hunting societies may then provide the ideal contexts for exploring the role of women's labor through material goods. While I am not willing to assume that the specific activities identified in the previous chapter (leatherworking, house construction, and burden carrying) necessarily apply to Clovis women, I believe it is justified to expect that Clovis women took a prominent role in the production of technology. Further, since chipped stone was probably a fundamental component of that technology, it is reasonable to assume that women were active participants in its production. Beginning with the simple premise that women made tools, developing testable hypotheses for identifying and differentiating between multiple technological strategies in the archaeological record seems a more fruitful endeavor for examining the role of Clovis women than assuming they were busy gathering plants that we cannot recover. In a similar vein work by Dobres (1995, 2000) concerning European Upper Paleolithic bone/antler technologies is beginning to elucidate the role of women in these "hard" technologies as well.

Determining whether any given tool was made (and used) by a man or women seems very difficult if not impossible. Identifying multiple technologies strategies that may influence the manufacture and use of lithic technology is feasible. Although the production of lithic artifacts has received much attention by archaeologists, it is generally conceived of as a generalized strategy employed by prehistoric toolmakers irrespective of individual needs and goals. If organizational approaches to lithic technology are meant to elucidate the ways in which people solve problems (Bleed 1986; Kuhn 1995; Shott 1986; Torrence 1983), then the human component minimally involves men and women, two agents of production likely to be operating with different technological goals and constraints. To explore this issue in relation to Clovis I begin by questioning the predominant “one strategy fits all” view of Clovis lithic technology. I then develop some basic predictions concerning how multiple strategies resulting from a gendered division of labor might be established from lithic assemblage attributes.

#### Identifying Multiple Agents in Lithic Production

The Clovis literature typically portrays technological systems designed to conserve raw material under conditions of high mobility. Salient characteristics include core morphologies that minimize production waste, such as the use of bifacial (Bradley 1993; Stanford 1991) and blade cores (Collins 1999; Green 1963), and the use of high quality raw materials, often from distant source locations (Goodyear 1989; Stanford 1991). Biface production, particularly the manufacture of fluted projectile points using an *outré-passé* thinning technique is arguably the most diagnostic artifact and

manufacturing characteristic of Clovis technology (Bradley 1993; Frison and Bradley 1999; Stanford and Bradley 2002). A diversity of less morphologically distinct retouched flake and blade tools are also common in Clovis assemblages (Collins 1999a; Meltzer 1988; Stanford 1999). Studies emphasizing the debitage, non-bifacial tool and informal tool components of assemblages are relatively infrequent and rarely address how these technological aspects may contribute to any particular technological strategy.

Alternatively, analyses of non-bifacial formal tool forms, items such as spurred endscrapers and graters are generally geared towards identifying their functional roles (e.g. Grimes and Grimes 1985; Tomenchuk and Stork 1997).

While unifacial flake tools often constitute the majority of tools in Clovis assemblages (Meltzer 1988; Stanford 1999), the main interpretations of Clovis lithic reduction strategy are drawn from the production of bifaces. Focusing almost exclusively on hunting technology (i.e. bifacial projectile points), the Clovis toolkit is argued to be designed and produced in order to meet the technological needs of mobile hunters (Frison 1989, 1993; Pearson 2001; Seeman et al. 1994; Storck 1991; Tankersley 1994; Willig 1991; Young and Bonnicksen 1984). Conservation of lithic raw materials for both initial production and subsequent refurbishing of reliable weaponry, even when raw material may be scarce certainly is congruent with an emphasis on large game. It is generally further postulated that this strategy extends beyond the production of bifaces to encompass all of Clovis lithic technology:

“The well-designed and wholly integrated technology ensured a fail-proof reduction strategy with minimal loss of high quality stone. While individual knapping actions emphasized reduction of bifacial flake cores through detachment of thin flat flakes for apparent use as cutting tools, the

entire reduction technology was focused ultimately toward Clovis point production” (Wilke et al. 1991: 245).

Lithic studies that have examined early Paleoindian assemblages from the perspective of identifying potential sources of intra-group technological variability, have suggested that different tool forms may be produced from correspondingly different raw material supply strategies (Amick 1999), and that certain tool types may be associated with particular components of the labor force (Hall 2000; Jodry 1999). These interpretations are based primarily on distinctions between weaponry production (i.e. projectile points) and other tools presumably used to process game or other food resources (i.e. cutting and scraping tools) in Folsom technological systems. Amick’s analysis of raw material use in 13 Folsom assemblages indicates that, when lithic raw materials are locally available, maintenance tools (defined as all non-weaponry components of the assemblage) are preferentially manufactured using local sources. He attributes the dichotomy between projectile points made of exotic raw materials and locally made tools to differential mobility, and hence to lithic raw material access. Because males were likely to be more mobile due to their role as hunters, he argues that female access to lithic raw materials may have been more limited to source locations near residential camps. Jodry (1999) argues that Folsom ultra-thin bifaces, extremely thin bifaces which are often biconcave in latitudinal cross section (Root et al. 1999) functioned as women’s knives. She interprets ultrathins as specialized butchery tools—a task she associates with women’s labor.

Although drawn from Folsom rather than Clovis lithic technology, these Paleoindian examples suggest that particular tools or classes of tools may be manufactured and used by different segments of Paleoindian populations. The dichotomy between biface production and a core/flake based manufacturing strategy has been linked to the division of labor in other archaeological contexts (Gero 1991; Sassaman 1992a,b) and may represent a widespread phenomenon in labor allocation and mobility between genders. It is possible that the general strategy of maximizing tool use life and minimizing raw material waste may not be applicable to all components of Clovis technology. The following section outlines some basic attributes of lithic technology that may be differentially expressed between male and female tool makers. The effects of mobility on raw material availability and functional constraints on tool production and design are considered. Predictions regarding how different technological strategies may be identified using Clovis archaeological assemblages are then proposed. Since bifaces form the basis of current interpretations of Clovis technology, they are discussed as a point of contrast.

#### Hunter-Gatherer Mobility and Raw Material Access

Hunter-gatherer mobility is commonly divided into two distinct forms of movement, residential and logistical mobility. Residential mobility denotes the movement of co-residential groups (i.e. household and multiple household units) from residential camp (or “base”) to residential camp (Binford 1980). Logistical mobility refers to forays departing from, and returning to, residential camps (Binford 1980).

Residential mobility is a pattern shared by female and male foragers within a co-habiting group. However logistical mobility is unlikely to be equivalently expressed between the sexes. In terms of the distance traveled and the frequency with which logistical forays are made, two general differences can be identified. Women generally engage in shorter logistical trips than men (Jochim 1981:128; Kelly 1992; 1995:132-141; Surovell 2000; Watanabe 1968). Gathering plants and small game can often be accomplished near the residential camp, while hunting large prey generally requires searching for prey over large areas. The differences in distances traveled between female and male logistical trips are greatest if hunters focus on large prey. This may occur because men travel greater distances in their search for dispersed prey and/or because women may travel very short distances when reliance on gathered foods is minimal. Because large game is likely to be encountered less frequently than smaller prey, a specialized hunting strategy likely requires searching larger areas, resulting in greater logistical mobility for specialized hunters. While traveling shorter distances on average, females make logistical trips more frequently than males. While male logistical mobility is often sporadic, female procurement excursions occur on a daily or near daily basis (reviewed in Jochim 1981:128-133).

Among big-game hunters, women's logistical mobility patterns may thus be characterized by frequent short distance forays from residential localities while men engage in infrequent long distance trips. Assuming that the procurement of lithic raw materials is embedded in other activities, then men and women may have very different access to lithic sources. Women could have regular access to local raw material, while

men may have sporadic access to raw materials sources found either locally or at distances extending beyond the limits of female logistical mobility. If men and women are acquiring their own raw materials, then men are perhaps more prone to the constraints of limited raw material availability for the production of tools than women. If males have access to stone on a more sporadic basis, then although they may have access to both local and distant sources, procurement may be more sporadic and raw materials used conservatively to ensure an available supply. The emphasis on minimizing production waste interpreted from the reliance on bifacial weaponry may reflect a predominately male concern. Women, residing in areas with immediately available tool stone, may be freed from the constraints of limited raw material economy due to more frequent logistical mobility and highly conservative manufacturing strategies may not be necessary. Comparative analysis of raw material profiles between bifacial and core/flake assemblage components for Clovis residential sites would provide one way to explore the role of differential mobility in the production of technology. If particular tool forms and/or manufacturing strategy are consistently associated with the use of locally available materials, as with Amick's (1999) study of Folsom assemblages, then an argument for multiple technological strategies is warranted, and associating it to the division of labor is not far-fetched. This need not imply that only particular types or classes of tools are made of exotic raw materials, since residential mobility could result in the transport of tools over long distances, only that particular tools may be preferentially manufactured of local materials in residential site contexts.

As with raw material constraints due to mobility, the function and context in which tools are used are unlikely to be equivalent between the sexes. Weaponry is subject to unique constraints. Because it is used on moving targets in unpredictable contexts, design often associated maximizes features such as reliability and maintainability (Bamforth and Bleed 1997; Bleed 1986; Torrence 1983). While these concepts are difficult to clearly define or quantify, it is evident that once a pursuit begins the weapon being used must function well, since there is little or no time to fashion or repair it between the time of encounter and pursuit (Torrence 1983, 2001). The location where a weapon is needed is also unpredictable, since even if one knows where prey will likely to be encountered the exact location cannot be known. As a consequence of this unpredictability, manufacturing hunting tools which are portable, reliable, and easily repaired are ways to ensure their effectiveness (Oswalt 1976; Torrence 1989). As a means of reducing risk, which in this case refers to the probability of a tool failing to function when needed, the production and design of hunting technology may also be more constrained by the context of their use and manufacture than other tool forms.

Tools meant to function in predictable contexts can be made when needed and may not be subject to the same constraints. If women's activities are more predictably structured in time and space, the production strategy may be inherently more flexible. Since women are not likely engaged in lengthy logistical forays, their work is generally centered around residential camps, meaning their technology is used in more predictable locations and contexts. Women's tools can potentially be made as needed whereas men's hunting equipment may be made well in advance of their potential use. Such differences

would perhaps be reflected in the rate at which tools are discarded, transported, and refurbished. If particular tools or classes of tools consistently reflect a disregard for use-life longevity or greater variation in the morphology of suitable tool blanks, multiple tool-specific strategies may be evident. Differences between where tools are made and where they are utilized and discarded would also be apparent.

The distinctions between male and female technological patterns outlined above, rest on two potentially problematic assumptions. The first concerns the raw material environment in which men and women procure stone. When lithic material is not available locally, the production of tools for low risk predictable activities would be derived from distant sources. In such cases all tools, regardless of the mobility patterns of their producers, would be manufactured using similar raw materials. Consequently, the relationship I have proposed between women's mobility and use of local tool stone would not hold when distant sources are the only option available. Second, I have assumed that women were not engaged in the production of bifacial weaponry. This may be an erroneous assumption, especially in light of the dominant role women in ethnographically documented large-game hunting societies play in the manufacturing arena.

Establishing reliable means of identifying the role of men and women in prehistoric technology is no easy task. We are only beginning to understand how very general subsistence and technological strategies can be identified archaeologically. Attempting to interpret the signatures of multiple contemporaneous strategies is certainly difficult, though not impossible. If multiple strategies exist (which they likely do) in

forager societies, the manufacture and use of particular technologies and raw materials may reflect different technological constraints of the agents who produce them. Without the ability to compare the manufacturing behaviors of individual foragers and to assess the degree to which they reflect variation within a single strategy or represent distinct strategies, archaeologists must rely on attributes of the composite record of foraging and technological behaviors.

Cross-cultural ethnographic comparisons give no reason to assume that the labor of Clovis women was peripheral to the economic system or limited to plant gathering roles. Rather than assume that big-game hunting necessarily equates to male dominance in the food quest, it should be acknowledged that the ability to devote time and energy to hunting is facilitated by the labor of non-hunting individuals. By taking on a greater proportion non-subsistence tasks, women's labor was likely to have been an integral component the Clovis big-game predation strategy. While it may be easier for Paleoindian archaeologists to outright the role of women such approaches may never yield a useful understanding of Clovis lifeways.

## CHAPTER VII: CONCLUSIONS

One longstanding issue in studies of hunter-gatherer economics is the degree to which foraging populations conform to traditional Western interpretations of work. Ideas about how “hard” foraging peoples do, or do not, “work” to make a living have varied from one extreme to another, and back again, throughout the history of hunter-gatherer research. The ethnographic record, as interpreted by some investigators, suggests that a hunting and gathering lifestyle is frequently associated with abundant “leisure” time. Hence questions regarding how time and labor are partitioned are treated as less important, since there is plenty of time and labor available to complete required tasks. Contrary to this view is the assumption that foraging is essentially an arduous economic activity that necessitates efficient use of all available time and energy to sustain. Fortunately these extremes have largely been replaced by a more realistic and theoretically useful understanding of the time and labor inputs associated with foraging economies. Yet the persistence of the “lazy” versus “hardworking” stereotypes have exerted considerable influence on the literature concerning forager time and labor use, and beg the question of whether time and labor constraints are relevant factors to the study prehistoric hunter-gatherer subsistence.

Longstanding categorizations of forager time and labor expenditure have generally reflected contemporary anthropological perceptions (i.e. stereotypes) of hunter-gatherer lifeways more so than documented labor patterns. Exemplified by Sahlins’ “affluent forager” in *Stone Age Economics* (1972), and with roots extending from the early 1600s (e.g., Lescarbot 1969 [1609]) to the late 20<sup>th</sup> century (e.g. Gowdy 1998), the

opinion that foraging peoples “work” relatively little and enjoy a quantity of leisure time unparalleled in other economic systems is a persistent theme in hunter-gatherer research. Whether interpreted as an intrinsic quality of forager nobility (reviewed in Ellingson 2001), affluence (Lee 1968; Sahlins 1968), or sheer ineptitude (McGee 1898), the removal of time and energy constraints as variables influencing behavioral decisions would render hunting and gathering based economies exempt from the strategic decision making processes underlying behavioral ecology. At the opposite end of the spectrum is the perception that foraging peoples live under conditions of extreme time, labor, and resource stress (Hobbes 1962 [1651]; Lubbock 1872). Based on the assumption that foraging is an inherently difficult mode of life requiring all available time and energy, decisions regarding which resources to take and what and who should perform particular tasks are also rendered somewhat moot since time and labor are always in short supply. These extremes have largely been tempered by greater recognition of the diversity of hunter-gatherer lifeways and a more relative understanding of “work” in foraging and other contexts. However these stereotypes persist, although in a more subtle form.

The nature of “work” and its expression in foraging societies is an issue particularly relevant to Clovis populations. Although few archaeologists would condone labeling Clovis peoples as either hardworking or lazy, it is not difficult to see the manifestations of these concepts in modern interpretations of Clovis lifeways. Were they savvy and brave hunters of megafauna, or humble generalized foragers relying on a diverse array of resources? Were women idling away their time while men hunted, or invisibly gathering the majority of food consumed? The subsistence decisions made by

Clovis peoples have implications for the organization of labor. While I cannot speculate on the personality traits associated with these stereotypical characterizations, the preceding analysis provides insight into the attributes underlying forager prey selection decisions and the role of hunting in the sexual division of labor. Rather than attempting to fit interpretations of Clovis lifeways to stereotypical expectations, I have attempted to extend the diversity of hunter-gatherer subsistence behaviors to include potentially novel prehistoric strategies.

#### Clovis Hunters and Their Prey

I began with the suggestion that Clovis predation on animals the size of Pleistocene mammoths was a relatively odd subsistence strategy. In relation to other terrestrial carnivores it clearly is. The body size relationship between terrestrial predators and their prey is well established. Both ecological and physical constraints limit the size of prey a carnivore can efficiently capture and consume and rarely do prey exceed a predator's own body mass. However, human predators, of the past and present, are able to alter the constraints which limit the maximum and minimum body mass of prey taken by other predatory species through the use of technology. Further, from an optimal foraging perspective and considering the range of prey human hunters have the ability to potentially capture, there can be an economic benefit to hunting the largest prey available. So while mammoth predation may be odd in light of other carnivores, it is a logical and arguably *predictable* human subsistence activity to occur when the option to do so exists.

As many critics of the hypothesis that Clovis people were large-game hunters point out, specialized human predation strategies are documented ethnographically in only a limited range of environmental contexts. Seen among arctic dwelling caribou hunters, plains grassland bison hunters, and among the Bisa farmers of the African savannah, specialization occurs where large game animals are available in sufficient quantities to support a selective predation strategy. This condition is rarely met in historic and modern environments where human population densities are likely too high and/or large prey densities too low for specialized hunting strategies to occur. However it cannot be assumed that such conditions were rare in the past as well. During the late Pleistocene in North America, and at varying times and places throughout the world, human population densities were undoubtedly extremely low. In circumstances where large animals are available and encountered frequently enough to meet human subsistence needs, either because humans are few, prey are plentiful or some combination of the two, the option to exercise a specialized predation strategy exists. While hunting prey as they are encountered, regardless of their size, may ensure that meat is procured on a more regular basis, passing on opportunities to capture small animals and selectively choosing larger higher ranked items increases overall return rates. Since it may provide a more efficient means of procuring animal resources, predation on very large game was likely far more common in past hunter-gatherer societies than is represented in the recent ethnographic record.

The degree to which hunter-gatherers can selectively target particular species or types of animals for predation is constrained both by attributes of the prey available and

by the subsistence needs of the procurers and those they provision. While the largest resources available may always be high ranked from a diet breadth perspective, taking into account other procurement costs such as when they are encountered and captured too infrequently to meet dietary needs, their potential economic benefit of large animals is far outweighed by their procurement costs. Although they should still be taken when encountered, lengthy searches and unpredictable, infrequent successes are costly and when these costs exceed the economic gain an encounter based strategy may provide a more profitable prey selection strategy. Assuming that predation on large prey provides an efficient means of providing resources that enable human population growth, at some point in time humans may outgrow the large animal resource base available to them. Only in environments capable of supporting large ungulate populations has a specialized strategy persisted into modern times.

In order to identify the degree of selectivity expressed in prey choice through faunal assemblage attributes I have focused on the relationship between prey size and population density. Using prey density as a proxy measure for encounter rate, it has been assumed that deviation between the proportion of animals killed and the frequency with which they were encountered on the landscape, relative to their body size, provides a measure of selectivity. In a sample of ethnographically documented subsistence hunters this method clearly delineated specialized large game and encounter based hunting strategies. When applied to the Clovis zooarchaeological record, Clovis prey assemblages contain significantly more large prey than would be expected to result from a generalized encounter based hunting strategy. So there is not only empirical evidence

that Clovis peoples were specialized predators of large game, but also clear economic reasons why hunter-gatherers should favor procurement of large prey when the option to do so is available.

My analysis of Clovis hunting has not explicitly addressed the role of human predation in the extinction of numerous species of Pleistocene fauna, but it has some bearing on the issue. Debate concerning the role of human involvement ranges from active participation through over harvesting of megafaunal species (Alroy 2001; Martin 1984) to bystanders of an event triggered by climate change (Grayson and Meltzer 2002, 2003) or perhaps disease (Greenwood et al. 2001). Resolving this issue will ultimately require more detailed analysis of the temporal sequence of events, documenting the relationship between species extinction and human hunting. Clovis peoples were certainly predators of some species (primarily mammoth and mastodon) which eventually became extinct. Whether their hunting strategy caused, contributed to, or was purely ancillary to the extinction process remains open to question. However considering their hunting strategy, it is prudent to question not only how humans may have impacted Pleistocene extinctions, but also how the extinction of numerous species of large prey impacted subsequent human predation strategies.

#### Men Hunt, Women Gather (Make Tools, Move Camp, and Build Houses)

Foraging societies are not simply an aggregate of individual hunters and individual gatherers who work and live together. While hunter-gatherers are called *hunter* and *gatherers* for a reason, hunters also gather and gatherers also hunt and both

perform a variety of other tasks. Rarely however, do individuals within foraging societies both hunt and gather in equal proportions or rely exclusively on resources derived solely from either hunting or gathering. By acting *primarily* as either hunters or gatherers it may be argued that that these different subsistence tasks can in fact be examined as wholly independent foraging behaviors. But as discussed previously, these two subsistence roles are not roles mutually independent strategies. By cooperating in their subsistence efforts individual hunters and gatherers have the ability to carry out complimentary subsistence roles, such that the time, energy, and labor channeled into one activity may directly influence the resources available for the completion of other tasks.

Like other social animals but perhaps even more so, humans are able to partition necessary tasks and resources, by dividing labor, time, skill, and materials among an aggregate of individuals. Such divisions may not always be truly cooperative in that they equally facilitate the economic goals of all parties involved, but they do allow for the segmentation of food procurement behaviors in ways that potentially optimize the relative costs, benefits, and risks associated with different resource types. By segmenting tasks and resources among multiple individuals, strategies can emerge that may be impossible for a single forager to implement. In relation to hunter-gatherer subsistence economics, the partitioning of tasks may result in the differential targeting of resource classes by different components of the work force and may influence the type and quantity of food items targeted within each resource class.

Although it has long been acknowledged that men and women engage in different behaviors in order to pursue their own sex related initiatives- whether they be construed

as reproductive (Bird 2000), economic (Halperin 1980), or social goals (Leacock 1978), how such differences are integrated and negotiated within and among past and present human societies remains poorly understood. Examination of sex related differences have, unfortunately, frequently been studied in isolation. For instance, the division of labor between male hunting activities and female foraging behaviors among hunter-gatherers are commonly explored through separate means and data sets. Variation in male hunting strategies is commonly attributed to economic/environmental parameters, wherein the reliance on hunted game, prey choice, capture frequency, distances traveled, and technology utilized are all ultimately tied to the diversity and distribution of faunal resources available (e.g. Bailey 1991; Isaac 1978; Robinson and Bennett 2000; Oswalt 1973; Smith 1991; Steele and Baker 1993). With few exceptions (e.g. Hill et al. 1985), the implicit assumption in such arguments is that men hunt simply because they *can*, and unless actively prohibited from doing so *will*. Alternatively, studies of female foraging tactics often begin by noting the reproductive constraints that prevent women from hunting, or more pessimistically, that prevent women from generally behaving like men. Consequently, foraging strategies focused on the procurement of plants, and occasionally small game, are discussed in light of issues associated with differential mobility, risk aversion tactics, and physiological needs of pregnancy and childcare constraints (summarized in Hames 1988; Kelly 1995). Though useful for some purposes, isolating these causal relationships provides little insight into how such behaviors are integrated within foraging societies, since neither women nor men operate in single-sex worlds.

I have attempted to explore the way labor is partitioned between male and female foragers based primarily on the degree of dependence on animal resources. Examining the sexual division of labor through hunting may appear a rather ironic means of approaching the issue. Since large game hunting is a predominately male activity it seems a rather poor choice for addressing the labor contributions of women. However two fundamental attributes of forager economies have compelled me to do so. First, recent ethnographic work among foraging peoples has highlighted the interrelatedness of female and male subsistence activities. It has been established that the activities of one sex often directly impact the activities of the other, such that the allocation of time and energy to particular tasks is contingent upon the activities of each sex (Bailey and Auinger 1989; Blurton Jones et al. 1996; Hawkes et al. 1982, 2001; Hurtado and Hill 1990; Hurtado et al. 1992). Female labor is then, at least in part, affected by male activities and vice versa. Second, hunting behaviors result in the accumulation of faunal remains. Signatures of both male and female activities are certainly represented in the archaeological record, but in many contexts such as Clovis, the hunted remains of large fauna provide the clearest and often most abundant evidence of gender-specific activities. So while the behaviors of either males or females should provide insight into the activities of the other and recognizing that *all* animals procured may not be the sole result of male hunting, examining hunting patterns in order to address female labor provides one method of exploring the issue without relying on negative evidence.

In Paleoindian archaeology, ethnographic analogy is consistently applied to support the labor dichotomy between man the hunter and woman the gatherer (e.g.

Adovasio and Page 2002; Dillehay 2000; Hudecek-Cuffe 1998; Johnson 1991), a position which leaves little room for identifying the contribution of female tasks when the majority of food is large game. Addressing gender relations archaeologically is undoubtedly difficult and it is unfortunately all too easy to make unfounded presumptions about prehistoric gender roles based on modern stereotypes. For as long as it is uncritically assumed that women's primary economic role is that of plant procurers and that archaeological evidence of their gathering activities has undergone preferential attrition we are left with few options other than to simply assume that they contributed relatively to little to Clovis lifeways or were busily engaged in "invisible" behaviors. Without more comprehensive and objective evaluation, the application of other stereotypes such as that presented in Figure 7.1, are perhaps no more or less justifiable than current interpretations of Clovis labor. My intent is not to substitute one stereotype for another.



Figure 7.1: An alternative depiction of Clovis subsistence and labor organization. Reprinted with special permission of King Features Syndicate.

What can be concluded regarding the sexual organization of Clovis labor is that women were likely involved in a variety of non-food procurement tasks. Based on time allocation data from a sample of hunter-gatherers it has been shown that with greater reliance on hunted resources, women spend significantly less time engaged in food procurement activities. The types of plant foods gathered by women in hunting-focused economies are also more likely to be high-return rate items requiring minimal processing such as fruits, vegetables, and tubers. However, coincident with greater reliance on hunted foods is increased female participation in the production of material goods and involvement in other tasks such as house construction and burden carrying. These general trends clearly, and not surprisingly, suggest that labor is partitioned between the sexes in a manner extending well beyond the “men hunt/ women gather” dichotomy. A large-game hunting focused subsistence strategy does not necessarily imply limited economic participation by female hunter-gatherers.

The implication of these findings for the interpretation of Clovis labor organization is that women were likely far more involved in technological activities than is currently recognized. Clovis women likely spent little time engaged in the procurement of plant foods, which is not to say they did not procure other resources such as small game. This position does not imply that plant resources did not contribute to subsistence; only that other resources provided the majority of consumed calories. It can be further speculated that the plants utilized required relatively little time and technological investment in their procurement and processing. If women’s time and energy were preferentially allocated to manufacturing activities instead of plant

gathering, then female labor is not so much “invisible” as it is unrecognized. Because interpretations of Clovis lithic technology are often formulated relative to the constraints and needs associated with male hunting behaviors, I have suggested that female participation in tool production has not been adequately addressed. While analysis of Clovis lithic assemblages is beyond the scope of this study, I have attempted to outline how differences between female and male manufacturing strategies may eventually be evidenced in lithic assemblage attributes.

Beyond Clovis, the organization of labor with regards to hunting has larger scale implications for the sexual division of labor in prehistoric contexts. A major shift in the partitioning of labor is generally associated with the advent of plant and animal domestication and/or increases in hunter-gatherer population density (Arnold 1993; Bender 1978; Binford 2001; Hayden 1994; Layton et al. 1991). My and others’ analyses of hunter-gatherer economies (Keeley 1995; Hurtado and Hill 1990) suggest that the partitioning of labor between food procurement and other tasks is, at least in part, related to the degree of dependence on hunted versus gathered foods. This may imply that a fundamental change occurs in the organization of labor when hunting based economies becoming increasing reliant on gathered foods, a change antecedent to the shift between foraging and food producing subsistence regimes.

### Closing Thoughts

There was a time when interpretations of the Clovis archaeological were straightforward and established, with widespread agreement that Clovis peoples were the

original colonizers of North America and were hunters of Pleistocene megafauna. This general consensus has given way to considerable, and often heated, debate regarding their status both as colonizers and hunters. While I imagine the confidence many archaeologists had in these ideas provided a sense of assurance that future work would neatly build and expand upon these basic Clovis principles, such a progression is rarely the case in science—and has certainly not occurred in Paleoindian archaeology. Rather than becoming increasingly comprehensive, interpretations of Clovis lifeways have become highly contentious. One of the most polarizing issues to emerge is the role of big-game hunting. Interpreting Clovis subsistence as a generalized foraging strategy, with foods consisting primarily of small game and plants, would mark a radical departure from longstanding views of Clovis subsistence. If warranted, such a dramatic paradigm change could represent the natural course of scientific development and spur the discipline into new avenues of research (Kuhn 1996). However debunking the “old” Clovis as hunter idea in favor of the “new” generalized interpretation is a change that is simply not empirically supported by the current Clovis archaeological record.

Although there has been much discussion of Clovis diet and subsistence, few attempts have been made to quantitatively analyze Clovis faunal assemblages. The zooarchaeological data collected for the current analysis is admittedly imperfect but provides one important source of evidence for the examination of Clovis prey choice. In this study the contrast between hunting specialization and generalization hinges on the degree of selectivity expressed in prey choice in a manner consistent with optimal foraging theory. Selectivity has been defined as the relative degree to which lower-

ranked taxa are not exploited upon encounter, using the relation of body size and population density as an independent reference. Specialized hunters bypass numerous potential prey in favor of higher ranked resources, while the quintessential generalist exploits all or nearly all prey encountered. Despite their presentation here as alternative strategies, they are intended only to describe two possible extremes of a continuum. Based on the analysis of 33 faunal assemblages it has been argued that Clovis hunting behaviors clearly appear more closely aligned with a specialized, rather than generalized strategy. This strategy does not imply that Clovis peoples never utilized plant foods or small game, only that they preferentially targeted extremely large animals. It is further postulated that their specialized hunting strategy provides insight into the organization of Clovis labor. I have argued that the economic contribution of female labor in hunting dependent foraging societies, such as is likely represented by Clovis, is often expressed in technological and other tasks and not primarily through plant gathering activities. Taken collectively, these findings provide a view of Clovis subsistence that in some ways better resembles the “old” image of Clovis mammoth hunters (e.g. Figure 1.1) yet it hopefully is a departure from the ethnographic stereotypes often inherent in prior interpretations of Clovis lifeways.

## APPENDIX A:

BODY SIZE AND POPULATION DENSITY DATA FOR A SAMPLE OF  
TERRESTRIAL ANIMALS*Carnivore Species (data from Gittleman 1989)*

<b>Species</b>	<b>Common Name</b>	<b>Weight (kg)</b>	<b>Density (100 sq km)</b>
<i>Vulpes vulpes</i>	Red Fox	4.6	61.00
<i>Vulpes macrotis</i>	Kit Fox	2.02	20.00
<i>Vulpes chama</i>	Cape Fox	4	30.00
<i>Urocyon littoralis</i>	Channel Island Fox	2.16	957.00
<i>Canis mesomelas</i>	Black-backed Jackal	9.75	270.00
<i>Canis simensis</i>	Ethiopian Wolf	14.5	70.00
<i>Canis lupus</i>	Wolf	46	2.00
<i>Canis latrans</i>	Coyote	13	23.00
<i>Otocyon megalotis</i>	Bat-eared Fox	4.15	85.00
<i>Alopex lagopus</i>	Arctic Fox	3.19	15.00
<i>Cuon alpinus</i>	Dhole	25	22.00
<i>Ursus maritimus</i>	Polar Bear	310	1.00
<i>Mustela erminea</i>	Ermine	0.16	719.00
<i>Mustela nivalis</i>	Least Weasel	0.14	4092.00
<i>Martes americana</i>	Pine Marten	1.3	57.00
<i>Martes pennati</i>	Fisher	2.25	500.00
<i>Mephitis mephitis</i>	Striped Skunk	1.6	330.00
<i>Herpestes javanicus</i>	Small Indian Mongoose	0.55	2075.00
<i>Proteles cristatus</i>	Aardwolf	11.5	100.00
<i>Crocuta crocuta</i>	Spotted Hyena	58.6	92
<i>Felis lynx</i>	Eurasian Lynx	20	2.00
<i>Felis canadensis</i>	Canada Lynx	11.2	12.00
<i>Felis rufus</i>	Bobcat	10	3.00
<i>Felis concolor</i>	Mountain Lion	51.9	4.00
<i>Meles meles</i>	European Badger	13	475.00
<i>Lycaon pictus</i>	Wild Dog	25	8.00
<i>Uncia uncia</i>	Snow Leopard	40	6.00
<i>Panthera pardus</i>	Leopard	46.5	19.00
<i>Acinonyx jubatus</i>	Cheetah	50	4.00
<i>Panthera leo</i>	Lion	142	20.00
<i>Panthera tigris</i>	Tiger	181	8.00

## APPENDIX A (Continued)

*Herbivore Species (data from Nowak 1999)*

<b>Species</b>	<b>Common Name</b>	<b>Weight (kg)</b>	<b>Density (100 sq km)</b>
Genus <i>Muscardinus</i>	Common Dormouse	0.03	18000.0
Genus <i>Abrothrix</i>	Genus Abrothrix	0.04	60000.0
Genus <i>Paraxerus</i>	African Bush Squirrels	0.05	35000.0
Genus <i>Gerbillus</i>	Northern Pygmy Gerbils	0.07	37500.0
Genus <i>Reithrodon</i>	Coney rat	0.09	6900.0
Genus <i>Tamiasciurus</i>	Red Squirrels	0.23	47500.0
<i>Lagostomus maximus</i>	Plains Visacha	5.63	47500.0
<i>Erethizon dorsatum</i>	North American Porcupine	5.25	750.0
<i>Hydrochaeris hydrochaeris</i>	Capybara	53.00	975.0
Genus <i>Sylvilagus</i>	Cottontail rabbits	1.15	96325.0
<i>Bunolagus monticularis</i>	Bushman Rabbit	1.25	11500.0
Genus <i>Lepus</i>	Jack Rabbits (Hares)	4.18	9333.3
<i>Giraffa camelopardalis</i>	Giraffe	800.00	97.0
Genus <i>Madoqua</i>	Dik-diks	5.00	2400.0
<i>Hyemoschus aquaticus</i>	Water Chevrotain	11.00	1785.0
<i>Pecari tajacu</i>	Javelina	22.00	500.0
<i>Tayassu peccari</i>	White-Lipped Peccary	35.00	130.0
Genus <i>Gazella</i>	Gazelles	48.50	1600.0
<i>Vicugna vicugna</i>	Vicuña	50.00	5000.0
<i>Aepyceros melampus</i>	Impala	52.50	254.0
<i>Antilocapra americana</i>	Pronghorn	53.00	1640.0
Genus <i>Redunca</i>	Reedbucks	57.00	1750.0
Genus <i>Pseudois</i>	Blue Sheep	57.50	990.0
Genus <i>Axis</i>	Axis deer	68.50	2300.0
<i>Capra Ibex</i>	Ibex	92.50	382.0
<i>Odocoileus virginianus</i>	White-Tailed deer	100.00	3750.0
Genus <i>Phacochoerus</i>	Wart hogs	100.00	1000.0
Genus <i>Oryx</i>	Gemsbok	155.00	140.0
<i>Alcelaphus buselaphus</i>	Hartebeest	162.50	140.0
<i>Cervus elaphus</i>	Wapiti	245.00	504.0
<i>Tragelaphus strepsiceros</i>	Greater Kudu	250.00	260.0
<i>Alces alces</i>	Moose	512.50	60.0
<i>Syncerus caffer</i>	African Buffalo	600.00	908.5
<i>Equus burchelli</i>	Burchell's Zebra	280.00	995.0
<i>Diceros bicornis</i>	Black Rhinoceros	1100.00	285.0
<i>Elephas maximus</i>	Indian Elephant	4060.00	56.0

## APPENDIX B:

## A GLOBAL SAMPLE OF HUNTER-GATHERERS

**Key to Variables and Codes****Environ****Environment Codes**

A=arctic  
 SA=subarctic  
 NWC= Northwest Coast  
 C=California  
 TD=temperate desert  
 TF=temperate forest  
 P=plains  
 TRD=tropical/sub tropical desert  
 TRF=tropical forest

**Population Density\***

people per 100 km<sup>2</sup>

\* values in regular type from Kelly 1995: Table 6-4,  
 values in italics from Binford 2001: Table 5.01

**Dietary Dependence<sup>†</sup>****Relative Contribution of Each Resource**

0= 0-5%  
 1= 6-15%  
 2= 16-25%  
 3= 26-35%  
 4= 36-45%  
 5= 46-55%  
 6= 56-65%  
 7= 66-75%  
 8= 76-85%  
 9= 86-100%

<sup>†</sup> from Murdock 1986

**Dietary Dependence<sup>††</sup>**

actual contribution of each resource (0-100%)

<sup>††</sup> from Binford 2001: Table 5.01, data used in Chapter V

**Staple Plant<sup>‡</sup>****Predominate Plant Type Utilized**

1= foliage  
 2= soft fruits (including berries)  
 3= fruits and roots  
 4= roots and other storage organs  
 5= roots and nuts/seeds  
 6= nuts  
 7= nuts and seeds  
 8= seeds

<sup>‡</sup>from Keeley 1995

**Activities by Gender<sup>††</sup>**

O=activity absent/unimportant

E= equal participation

F= primarily female

M= primarily male

<sup>††</sup> adapted from Murdock 1973,1986

## APPENDIX B (Continued)

Culture	Environ	Population Density	Dietary Dependence			Dietary Dependence2		
			small game and plants	medium/ large game	Aquatic	% Gather	% Hunt	% Aquatic
Ache (Guayaki)	TRF	3				30	62	8
Achumawi	C	17.5				30	40	30
Agaiduka (River Shoshone)	TD	2.75	3	3	4	30	50	20
Agta (Aeta)	TRF	87				45	15	40
Ainu	TRF	343.8				10	15	75
Aka	TRF	28				79.5	20	0.5
Alacaluf	C	14.98	1	2	7	5	20	75
Aleut	A	65	1	3	6	1	5	94
Alsea	NWC	73	1	2	7	10	15	75
Alyawara	TRD	2.5				65	35	0
Anbarra	TRD	2				35	10	55
Andamanese	TRF	86	4	2	4			
Angmagsalik	A	8	0	2	8	0	10	90
Aranda (Arrernte)	TRD	3	6	4	0	65	30	5
Arapaho	P	3	2	8	0	20	80	0
Assinboine	P	5.8	2	7	1	20	70	10
Atsugewi	C	45	4	3	3	35	40	25
Aweikoma	TRF	3.8	4	6	0	35	60	5
Baffin Inuit	A	0.5				0	5	75
Batak	TRF	54				65	30	5
Bella Bella	NWC	20.51				10	20	70
Bella Coola	NWC	10	2	2	6	5	25	70
Birhor	TRF	22				65	35	0
Blackfoot	P	4.3	2	8	0	20	75	5
Borjeno	TRD	37.3						
Bororo	TRF	51.36	4	5	1	70	20	10
Boto Cudo	TRF	11	5	4	1	60	30	10
Caribou Eskimo	A	0.2	1	5	4	0	55	45
Cahuilla	C	68				75	25	0
Carrier	SA	7.6	2	4	4	10	47	43
Cheyenne	P	3	2	8	0	15	80	5
Chenчу	TRD	123.3				85	10	5
Chilkotin	SA	13	2	3	5	10	40	50
Chinook	NWC	148.6				15	10	75
Chipewyan	SA	0.4				5	70	25
Chiricahua	TD	1.16	6	4	0	60	40	0
Chugach	A	18	0	2	8	0	10	90
Chumash	C	843				25	5	70
Coast Yuki	C	166	4	2	4	25	15	60
Comanche	P	5	1	9	0	20	80	0
Copper Eskimo	A	1.2	0	4	6	0	25	75
Coeur d'Alene	TF	1.5				20	55	25
Cree	SA	0.55	2	5	3	3	56	41
Crow	P	2.6	2	8	0	20	80	0
Diegueno	C	18.1	5	4	1	55	25	20
Dieri	TRD	1.9	7	3	0	55	25	20
Dorobo (Okiek)	TRF	40.81	4	6	0	45	55	0
Etolo	TRF							
Flathead	P	1.5	3	4	3	20	60	20
Gidjingali	TRF	77	5	3	2	35	10	55
Gilyak (Nivkh)	SA	19.2	2	3	5	3	12	85
Gosiute	TD	1.5	5	4	1			
Groote Eylante	TRF	11.5	3	1	6	30	10	60
Gros Ventre	P	3.37	2	8	0	20	80	0
Gwi (/Gwi)	TRD	8				55	45	0
Hadza (Kindiga)	TRD	15	6	4	0	60	40	0
Haida	NWC	79	2	2	6	1	10	89
Haisla	NWC	16				10	35	55
Hill Pandaram	TRF	69.6				82	16	2



## APPENDIX B (Continued)

Culture	Environ	Population Density	Dietary Dependence			Dietary Dependence2		
			small game and plants	medium/ large game	Aquatic	% Gather	% Hunt	% Aquatic
Ingalik	SA	3.25	1	4	5	2	43	55
Iglulingmiut (Iglulik)	A	0.5	0	5	5	0	15	85
Kaibab	TD	3.5	7	3	0	60	40	0
Karankawa	TF	30.5				30	15	55
Kariera	TRD	7.6	3	5	2	55	10	35
Karok	C	98.5				35	10	55
Kaska	SA	1	1	4	5	10	65	25
Kawaiisu	C	11.9						
Kiowa	P	1.4	1	9	0	20	80	0
Kiowa-Apache	P	1.4	2	8	0	10	90	0
Klamath	C	25	3	2	5	30	20	50
Kua	TRD	2.55				55	45	0
Kutchin	SA	1.1	1	4	5	2	65	33
Kung (Ju'hoansi)	TRD	13	8	2	0	67	33	0
Kutenai	TF	2	3	3	4	15	45	40
Kuyuidokado (Lake Paiute)	TD	18	5	2	3	50	20	30
Kwakiutl	NWC	57	3	2	5	5	10	85
Luiseno	C	148	6	2	2	60	15	25
Maidu	C	103	5	3	2	50	30	20
Makah	NWC	86				10	10	80
Mardudjara	TRD	0.6				70	30	0
Mbuti	TRF	17	3	7	0	90	9	1
Micmac	SA	2.3	1	5	4	10	55	35
Mikca	TRD	4.36				85	15	0
Miwok	C	117.5	6	3	1	40	10	50
Mlabri	TRF	23.16				75	20	5
Modoc	TF	4.8	5	3	2	45	30	25
Mono	C	40.9	5	4	1	48	45	7
Montagnais	SA	0.41				10	50	40
Mungin	TRF	5	5	3	2	55	35	10
Nabesna	SA	0.6	2	6	2	3	40	57
Naskapi	SA	0.4	1	7	2	1	73	26
Netsilik	A	0.5				0	25	75
Nesbitt	TRF	40						
Nez Perce	TF	8.9	3	3	4	33	15	52
Ngadadjara	TRD	0.4				75	25	0
Nooksack	SA							
Nootka	NWC	71.5	2	2	6	5	5	90
Nunamiut	A	2	1	7	2	0	90	10
Nunivak	A	30	1	3	6	1	15	84
Ojibwa	SA	4	3	4	3			
Ona	TF	7.27				5	75	20
Onge	TRF	40.1				35	20	45
Paiute	TD	10.15				50	30	20
Paliyan	TRF	77				85	14	1
Panamint (Shoshone)	TD	2.1				65	35	0
Paraujano	TRF	35	3	1	6	30	10	60
Penan (Punan)	TRF	11.8				65	30	5
Pintupi	TRD	0.5				65	35	0
Pitjandjara	TD	0.6				65	35	0
Plains Cree	P	1.9	2	6	2	10	75	15
Polar Eskimo	A	0.5	1	4	5	0	30	70
Pomo	C	317	4	3	3	60	15	25
Puyallup	NWC	195	3	2	5	15	15	70
Quileute	NWC	64.5				10	15	75
Quinault	NWC	46	2	3	5	10	15	75
Sampoil	TF	38	3	2	5	25	35	40
Sarsi	SA	1.75	2	8	0	10	82	8
Saulteaux	SA	0.6	2	4	4	5	65	30
Semang	TRF	12	4	3	3	50	40	10
Seri	TD	5				30	10	60
Shasta	C	74	4	3	3	45	25	30
Shiriana	TRF	15.6	3	4	3	60	35	5
Shoshone (Wind River)	TRD	6				20	65	15
Shuswap	TF	9.25	3	3	4	15	30	55

## APPENDIX B (Continued)

Culture	Staple Plant	Activities by Gender							
		Weave	Pottery	Butchery	House	Rope	Skins	Basketry	Burden
Ingalik	2	O	F	M	M	E	F	F	E
Iglulingmuit (Iglulik)		O	O						
Kaibab		O	M						
Karankawa	3								
Kariera	5	O	O						
Karok									
Kaska	2	O	O	M	M	F	F	F	F
Kawaiisu									
Kiowa		O	P						
Kiowa-Apache		O	O						
Klamath	5	O	O	M	E	E	F	F	E
Kua									
Kutchin	2	O	O						
Kung (Ju'hoansi)	6	O	O	M	F	E	M	O	F
Kutenai		O	P	M	E	E	F	F	E
Kuyuidokado (Lake Paiute)	7	O	O						
Kwakiutl		F	O						
Luiseno	6	O	O						
Maidu	6	O	O						
Makah									
Mardudjara									
Mbuti	2	O	O	M	F	F	O	F	F
Micmac	3	F	O	F	F	M	F	F	F
Mikea									
Miwok	7	O	O						
Mlabri									
Modoc		O	O						
Mono		O	F						
Montagnais		F	O	M	M	F	F	F	E
Mumgin	5	O	O						
Nabesna	2	O	O						
Naskapi		O	O						
Netsilik									
Nesbitt									
Nez Perce		O	O						
Ngadadjara									
Nooksack									
Nootka	3	F	O						
Nunamiut	2	O	F						
Nunivak	2	O	F						
Ojibwa	5	O	O						
Ona	2								
Onge									
Paiute	6	F	O	M	F	M	M	F	E
Paliyan									
Panamint (Shoshone)	8								
Paraujano									
Penan (Punan)									
Pintupi									
Pitjandjara	5								
Plains Cree		O	O						
Polar Eskimo		O	O						
Pomo	6	O	O	M	M	O	M	F	F
Puyallup	4	F	O						
Quilcute									
Quinault	3	P	O						
Sanpoil	4	O	O						
Sarsi		O	O						
Saulteaux	2	O	O	M	F	O	F	O	O
Semang	2	O	O	O	F	E	O	M	F
Seri	6								
Shasta	6	O	O						
Shiriana	7	P	F						
Shoshone (Wind River)									
Shuswap	4	O	O						

## APPENDIX B (Continued)

Culture	Environ	Population Density	Dietary Dependence			Dietary Dependence2		
			small game and plants	medium/ large game	Aquatic	% Gather	% Hunt	% Aquatic
Sinkaietk (Okanagon)	TF	14.51	3	3	4	15	25	60
Sinkyone	C	270	4	3	3	40	15	45
Siriono	TRF	6				45	50	5
Skagit	SA							
Slave	SA	1.4	1	5	4	10	60	30
Stalo	NWC	66	3	3	4	10	15	75
Squamish	SA	56.5				15	25	60
Tahltan	SA	1.1	1	5	4	10	60	30
Tanaina	SA	5	1	4	5	3	51	46
Taremiut	A	4	0	3	7	0	25	75
Tehueltche	TD	1.89	2	7	1	30	65	5
Tenino	TF	18	3	2	5	30	20	50
Timpanogots	TD	10.35						
Tiwi	TRF	37.5	5	3	2	40	25	35
Tlingit	NWC	25	1	3	6	1	15	84
Tolowa	C	138	4	2	4	25	10	65
Tsimshian	NWC	57.5	2	2	6	5	20	75
Tubatulabal	C	30	5	3	2	50	35	15
Tutchone	SA	0.6				2	62	36
Twana	NWC	25	1	3	6	10	20	70
Umatilla	TF	4.5	3	3	4	30	30	40
Uncompahgre	P	4.29				35	50	15
Ute	TD	8.1				35	55	10
Vedda	TRF	65	4	3	3	65	30	5
Wadadika (Valley Paiute)	TD	13.4	5	3	2	50	30	20
Walapai	TRD	4	6	4	0	65	35	0
Walbiri	TRD	1	6	4	0	70	30	0
Washo	C	28	4	3	3	48	37	15
Wikmunkan	TRF	18.7	4	4	2	50	30	20
Wind River Shoshone	TD	1	3	5	2	20	65	15
Wintu	C	281	3	3	4	35	25	40
Wishram	NWC	231.7	3	2	5	25	15	60
Wiyot	C	266				30	5	65
Worora	TRD	2				60	30	10
Yahgan (Yamana)	TF	4.6	1	2	7	5	25	70
Yana	C	35	5	2	3	45	25	30
Yavapai	TRD	2.7				60	35	5
Yir Yoront	TRF	16				65	25	10
Yokuts	C	163.5	4	3	3	50	20	30
Yukaghir	A	0.5	1	5	4	5	55	40
Yurok	C	180	4	1	5	20	10	70

## APPENDIX B (Continued)

Culture	Staple Plant	Activities by Gender							
		Weave	Pottery	Butchery	House	Rope	Skins	Basketry	Burden
Sinkaietk (Okanagon)		O	O						
Sinkyone	6	O	O						
Siriono		F	O	E	M	F	O	F	E
Skagit									
Slave		O	O	M	M	O	F	O	O
Stalo		P	O						
Squamish									
Tahltan	2	O	O						
Tanaina		O	O						
Taremiut		O	F						
Tehuelche		M	F	M	F	M	F	O	F
Tenino	4	O	O						
Timpanogots									
Tiwi		O	O	M	O	O	O	F	F
Tlingit	2	F	O						
Tolowa	6	O	O						
Tsimshian	3	F	O						
Tubatulabal	6	O	F						
Tutchone									
Twana	3	F	O	M	M	F	F	F	E
Unatilla		O	O						
Uncompahgre									
Ute		O	O						
Vedda		O	E	M	M	F	O	O	M
Wadadika (Valley Paiute)		O	O						
Walapai		E	F						
Walbiri	8	O	O						
Washo	6	O	O						
Wikmunkan	4	O	O						
Wind River Shoshone		O	O						
Wintu	6	O	O						
Wishram		O	O						
Wiyot	6								
Worora									
Yahgan (Yamana)	1	O	O	M	F	F	F	F	E
Yana		O	O						
Yavapai									
Yir Yoront									
Yokuts	8	O	F	O	F	M	M	F	E
Yukaghir	2	P	P	M	F	O	F	O	F
Yurok	6	O	O	M	M	M	M	F	F

APPENDIX C:  
SUBSISTENCE HUNTER PREY INVENTORIES

*Ache (from Hill and Padwe 2000:Table 5-2)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Nine banded Armadillo	1500	3.8336	5750.4	35.35%	42.82%
Paca	390	6.74384615	2630.1	16.17%	11.13%
Capuchin Monkey	889	2.28661417	2032.8	12.49%	25.38%
Coati	261	3.45823755	902.6	5.55%	7.45%
Tegu Lizard	77	2.32207792	178.8	1.10%	2.20%
Naked-tailed Armadillo	24	5.4	129.6	0.80%	0.69%
Agouti	26	2.7	70.2	0.43%	0.74%
Collared Anteater	11	5	55	0.34%	0.31%
Yellow Armadillo	10	0.5	5	0.03%	0.29%
Rusty-margined Guan	44	0.81363636	35.8	0.22%	1.26%
Caimen	7	5	35	0.22%	0.20%
Bushmaster Snake	33	1	33	0.20%	0.94%
Birds	43	0.7	30.1	0.19%	1.23%
Black Howler Monkey	5	5.8	29	0.18%	0.14%
Bush Dog	4	5.5	22	0.14%	0.11%
Black Vulture	11	2	22	0.14%	0.31%
Tayra	3	4	12	0.07%	0.09%
King Vulture	3	3	9	0.06%	0.09%
Solitary Tinamou	8	1	8	0.05%	0.23%
Wood Quail	8	1	8	0.05%	0.23%
Tinamou	5	1	5	0.03%	0.14%
Red-breasted Toucan	3	1	3	0.02%	0.09%
Oncilla	1	2.2	2.2	0.01%	0.03%
Turkey Vulture	1	2	2	0.01%	0.03%
Barc-faced Currasow	1	2	2	0.01%	0.03%
Rabbit	2	0.9	1.8	0.01%	0.06%
Seven-banded Armadillo	1	1.6	1.6	0.01%	0.03%
Opossum	1	1.5	1.5	0.01%	0.03%
Tortoise	1	1	1	0.01%	0.03%
Scarlet Macaw	1	1	1	0.01%	0.03%
Black-fronted Piping Guan	1	1	1	0.01%	0.03%
Western Wooly Opossum	3	0.33333333	1	0.01%	0.09%
Toco Toucan	1	0.7	0.7	0.00%	0.03%
Mice	1	0.3	0.3	0.00%	0.03%
White Lipped Peccary	55	24.9236364	1370.8	8.43%	1.57%

## APPENDIX C (Continued)

*Ache (continued)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Giant Anteater	1	30.5	30.5	0.19%	0.03%
Brocket Deer	27	25.8	696.6	4.28%	0.77%
Collard Peccary	27	16.318519	440.6	2.71%	0.77%
Capybara	1	45	45	0.28%	0.03%
Anaconda	1	40	40	0.25%	0.03%
Boa Constrictor	1	15	15	0.09%	0.03%
Jaguar	1	15	15	0.09%	0.03%
Tapir	9	177	1593	9.79%	0.26%
<b>TOTAL</b>	<b>3503</b>		<b>16269</b>		

*Bisa (Marks 1976: Table 38)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Impala	23	49.94	1148.62	3.51%	22.77%
Warthog	17	68.1	1157.7	3.54%	16.83%
Bushbuck	2	34.05	68.1	0.21%	1.98%
Waterbuck	8	204.3	1634.4	5.00%	7.92%
Zebra	7	238.35	1668.45	5.10%	6.93%
Buffalo	39	522.1	20361.9	62.30%	38.61%
Puku	2	62.198	124.396	0.38%	1.98%
Eland	1	340.5	340.5	1.04%	0.99%
Hippo	1	2,550	2550	7.80%	0.99%
Elephant	1	3632	3632	11.11%	0.99%
<b>TOTAL</b>	<b>101</b>		<b>32686.066</b>		

## APPENDIX C (Continued)

*Efe (Bailey 1991:Table 5.1, 5.2)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Monkey	14	4.6192857	64.67	6.03%	5.17%
Squirrel	5	0.284	1.42	0.13%	1.85%
Duiker	252	3.9947222	1006.67	93.84%	92.99%
<b>TOTAL</b>	<b>271</b>		<b>1072.76</b>		

*Gwi (Tanaka 1980:Table 11)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Giraffe	0.25	1000	250	4.46%	0.15%
Eland	4	300	1200	21.41%	2.34%
Kudu	3	300	900	16.05%	1.75%
Gemsbok	10	200	2000	35.68%	5.84%
Hartebeest	0.5	200	100	1.78%	0.29%
Wildebeest	1	200	200	3.57%	0.58%
Springbok	3	50	150	2.68%	1.75%
Duiker	10	15	150	2.68%	5.84%
Steenbok	36	10	360	6.42%	21.02%
Warthog	0.5	16	8	0.14%	0.29%
Leopard	0.5	20	10	0.18%	0.29%
Cheetah	0.5	20	10	0.18%	0.29%
Ostrich	3	20	60	1.07%	1.75%
Black-backed Jackal	6	4	24	0.43%	3.50%
Bat-eared Fox	14	2	28	0.50%	8.18%
Cape fox	1	2	2	0.04%	0.58%
Genet	2	1	2	0.04%	1.17%
Porcupine	2	2	4	0.07%	1.17%
Springhare	50	1	50	0.89%	29.20%
Hare	2	1	2	0.04%	1.17%
Kori bustard	12	6	72	1.28%	7.01%
Guinea fowl	2	0.5	1	0.02%	1.17%
Korhaan	5	0.4	2	0.04%	2.92%
Rock Python	3	7	21	0.37%	1.75%
<b>TOTAL</b>	<b>171.25</b>		<b>5606</b>		

## APPENDIX C (Continued)

*Gidra (Ohtsuka and Suzuki 1990: Table 1)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Cassowaries	4	50.3	201	11.81%	1.93%
Pigs	7	44	308	18.10%	3.38%
Deer	1	58	58	3.41%	0.48%
Grass Wallabies	58	12.4	720.6	42.34%	28.02%
Bush Wallabies	67	4.4	296.8	17.44%	32.37%
Bandicoots	26	1.8	45.5	2.67%	12.56%
Bats	12	0.3	4.1	0.24%	5.80%
Rat	1	0.8	0.8	0.05%	0.48%
Echidna	1	2.7	2.7	0.16%	0.48%
Mid-sized Birds	10	1.7	16.6	0.98%	4.83%
Small-sized Birds	16	0.3	5.5	0.32%	7.73%
Python	1	20	20	1.18%	0.48%
Monitor Lizard	3	7.4	22.2	1.30%	1.45%
<b>TOTAL</b>	<b>207</b>		<b>1701.8</b>		

*Inujuamiut (Smith 1991: Chapter 6)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Canada Goose	91	3.5	318.5	4.79%	28.71%
Bearded Seal	6	207	1242	18.68%	1.89%
Eider Duck	53	2.6	137.8	2.07%	16.72%
Ringed Seal	15	33	495	7.45%	4.73%
Merganser	3	0.8	2.4	0.04%	0.95%
Beluga Whale	1	499	499	7.51%	0.32%
Ptarmigan	78	0.7	54.6	0.82%	24.61%
Caribou	37	102.5	3792.5	57.04%	11.67%
Arctic Fox	4	2.5	10	0.15%	1.26%
Snow Goose	3	2.7	8.1	0.12%	0.95%
Lake Trout	26	3.4	88.4	1.33%	8.20%
<b>TOTAL</b>	<b>317</b>		<b>6648.3</b>		

APPENDIX C (Continued)

*Nunamiut (Binford 1991:Table 39)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Caribou	518	102.5	53095	81.29%	69.53%
Sheep	105	70	7350	11.25%	14.09%
Moose	1	512.50	512.5	0.78%	0.13%
Polar Bear	9	310	2790	4.27%	1.21%
Large Fur-bearer*	64	23	1472	2.25%	8.59%
Small Fur-bearer**	48	2	96	0.15%	6.44%
<b>TOTAL</b>	<b>745</b>		<b>65315.5</b>		

\* wolf, fox, and wolverine

\*\* marmot and squirrel

*Pume (Greaves 1997:Table 2)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Armadillo	68	0.8676471	59	35.50%	43.87%
Cottontail Rabbit	7	1.0428571	7.3	4.39%	4.52%
Lesser Anteater	1	5.4	5.4	3.25%	0.65%
White-Tailed Deer	1	11.25	11.25	6.77%	0.65%
Tegu Lizard	32	0.595625	19.06	11.47%	20.65%
Small Teiid Lizard	21	0.082381	1.73	1.04%	13.55%
Llanos Turtle	8	0.7	5.6	3.37%	5.16%
Red-footed Tortoise	1	3.2	3.2	1.93%	0.65%
Caiman	3	16.55	49.65	29.88%	1.94%
Birds	13	0.3069231	3.99	2.40%	8.39%
<b>TOTAL</b>	<b>155</b>		<b>166.18</b>		

*Siriono (Townsend 2000:Table 13-1)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Banded Anteater	27	4.32	116.64	0.55%	1.17%
Nine Banded Armadillo	642	3.79	2433.18	11.48%	27.91%
Six Banded Armadillo	27	3.2	86.4	0.41%	1.17%
Saddle Backed Tamarin	7	0.38	2.66	0.01%	0.30%
Night Monkey	12	1.15	13.8	0.07%	0.52%
Tufted Capuchin	20	2.98	59.6	0.28%	0.87%
Squirrel Monkey	1	1	1	0.00%	0.04%
Coatimundi	246	3.26	801.96	3.78%	10.70%
Kinkajou	1	1.6	1.6	0.01%	0.04%
Ocelot	3	13	39	0.18%	0.13%
Squirrel	11	0.45	4.95	0.02%	0.48%
Porcupine	41	4.3	176.3	0.83%	1.78%
Paca	104	7.27	756.08	3.57%	4.52%
Agouti	167	3.31	552.77	2.61%	7.26%
Greater Rhea	2	0.5	1	0.00%	0.09%
Undulated Tinamou	3	0.52	1.56	0.01%	0.13%
Cormorant	1	1.4	1.4	0.01%	0.04%
Rufescent Tiger-heron	44	1.05	46.2	0.22%	1.91%
Wood Stork	8	2.46	19.68	0.09%	0.35%
Maguari Stork	7	3.48	24.36	0.11%	0.30%
Jabira	5	7.96	39.8	0.19%	0.22%
Green Ibis	1	1	1	0.00%	0.04%
Southern Screamer	1	1.4	1.4	0.01%	0.04%
Black-bellied Duck	14	0.57	7.98	0.04%	0.61%
Muscovy Duck	5	2.65	13.25	0.06%	0.22%
Hawk-eagle	1	3	3	0.01%	0.04%
Harpy Eagle	1	4.48	4.48	0.02%	0.04%
Hawk	8	0.68	5.44	0.03%	0.35%
Speckled Chachalaca	8	0.51	4.08	0.02%	0.35%
Spix's Guan	17	1.29	21.93	0.10%	0.74%
Blue-throated Guan	21	1.45	30.45	0.14%	0.91%
Bare-face Curassow	3	2.65	7.95	0.04%	0.13%
Limpkin	13	1.22	15.86	0.07%	0.57%
Gray-necked Wood-rail	1	0.45	0.45	0.00%	0.04%
Pale-vented Pigeon	7	0.29	2.04	0.01%	0.30%

## APPENDIX C (Continued)

*Siriono (continued)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Blue-and-yellow Macaw	6	1.07	6.42	0.03%	0.26%
Red-and-green Macaw	4	1.07	4.28	0.02%	0.17%
Chestnut Macaw	1	0.39	0.39	0.00%	0.04%
Blue-headed Parrot	3	0.255	0.76	0.00%	0.13%
Hoatzin	3	0.85	2.55	0.01%	0.13%
Chestnut Aracari	3	0.25	0.75	0.00%	0.13%
Toco Toucan	5	0.5	2.5	0.01%	0.22%
Yellow-headed Sideneck	123	2.97	365.31	1.72%	5.35%
Matamata	57	5.88	335.16	1.58%	2.48%
Geoffrey's Turtle	23	1.35	31.05	0.15%	1.00%
Grooved Turtle	1	1	1	0.00%	0.04%
Red-footed Tortoise	20	5.93	118.6	0.56%	0.87%
Yellow-footed Tortoise	52	5.19	269.88	1.27%	2.26%
Scorpion Mud Turtle	40	0.45	18	0.08%	1.74%
Caiman	9	6.28	56.52	0.27%	0.39%
Gaint Anteater	8	14.3	114.4	0.54%	0.35%
Collard Peccary	200	15.31	3062	14.44%	8.70%
White Lipped Peccary	139	28.53	3965.67	18.71%	6.04%
Red Brocket Deer	26	29.72	772.72	3.64%	1.13%
Grey Brocket Deer	21	17.28	362.88	1.71%	0.91%
Giant Armadillo	1	60	60	0.28%	0.04%
Marsh Deer	70	80	5600	26.41%	3.04%
Tapir	5	150	750	3.54%	0.22%
<b>TOTAL</b>	<b>2300</b>		<b>21200.09</b>		

## APPENDIX C (Continued)

*Yanomamo (Hames 1979:Table II)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Heron	1	1.55	1.55	0.08%	0.58%
Green-backed Guan	10	1.45	14.5	0.73%	5.85%
White Piping Guan	2	1.55	3.1	0.16%	1.17%
Black Curassow	15	3.86	57.9	2.92%	8.77%
Crestless Curassow	2	2.45	4.9	0.25%	1.17%
White-throated Toucan	7	0.8	5.6	0.28%	4.09%
Red-legged Tinamou	1	0.45	0.45	0.02%	0.58%
Barn Owl	2	0.45	0.9	0.05%	1.17%
Grey-winged Trumpeter	2	1	2	0.10%	1.17%
Spectacled Caiman	1	3.64	3.64	0.18%	0.58%
Wata Snake	2	6.82	13.64	0.69%	1.17%
Tortoise	8	1.14	9.1	0.46%	4.68%
Three-toed Edentate	1	8.64	8.64	0.44%	0.58%
Nin-banded Armadillo	12	5.45	65.4	3.30%	7.02%
Collared Anteater	10	5	50	2.52%	5.85%
Agouti	20	3.64	72.8	3.68%	11.70%
Picure	5	1.36	6.8	0.34%	2.92%
Paca	3	8.41	25.23	1.27%	1.75%
Red Howler Monkey	2	7.27	14.54	0.73%	1.17%
Saki	2	1.14	2.28	0.12%	1.17%
Spider Monkey	1	9.66	9.66	0.49%	0.58%
White Monkey	13	4.09	53.17	2.68%	7.60%
Coati	3	1.82	5.46	0.28%	1.75%
Kinkajou	1	0.45	0.45	0.02%	0.58%
Squirrel	1	0.45	0.45	0.02%	0.58%
Ocelot	1	8.18	8.18	0.41%	0.58%
Boa Constrictor	2	14.55	29.1	1.47%	1.17%
Armadillo	1	30	30	1.51%	0.58%
Giant Anteater	5	40.91	204.55	10.33%	2.92%
White-lipped Peccary	22	36.36	799.9	40.39%	12.87%
Collared Peccary	10	16.679	166.79	8.42%	5.85%
Brocket Deer	1	39.09	39.09	1.97%	0.58%
Jaguar	1	43.64	43.64	2.20%	0.58%
Tapir	1	227.27	227.27	11.47%	0.58%
<b>TOTAL</b>	<b>171</b>		<b>1980.68</b>		

## APPENDIX C (Continued)

*Ye'kwana (Hames 1979:Table II)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
White-necked Heron	5	2.27	11.35	0.22%	0.70%
Heron	6	1.55	9.3	0.18%	0.84%
Egret	23	1.59	36.57	0.70%	3.21%
Mutum	4	1.82	7.28	0.14%	0.56%
Green-backed Guan	45	1.45	65.25	1.25%	6.28%
White Piping Guan	52	1.55	80.6	1.54%	7.26%
Black Curassow	94	3.86	362.84	6.94%	13.13%
Crestless Curassow	21	2.45	51.54	0.99%	2.93%
Toucan	1	1.59	1.59	0.03%	0.14%
White-throated Toucan	47	0.8	37.6	0.72%	6.56%
Scarlet Macaw	8	1.7	13.6	0.26%	1.12%
Mealy Parrott	9	0.55	4.95	0.09%	1.26%
Grey Tinamou	18	1.18	21.24	0.41%	2.51%
Great Tinamou	3	0.82	2.46	0.05%	0.42%
Red-legged Tinamou	2	0.45	0.9	0.02%	0.28%
Tinamou	1	0.45	0.45	0.01%	0.14%
Ruddy Pigeon	4	0.41	1.64	0.03%	0.56%
Bokorama	1	1.82	1.82	0.03%	0.14%
Barn Owl	2	0.45	0.9	0.02%	0.28%
White-tipped Dove	4	0.36	1.44	0.03%	0.56%
Limpkin	2	0.77	1.54	0.03%	0.28%
Marbled Quail	1	0.3	0.3	0.01%	0.14%
Paiweri	3	0.32	0.96	0.02%	0.42%
Semadi	2	0.45	0.9	0.02%	0.28%
Crimson Woodpecker	2	0.36	0.72	0.01%	0.28%
Grey-winged Trumpeter	45	1	45	0.86%	6.28%
Wata Snake	1	6.82	6.82	0.13%	0.14%
Tortoise	2	1.45	2.9	0.06%	0.28%
Three-toed Edentate	2	8.64	17.28	0.33%	0.28%
Nin-banded Armadillo	17	5.45	92.65	1.77%	2.37%
Silky Anteater	1	0.91	0.91	0.02%	0.14%
Collared Anteater	3	5	15	0.29%	0.42%
Agouti	10	3.64	36.4	0.70%	1.40%
Picture	6	1.36	8.16	0.16%	0.84%
Paca	45	8.41	378.45	7.24%	6.28%

## APPENDIX C (Continued)

*Ye'kwana (continued)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Red Howler Monkey	11	7.27	79.97	1.53%	1.54%
Window Monkey	17	1	17	0.33%	2.37%
Saki	9	1.14	10.26	0.20%	1.26%
Spider Monkey	13	9.66	125.58	2.40%	1.82%
White Monkey	29	4.09	122.7	2.35%	4.05%
Coati	3	1.82	5.46	0.10%	0.42%
Kinkajou	1	0.45	0.45	0.01%	0.14%
Squirrel	1	0.45	0.45	0.01%	0.14%
Otter	1	7.27	7.27	0.14%	0.14%
Black Caiman	2	13.64	27.28	0.52%	0.28%
Spectacled Caiman	96	36.36	1574.72	30.13%	13.41%
Boa Constrictor	1	14.55	14.55	0.28%	0.14%
Armadillo	2	30	60	1.15%	0.28%
Giant Anteater	2	40.91	81.82	1.57%	0.28%
Capybara	1	48.18	48.18	0.92%	0.14%
White-lipped Peccary	20	35.42	708.54	13.56%	2.79%
Collared Peccary	7	17.27	120.89	2.31%	0.98%
Brocket Deer	1	39.09	39.09	0.75%	0.14%
Swamp Deer	3	45	135	2.58%	0.42%
Jaguar	1	43.64	43.64	0.84%	0.14%
Tapir	3	227.27	681.81	13.05%	0.42%
<b>TOTAL</b>	<b>716</b>		<b>5225.97</b>		

## APPENDIX C (Continued)

*Yiwara (Gould 1980: Table 5)*

Species	Number	Individual	Total	Percent of Total	
	Killed	Wt (kg)	Wt (kg)	%Wt	%MNI
Sandplains goanna	216	0.3043056	65.73	3.21%	18.70%
Perentie Lizard	12	2.75	33	1.61%	1.04%
Blue Tongue Lizard*	300	0.78	234	11.41%	25.97%
European Rabbit	184	1.4847826	273.2	13.32%	15.93%
Mouse	350	0.5	175	8.53%	30.30%
Kangaroo**	19	34.936842	663.8	32.37%	1.65%
Emu	4	27	108	5.27%	0.35%
Feral Cat	29	5.4	156.6	7.64%	2.51%
Australian Bustard	22	2.3454545	51.6	2.52%	1.90%
Carpet Snake	1	3.7	3.7	0.18%	0.09%
Peregrine Falcon	2	1	2	0.10%	0.17%
Wild Dingo	14	20	280	13.65%	1.21%
Spoonbill	1	2	2	0.10%	0.09%
Pelican	1	2	2	0.10%	0.09%
<b>TOTAL</b>	<b>1155</b>		<b>2050.63</b>		

\* and other small lizards

\*\* and other macropods

## REFERENCES

- Adovasio, J. M. and J. Page  
2002 *The First Americans: In Pursuit of Archaeology's Greatest Mystery*. Random House, New York.
- Adovasio, J. M. and D. R. Pedler  
1997 Monte Verde and the Antiquity of Humankind in the Americas. *Antiquity* 71:573-580.
- Alcock, J.  
1993 *Animal Behavior: An Evolutionary Approach*. Sinauer Associates, Sunderland, Massachusetts.  
2001 *The Triumph of Sociobiology*. Oxford University Press, Oxford.
- Alexander, R. M.  
1996 *Optima for Animals*. Princeton University Press, Princeton.
- Alroy, J.  
1998 Putting North America's End-Pleistocene Megafaunal Extinctions in Context: Large-scale analyses of Spatial Patterns, Extinction Rates, and Size Distributions. In *Extinctions in Near Time*, edited by R. MacPhee, pp. 105-143. Kluwer Academic/Plenum Publishers, New York.  
2001 A Multispecies Overkill Simulation of the End-Pleistocene Megafaunal Mass Extinction. *Science* 292:1893-1896.
- Amick, D. S.  
1999 Raw Material Variation in Folsom Stone Tool Assemblages and the Division of Labor in Hunter-Gatherer Societies. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. S. Amick, pp. 169-187. International Monographs In Prehistory, Ann Arbor.
- Andrewartha, H. G. and L. C. Birch  
1961 *The Distribution and Abundance of Animals*. University of Chicago Press, Chicago.
- Arnold, J. E.  
1993 Labor and the Rise of Complex Hunter-Gatherers. *Journal of Anthropological Archaeology* 12:75-119.

- Bailey, R. C.  
1991 *The Behavioral Ecology of Efe Pygmy Men in the Ituri Forest, Zaire*.  
Museum of Anthropology University of Michigan, Ann Arbor.
- Bailey, R. C. and R. A. Jr.  
1989 Net Hunters vs. Archers: Variation in Women's Subsistence Strategies in the Ituri Forest. *Human Ecology* 17(3):273-297.
- Bamforth, D. and P. Bleed  
1997 Technology, Flaked Stone Technology, and Risk. In *Rediscovering Darwin: Evolutionary Theory in Archaeological Explanation*, edited by C. M. Barton and G. A. Clark, pp. 109-140. vol. 7. American Anthropological Association, Arlington.
- Barton, C. M. and G. A. Clark  
1997 Evolutionary Theory in Archaeological Explanation. In *Rediscovering Darwin: Evolutionary Theory and Archaeological Explanation*, edited by C. M. Barton and G. A. Clark, pp. 3-20. American Anthropological Association No. 7, Arlington.
- Begon, M., J. L. Harper and C. R. Townsend  
1996 *Ecology*. 3rd ed. Blackwell, Oxford.
- Bekoff, M.  
1978 Social Play: Structure, Function, and the Evolution of a Cooperative Social Behavior. In *The Development of Behavior: Comparative and Evolutionary Aspects*, edited by G. Burghardt and M. Bekoff, pp. 367-383. Garland, New York.  
  
1989 Behavioral Development of Terrestrial Carnivores. In *Carnivore Behavior, Ecology, and Evolution*, edited by J. Gittleman, pp. 89-124, Cornell University Press, Ithaca.
- Bekoff, M., T. J. Daniels and J. L. Gittleman  
1984 Life History Patterns the Comparative Social Ecology of Carnivores. *Annual Review of Ecological Systems* 15:191-232.
- Bell, D.  
1995 On the Nature of Sharing: Beyond the Range of Methodological Individualism. *Current Anthropology* 36(5):826-830.
- Bender, B.  
1978 Gatherer-Hunter to Farmer: A Social Perspective. *World Archaeology* 10(2):204-222.

- Berger, J., J. E. Swenson and I. Persson  
2001 Recolonizing Carnivores and Naive Prey: Conservation Lessons from Pleistocene Extinctions. *Science* 291:1036-1039.
- Binford, L. R.  
1977 General Introduction. In *For Theory Building in Archaeology*, edited by L. R. Binford, pp. 1-10. Academic Press, New York.  
  
1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35(3):255-273.  
  
1980 Willow Smoke and Dog's Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4-20.  
  
1987 Researching Ambiguity: Frames of Reference and Site Structure. In *Method and Theory for Activity Area Research*, edited by S. Kent, pp. 449-512. Columbia University Press, New York.  
  
1991 When the Going Gets Tough, the Tough Get Going: Nunamiut Local Groups, Camping Patterns and Economic Organisation. In *Ethnoarchaeological Approaches to Mobile Campsites*, edited by C. S. Gamble and W. A. Boismier, pp. 25-138. International Monographs in Prehistory, Ann Arbor.  
  
2001 *Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building Using Hunter-Gatherer and Environmental Data Sets*. University of California Press, Berkeley.
- Bird, D. W.  
1997 Behavioral Ecology and the Archaeological Consequences of Central Place Foraging among the Meriam. In *Rediscovering Darwin: Evolutionary Theory in Archaeological Explanation*, edited by C. M. Barton and G. A. Clark, pp. 291-308. vol. 7. American Anthropological Association, Arlington.
- Bird, R.  
1999 Cooperation and Conflict: The Behavioral Ecology of the Sexual Division of Labor. *Evolutionary Anthropology* 65-75.
- Bird, D. W. and R. Bird  
2000 The Ethnoarchaeology of Juvenile Foragers: Shellfishing Strategies Among the Meriam Children. *Journal of Anthropological Archaeology* 19:461-476.

- Blackburn, T. and K. Anderson (editors)  
1993 *Before the Wilderness: Environmental Management by Native Californians*. Ballena Press Anthropological Papers No. 40, Menlo Park.
- Blackburn, T. M., P. H. Harvey and M. D. Pagel  
1990 Species Number, Population Density, and Body Size Relationships in Natural Communities. *Journal of Animal Ecology* 59:335-345.
- Bleed, P.  
1986 The Optimal Design of Hunting Weapons: Maintainability or Reliability. *American Antiquity* 51:737-747.
- Blumenshine, R. J., J. A. Cavallo and S. D. Capaldo  
1994 Competition for Carcasses and Early Hominid Behavioral Ecology: A Case Study and Conceptual Framework. In *Early Hominid Behavioural Ecology*, edited by J. S. Oliver, N. E. Sikes and K. M. Stewart, pp. 197-214. Academic Press, London.
- Blurton-Jones, N., K. Hawkes and J. O'Connell  
1996 The Global Process and Local Ecology: How Should We Explain Differences Between the Hadza and the !Kung? In *Cultural Diversity Among Twentieth-Century Foragers*, edited by S. Kent, pp. 159-187. Cambridge University Press, Cambridge.
- Boitani, L. and T. Fuller (editors)  
2000 *Research Techniques in Animal Ecology: Controversies and Consequences*. Columbia University Press, New York.
- Bonnichsen, R. and A. L. Schneider  
1999 Breaking the Impasse on the Peopling of the Americas. In *Ice Age Peoples of North America*, edited by R. Bonnichsen and K. Turnmire, pp. 497-519. Oregon State University Press, Corvallis.
- Boserup, E.  
1965 *The Conditions of Agricultural Growth*. Allen and Unwin, London.
- Bradley B. A.  
1993 Paleo-Indian Flaked Stone Technology in the North American High Plains. In *From Kostenki to Clovis: Upper Paleolithic—Paleo-Indian Adaptations*, edited by O. Soffer and N. Praslov, pp. 251-262. Plenum Press, New York.
- Brandt, S. A. and K. Weedman  
2002 Woman the Toolmaker. *Archaeology* September/October: 50-53.

- Brantingham, P. J.  
1998 Hominid-carnivore Coevolution and Invasion of the Predatory Guild. *Journal of Anthropological Archaeology* 17(4): 327-353.
- Brightman, R.  
1996 The Sexual Division of Foraging Labor: Biology, Taboo and Gender Politics. *Comparative Studies in Social History* 38:687-729.
- Broughton, J. M.  
1994 Late Holocene Resource Intensification in the Sacramento Valley, California: The Vertebrate Evidence. *Journal of Archaeological Science* 21:501-514.  
  
1997 Widening Diet Breadth, Declining Foraging Efficiency, and Prehistoric Harvest Pressure: Ichthyofaunal Evidence from the Emeryville Shellmound. *Antiquity* 71: 845-862.  
  
2002 Pre-Columbian Human Impact on California Vertebrates: Evidence from Old Bones and Implications for Wilderness Policy. In *Wilderness and Political Ecology: Aboriginal Influences and the Original State of Nature*, edited by C. Kay, and R. T. Simmons. University of Utah Press, Salt Lake
- Broughton, J. M., and D. K. Grayson  
1993 Diet breadth, adaptive change, and the White Mountain faunas. *Journal of Archaeological Science* 20:331-336.
- Broughton, J. M. and J. F. O'Connell  
1999 On Evolutionary Ecology, Selectionist Archaeology, and Behavioral Archaeology. *American Antiquity* 64(1):153-165.
- Brown, J.  
1970 A Note on the Division of Labor. *American Anthropologist* 72:1073-1078.
- Brugal, J., F. David, J. G. Enloe and J. Jaubert  
1999 Introduction. In *Le Bison: Gibier et Moyen de Subsistance des Hommes du Paléolithique aux Paléoindiens des Grandes Plaines*, edited by J. Grugal, F. David, G. E. J and J. Jaubert, pp. 7-11. Éditions APDCA, Antibes.
- Brumbach, H. J. and R. Jarvenpa  
1997 Ethnoarchaeology of Subsistence Space and Gender: A Subarctic Dene Case. *American Antiquity* 62(3):414-436.

- Brunswig, R. H. Jr., and D. C. Fisher  
1993 Research on the Dent Mammoth Site. *Current Research in the Pleistocene* 10:63-65.
- Brush, N., M. Newman, and F. Smith  
1994 Immunological analysis of flint flakes from the Martins Creek Mastodon Site. *Current Research in the Pleistocene* 11:16-18.
- Brush, N., and F. Smith  
1994 The Martins Creek mastodon: A Paleoindian butchery site in Holmes County, Ohio. *Current Research in the Pleistocene* 11:14-15.
- Bryan, A. L.  
1991 The fluted-point tradition in the Americas- One of several adaptations to late Pleistocene American environments. In *Clovis: Origins and Adaptations*, edited by R. Bonnicksen and K. L. Tunmire, pp. 15-33. Center for the Study of the First Americans, Corvallis, Oregon.
- Burness, G. P., J. Diamond and T. Flannery  
2001 Dinosaurs, Dragons, and Dwarfs: The Evolution of Maximal Body Size. *Proceedings of the National Academy of Science* 98(25):14518-14523.
- Byers, D. S.  
1955 Additional information on the Bull Brook site, Massachusetts. *American Antiquity* 20:274-276.
- Caraco, T, and L. L. Wolf  
1975 Ecological Determinants of Group Sizes of Foraging Lions. *American Naturalist* 109:343-352.
- Carbone, C. and J. L. Gittleman  
2002 A Common Rule for the Scaling of Carnivore Density. *Science* 295:2273-2276.
- Case, T. J.  
1978 A General Explanation for Insular Body Size Trends in Terrestrial Vertebrates. *Ecology* 59:1-18.
- Cashden, E. A.  
1985 Coping With Risk: Reciprocity Among the Basarwa of Northern Botswana. *Man* 20:454-474.

- Casteel, R. W.  
1972 Two Static Maximum Population-Density Models for Hunter-Gatherers: A First Approximation. *Human Ecology* 4(1):19-39.
- Charnov, E. L.  
1976 Optimal foraging: Attack strategy of a Mantid. *The American Naturalist* 110:141-151.
- Churchill, S. E.  
1993 Weapon Technology, Prey Size Selection, and Hunting Methods in Modern Hunter-Gatherers: Implications for Hunting in the Palaeolithic and Mesolithic. In *Hunting and Animal Exploitation in the Later Palaeolithic and Mesolithic of Eurasia*, edited by G. Peterkin, H. Bricker, and P. Mellars, pp. 11-24. Archaeological Papers of the American Anthropological Association No. 4, Arlington.
- Clausen, C. J., A. D. Cohen, C. Emiliani, J. A. Holman, and J. J. Stipp  
1979 Little Salt Spring, Florida: A unique underwater site. *Science* 203:609-614.
- Cleland, C.  
1965 Barren Ground Caribou (*Rangifer arcticus*) from an Early Man Site in Southeastern Michigan. *American Antiquity* 30:350-351.  
  
1976 The Focal-diffusive Model: An Evolutionary Perspective on the Prehistoric Cultural Adaptations of the Eastern United States. *Midcontinental Journal of Archaeology* 1:59-76.
- Cohen, M. N.  
1985 Prehistoric Hunter-Gatherers: The Meaning of Social Complexity. In *Prehistoric Hunter-Gatherers: The Emergence of Social Complexity*, edited by T. D. Price and J. A. Brown, pp. 99-119. Academic Press, San Diego.
- Cohen, J. E., S. L. Pimm, P. Yodzis and J. Saldana  
1993 Body Sizes of Animal Predators and Animal Prey in Food Webs. *Journal of Animal Ecology* 62:67-78.
- Colinvaux, P.  
1978 *Why Big Fierce Animals are Rare: An Ecologist's Perspective*. Princeton University Press, Princeton.

- Colley, S.  
2000 Sisters Are Doing it for Themselves? Gender, Feminism, and Australian "Aboriginal" Archaeology. In *Gender and Material Culture an Archaeological Perspective*, edited by M. Donald and L. Hurcombe, pp. 20-32. MacMillan Press, New York.
- Collins, M. B.  
1999a *Clovis Blade Technology*. University of Texas Press, Austin.  
1999b Clovis and Folsom Lithic Technology on and near the Southern Plains: Similar Ends, Different Means. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. Amick, pp. 12-38. International Monographs in Prehistory, Ann Arbor.
- Collins, M. B., G. L. Evans, T. N. Campbell, M. C. Winans, and C. E. Mear  
1989 Clovis Occupation at Kincaid Shelter, Texas. *Current Research in the Pleistocene* 6:3-4.
- Collins, M. B., T. R. Hester, and P. J. Headrick  
1992 Engraved Cobbles from the Gault Site, Central Texas. *Current Research in the Pleistocene* 8:13-15.
- Condon, R. G., P. Collings and G. Wenzel  
1995 The Best Part of Life: Subsistence Hunting, Ethnicity, and Economic Adaptation among Young Inuit Males. *Arctic* 48(1):31-46.
- Connolly, G. E.  
1978 Predators and Predator Control. In *Big Game of North America*, edited by J. Schmidt and D. Gilbert, pp. 369-394. Stackpile Books, Harrisburg.
- Cotter, J. L.  
1937 The Occurrence of Flints and Extinct Animals in Pluvial Deposits Near Clovis, New Mexico. *Proceedings of the Philadelphia Academy of Natural Sciences* 89:2-16.
- Crook, W. W., Jr., and R. K. Harris  
1957 Hearths and artifacts of early man near Lewisville, Texas and Associated Faunal Material. *Bulletin of the Texas Archaeological Society* 28:7-97.
- Dahlberg, F. (editor)  
1981 *Woman the Gatherer*. Yale University Press, New Haven.

- Davies, N. B. and A. I. Houston  
1984 Territory Economics. In *Behavioral Ecology: An Evolutionary Approach*, edited by J. R. Krebs and N. B. Davies, pp. 148-169. 2nd ed. Blackwell, Oxford.
- DeMallie, R. J. and D. R. Miller  
2001 Assinboine. In *Handbook of North American Indians: Plains*, edited by R. DeMallie, pp. 572-595. Smithsonian Institution Press, Washington D. C.
- Dempsey, H. A.  
2001 Blackfoot. In *Handbook of North American Indians: Plains*, edited by R. DeMallie, pp. 604-628. Smithsonian Institution Press, Washington D. C.
- Dent, R. J., and B. E. Kauffman  
1985 Aboriginal Subsistence and Site Ecology Interpreted from Microfloral and Faunal Remains. In *Shawnee-Minisink: A Stratified Paleoindian-Archaic Site in the Upper Delaware Valley of Pennsylvania*, edited by C. McNett, pp. 55-79. Academic Press, New York.
- Dillehay, T. D.  
2000 *The Settlement of the Americas: A New Prehistory*. Basic Books, New York.
- Dillehay, T. D. and J. Rossen  
2002 Plant Food and its Implications for the Peopling of the New World: A View from South America. In *The First Americans: The Pleistocene Colonization of the New World*, edited by N. Jablonski, pp. 237-254. Memoirs of the California Academy of Science, San Francisco.
- Dincauze, D. F.  
1984 An Archaeo-Logical Evaluation of the Case for Pre-Clovis Occupations. *Advances in World Archaeology* 3:275-323.
- Dixon, E. J.  
1999 *Bones, Boats, and Bison: Archeology and the First Colonization of Western North America*. University of New Mexico Press, Albuquerque.
- Dobres, M. A.  
1995 Gender and Prehistoric Technology: On the Social Agency of Technical Strategies. *World Archaeology* 27(1):25-49.
- 2000 *Technology and Social Agency: Outlining a Practice Framework for Archaeology*. Blackwell. Oxford.

Driver, J. C.

1990 Meat in Due Season: The Timing of Communal Hunts. In *Hunters of the Recent Past*, edited by L. B. Davis, and B. O. K. Reeves, pp. 11-33. Unwin Hyman, London.

1999 Raven skeletons from Paleoindian contexts, Charlie Lake Cave, British Columbia. *American Antiquity* 64:289-298.

Duffy, K.

1984 *Children of the Forest*. Dodd, Mead & Company, New York.

Eaton, R. L.

1974 *The Cheetah: The Biology, Ecology, and Behavior of an Endangered Species*. Van Nostrand Reinhold, New York.

Edwards, D. A. and J. F. O'Connell

1995 Broad Spectrum Diets in Arid Australia. *Antiquity* 69:769-783.

Eisenberg, J. F.

1981 *The Mammalian Radiations: An Analysis of Trends in Evolution, Adaptation, and Behavior*. University of Chicago Press, Chicago.

Eisenberg, L.

1978 *Paleo-indian Settlement Pattern in the Hudson and Delaware River Drainages*. Department of Anthropology, Franklin Pierce College, Occasional Publications in Northeastern Anthropology, No. 4, Rindge, New Hampshire.

Ellingson, T.

2001 *The Myth of the Noble Savage*. University of California Press, Berkeley.

Enloe, J. G.

1999 Hunting Specialization: Single-Species Focus and Human Adaptation. In *Le Bison: Gibier et Moyen de Subsistance des Hommes du Paléolithique aux Paléoindiens des Grandes Plaines*, edited by J. Grugal, F. David, G. E. J and J. Jaubert, pp. 501-510. Éditions APDCA, Antibes.

Estioko-Griffin, A. and P. Griffin

1981 Woman the Hunter: The Agta. In *Women the Gatherer*, edited by F. Dahlberg, pp. 121-151. Yale University Press, New Haven.

Ewers, J. C.

1955 *The Horse in Blackfoot Indian Culture*. Bureau of American Ethnology Bulletin 159, Washington D.C.

1989 *The Blackfeet: Raiders on the Northwestern Plains*. ninth ed. University of Oklahoma Press, Norman.

Ferring, C. R.

1995 The Late Quaternary Geology and Archaeology of the Aubrey Clovis site, Texas: A Preliminary Report. In *Ancient Peoples and Landscapes*, edited by E. Johnson, pp. 273-281. Museum of Texas Tech University, Lubbock.

2001 *The Archaeology and Paleoecology of the Aubrey Clovis Site (41DN479) Denton County, Texas*. U.S. Army Corps of Engineers Fort Worth District, Fort Worth.

Figgins, J.D.

1933 A Further Contribution to the Antiquity of Man in America. *Proceedings of the Colorado Museum of Natural History* XII(2).

Fisher, D. C.

1986 Mastodont Procurement by Paleoindians of the Great Lakes region: Hunting or Scavenging. In *The Evolution of Human Hunting*, edited by M. H. Nitecki and D. V. Nitecki, pp. 309-421. Plenum Press, New York.

Fitting, J. E., J. DeVisscher and E. J. Wahla

1966 *The Paleo-Indian Occupation of the Holcombe Beach*. Anthropological Papers of the Museum of Anthropology, University of Michigan, No. 27, The University of Michigan, Ann Arbor.

Fladmark, K., J. C. Driver, and D. Alexander

1988 The Paleoindian Component at Charlie Lake Cave (HbRF 39), British Columbia. *American Antiquity* 53:371-384.

Force, F. P.

1997 *The Domebo Site: A Taphonomic Reanalysis*, University of Oklahoma.

Fowler, L. and R. Flannery

2001 Gros Ventre. In *Handbook of North American Indians: Plains*, edited by R. DeMallie, pp. 677-694. Smithsonian Institution Press, Washington D. C.

Frisancho, A. R.

1993 *Human Adaptation and Accommodation*. Enlarged and Revised Edition of Human Adaptation ed. The University of Michigan Press, Ann Arbor.

Frison, G. C.

1982 The Sheaman site: A Clovis component. In *The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains*, edited by G. C. Frison and D. J. Stanford, pp. 143-157. Academic Press, New York.

1989 Experimental use of Clovis weaponry and tools on African elephants. *American Antiquity* 54(4):766-784.

1991 *Prehistoric Hunters of the High Plains*. Academic Press, San Diego.

1993 Paleo-indian Flaked Stone Technology in the North American High Plains. In *From Kostenki to Clovis: Upper Paleolithic—Paleo-Indian Adaptations*, edited by O. Soffer and N. Praslov, pp. 237-248. Plenum Press, New York.

Frison, G. C., and B. Bradley

1999 The Fenn Cache, Clovis Weapons and Tools. One Horse Land & Cattle Co., Santa Fe.

Frison, G. C., and L. C. Todd

1986 *The Colby mammoth site*. University of New Mexico Press, Albuquerque.

Funston, P. J., M. Mills, H. C. Biggs and P. Richardson

1998 Hunting by Male Lions: Ecological Influences and Socioecological Implications. *Animal Behavior* 56:1333-1345.

Geffen, E., M. Gompper, J. Gittleman, H.-K. Luh, D. Macdonald and R. Wayne

1996 Size, Life History Traits, and Social Organization in the Canidae: A Reevaluation. *The American Naturalist* 147(1):140-160.

Giffen, N. M.

1930 *The Roles of Men and Women in Eskimo Culture*. University of Chicago Press, Chicago.

Giraldeau, L., and T. Caraco

2000 *Social Foraging Theory*. Princeton University Press, Princeton.

Gero, J.

1991 Genderlithics: Women's Roles in Stone Tool Production. In *Engendering Archaeology: Women and Prehistory*, edited by J. Gero and M. Conkey, pp. 163-193. Basil Blackwell, Oxford.

1995 Railroading epistemology: Paleoindians and women. In *Interpreting Archaeology*, edited by I. Hodder et al. 175-180. Routledge, New York.

Gittleman, J. L.

1989 Carnivore Group Living: Comparative Trends. In *Carnivore Behavior, Ecology, and Evolution*, edited by J. L. Gittleman, pp. 183-208. Cornell University Press, Ithaca.

Goodyear, A. C.

1989 A Hypothesis for the use of Cryptocrystalline Raw Materials among Paleoindian Groups of North America. In *Eastern Paleoindian Lithic Resource Use*, edited by C.J. Ellis and J. C. Lothrop, pp. 1-9. Westview Press, Boulder, Colorado.

Gould, R.

1980 *Living Archaeology*. Cambridge University Press, Cambridge.

Graham, R. W., C. V. Haynes, D. L. Johnson, and M. Kay

1981 Kimmswick: A Clovis-Mastodon Association in eastern Missouri. *Science* 213:1115-1117.

Graham, R. W., and M. Kay

1988 Taphonomic comparisons of cultural and noncultural faunal deposits at the Kimmswick and Barnhart sites, Jefferson County, Missouri. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller and D. W. Steadman, pp. 227-240. Bulletin of the Buffalo Society of Natural Sciences, Vol. 33, Buffalo.

Grayson, D. K.

1984 Archaeological Associations with Extinct Pleistocene Mammals in North America. *Journal of Archaeological Science* 11:213-221.

Grayson, D. K., and F. Delpech

1998 Changing Diet Breadth in the Early Upper Paleolithic of Southwestern France. *Journal of Archaeological Science* 25:1119-1129.

2001 The Upper Paleolithic at Grotte XVI (Dordogne, France): Richness, Evenness and Cave Bears. In *Questioning the Answers: Re-Solving Fundamental Problems of the Early Upper Paleolithic*, edited by M. A. Hays and P. T. Thacker, pp. 187-195. BAR International Series 1005, British Archaeological Reports, Oxford.

- Grayson, D. K. and D. J. Meltzer  
2002 Clovis Hunting and Large Mammal Extinction: A Critical Review of the Evidence. *Journal of World Prehistory* 16(4):313-359.
- 2003 Requiem for North American Overkill. *Journal of Archaeological Science* 30:585-593.
- Greaves, R. D.  
1997 Hunting and Multifunctional Use of Bows and Arrows. In *Projectile Technology*, edited by H. Knecht, pp. 287-320. Plenum Press, New York.
- Green, F. E.  
1963 The Clovis Blades: An Important Addition to the Llano Complex . *American Antiquity* 29(2):145-165.
- Greenwood, A. D., F. Lee, C. Capelli, R. DeSalle, A. Tikhonov, P. A. Marx and R. MacPhee  
2001 Evolution of Endogenous Retrovirus-like Elements of the Woolly Mammoth and its Relatives. *Molecular Biology and Evolution* 18(5):840-847.
- Griffiths, D.  
1980 Foraging Costs and Relative Prey Size. *American Naturalist* 116(5):743-752.
- Grimes, J. R., and B. G. Grimes  
1985 Flake Shavers: Morphometric, Functions, and Life-Cycle Analyses of a Paleoindian Unifacial Tool Class. *Archaeology of Eastern North America* 12:122-158.
- Gruhn, R.  
1994 The Pacific Coast Route of Initial Entry: An Overview. In *Method and Theory for Investigating the Peopling of the Americas*, edited by R. Bonnichsen and D. Steele, pp. 249-256. Center for the Study of the First Americans, Corvallis.
- Gubser, N. J.  
1965 *The Nunamiut Eskimos: Hunters of Caribou*. Yale University Press, New Haven.
- Gurven, M., K. Hill, H. Kaplan, A. Hurtado and R. Lyles  
2000 Food Transfers Among Hiwi Foragers of Venezuela: Tests of Reciprocity. *Human Ecology* 28(2):171-218.

- Gustafson, C. E., D. Gilbow, and R. D. Daugherty  
1979 The Manis mastodon: Early man on the Olympic Peninsula. *Canadian Journal of Archaeology* 3:157-164.
- Hall, D. A.  
2000 A Very Delicate Tool for a Very Delicate Purpose. *The Mammoth Trumpet* 16(2):
- Halperin, R. H.  
1980 Ecology and Mode of Production: Seasonal Variation and the Division of Labor by Sex among Hunter-Gatherers. *Journal of Anthropological Research* 36:379-399.
- Hames, R. B.  
1979 A Comparison of the Efficiencies of the Shotgun and the Bow in Neotropical Forest Hunting. *Human Ecology* 7(3):219-252.  
  
1992 Time Allocation. In *Evolutionary Ecology and Human Behavior*, edited by E. A. Smith and B. Winterhalder, pp. 203-236. Aldine de Gruyter, New York.
- Hannus, L. A.  
1989 Flaked Mammoth Bone from the Lange/Ferguson site White River Badlands area, South Dakota. In *Bone Modification*, edited by R. Bonnicksen and M. H. Sorg, pp. 395-412. Center for the Study of the First Americans, University of Maine, Orono, Maine.  
  
1990 The Case for Mammoth Bone-butchering Tools. In *Megafauna and Man: Discovery of America's Heartland*, edited by L. D. Agenbroad, J. Mead and L. Nelson, pp. 86-99. Mammoth Site of Hot Springs, Hot Springs, South Dakota.
- Hart, J. A.  
1978 From Subsistence to Market: A Case Study of the Mbuti Net Hunters. *Human Ecology* 6(3):325-353.
- Haury, E. W.  
1953 Artifacts with Mammoth Remains, Naco, Arizona. *American Antiquity* 19:1-14.
- Haury, E. W., E. B. Sayles, and W. W. Wasley  
1959 The Lehner Mammoth Site, Southeastern Arizona. *American Antiquity* 25:2-42.

Hawkes, K.

1991 Showing Off: Tests of an Hypothesis About Men's Foraging Goals. *Ethology and Sociobiology* 12:29-54.

1992 Sharing and Collective Action. In *Evolutionary Ecology and Human Behavior*, edited by E. A. Smith and B. Winterhalder, pp. 269-300. Aldine de Gruyter, New York.

Hawkes, K., K. Hill, and J. F. O'Connell

1982 Why Hunters Gather: Optimal Foraging and the Ache of Eastern Paraguay. *American Ethnologist* 9:379-398.

Hawkes, K. and J. F. O'Connell

1985 Optimal Foraging Models and the Case of the !Kung. *American Anthropologist* 87:401-405.

Hawkes, K., J. F. O'Connell and N. G. Blurton-Jones

1997 Hadza Women's Time Allocation, Offspring Provisioning, and the Evolution of Long Postmenopausal Life Spans. *Current Anthropology* 38(4):551-577.

2001 Hunting and Nuclear Families: Some Lessons from the Hadza about Men's Work. *Current Anthropology* 42(5): 681-710.

Hayden, B.

1994 Competition, Labor, and Complex Hunter-Gatherers. In *Key Issues in Hunter-Gatherer Research*, edited by E. Burch and L. Ellana, pp. 223-239. Berg, Oxford.

1981 Subsistence and Ecological Adaptations of Modern Hunter/Gatherers. In *Omnivorous Primates*, edited by R. Harding and G. Teleki, pp. 344-421. Columbia University Press, New York.

Haynes, G.

1988 Mass Deaths and Serial Predation: Comparative Taphonomic Studies of Modern Large Mammal Death Sites. *Journal of Archaeological Science* 15:219-235.

1991 *Mammoths, Mastodons, and Elephants*. Cambridge University Press, Cambridge.

- 1995 Pre-Clovis and Clovis Megamammals: A Comparison of Carcass Disturbance, Age-profiles, and other Characteristics in Light of Recent Actualistic Studies. In *Ancient Peoples and Landscapes*, edited by E. Johnson, pp. 9-28. Museum of Texas Tech University, Lubbock.
- 2002 The Catastrophic Extinction of North American Mammoths and Mastodons. *World Archaeology* 33:391-416.
- Haynes, C. V., Jr.  
1966 Elephant Hunting in North America. *Scientific American* 214:104-112.
- 1992 Contributions of Radiocarbon Dating to the Geochronology of the Peopling of the New World. In *Radiocarbon After Four Decades*, edited by R. E. Taylor, A. Long, and S. Kra, pp. 355-374. Springer-Verlag, New York.
- 1993 Clovis-Folsom Geochronology and Climatic Change. In *From Kostenki to Clovis: Upper Paleolithic - Paleo-Indian Adaptations*, edited by O. Soffer and N. D. Praslov, pp. 219-236. Plenum Press, New York.
- Haynes, C. V. Jr., D. J. Donahue, A. Tull, and T Zebel  
1984 Application of Accelerator Dating to Fluted Point Paleoindian Sites. *Archaeology of Eastern North America* 12:184-191.
- Haynes, C. V. Jr., and E. W. Haury  
1982 Archaeological Investigations at the Lehner site, Arizona, 1974-1975. *National Geographic Research Reports* 14:325-334.
- Heizer, R. F., and M. A. Baumhoff  
1970 Big game Hunters in the Great Basin: A Critical Review of the Evidence. *Contributions of the University of California Archaeological Research Facility* 7:1-12.
- Hemmings, T. E.  
1970 Early Man Sites in the San Pedro Valley, Arizona. PhD Dissertation, Department of Anthropology, University of Arizona.
- Hemmings, E. T., and C. V. Haynes, Jr.  
1969 The Escapule Mammoth and Associated Projectile Points, San Pedro valley, Arizona. *Journal of the Arizona Academy of Science* 5:184-188.
- Hill, K., H. Kaplan, K. Hawkes and A. M. Hurtado  
1985 Men's Time Allocation to Subsistence Work Among the Ache of Eastern Paraguay. *Human Ecology* 13(1):29-47.

- Hill, K., H. Kaplan, K. Hawkes and A. M. Hurtado  
1987 Foraging Decisions among Ache Hunter-gatherers: New data and Implications for Optimal Foraging Models. *Ethnology and Sociobiology* 8:1-36.
- Hill, K. and J. Padwe  
2000 Sustainability of Ache Hunting in the Mbaracayu Reserve, Paraguay. In *Hunting for Sustainability in Tropical Forests*, edited by J. Robinson and E. Bennett, pp. 79-105. Columbia University Press, New York.
- Hobbes, T.  
1962 *Leviathan*. Collier (reprint of 1651 edition), New York.
- Hoffman, C. A.  
1983 A Mammoth Kill Site in the Silver Springs Run. *The Florida Anthropologist* 36:83-87.
- Holliday, V. T., J. C. Vance Haynes, J. L. Hofman, and D. J. Meltzer  
1994 Geoarchaeology and Geochronology of the Miami (Clovis) Site, Southern High Plains of Texas. *Quaternary Research* 41:234-244.
- Howard, E. B.  
1935 *Evidence of Early Man in North America*. The Museum Journal, Vol. XXIV, No. 2-3, The University Museum, University of Pennsylvania, Philadelphia.
- Hudecek-Cuff, C.  
1998 *Engendering Northern Plains Paleoindian Archaeology*. B.A.R. International Series, Oxford.
- Hurtado, A. M. and K. R. Hill  
1990 Seasonality in a Foraging Society: Variation in Diet, Work Effort, Fertility, and Sexual Division of Labor Among the Hiwi of Venezuela. *Journal of Anthropological Research* 46:293-346.
- Hurtado, A. M., K. Hawkes, K. Hill and H. Kaplan  
1985 Female Subsistence Strategies Among Ache Hunter-Gatherers of Eastern Paraguay. *Human Ecology* 13(1):1-27.
- Isaac, G. L.  
1978 The Food Sharing Behavior of Protohuman Hominids. *Scientific American* 238(4): 90-108.

- Janetski, J. C.  
1997 Fremont Hunting and Resource Intensification in the Eastern Great Basin. *Journal of Archaeological Science* 24:1075-1088.
- Jochim, M. A.  
1976 *Hunter-Gatherer Subsistence and Settlement: A Predictive Model*. Academic Press, New York.  
  
1981 *Strategies for Survival: Cultural Behavior in an Ecological Context*. Academic Press, New York.
- Johnson, D., P. Kawano, and E. Ekker  
1980 Clovis Strategies of Hunting Mammoth. *Canadian Journal of Anthropology* 1:107-114.
- Johnson, A.  
1977 The Energy Costs of Technology in a Changing Environment: A Machiguenga Case. In *Material Culture: Styles, Organization, and Dynamics of Technology*, edited by H. Lechtman and R. S. Merrill, pp. 155-167. West Publishing, St. Paul.
- Johnson, E.  
1977 Animal Food Resources of Paleoindians. In *Paleo-Indian Lifeways*, edited by E. Johnson, pp. 65-77. vol. The Museum Journal 17.  
  
1987 *Lubbock Lake: Late Quaternary Studies on the Southern High Plains*. Texas A&M University Press, College Station.  
  
1991 Late Pleistocene Cultural Occupation of the Southern Plains. In *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. L. Tunmire, pp. 215-236. Center for the Study of the First Americans, Corvallis, Oregon.
- Jodry, M. A.  
1999 Folsom Technological and Socioeconomic Strategies: Views from Stewart's Cattle Guard and the Upper Rio Grande Basin, Colorado. PhD Dissertation, Department of Anthropology, American University.
- Kaplan, H. and K. Hill  
1992 The Evolutionary Ecology of Food Acquisition. In *Evolutionary Ecology and Human Behavior*, edited by E. A. Smith and B. Winterhalder, pp. 157-202. Aldine de Gruyter, New York.

- Kay, C. and R. T. Simmons (editors)  
2002 In *Wilderness and Political Ecology: Aboriginal Influences and the Original State of Nature*, University of Utah Press, Salt Lake.
- Keeley, L.  
1988 Hunter-Gatherer Economic Complexity and "Population Pressure": A Cross-Cultural Analysis. *Journal of Anthropological Archaeology* 7:373-411.  
  
1995 Protoagricultural Practices among Hunter-Gatherers: A Cross-Cultural Survey. In *Last Hunters First Farmers: New Perspectives on the Prehistoric Transition to Agriculture*, edited by T. D. Price and A. B. Gerbauer, pp. 243-272. School of American Research Press, Santa Fe.
- Kehoe, A. B.  
1983 The Shackles of Tradition. In *The Hidden Half*, edited by P. Albers and B. Medicine, pp. 53-73. University Press of America, Washington.
- Kelly, R. L.  
1983 Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research* 39(3):277-306.  
  
1995 *The Foraging Spectrum*. Smithsonian Institution Press, Washington DC.  
  
1996 Ethnographic analogy and migration to the western hemisphere. In *Prehistoric Mongoloid Dispersals*, edited by T. Akazawa and E. J. E. Szathmary, pp. 228-240. Oxford University Press, New York.  
  
1999 Hunter-Gatherer Foraging and Colonization of the Western Hemisphere. *Anthropologie* 37:143-153.  
  
2000 Elements of a Behavioral Ecological Paradigm for the Study of Prehistoric Hunter-Gatherers. In *Social Theory in Archaeology*, edited by M. B. Schiffer, pp. 63-78. University of Utah Press, Salt Lake City.
- Kelly, R. L., and L. C. Todd  
1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53:231-244.
- Kelt, D. A. and D. H. V. Vuren  
2001 The Ecology and Macroecology of Mammalian Home Range Area. *The American Naturalist* 157:637-645.

- Kensinger, K. M.  
1995 *How Real People Ought to Live: The Cashinahua of Eastern Peru*.  
Waveland Press, Prospect Heights.
- Klein, L. F. and L. A. Ackerman (editors)  
1995 *Women and Power in Native North America*. University of Oklahoma Press,  
Norman.
- Kornfeld, M.  
1988 The Rocky Fools Site: A Small Folsom Lithic Assemblage from the  
Northwestern Plains. *North American Archeologist* 9:197-222.
- Krebs, J. R. and N. B. Davies (editors)  
1984 *Behavioural Ecology: An Evolutionary Approach*. 2nd ed. Blackwell, Oxford.
- Krebs, J. R. and R. H. McCleery  
1984 Optimization in Behavioural Ecology. In *Behavioural Ecology: An  
Evolutionary Approach*, edited by J. R. Krebs and N. B. Davies, pp. 91-121. 2nd  
ed. Blackwell, Oxford.
- Kuhn, S. L.  
1995 *Mousterian Lithic Technology: An Ecological Perspective*. Princeton  
University Press, Princeton.
- Kuhn, T. S.  
1996 *Structure of Scientific Revolutions*. Third edition, University of Chicago  
Press, Chicago.
- Kurtén, B. and E. Anderson  
1980 *Pleistocene Mammals of North America*. Columbia University Press, New  
York.
- Lahren, L. and R. Bonnicksen  
1974 Bone Foreshafts from a Clovis Burial in Southwestern Montana. *Science*  
186:147-150.
- Lamprecht, J.  
1978 On Diet, Foraging Behavior and Interspecific Food Competition of Jackals  
in the Serengeti National Park, East Africa. *Säugetierk* 43:210-223.
- Lance, J. F.  
1959 Faunal Remains from the Lehner Mammoth Site. *American Antiquity*  
25(1):35-42.

- Landre, J. W. and L. Hernandez  
2003 (in press) Total Energy Budget and Prey Requirements of Free-ranging Coyotes in the Great Basin Desert of the Western United States. *Journal of Arid Environments*.
- Laub, R. S., M. F. DeRemer, and C. A. Duport  
1988 The Hiscock site: A Rich Late Quaternary Locality in Western New York State. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller and D. W. Steadman, pp. 67-81. Bulletin of the Buffalo Society of Natural Sciences, Vol. 33, Buffalo.
- Layton, R., R. Foley and E. Williams  
1991 The Transition Between Hunting and Gathering and the Specialized Husbandry of Resources. *Current Anthropology* 32(3):255-274.
- Leacock, E.  
1978 Women's Status in Egalitarian Society: Implications for Social Evolution. *Current Anthropology* 19(2).
- Lee, R. B.  
1968 What Hunters do for a Living, or How to Make out on Scarce Resources. In *Man the Hunter*, edited by R. B. Lee and I. DeVore, pp. 30-48. Aldine, Chicago.  
1979 *The !Kung San: Men, Women, and Work in a Foraging Society*. Cambridge University Press, Cambridge.
- Lee, R. B. and I. DeVore  
1968 Problems in the Study of Hunter-Gatherers. In *Man the Hunter*, edited by R. Lee and I. DeVore, pp. 3-13. Aldine, New York.
- Leonhardy, F. C.  
1966 *Domebo: A Paleo-Indian Mammoth Kill in the Prairie-Plains*. Contributions of the Museum of the Great Plains, Lawton, Oklahoma.
- Leonhardy, F. C., and A. D. Anderson  
1966 The Archaeology of the Domebo site. In *Domebo: A Paleo-Indian Mammoth Kill in the Prairie-Plains*, edited by F. C. Leonhardy, pp. 14-26. Contributions of the Museum of the Great Plains, No. 1, Lawton, Oklahoma.
- Lescarbot, M.  
1969 *History of New France*. Greenwood Press (reprint of 1609 edition), Westport.

- Lotka, A. J.  
1932 The Growth of Mixed Populations: Two Species Competing for a Common Food Supply. *Journal of the Washington Academy of Sciences* 22:461-469.
- Lovegrove, B. G.  
2000 The Zoogeography of Mammalian Basal Metabolic Rate. *The American Naturalist* 156:201-219.
- Lubbock, J.  
1872 *Prehistoric Times as Illustrated by Ancient Remains and the Manners and Customs of Modern Savages*. Appleton and Company, New York.
- Lundelius, E.L.  
1972 Vertebrate Remains from the Gray Sand. In *Blackwater Locality No. 1: A Stratified Early Man Site in Eastern New Mexico*, edited by J.J. Hester, pp.148-163. Fort Burgwin Research Center, Taos.
- Lyman, R. L. and M. J. O'Brien  
1998a The Goals of Evolutionary Archaeology. *Current Anthropology* 39(5):615-652.  
  
1998b A Mechanical and Functional Study of Bone Rods from the Richey-Roberts Clovis Cache, Washington, U.S.A. *Journal of Archaeological Science* 25:887-906.
- Marks, S. A.  
1976 *Large Mammals and a Brave People*. University of Washington Press, Seattle.
- Martin, P. S.  
1984 Prehistoric Overkill: The Global Model. In *Quaternary Extinctions*, edited by P. S. Martin and R. G. Klein, pp. 354-403. The University of Arizona Press, Tucson, Arizona.
- Martin, J. E.  
1984 Fossil Vertebrates and the Paleoenvironment of the Lange/Ferguson Clovis Kill Site in the Badlands of South Dakota. *Current Research in the Pleistocene* 1:69-71.
- McGee  
1898 *The Seri Indians*. Seventeenth Annual Report of the Bureau of American Ethnology, pp. 1-344, Washington D. C.

McNab, B. K.

1989 Basal Rate of Metabolism, Body Size, and Food Habits in the Order Carnivora. In *Carnivore Behavior, Ecology, and Evolution*, edited by J. L. Gittleman, pp. 335-354. Cornell University Press, Ithaca.

McNett, C. W., B. A. McMillan, and S. B. Marshall

1977 The Shawnee-Minisink site. In *Amerinds and Their Paleoenvironments*, edited by W. S. Newman and B. Salwen, pp. 282-296. Annals of the New York Academy of Science Vol. 288, New York.

Mehringer, P. J.

1988 Weapons Cache of Ancient Americans. *National Geographic* 174:500-503.

Meltzer, D. J.

1988 Late Pleistocene Human Adaptations in Eastern North America. *Journal of World Prehistory* 2:1-52.

1989 Why Don't We Know When the First People came to North America? *American Antiquity* 54:471-490.

1993 Is There a Clovis Adaptation? In *From Kostenki to Clovis: Upper Paleolithic:*

Paleo-Indian Adaptations, edited by O. Soffer and N. D. Praslov, pp. 293-310. Plenum Press, New York.

1995 Clocking the First Americans. *Annual Review of Anthropology* 24:21-45.

2002 What Do You Do When No One's Been There Before? Thoughts on the Exploration and Colonization of New Lands. In *The First Americans: The Pleistocene Colonization of the New World*, edited by N. Jablonski, pp. 27-58. Memoirs of the California Academy of Science, San Francisco.

Meltzer, D. J., and J. I. Mead

1985 Dating late Pleistocene extinctions: Theoretical issues, analytical bias, and substantive results. In *Environments and Extinctions: Man in Late Glacial North America*, edited by J. I. Mead and D. J. Meltzer, pp. 145-174. Center for the Study of Early Man, Orono, Maine.

Meltzer, D. J., and B. D. Smith

1986 Paleoindian and Early Archaic subsistence strategies in eastern North America. In *Foraging, Collecting, and Harvesting: Archaic Period Subsistence and Settlement in the Eastern Woodlands*, edited by S. Neusius, pp. 3-31. Center for Archaeological Investigations, Southern Illinois University, Carbondale.

- Mena, P., J. Stallings, J. Regalado and R. Cueva  
 2000 The Sustainability of Current Hunting Practices by the Huaorani. In *Hunting for Sustainability in Tropical Forests*, edited by J. G. Robbins and E. L. Bennett, pp. 57-78. Columbia University Press, New York.
- Mithen, S.  
 1993 Simulating mammoth hunting and extinction: Implications for the Late Pleistocene of the Central Russian Plain. In *Hunting and Animal Exploitation in the Later Paleolithic and Mesolithic of Eurasia*. G. L. Peterkin, H.M. Bricker, and P. Mellars, eds. Pp. 163-178: Archaeological Papers of the American Anthropological Association, No. 4.
- Moehlman, P. D.  
 1986 Ecology of Cooperation in Canids. In *Ecological Aspects of Social Evolution*, edited by D. Rubenstein and R. Wrangham, pp. 64-86. Princeton University Press, Princeton.
- 1989 Intraspecific Variation in Canid Social Systems. In *Carnivore Behavior, Ecology, and Evolution*, edited by J. L. Gittleman, pp. 143-163. Cornell University Press, Ithaca.
- Mosimann, J. F., and P. S. Martin  
 1975 Simulating Overkill by Paleoindians. *American Scientist* 63:304-313.
- Murdock, G. P.  
 1981 *Atlas of World Cultures*. University of Pittsburgh Press, Pittsburgh.
- Murdock, G. P. and C. Provost  
 1973 Factors in the Division of Labor by Sex: A Cross-Cultural Analysis. *Ethnology* 12:203-225.
- Neiman, F.  
 1997 Conspicuous Consumption as Wasteful Advertising: A Darwinian Perspective on Spatial Patterns in Classic Maya Terminal Monument Dates. In *Rediscovering Darwin: Evolutionary Theory and Archaeological Explanation*, edited by C. M. Barton and G. A. Clark, pp. 267-290. American Anthropological Association No. 7, Arlington.
- Nudds, T. D.  
 1978 Convergence of Group Size Strategies by Mammalian Carnivores. *American Naturalist* 112:957-960.

- Nowak, R. M.  
1999 *Walker's Mammals of the World, Sixth Edition, Volumes 1 & II*. Johns Hopkins University Press, Baltimore.
- O'Connell, J. F. and K. Hawkes  
1981 Alyawara Plant Use and Optimal Foraging Theory. In *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses*, edited by B. Winterhalder and E. A. Smith, pp. 99-125. University of Chicago Press, Chicago.
- Oftedal, O. T. and J. L. Gittleman  
1989 Patterns of Energy Output During Reproduction in Carnivores. In *Carnivore Behavior, Ecology, and Evolution*, edited by J. L. Gittleman, pp. 355-378. Cornell University Press, Ithaca.
- Ohtsuka, R. and T. Suzuki  
1990 *Population Ecology of Human Survival: Bioecological Studies of the Gidra in Papua New Guinea*. University of Tokyo Press, Tokyo.
- Opler, M. E.  
2001 Lipan Apache. In *Handbook of North American Indians: Plains*, edited by R. DeMallie, pp. 941-952. Smithsonian Institution Press, Washington D. C.
- Oswalt, W. H.  
1973 *Habitat and Technology: The Evolution of Hunting*. Holt, Rinehart and Winston, New York.  
  
1976 *An Anthropological Analysis of Food-Getting Technology*. John Wiley & Sons, London.
- Overstreet, D. F.  
1996 Still More on Cultural Contexts of Mammoth and Mastodon in the Southwestern Lake Michigan basin. *Current Research in the Pleistocene* 13:36-38.
- Overstreet, D. F., D. J. Joyce, and D. Wasion  
1995 More on Cultural Contexts of Mammoth and Mastodon in the Southwestern Lake Michigan basin. *Current Research in the Pleistocene* 12:40-42.
- Overstreet, D. F., and T. W. Stafford, Jr.  
1997 Additions to a Revised Chronology for Cultural and Non-cultural Mammoth and Mastodon Fossils in the Southwestern Lake Michigan Basin. *Current Research in the Pleistocene* 14:70-71.

- Palmer, H. A., and J. B. Stoltman  
 1975 The Boaz Mastodon: A Possible Association of Man and Mastodon in Wisconsin. *Midcontinental Journal of Archaeology* 1(2):163-177.
- Pearson, G. A.  
 2001 Mammoth Extinction and Technological Compromise: the Clovis Coup de Grâce. In *On Being First: Cultural and Environmental Consequences of First Peopling, Proceedings of the 31<sup>st</sup> Annual Chacmool Conference*, edited by J. Gillespie, Susan Tupaka, and Christy de Mille, pp.223-233, The Archaeological Association of the University of Calgary, Calgary.
- Pennington, J.  
 1989 *Bowes and Church's Food Values of Portions of Commonly Used Foods*. Harper and Row, New York
- Peters, R. H.  
 1983 *The Ecological Implications of Body Size*. Cambridge University Press, Cambridge.
- Peterson, N.  
 1993 Demand Sharing: Reciprocity and the Pressure for Generosity among Foragers. *American Anthropologist* 95(4):860-874.
- Pianka, E. R.  
 1974 *Evolutionary Ecology*. Harper and Row, New York.
- Pierce, G. J. and J. G. Ollason  
 1987 Eight Reasons Why Optimal Foraging Theory is a Complete Waste of Time. *Oikos* 49:111-117.
- Potvin, F. and H. Jolicoeur  
 1988 Wolf Diet and Prey Selectivity During Two Periods for Deer in Quebec: Decline versus Expansion. *Canadian Journal of Zoology* 66:1274-1279.
- Rai, N. K.  
 1990 *Living in a Lean-To: Philippine Negrito Foragers in Transition*. Anthropological Papers, Museum of Anthropology, University of Michigan, Ann Arbor.
- Ray, C. N.  
 1930 Report on some Recent Research in the Abilene section. *Bulletin of the Texas Archaeological and Paleontological Society* 2:45-58.

- Ray, C. N.  
1942 Ancient Artifacts and Mammoth's Teeth of the McLean Site. *Bulletin of the Texas Archaeological and Paleontological Society* 14:137-146.
- Ray, C. N., and K. Bryan  
1938 Folsomoid Point found in Alluvium beside a Mammoth's Bones. *Science* 88:257-258.
- Rayl, S. L.  
1974 A Paleo-Indian Mammoth Kill Site Near Silver Springs, Florida.  
Unpublished Master's Thesis, Department of Anthropology, Northern Arizona University, Flagstaff.
- Richerson, P. J., R. Boyd and R. L. Bettinger  
2001 Was Agriculture Impossible During the Pleistocene but Mandatory During the Holocene: A Climate Change Hypothesis. *American Antiquity* 66(3):387-412.
- Robinson, J. G. and E. L. Bennett (editors)  
2000 *Hunting for Sustainability in Tropical Forests*. Columbia University Press, New York.
- Roosevelt, A. C., J. Douglas, and L. Brown  
2002 The Migrations and Adaptations of the First Americans: Clovis and Pre-Clovis Viewed from South America. In *The First Americans: The Pleistocene Colonization of the New World*, edited by N. Jablonski, pp. 159-236. Memoirs of the California Academy of Sciences No. 27, San Francisco.
- Root, M. J., J. D. William, M. Kay, and L. K. Shifrin  
1999 Folsom Ultrathin Biface and Radial Break Tools in the Knife River Flint Quarry Area. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. Amick, pp. 144-168. International Monographs in Prehistory, Ann Arbor.
- Rosenzweig, M. L.  
1966 Community Structure in Sympatric Carnivora. *Journal of Mammology* 47:602-612.
- Sahlins, M.  
1968 Notes on the Original Affluent Society. In *Man the Hunter*, edited by R. Lee and I. DeVore, pp. 85-89. Aldine, Chicago.  
1972 *Stone Age Economics*. Aldine, Chicago.

- Sanday, P. R.  
1981 *Female Power and Male Dominance: On the Origins of Sexual Inequality*. Cambridge University Press, Cambridge.
- Sandell, M.  
1989 The Mating Tactics and Spacing Patterns of Solitary Carnivores. In *Carnivore Behavior, Ecology, and Evolution*, edited by J. L. Gittleman, pp. 164-182. Cornell University Press, Ithaca.
- Sassaman, K. E.  
1992a Lithic Technology and the Hunter-Gatherer Sexual Division of Labor. *North American Archaeologist* 13:249-262.  
  
1992b Gender and Technology at the Archaic-Woodland Transition. In *Exploring Gender Through Archaeology*, edited by C. Claassen, pp. 71-79. Prehistory Press, Madison.
- Satterthwait, L.  
1987 Socioeconomic Implications of Australian Net Hunting. *Man* 22:613-636.
- Saunders, J. J.  
n.d. Late Pleistocene Fossil Vertebrates of the San Pedro Valley 11,000 B.P. In *The Clovis Hunters*, edited by C. V. Haynes, Jr. The University of Arizona Press, Tucson.  
  
1977 Lehner Ranch Revisited. In *Paleo-Indian Lifeways*, edited by E. Johnson, pp. 48-64, *The Museum Journal* 17.  
  
1980 A model for Man-mammoth Relationships in Late Pleistocene North America. *Canadian Journal of Anthropology* 1:87-98.  
  
1992 Blackwater Draws: Mammoths and mammoth hunters in the terminal Pleistocene. In *Proboscidean and Paleoindian Interactions*, edited by J.W. Fox, C.B. Smith, and K.T. Wilkins, pp. 123-147. Baylor University Press, Waco, Texas
- Scheel, D. and C. Packer  
1991 Group Hunting Behavior in Lions: A Search for Cooperation. *Animal Behavior* 41:697-709.
- Schiffer, M. B.  
1988 The Structure of Archaeological Theory. *American Antiquity* 53(3):261-485.

- Schmitt, D. N. and K. D. Lupo  
1995 On Mammalian Taphonomy, Taxonomic Diversity, and Measuring Subsistence Data in Zooarchaeology. *American Antiquity* 60(3):496-514.
- Schoener, T. W.  
1969 Models of Optimal Size for Solitary Predators. *American Naturalist* 103(931):277-313.
- Seeman, M. F., G. Summers, E. Dowd, and L. Morris  
1994 Fluted Point Characteristics at Three Large Sites: The Implications For Modelling Early Paleoindian Settlement Patterns in Ohio. In *The First Discovery of America: Archaeological Evidence of the Early Inhabitants of the Ohio Area*, edited by W. Dancy, pp. 77-94. The Ohio Archaeological Council, Columbus.
- Sellards, E. H.  
1952 *Early Man in America: A Study in Prehistory*. University of Texas Press, Austin.
- Shine, R., and J. B. Iverson  
1995 Patterns of Survival, Growth and Maturation in Turtles. *Oikos* 72: 343-348.
- Shott, M.  
1986 Technological Organization and Settlement Mobility: An Ethnographic Examination. *Journal of Anthropological Research* 42:15-51.
- Sih, A. and B. Christensen  
2001 Optimal Diet Theory: When Does it Work, and When and Why Does it Fail? *Animal Behavior* 61:379-390.
- Silva, M., M. Brimacombe and J. A. Downing  
2001 Effect of Body Mass, Climate, Geography, and Census Area on Population Density of Terrestrial Mammals. *Global Ecology and Biogeography* 10:469-485.
- Simms, S.  
1987 *Behavioral Ecology and Hunter-Gatherer Foraging: An Example from the Great Basin*. BAR International Series 381, Oxford.
- Slaughter, B. H.  
1966 The Vertebrates of the Domebo Local Fauna, Pleistocene of Oklahoma. In *Domebo: A Paleo-Indian Mammoth Kill in the Prairie-Plains*, edited by F. C. Leonhardy, pp. 31-35. Contributions of the Museum of the Great Plains, No. 1, Lawton, Oklahoma.

- Smith, C. S., W. Martin and K.A. Johansen  
2001 Sego Lilies and Prehistoric Foragers: Return Rates, Pit Ovens, and Carbohydrates. *Journal of Archaeological Science* 28(2):169-184.
- Smith, E.A.  
1987 On Fitness Maximization, Limited Needs, and Hunter-Gatherer Time Allocation. *Ethology and Sociobiology* 8:73-85.  
  
1991 *Inujjamiut Foraging Strategies: Evolutionary Ecology of an Arctic Hunting Economy*. Aldine de Gruyter, New York.
- Smith, E. A. and S. A. Smith  
1994 Inuit Sex-Ratio Variation: Population Control, Ethnographic Error, or Parental Manipulation? *Current Anthropology* 35(5):595-624.
- Smith, E. A. and B. Winterhalder (editors)  
1992 *Evolutionary Ecology and Human Behavior*. Aldine de Gruyter, New York.
- Soffer, O., J. M. Adovasio, D. C. Hyland, B. Klima and J. Svoboda  
1998 Perishable Technologies and the Genesis of the Eastern Gravettian. *Anthropologie* XXXVI/1-2:43-68.
- Speth, J. D.  
1983 *Bison Kills and Bone Counts*. University of Chicago Press, Chicago.
- Spiess, A. E., M. L. Curran, and J. R. Grimes  
1985 Caribou (*Rangifer tarandus*) Bones from New England Paleoindian sites. *North American Archaeologist* 6:145-159.
- Stanford, D.  
1999 Paleoindian Archaeology and Late Pleistocene Environments in the Plains and Southwestern United States. In *Ice Age Peoples of North America: Environments, Origins, and Adaptations of the First Americans*, edited by R. Bonnicksen and K. Turnmire, pp. 281-339. Center for the Study of the First Americans, Orono.
- Stanford, D., and B. Bradley  
2002 Ocean Trails and Prairie Paths? Thoughts about Clovis Origins. In *The First Americans: The Pleistocene Colonization of the New World*, edited by N. Jablonski, pp. 255-272. Memoirs of the California Academy of Sciences, San Francisco.

- Stanford, D., W. R. Wedel, and G. R. Scott  
1981 Archaeological Investigations of the Lamb Spring Site. *Southwestern Lore* 47:14-27.
- Steadman, D. W.  
1988 Vertebrates from the late Quaternary Hiscock Site, Genesee County, New York. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller and D. W. Steadman, pp. 95-113. Bulletin of the Buffalo Society of Natural Sciences, Vol. 33, Buffalo.
- Steele, D. G. and B. W. Baker  
1993 Multiple Predation: A Definitive Human Hunting Strategy. In *From Bones to Behavior*, edited by J. Hudson, pp. 9-37. Southern Illinois University Center for Archaeological Investigations, Carbondale.
- Steele, D. G. and D. L. Carlson  
1989 Excavation and Taphonomy of Mammoth Remains from the DUEwall-Newberry Site, Brazos County, Texas. In *Bone Modification*, edited by R. Bonnicksen and M. H. Sorg, pp. 413-430. Center for the Study of the First Americans, University of Maine, Orono, Maine.
- Steele, J., J. Adams and T. Sluckin  
1998 Modeling Paleoindian Dispersals. *World Archaeology* 30(2):286-305.
- Stephens, D. W., and J. R. Krebs  
1986 *Foraging Theory*. Princeton, Princeton University Press.
- Stiner, M. C.  
1990 The Use of Mortality Patterns in Archaeological Studies of Hominid Predatory Adaptations. *Journal of Anthropological Archaeology* 9:305-351.  
1991 Food Procurement and Transport by Human and Non-human Predators. *Journal of Archaeological Science* 18:455-482.  
2001 Thirty Years on the "Broad Spectrum Revolution" and Paleolithic Demography. *Proceedings of the National Academy of Science* 98(13):6993-6996.  
2002 Carnivory, Coevolution, and the Geographic Spread of the Genus *Homo*. *Journal of Archaeological Research* 10(1):1-63.
- Stiner, M. C., N. D. Munro, and T. A. Surovell  
2000 The Tortoise and the Hare: Small Game Use, the Broad Spectrum Revolution, and Paleolithic Demography. *Current Anthropology* 41(1):39-73.

- Stiner, M. C., N. D. Munro, T. A. Surovell, E. Tchernov, and O. Bar-Yosef  
1999 Paleolithic Population Growth Pulses Evidenced by Small Animal Exploitation. *Science* 283:190-194.
- Storck, P. L.  
1991 Imperialists Without a State: The Cultural Dynamics of Early Paleoindian Colonization as seen from the Great Lakes Region. In *Clovis Origins and Adaptations*, edited by R. Bonnicksen and K. Turnmire, pp. 153-162. Center for the Study of the First Americans, Corvallis.
- Strauss, L. G.  
2000 Solutrean Settlement of North America? A View of Reality. *American Antiquity* 65:219-226.
- Sunquist, M. E. and F. C. Sunquist  
1989 Ecological Constraints on Predation by Large Felids. In *Carnivore Behavior, Ecology, and Evolution*, edited by J. Gittleman, pp. 283-301, Cornell University Press, Ithaca.
- Surovell, T. A.  
2000 Early Paleoindian Women, Children, Mobility, and Fertility. *American Antiquity* 65:493-509.  
  
2003 The Behavioral Ecology of Lithic Technology. PhD Dissertation, Department of Anthropology, University of Arizona, Tucson.  
  
in press Simulating Coastal Migration in New World Colonization. *Current Anthropology*.
- Tanaka, J.  
1980 *The San: Hunter-Gatherers of the Kalahari*. Translated by D. W. Hughs. University of Tokyo Press, Tokyo.
- Tankersley, K. B.  
1994 The Effects of Stone and Technology on Fluted-Point Morphometry. *American Antiquity* 59(3): 498-510.
- Tankersley, K. B., K. D. Schlecht, and R. S. Laub  
1998 Fluoride dating of Mastodon bone from an Early Paleoindian spring site. *Journal of Archaeological Science* 25:805-812.
- Taylor, R. E., C. V. Haynes Jr., and M. Stuiver  
1996 Clovis and Folsom Age Estimates: Stratigraphic Context and Radiocarbon Calibration. *Antiquity* 70:515-525.

- Testart, A.  
1986 Game Sharing Systems and Kinship Among Hunter-Gatherers. *Man* 22:287-304.
- Thompson, P. R.  
1981 Size and Evolution in Mammalian Carnivores: New Tests for an Old Theory of Human Evolution, A Pilot Study. *Carnivore* 4:7-42.
- Todd, L. C.  
1987 Analysis of Kill-Butchery Bonebeds and Interpretation of Paleoindian Hunting. In *The Evolution of Human Hunting*, edited by M. H. Nitecki and D. V. Nitecki, pp. 371-403. Plenum Press, New York.
- Tomenchuck, J., and P. L. Storck  
1997 Two Newly Recognized Paleoindian Tool Types: Single and Double-Scribe Compass Gravers and Coring Gravers. *American Antiquity* 63(3):508-522.
- Torrence, R.  
1983 Time Budgeting and Hunter-Gatherer Technology. In *Hunter-Gatherer Economy in Prehistory*, edited by G. Bailey, pp. 11-22. Cambridge University Press, Cambridge.  
  
1989 Re-tooling: Towards a Behavioral Theory of Stone Tools. In *Time, Energy and Stone Tools*, edited by R. Torrence, pp. 57-66. Cambridge University Press, Cambridge.  
  
2001 Hunter-Gatherer Technology: Macro- and Microscale Approaches. In *Hunter-Gatherers: An Interdisciplinary Perspective*, edited by C. Panter-Brick, R. H. Layton and P. Rowley-Conwy, pp. 73-98. Cambridge University Press, Cambridge.
- Townsend, W. R.  
2000 The Sustainability of Subsistence Hunting by the Siriono Indians of Bolivia. In *Hunting for Sustainability in Tropical Forests*, edited by J. G. Robinson and E. L. Bennett, pp. 267-281. Columbia University Press, New York.
- Treves, A. and L. Naughton-Treves  
1999 Risk and Opportunity for Humans Coexisting with Large Carnivores. *Journal of Human Evolution* 36:275-282.
- Vermeij, G. J.  
1982 Unsuccessful Predation and Evolution. *The American Naturalist* 120:701-720.

- Voget, F. W.  
2001 Crow. In *Handbook of North American Indians: Plains*, edited by R. DeMallie, pp. 695-717. Smithsonian Institution Press, Washington D. C.
- Walker, D. N., and G. C. Frison  
1980 The Late Pleistocene Fauna from the Colby Mammoth Kill Site, Wyoming. *Contributions to Geology, University of Wyoming* 19(1):69-79.
- Walker, R., K. Hill, H. Kaplan and G. McMillan  
2002 Age-dependency in Hunting Ability among the Ache of Eastern Paraguay. *Journal of Human Evolution* 42:639-657.
- Wandsnider, L.  
1997 The Roasted and the Boiled: Food Composition and Heat Treatment with Special Emphasis on Pit-Hearth Cooking. *Journal of Anthropological Archaeology* 16:1-48.
- Watanabe, H.  
1968 Subsistence and Ecology of Northern Food Gatherers with Special Reference to the Ainu. In *Man the Hunter*, edited by R. B. Lee and I. Devore, pp. 69-77. Aldine, Chicago.
- Webb, S. D., J. T. Milanich, R. Alexon, and J. S. Dunbar  
1984 A *Bison antiquus* Kill Site, Wacissa River, Jefferson County, Florida. *American Antiquity* 49:384-392.
- Wenzel, G. W.  
1995 Ningiqtuq: Resource Sharing and Generalized Reciprocity in Clyde River, Nunavut. *Arctic Anthropology* 32(2):43-60.
- White, R.  
1982 Rethinking the Middle/Upper Paleolithic Transition. *Current Anthropology* 23(2):169-192.
- Whitley, D. S. and R. I. Dorn  
1993 New Perspectives on the Clovis vs. Pre-Clovis Controversy. *American Antiquity* 58(4):626-647.
- Wilke, P. J., J. J. Flenniken, and T. L. Ozbun  
1991 Clovis Technology at the Anzick Site, Montana. *Journal of California and Great Basin Anthropology* 13(2):242-272.

Winterhalder, B.

1981 Foraging Strategies in the Boreal Forest: An Analysis of Cree Hunting and Gathering. In *Hunter-Gatherer Foraging Strategies*, edited by B. Winterhalder and E. A. Smith, pp. 66-98. The University of Chicago Press, Chicago.

1986 Optimal Foraging: Simulation Studies of Diet Choice in a Stochastic Environment. *Journal of Ethnobiology* 6:205-223.

1987 The analysis of Hunter-Gatherer Diets: Stalking an Optimal Foraging Model. In *Food and Evolution: Toward a Theory of Human Food Habits*, edited by M. Harris and E. Ross, pp. 311-339. Temple University Press, Philadelphia.

Winterhalder, B., F. Lu, and B. Tucker

1999 Risk-sensitive Adaptive Tactics: Models and Evidence from Subsistence Studies in Biology and Anthropology. *Journal of Archaeological Research* 7: 301-348.

Winterhalder, B. and E. A. Smith (editors)

1981 *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses*. University of Chicago Press, Chicago.

Wright, K. I

1994 Ground-Stone Tools and Hunter-Gatherer Subsistence in Southwest Asia: Implications for the Transition to Farming. *American Antiquity* 59(2): 238-263.

Young, D., and R. Bonnicksen

1984 *Understanding Stone Tools: A Cognitive Approach*. Center for the Study of Early Man, Orono, Maine.

Zihlman, A.

1989 Woman the Gatherer: The Role of Women in Early Hominid Evolution. In *Gender and Anthropology*, edited by S. Morgan, pp. 21-40. American Anthropological Association, Washington D.C.