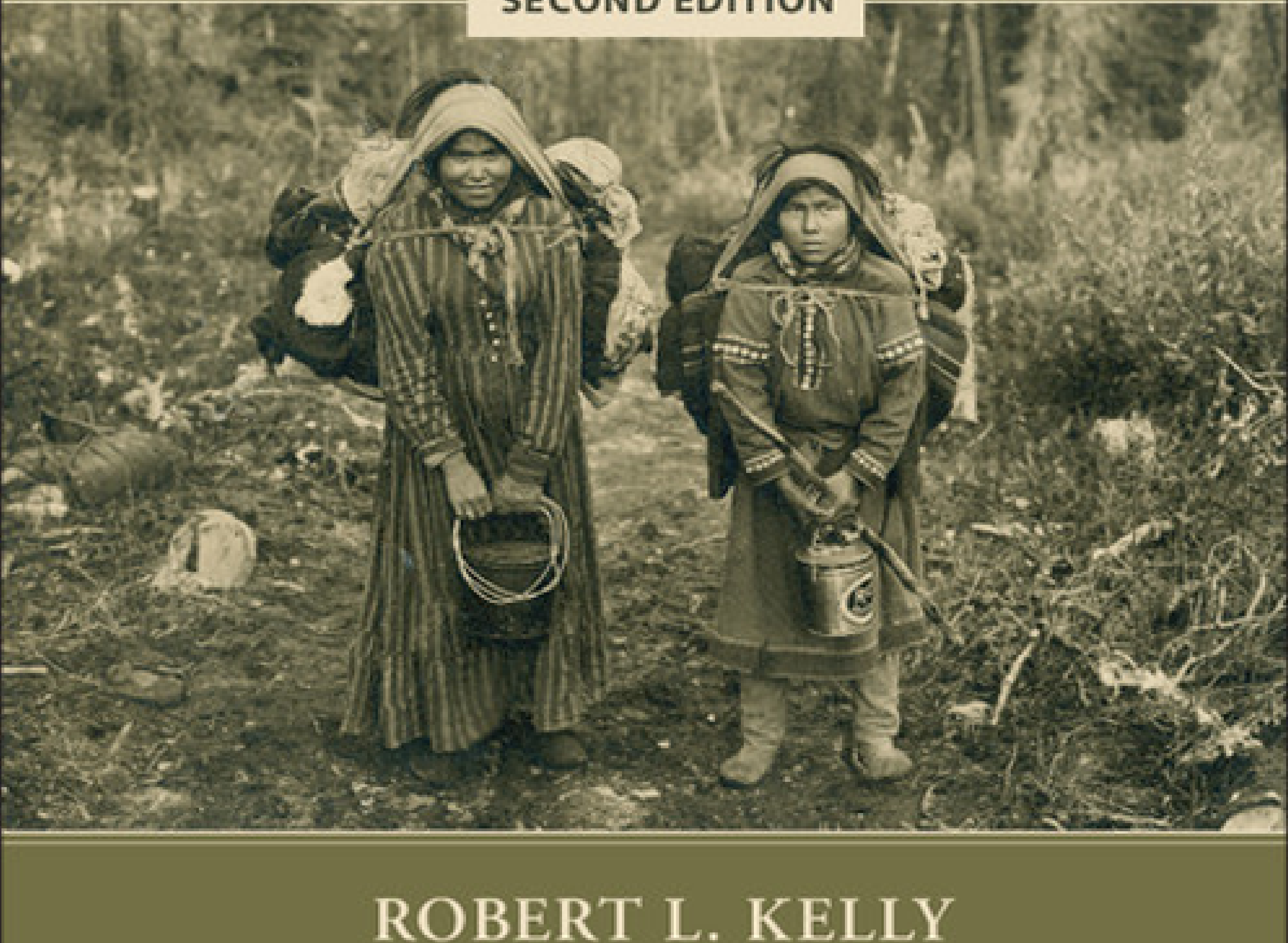
THE LIFEWAYS OF HUNTER-GATHERERS

The Foraging Spectrum

SECOND EDITION



ROBERT L. KELLY

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The Lifeways of Hunter-Gatherers

In this book, Robert L. Kelly challenges the preconception that hunter-gatherers should conform to a single type, be that of Paleolithic relics living in a raw state of nature, the original affluent society, or downtrodden proletariat. Instead, he crafts a position that emphasizes diversity in foraging lifeways and efforts to explain that diversity. Kelly reviews the anthropological literature for variation among living foragers in terms of diet, mobility, sharing, land tenure, technology, exchange, male–female relations, division of labor, marriage, descent, and political organization. Using the paradigm of human behavioral ecology, he analyzes the diversity in these areas and he argues for an approach to prehistory that uses archaeological data to test theory rather than one that uses ethnographic analogy to reconstruct the past.

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For my parents, who showed me the paths in the forest.

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Preface

I remember that I was amazed, amazed at the faces of Tasaday men and women looking back at me from the pages of *National Geographic* in 1972. To a young high school student who yearned to visit exotic places and to study prehistoric peoples, those photos of the Tasaday afforded the opportunity to do both vicariously. Here was the Stone Age! Hunters and gatherers, unsullied by civilization, who lived "much as our ancestors did thousands of years ago" (MacLeish and Launois 1972: 219).

Anthropology, the Tasaday, and, I like to think, I myself have come a long way since 1972. The Tasaday, of course, are not Pleistocene relics; frankly, I don't know what they were or are – perhaps they were only, as some say, pawns in a hoax perpetrated by the Philippine government for geopolitical reasons (see Headland 1992; Hemley 2003). But their legacy continues in the public and, sometimes, anthropology's perception of hunter-gatherers. The popular media likes to see hunter-gatherers as humanity stripped of its technological trappings, relics of the Paleolithic, people whom time forgot. Thus, they are often described by what they lack. The Tasaday, for example, apparently had "no agricultural implements . . . no woven cloth . . . no pipes . . . no pottery . . . no weapons . . . no word for war" (MacLeish and Launois 1972: 242). The Tasaday, and all hunter-gatherers, indeed *seem* to be "man in the raw state of nature" (Holmberg 1950: 261). And that is reason enough for us to know who foragers *really* are.

Opinions differ on whether humanity in the raw is a good thing. Some come down on the side of Jean-Jacques Rousseau's Noble Savage, whereas others see humanity's darker side in "primitive" society. Many use hunter-gatherers as a foil to our own industrialized society, to demonstrate its failures or successes. Some see in hunter-gatherers evidence of an evolutionarily ingrained propensity for savage hunting and bloodshed, a biological imperative for carnage (see Cartmill 1993), whereas others see in these same societies a kinder and gentler form of human organization that provides a model for corporate culture (Bernhard and Glantz 1992). In popular books such as *Clan of the Cave Bear* and movies such as *Quest for Fire*, *Dances with Wolves*, and *The Gods Must Be Crazy*, hunter-gatherers are schizophrenically portrayed as what we think we were in the distant past: the original hippies or the ultimate road warriors. They either represent the simpler, egalitarian past that we all yearn for or they testify to the fact that we are club-wielding troglodytes at heart.

So let's make this clear: the hunter-gatherers we discuss in this volume are not the alter ego of Western civilization; they are not "simple" societies; they are not humanity in a state of nature; they are not Pleistocene relics; we cannot, as E. O. Wilson (1978) suggested, reconstruct ancient human society by extrapolating backward from living hunter-gatherers.

Unfortunately, social scientists are guilty of some of the same simplifications as the popular media. Portrayals of foragers in many theoretical formulations and textbooks ignore or downplay the importance of the modern social and economic contexts of foragers and of the variability among those who hunt and gather to obtain their food. I can appreciate that some simplification is necessary in teaching or building theory. But too much unwittingly lends itself to facile constructions of other people's lives and to erroneous understandings of both evolution and the factors that affect the lives of living foragers.

This book is a contribution to combating both of these problems, the tendency to simplify foraging societies and the tendency to misunderstand the factors that condition human differences. To achieve this goal, *The Lifeways of Hunter-Gatherers* focuses on variability in the foraging lifeway and on the factors that may account for this variability. To do so, I rely on the perspective of human behavioral ecology. I hope the reader finds this a useful approach. He or she will be disappointed, however, if they hope to find a thumbnail sketch of hunter-gatherers because it is not here. And it is not here because such a sketch would only propagate a new stereotype.

I have written this book for two audiences. First, it is for undergraduates, to direct their attention to the causal variables that lie behind behavior. I want students to understand that if some characteristic – sharing, for example – is common among hunter-gatherers, it is not simply because they are hunter-gatherers or because they preserve some ancient, core trait of humanity but rather because of a set of conditions that is prevalent among living hunter-gatherers. I strive to achieve this by focusing on how foragers differ in terms of subsistence, mobility, technology, demography, sharing, territoriality, and social and political organization. Rather than leave students with a yearning for another time or place, an approach that focuses on the relationships between behavior and environment, although less romantic, provides students with the tools to see how structural elements of their own society encourage (or discourage) certain behaviors.

Second, this book is also for graduate students, especially those in archaeology. It assumes some knowledge of anthropology, but it does not assume familiarity with the hunter-gatherer literature or human behavioral ecology. My goal is to help students of archaeology avoid using a modern hunter-gatherer people, or some amalgam of foraging societies, as an analogy for reconstructing the past. This does not mean that ethnographic data are useless to archaeologists; quite the contrary, in fact. But those data are useful only if we understand them from an explicitly theoretical point of view; otherwise, they will indeed "tyrannize" our reconstructions of the past (Wobst 1978). We cannot look to living foragers for analogues of prehistoric ones, but we can use data from them to test some ideas about human behavior. Simply put, I hope this book encourages students to think theoretically. My goal was to provide an overview, and, consequently, some fascinating topics have been shortchanged. I will leave them to the student to investigate further.

Finally, a word about words and a caution about data. In recent years, the term "hunter-gatherer" has been discarded by many in favor of the more generic term "forager" since that term avoids privileging the "hunter" in hunter-gatherer. I will use both terms interchangeably simply to avoid monotony. Also, the appellations given to different groups of hunter-gatherers change as anthropology educates itself, as the subjects of anthropology gain a greater voice, and as societies change and redefine themselves. I try to strike a balance between terms that will assist the student in exploring ethnographic literature and terms that will not insult members of foraging or formerly foraging societies who might read this book. Also, in some places, I use the ethnographic present tense, but the reader should not assume that the particular group has not changed between the time of ethnographic study and today. Conversely, where the past tense is used, the reader should not assume that a people no longer exist. Students should take care to not uncritically use the data presented in tables here. These data were collected under diverse conditions for different purposes. I have provided them to indicate some of the variability present among foragers and as a guide to potential sources of data. But I advise students to consult the original sources to determine the suitability of data for their analyses.

I wrote the first edition of this book when I was a fairly new professional. Although I am an archaeologist, in my first graduate course, Lewis Binford instilled a fascination of ethnography in me. When I was looking for my first academic post, I sold myself as a specialist in foraging societies. But once I began teaching, I realized that I knew next to nothing about them, and so I undertook this book in large measure to educate myself. The first edition was published in 1995, by the Smithsonian Institution Press. After that press ceased to exist in about 2004, Eliot Werner published a slightly revised edition through Percheron Press (we fixed a few errors). What you have in your hands is a completely revised second edition. What has changed since then?

The second edition contains a new chapter on technology (Chapter 5), about which very little had been written prior to 1995 from the perspective of human behavioral ecology. The chapter on sharing is significantly updated and rewritten because there has been a large amount of research conducted on that subject since 1995. Likewise, the section on reproductive ecology in the demography chapter (Chapter 7) has been substantially updated, as has the chapter on the development of inequality (Chapter 9), although the 1995 model's essentials are unchanged. Throughout the book, I updated references, added some new photos and figures, corrected mistakes, and improved the writing. I hope you find this new edition worth reading.

It has been some forty years since I first looked in wonder at those pictures of the Tasaday. I no longer see in them the faces of ancient relatives. For the most part, I now see costs and benefits of resources, and differences in time allocation, caloric returns, opportunity costs, and utility curves. But occasionally I can see beyond these, to the aspirations and dreams and desires that help shape the evolutionary processes that create the diversity and trajectory of humanity. And I am still amazed.

Acknowledgments

I have revised this book over several years, and I will undoubtedly leave out many deserving individuals from this list. To them, I say that your input has nonetheless been greatly appreciated. I would be remiss if I did not first acknowledge a large debt to David Hurst Thomas, who, through the archaeology of the Great Basin, introduced me to the anthropological study of hunter-gatherers, and to the late Lewis Binford, who has shaped much of the way I approach anthropology. Without their guidance and patience over the years, I would not be in a position to indulge in the pleasure of thanking them.

The first edition took shape while I was a Weatherhead Fellow at the School of Advanced Research in 1988–89. I am grateful to the school for that opportunity. I continued to write the first edition while teaching at the University of Louisville. It was finally completed on the island of Chuuk in Micronesia, where I was assisting my wife, Lin Poyer, in her ethnographic fieldwork. But Lin has given me far more assistance through her support, encouragement, and running commentary on evolutionary theory over the last thirty years; without it, I doubt this second edition would exist. Although I would have preferred a tropical island again, this edition was mostly written while sitting at our kitchen counter in Laramie, Wyoming, where the cats, Dusty and Pamina, and the dog, Xena, kept an eye on me. The final copyediting was completed in the fall of 2012, when I was a visiting scholar at St. John's College, Cambridge University. I am grateful to St. Johns for providing me with a quiet place overlooking the Master's garden to complete the work.

Many people have read and commented on the first- and second-edition manuscripts: Ken Ames, Jeanne Arnold, Robert Bettinger, Jane Collier, Robert Hard, Robert Hitchcock, Eric Ingbar, Julie Peteet, Lin Poyer, Rachel Reckin, Russell Reid, Steve Simms, Eric Alden Smith, John Speth, Todd Surovell, Robert Tonkinson, Bram Tucker, Nicole Waguespack, and several anonymous reviewers. I would especially like to thank Eric Alden Smith. Eric reviewed the first- and second-edition manuscripts, each time giving them more of his time than they deserved, and improving them enormously, catching errors both small and embarrassing. Rebecca Bliege Bird, Peter Brosius, P. Bion Griffin, Barry Hewlett, Kim Hill, Robert Hitchcock, and Jim O'Connell graciously made photographs available to me. Heather Rockwell drew Figure 1-1. I also appreciate the assistance of the Cambridge University Press staff; Peggy Rote of Aptara, Inc.; and the copy editor, JoAnn "Annie" Woy. I should probably have taken all of the advice given to me, but I did not, and so I alone am responsible for errors and shortcomings.

Many people want to write a book, but those who do are always happy to close the covers, so to speak, on their own. I am no different. A book is a demanding master, and it takes the author away from the people he loves. But it is also a wise master, and it makes the author cherish them even more. So, to Lin, Matthew, and Dycus, I say, it's finished! But most of all, I say thank you.

R.L.K.
Cambridge, U.K.

Chapter 1

Hunter-Gatherers and Anthropology

> [W]here every man is Enemy to every man . . . wherein men live without other security, than what their own strength, and their own invention shall furnish them withall. In such condition, there is no place for Industry; because the fruit thereof is uncertain: and consequently no Culture of the Earth; No navigation, nor use of the commodities that may be imported by Sea; no commodious Building; no Instruments of moving, and removing such things as require much force; no Knowledge of the face of the Earth; no account of Time; no Arts; no Letters; no Society; and which is worst of all, continuall feare, and danger of violent death; And the life of man, solitary, poor, nasty, brutish and short.
>
> Political philosopher (Hobbes 1968 [1651]: 186)

> To date, the hunting way of life has been the most successful and persistent adaptation man has ever achieved.
>
> Anthropologists (Lee and DeVore 1968: 3)

Hunter-gatherers play a pivotal role in anthropological theory. Nineteenth-century evolutionists saw them as living fossils of early human society. Emile Durkheim's theories of religion and society relied heavily on Australian Aboriginal culture. A. R. Radcliffe-Brown's studies of the Andaman Islanders and Australian Aborigines were the foundation of his theory of structural-functionalism. Cultural ecology was grounded in Julian Steward's intimate knowledge of western North America's Shoshone and Paiute. Australian Aboriginal ethnography figured prominently in Claude Lévi-Strauss's search for the elementary structures of kinship. In fact, because anthropology's foundation was the idea of a primal society (Kuper 1988), we could almost write the discipline's entire history in terms of hunter-gatherer ethnology (Yengoyan 1979). Hunter-gatherers are *the* quintessential topic of anthropology (Bettinger 1991).

But who are hunter-gatherers? Over the past century, different ethnographic cases waxed and waned in popularity as the "poster child" for foragers. In anthropology's early days, it was the Australian Aranda. Later, it was the Shoshone of western North America, who were then replaced by the Ju/'hoansi (the !Kung)[1] of southern Africa. In recent years, Paraguay's Ache, Tanzania's Hadza, and Australia's Meriam have each enjoyed their time in the spotlight. Sometimes hunter-gatherers are defined economically, as people without domesticated plants and herd animals, although this definition covers a variety of social forms. Other times they are defined socially, as *band* societies – people who live in small groups, with flexible membership and egalitarian sociopolitical relations – although this definition encompasses a variety of economic forms (Lee 1992; Roscoe 2002). Through the years, the archetypal hunter-gatherer society changed: from a closed, patrilineal horde to bilateral bands with fluid membership; from Man the Hunter to Woman the Gatherer; from egalitarian bands to rural proletariat; from isolated Paleolithic relics to marginalized members of the contemporary world system.

Yet even a cursory perusal of ethnographic literature shows that there is considerable diversity among ethnographically known foragers, even within a single region such as Africa's Kalahari Desert (e.g., Barnard 1992a; Kent 1996a) or Southeast Asia (Fortier 2009a). They have a variety of kinship systems; hunting is important in some whereas in others, gathering is critical. Colonialism consumed some, but others managed to reject it (Marlowe 2002). Some are territorial, others are not. Some live in large, sedentary groups; others in small nomadic camps. Some are egalitarian but others have social hierarchies. Some have high whereas others have low fertility rates. Would the real hunter-gatherer please stand up!

Anthropologists are aware of this variation[2] but for many years the objective of hunter-gatherer research was to seek out the essential core of the foraging lifeway by explaining away variability as the product of extraordinary environments or particular historical circumstances (Panter-Brick, Layton, and Rowley-Conwy 2001). In *The Hunters*, for example, Elman Service (1966) excluded Northwest Coast peoples because, he argued, they were adapted to a rare environment where food was abundant (more on that assertion in Chapter 9). Although shifts in models or archetypes reflect advances in knowledge and understanding, they also reflect shifts in emphasis, the highlighting of a particular point along a continuum of behavior. For each model proposed, variation is winnowed out, leaving behind a unitary description of the essential hunter-gatherer. Sometimes we are given two categories, such as "simple" and "complex," or "immediate return" and "delayed return" foragers, but one of the categories is usually privileged as capturing the essence of the hunter-gatherer lifeway – and of early human society.

There is indeed much that is common among ethnographically known hunter-gatherers. And, to an extent, the issue is whether one finds the commonalities or the differences among living foragers most intriguing. However, even when a behavior is common to modern foragers, it may only be so because of the current prevalence of a causal variable – for example, circumscription due to European colonization, trade, or low population density (Ember 1975; Schrire 1984a). More important, whatever is commonly associated with ethnographically known hunter-gatherers cannot be causally linked with hunting and gathering because "hunter-gatherer" is a category we impose on human diversity – it is not itself a causal variable. This means that we cannot justify using a common trait to reconstruct ancient foraging society simply because that trait is common to ethnographies.

My goal in this book is to review some of what anthropology has learned about the variability among ethnographically known foragers (Figure 1-1). So, who makes up this group? A hard definition would exclude any group that ever acquired anything from a neighboring nonforaging society; this would leave us with an ethnographic sample of zero. In this book, therefore, "hunter-gatherers" (or "foragers"; I use the terms interchangeably) simply refer to those people whom anthropology has traditionally recognized as hunter-gatherers. In other words, the history of the field, rather than some specific criterion, defines the subject. These people are indeed those who do (or did) procure much if not all of their food from hunting, gathering, and fishing. But the reader should know that many of these "hunter-gatherers" grow some of their own food, trade with agriculturalists for produce, or participate in cash economies. It should not bother us that some groups are not "pure" hunter-gatherers because we are looking for the causes of variation in human behavior, not the essential hunter-gatherer.

I wrote this book with archaeologists in mind, although it contains no prehistory and is by no means limited to archaeological interests. There is seldom enough time for archaeologists to

Figure 1-1. World map showing locations of the foraging societies discussed in the text.

read all of the ethnographic literature they would like to read; unfortunately, this tempts us to see prehistoric hunter-gatherers through the lens of a particular ethnographic group, the Ju/'hoansi, say, or the Hadza or Shoshone. My goal is to give fellow archaeologists and ethnologists who are not specialists in hunter-gatherer studies some knowledge of the variation that exists among foragers and some idea of what accounts for it. I do this by examining several areas of behavior: subsistence, mobility, trade, sharing, territoriality, technology, demography, and sociopolitical organization. I have had to leave aside some areas of foragers' lives, particularly cosmology and religion.[3]

To understand this variation, I use the perspective of human behavioral ecology. We'll look at this perspective in depth later, but let me explain why I use it. First, much hunter-gatherer research over the past fifty years has used an ecological or evolutionary perspective, and, in the past thirty years, this has been human behavioral ecology. As an overview of what anthropologists have learned, therefore, this book by necessity must reflect that perspective. Second, in my opinion, human behavioral ecology has proven to be a productive research strategy. It proceeds from theory, makes predictions, and then checks those predictions against empirical data. It's not the only way to study hunter-gatherers, but it has proven useful – and that's the most we can ask of a research paradigm.

To situate this book in the context of hunter-gatherer studies, we will briefly review the history of hunter-gatherer research in terms of three models: the patrilineal/patrilocal model, the generalized foraging model, and the interdependent model. First, however, let us turn to an earlier era and consider the place of hunter-gatherers in nineteenth-century thought. Although later models are often responses to the shortcomings (and racism) of nineteenth-century evolutionism, anthropology nonetheless inherited some characteristics of that century's intellectual posture.

Hunter-Gatherers in Pre-Twentieth-Century Thought

As the study of human diversity, anthropology began as soon as the first hominins wondered why those in the next valley were different. But more conservatively, anthropology appeared as a formal discipline in the late nineteenth century in Europe and the United States. Like much of Western thought, it was intellectually rooted in Enlightenment philosophy, in which ideas about "primitive" societies played a key role.

In Enlightenment thought, history was a record of progress, progress that was reflected in technology and material goods as well as in social order and morality. This view provided Europeans with a way to understand human diversity. In a world thought to be created by a perfect God, diversity in humanity reflected differences in the degree of perfection. And just as God stood above the whole of humanity, so could cultures and ethnic groups be ranked in terms of their perfection. Progress, according to European thinkers, arose from increasingly rational thought that resulted in the control of nature. Allegedly unable to think rationally, members of "primitive" society were controlled by nature. Today, this image of the foraging lifeway is summed up by Hobbes's famous words: "nasty, brutish, and short."[4]

During the nineteenth century, the pageant of technological advancements uncovered by archaeologists and enshrined in the Stone, Bronze, and Iron Ages made clear to intellectuals of the time that Europeans had passed through earlier stages in their progress to modernity. Anthropology developed as part of late-nineteenth-century efforts to reconstruct these past stages. These efforts included Lewis Henry Morgan's *Ancient Society* (1877), Henry Maine's *Ancient Law* (1861), John Lubbock's *Prehistoric Times* (1865), and Edward Tylor's *Primitive Culture* (1871).[5] These early evolutionists, however, faced a problem. Reconstructing prehistory requires archaeological evidence, the physical record of the human past. Although scholars had conducted sufficient archaeological research in the late nineteenth century to discern a past, there was not enough to flesh out the picture. What information they did have revealed technological advances and a cumulative domination of nature, but it had nothing to say about kinship, or politics, or social organization. To reconstruct prehistory where archaeological data were insufficient, the evolutionists fell back on ethnography and the *comparative method*.

With an intellectual pedigree that we could trace back to Greek philosophy (see Bock 1956), the comparative method was a widespread element of Enlightenment thought by the late eighteenth century and was formalized and given theoretical justification by the French philosopher Auguste Comte (the creator of positivism). In linguistics, it was a method of reconstructing dead languages; in biology, a way to reconstruct extinct species; and in anthropology, a way to reconstruct the European past. The comparative method took existing cultural diversity in the world and turned it into an evolutionary sequence. Simply put, different peoples represented different stages in humanity's march to perfection.

The theoretical paradigm of the evolutionists provided the justification for this methodology. Couched within Enlightenment notions of progress, early evolutionist thinking included themes of a "struggle for existence" and "survival of the fittest," themes that students of anthropology know best from the writings of Charles Darwin and Herbert Spencer. But Darwin's notion of natural selection played no role in the work of early evolutionists. Instead of a selective process, evolutionists saw change as transformative along a more or less single scale of progress, an idea that anthropologists today call *unilineal evolution*. In this paradigm, evolution resulted from the accumulation of ideas over time that improved peoples' minds and morals, as well as their ability to think rationally and to control nature. Some evolutionists, such as Morgan, saw that societies moved along different pathways due to their environments, with some environments placing more restrictions on a people's advance than on others. Diffusion of ideas also played a role. Nonetheless, the evolutionists were primarily intrigued by the general tempo of evolution. In *Ancient Society*, Lewis Henry Morgan described world history in terms of seven periods: the lower, middle, and upper status of Savagery; the lower, middle, and upper status of Barbarism; and the status of civilization, each with its critical discovery or invention that improved humanity's condition and ensured its progress.

This, of course, raised an important question: if everyone has been on earth for the same amount of time, why have some peoples made more progress than others? The Enlightenment paradigm provided the answer: variability among the world's peoples was attributed to variability in the tempo of mental improvement. Some people moved ("progressed") up the evolutionary ladder more quickly than others.[6] Handily enough, this meant that the evolutionists could see less-advanced societies as relics of an earlier age, "monuments of the past," as Morgan put it (1963 [1877]: 41). By placing the world's peoples into a ranked sequence, human prehistory could be reconstructed – and without dirtying one's hands in archaeological sites!

The criteria for constructing evolutionary sequences were various and included technological, social, political, intellectual, and moral factors. These criteria exposed the ethnocentrism of the comparative method, for invariably Western scholars judged other societies against the standard of European society. Monogamy was superior to polygamy, patrilineal descent was better than matrilineal descent, monotheism was morally superior to ancestor worship, and science was the successor to magic and religious superstition. Rankings also had a strongly racialist basis, with people of color at the bottom and Europeans (and especially northwestern, light-skinned Europeans) at the top of the sequence. "Few would dispute," Tylor (1871: 27) asserted, "that the following races are arranged rightly in order of culture: – Australian [Aborigines], Tahitian, Aztec, Chinese, Italian." To be fair, Morgan attributed some differences to environment or technology, and Tylor argued against biology as a cause, but ultimately cultural progress was linked to biological affinity (see Harris 1968: 137–41 on the racial determinism of Morgan and Tylor).

The comparative method generally placed hunter-gatherers at the lower rungs of the evolutionary ladder. Modern foragers were thought to be descendants of prehistoric ones and could, the nineteenth-century polymath Sir John Lubbock claimed, shed light on the past for the same reasons that modern pachyderms could tell us about prehistoric ones. He thought this was a boon to archaeology. Since the study of the past was "deprived . . . of any assistance from history," it was also "relieved at the same time from the embarrassing interference of tradition," and the prehistorian was "free to follow the methods which have been so successfully pursued in geology, the rude bone and stone implements of bygone ages being to the one what the remains of extinct animals are to the other" (1900: 407).

This perspective continued into the early twentieth century. The Arctic explorer Vilhjálmur Stefánsson (1966 [1913]: 177–8) said that the Eskimo were not "the remains of the Stone Age but the Stone Age itself." William Sollas (1911: 70) used the reconstructed physical features of Neanderthals (which we now know were incorrect) to argue that Australian Aborigines were their lineal descendants. To Sollas, Bushmen were Aurignacians and Eskimos were descendants of the Magdalenians, genetic relics of European Upper Paleolithic peoples.[7] Sollas (1911: 70) recognized that this was a tenuous approach, but with few archaeological data at his disposal, he saw no more secure alternative "in a subject where fantasy is only too likely to play a leading part."

Two factors helped place hunter-gatherers near the bottom of the evolutionary scale. First, they had few belongings. It might have been obvious that material goods were a hindrance to nomadic peoples, but nineteenth-century European scholars reversed the causal arrow: hunter-gatherers were nomadic because they were intellectually incapable of developing the technology needed to permit a sedentary existence – agricultural implements, storage facilities, houses, ceramics, and the like. Were their moral and intellectual character to be raised, hunter-gatherers would settle down and reap the material rewards of progress.

Second, because many were nomadic, hunter-gatherers had concepts of private property quite different from those of Europeans. Although it is incorrect to say that there are no territorial boundaries among hunter-gatherers (see Chapter 6), the subtlety of the ways in which hunter-gatherers relate people to geography was lost on European explorers and colonizers. To them, hunter-gatherers had no concept of private property, a sure sign of arrested development.[8]

Not everyone was on board with the comparative method. Most notable was Franz Boas, the founder of American anthropology. Unlike the armchair anthropologists of his day, Boas actually had experience with "primitive" peoples (beginning with a long stint in the Arctic), and that experience led him to see that such peoples were no less intelligent than Europeans. Others might also have seen that the comparative method was a remarkable piece of circular reasoning (Bock 1956: 17). If Australian Aborigines matched Neanderthal "culture" so well, it was because Europeans had already presumed what Neanderthal culture was like. This was hardly a demonstration that the Aborigines were a relic population (and no one seemed to worry about how Neanderthals got from Europe to Australia). If the comparative method seemed to work so well, it was because *it conveniently assumed the past it claimed to discover* (Kuper 1988).

Nonetheless, Enlightenment thought and the comparative method influenced social research into the twentieth century. It is why the foraging lifeway was considered undesirable, something people had to leave behind if they wished to avoid extinction. Lubbock, who would have included hunter-gatherers with all other "savages," said that a hunter was

> neither free nor noble; he is a slave to his own wants, his own passions; imperfectly protected from the weather, he suffers from the cold by night and the heat of the sun by day . . . hunger always stares him in the face, and often drives him to the dreadful alternative of cannibalism or death. . . . [H]e is always suspicious, always in danger, always on the watch. He can depend on no one, and no one can depend upon him. (1900: 595)

Perhaps we could excuse Lubbock, who never left Europe and never actually met a "savage." But even those who did were influenced by this view. Decades later, Allan Holmberg described the Bolivian Siriono's adaptation to the tropical rain forest as ineffectual, their lives dominated by a continual concern for food, their personalities as ungenerous and quarrelsome (1950; see commentary by Isaac 1977). Jules Henry (1941: 3) asserted that the Kaingang (Botocudo) of Brazil "resented" their nomadic way of life (since they had allegedly been horticulturalists 300 years previously). Others saw foragers as people who had been forced by agriculturalists into marginal areas where life was so precarious that their every waking moment was spent in a desperate food quest, leaving no time for cultural advancements. Early twentieth-century descriptions of foragers were often so bleak that they left students wondering "not only how hunters managed to make a living, but whether, after all, this was living" (Sahlins 1968: 85).

Anthropology eventually left this sad image behind, but there was a legacy of unilineal evolutionism that it found harder to shake. Victorian scholars could see that human societies were incredibly diverse – that's what allowed the comparative method. They assumed that this diversity came from a single original social form, a prehistoric hunter-gatherer Adam and Eve. Why? Evolutionists looked for what was common among societies that they thought belonged in the same stage. Some differences arose from diffusion and environment, but if the major cause of change was the accumulation of ideas over time, then, in the early stages of development, not enough time would have passed to produce much variation. There should, therefore, be less diversity in the early reaches of human evolution (when people were hunter-gatherers) than in later stages.

As a result, in the models developed in the twentieth century to describe hunter-gatherers, variation was something to be explained away to uncover the essential hunter-gatherer. We can see this in the succeeding twentieth-century models of foragers.

The Patrilineal/Patrilocal Band

Beginnings are often hard to pinpoint, but the formal concept of a patrilineal/patrilocal band can perhaps be attributed to A. R. Radcliffe-Brown (1930–31) and his description of Australian Aboriginal social organization, especially that of the Kariera and Aranda. Radcliffe-Brown argued that Australian Aborigines lived in patrilineal/patrilocal "hordes." We discuss social organization more in Chapter 8 but, briefly, for the uninitiated, a *patrilineal* society is one in which people belong to a social grouping that consists of people who trace their affiliation through a male line (a *matrilineal* society is the opposite). *Patrilocal* refers to the practice in which a newly married couple live where the groom's father lives (and in *matrilocal* societies, the couple lives where the bride's family resides).

Sometimes Radcliffe-Brown described hordes as small patrilineal groups, sometimes as clans, and sometimes as something like clans (but he stuck to the importance of patrilineal groups even when there was evidence to the contrary; see Elkin 1953; Radcliffe-Brown [1954]). Whatever it was, the horde owned a specific tract of land containing its totemic sites, to which it had exclusive use rights. Radcliffe-Brown described the horde as politically autonomous, with no provision that would permit a man to leave one and join another. The horde was also the basic war-making unit.

Only a few years later, in 1936, Julian Steward used ethnographic data, including Radcliffe-Brown's description of the horde, to formalize the concept of the *band*. Steward saw variability in the composition of bands, and he described three major types: patrilineal, matrilineal, and composite. Patrilineal bands had local exogamy, group sizes of fifty to a hundred, political autonomy, patrilineal descent and inheritance, patrilocal residence, and land ownership by the lineage. Theoretically, these bands contained a single patrilineage. Patrilineal bands were said to be the most common social form[9] and, for Steward, this meant they were the earliest. Matrilineal bands mirrored patrilineal bands but with matrilineal descent and matrilocal residence. Steward attributed matrilineal bands to factors such as a shortage of men in the wife's family, more favorable conditions in the territory of the wife's family, the desire to secure assistance of the wife's mother in child rearing, the lack of women for exchange with the wife's band, or diffusion of practices from a neighboring area. Steward gave matrilineal bands little consideration and, in later years, he all but omitted discussion of them (e.g., Steward 1955).

Composite bands consisted of several independent families, were endogamous with bilateral descent (trace relations through both the mother's and father's side), and had no firm rules of residence. Composite bands were frequently larger than patrilineal ones, Steward argued, due to more abundant food resources, especially herds of migratory game. Steward saw composite bands as resulting from a variety of factors, especially their size and the prior subdivision of land into family tracts for special economic purposes (e.g., Algonquian and Athapaskan fur-trapping territories; Speck 1915). Interband adoption and the legitimacy of cross- and parallel-cousin marriage, Steward argued, also encouraged the formation of composite bands.

Steward saw that some groups, such as the Western Shoshone and Eskimo,[10] did not fit into his classification. For these people, Steward claimed, there was no political unit beyond the family. He described this as the *family level of integration* and attributed it to harsh environments that prevented the formation of bands.

Although Steward clearly recognized that not all hunter-gatherers fit the patrilineal band model, the exceptions were given only slight attention. One reason is that Steward thought we could find the origin of patrilineal bands in natural male dominance (1936: 333, although he later dropped this idea; Steward 1968) and in the need for males (brothers) to bond together to hunt communally. Steward also argued that a hunter needed to remain in the area of his childhood since he assumed that local knowledge was a prerequisite for successful hunting. Although Steward claimed he had ascertained "the causes of primitive bands through analysis of the inner functional or organic connection of the components of the culture and their environmental basis" (1936: 344), he gave nearly equal weight to a priori concepts of land use, adoption practices, kinship, and ideas of human nature (male dominance and territoriality).

A student of Julian Steward, Elman Service (1962) critiqued his mentor's typology and, in the process, discounted variation even more. Steward saw the composite band as the result of ecological factors that prevented the formation of patrilineal bands, but Service claimed that composite bands, as well as family-level cases, were the result of depopulation and the fragmenting effect of European contact. Service emphasized postmarital residence rules more than Steward had, since he felt many cases of unilineal descent were de facto descent groups resulting from a postmarital residence rule (1962: 30–33, 60). Therefore, Service preferred the label patri*local* as opposed to patri*lineal* bands. Because these bands appeared to be common among hunter-gatherers, and because they appeared in many environments, Service concluded that the patrilocal band was the earliest form of human organization above the level of the family. And, in contrast to Steward, Service took the position that "ecological adaptation has nothing whatsoever to do with preventing or 'frustrating' the formation of the patrilocal band," since the patrilocal band was not an adaptation but an "inevitable" form of social organization (1962: 108). Thus, it could be extended to our earliest ancestors.

Within a few years, "patrilocal band" became nearly synonymous with hunter-gatherer (Owen 1965; Service 1966; Williams 1974). Yet, from the beginning, it was clear that the patrilocal-band model could not accommodate all known hunter-gatherer societies. In Australia, the mismatch between the model and ethnographic reality resulted in debates over whether the data were derived from hunter-gatherer behavior or from ideology. Since Radcliffe-Brown recorded "memory culture," he recorded the ideology of land use and descent rather than the actual behavior, but he assumed that the two were the same (Peterson and Long 1986: 18). Melvin Meggitt, and especially Les Hiatt, criticized Radcliffe-Brown's reconstruction of the patrilineal horde as too simple, static, and ignorant of variability in the ethnographic record (Meggitt 1962; Hiatt 1962, 1965, 1966, 1968; see review in Keen 1988).[11] Land-holding social groups, for example, were not universally patrilineal in Australia (Keen 1988: 88). Hiatt also pointed out that matrilineages existed, although they were not corporate land-owning or food-gathering units, and that economic relationships to land had to be differentiated from ritual ties to land.

Arguing that Hiatt had oversimplified Radcliffe-Brown's analysis, W. E. H. Stanner (1965) tried to resolve some of the ambiguity in the concept of horde in Australia with the concepts of *estate* and *range*. An estate is an area that is traditionally recognized as the land (a "country" or "dreaming place" in Aboriginal terms) that "belongs" to a patrilineal descent group, whereas the range is the actual land over which a foraging group may roam. Sometimes estate and range are identical, but often the range is much larger (Barker 1976). Patrilineal groups can cut across what are recognized as boundaries on other social levels, and members from many descent groups can make up a food-gathering unit. Also, many patrilineal groups did not have distinct territorial boundaries encompassing their ritual (totemic) sites, and food-gathering units could move through areas containing the ritual sites of others.

Clearly, many ethnographers, including Radcliffe-Brown, recognized variability in Australian Aboriginal social organization. They argued over whether this variation should be attributed to environment or to European contact, over whether data collected years after contact were valid, and over the ecological basis of patrilineal hordes (Stanner 1965; Birdsell 1970). But they also argued about whether the variation was significant. Was it that other forms of local group organization were no longer recognizable (L. Hiatt 1968: 100)? Or, were the observed organizations simply variations on a theme, not important enough in themselves to call for explanation? The critical point is seen in Stanner's (1965: 8) observation that "in remarks of wide application, [Radcliffe-Brown] tended to refer to hordes; in matters of detail or in analysis, to clans." Consequently, in the minds of many anthropologists, especially those outside of Australia, the clan and horde became synonymous. Any hints that Radcliffe-Brown gave of variability (and he did) were largely ignored by his readers (see Stanner 1965: 15–16) and, in more general discussions, by Radcliffe-Brown himself – because anthropology was looking for a single descriptive model of hunter-gatherer social organization.

By the 1960s, however, many anthropologists recognized that variation could not be easily subsumed under the patrilineal/patrilocal band model. A new synthesis was in order, and it was provided by the *Man the Hunter* conference.

The Generalized Foraging Model

In 1966, seventy-five scholars from around the world met in Chicago to discuss the state of knowledge about hunter-gatherers. Organized by Richard Lee and Irven DeVore at the urging of Sol Tax, the *Man the Hunter* conference proved to be the twentieth-century's watershed for knowledge about foragers.

The conference covered the topics of marriage, demography, territoriality, social and political organization, and evolution, employing data from Africa, Australia, the subarctic, Arctic, South America, and North America, from ethnographic as well as archaeological cases. It provided new perspectives on marriage practices and descent. Despite its title, the conference introduced anthropology to the importance of plant food and women's labor in hunter-gatherer diet, both of which eventually led to new interpretations of human evolution (see Slocum 1975; papers in Dahlberg 1981).

Since cultural ecology (see Chapter 2) was the order of the day, environment and subsistence took on increased importance at *Man the Hunter*. Presenters discussed marriage practices, for example, as ways of creating social ties to distant areas to facilitate migration in times of famine. They saw group movement, size, and membership as responses to local food density and variability. Lee characterized the Bushmen adaptation as "long term," adapted to environmental conditions as they are manifested over decades. In contrast to earlier descriptions of hunter-gatherers as evolution's failures, in the late 1960s, foragers gained a reputation as savvy lay ecologists. They were *t'xudi kaus*, as the Ju/'hoansi might say, masters of cleverness and bush lore.

Man the Hunter created a new model of foraging society that we shall call the *generalized foraging model* (Isaac 1990). In this model, plant food, rather than meat, was the focus of subsistence. Defense and territoriality were unimportant, and population was thought to be kept in balance with food resources through intentional cultural controls. *Man the Hunter* raised the importance of sharing, bilateral kinship, and bilocal postmarital residence in the hunter-gatherer adaptation.[12] Lee and DeVore described the five characteristics of what they called "nomadic style":

1. *Egalitarianism*. Mobility constrains the amount of property that can be owned and thus serves to maintain material equality.
2. *Low population density*. Population is kept below carrying capacity through intentional, conscious controls such as abstention, abortion, and infanticide.
3. *Lack of territoriality*. Long-term adaptation to resource variability requires that hunter-gatherers be able to move from one region to another, making defended territories maladaptive.
4. *A minimum of food storage*. Since the group is nomadic and food plentiful relative to population density (see characteristic 2), food storage is unnecessary; hence the potential of storage to create social hierarchy is thwarted.
5. *Flux in band composition*. Maintaining social ties requires frequent movement and visiting, which also discourages violence since disputes can be solved through group fissioning rather than fighting.

Where Steward had initially thought of (patrilineal) bands as large groups, at *Man the Hunter*, he used terms such as "minimum band," "multifamily primary bands," "lineage-based bands," and, still, "patrilineal band." He recognized that the ethnographic data could not be easily subsumed by a simple typology, to say nothing of a single concept of patrilineal (or patrilocal) band. After *Man the Hunter*, however, "band" became synonymous with "minimal band," a coresident group of around twenty-five persons. Notwithstanding the many exceptions, foraging as an economy became equated with this concept of band. Discussions of hunter-gatherers focused on "band societies" and excluded large, sedentary groups of North America's Northwest Coast, southern California's Chumash, or the Japanese Ainu (e.g., Leacock and Lee 1982a). In fact, foragers of the Kalahari Desert, and especially the Ju/'hoansi, came to be the model hunter-gatherers (Figure 1-2).

And not just a model but a model we should emulate. Dissatisfaction with modern life had been growing since World War I, and it came to a head in the 1960s and 1970s, with the grinding war of attrition in Vietnam, political assassinations and corruption, and widespread environmental degradation. Nineteenth-century notions of progress collapsed and, instead of an inexorable climb upward, social evolution now seemed to be a long fall from Eden. Increasingly dissatisfied, many rejected the materialism of Western society and searched for an alternative way of life in which material possessions meant little, people lived in harmony with nature, and there were no national boundaries to contest. It was the context for John Lennon's song, *Imagine*, and for the numerous hippie communes. Hunting and gathering had kept humanity alive for 99 percent of its history (Lee and DeVore 1968: ix); what could we learn from it?

Marshall Sahlins (1968, 1972) answered this question with his eloquent formulation of the "original affluent society," perhaps the most enduring legacy of *Man the Hunter*.

Prior to the conference, many social scientists saw foraging as a perpetual and barely adequate search for food (e.g., Kroeber 1939: 220). Paleolithic hunters, the argument went, adopted agriculture and animal domestication to relieve themselves of the time-consuming burden of hunting and gathering. They were evolution's success stories. Living hunter-gatherers, on the other hand, were the unfortunates who had been pushed into environments hostile to agriculture. Spending all of their waking hours in the food quest, hunter-gatherers could not develop elaborate culture because they did not have the spare time to build irrigation systems, bake ceramics, invent complex rituals, or erect pyramids.

Inspired by economist John Kenneth Galbraith's *The Affluent Society*, Sahlins (1968: 85) sought to overturn this misconception with "the most shocking terms possible." He argued that ethnographic data actually painted the opposite picture: hunter-gatherers spent relatively little time working, had all the food they needed, and spent leisure hours sleeping or socializing. Their devil-may-care attitude toward the future, which many explorers interpreted as stupidity or foolishness, Sahlins claimed was an expression of self-confidence and assurance that nature would

Figure 1-2. A Southern Kua woman prepares to cook the head of a donkey for two female-headed households in the Western Sandveld of the Kalahari Desert in August 1975. The woman to her right pounds maize received in exchange for work in the fields of a nearby cattle post. Although Bushmen were regarded as the quintessential hunter-gatherers in the 1960s and 1970s, they lived interdependently with agropastoralists. Courtesy of Robert Hitchcock.

meet one's needs. The carelessness with which hunter-gatherers treated material goods, previously interpreted as an inability to recognize personal property, was, Sahlins argued, a response to a nomadic lifestyle in which material goods are a hindrance. In Sahlins's memorable phrase, the foraging economy was a Zen economy: wanting little, hunter-gatherers had all they wanted. He dramatized the fact that Australian Aborigines and the Ju/'hoansi work only a few hours a day, yet they did not develop civilization. The development of writing, arts, architecture, and the like required something more than just free time.

Sahlins's idea of hunter-gatherers as "affluent" captured wide attention (and continues to do so; see Gowdy 1998; Kouravelos 2009).[13] Left unelaborated, however, was the relationship between the economic constraints of foraging, social relations, material goods, and culture (see Bird-David 1992a,b). As a result, anthropologists used the concept of affluence in different ways. For many, affluence was inherent in the foraging economy; therefore, all hunter-gatherers were, by definition, affluent. But, in reality, when these anthropologists thought about hunter-gatherers, they were thinking of groups similar to the Ju/'hoansi (and sometimes, I suspect, *only* the Ju/'hoansi), groups that fit the image conveyed by the generalized foraging model (Bird-David 1992b). Anthropologists' view of foraging societies became myopic, and they excluded matrilineal, sedentary, territorial, warring, and ranked foraging societies (e.g., those of North America's Northwest Coast). In archaeology, the concept of affluence had a particularly dramatic effect on explaining the origins of agriculture. Although archaeologists had long seen agriculture as a great improvement in human life, in the 1960s, we saw it as a lifeway adopted only under dire circumstances.[14] Theories explaining the origin of agriculture focused on how population growth and migration to environmentally marginal areas forced hunter-gatherers to leave their life of leisure behind, become agriculturalists, and work for a living (e.g., Binford 1968; Cohen 1977).

Other archaeologists, however, reversed the affluent forager image, labeling groups with high population densities, many material belongings, and food storage as the most affluent – people who, in contrast to Sahlins' original formulation, apparently wanted a lot and got a lot; desert hunter-gatherers became the least affluent (e.g., see papers in Koyama and Thomas 1981). In fact, some argued that Northwest Coast society, with its elaborate mortuary feasts and material culture, is a product of an environment with an abundance of food that permitted the free time to develop an elaborate culture – precisely the relationship that Sahlins sought to counter!

Different uses of affluence were generated partly by a misunderstanding of the original concept, but they were primarily generated by efforts to account for variability within a single descriptive model of hunter-gatherer society. At *Man the Hunter*, there was disagreement over most generalizations about hunting and gathering, and discomfort over the fact that generalizations could be made only if certain groups were set aside, in particular the Australian Aborigines (Lee and DeVore 1968: 336–7). The Aborigines were often treated as a special case, as were Northwest Coast and equestrian Plains Indian societies (meaning that a large portion of the available sample was considered special cases). Although conference participants admitted to variability among foragers, they were unwilling to give up the general category of hunter-gatherers. There was tension between those who sought universal characteristics of a modal form of hunter-gatherer society (e.g., Williams 1968: 126) and those who felt it necessary to account for variability. Although DeVore cautioned participants that "we might well be suspicious of any generalization that was intended to apply to all men who have ever hunted in any place or at any time" (Lee and DeVore 1968: 339), a nagging sense persisted that there ought to be something socially and culturally unique and common to all people who hunt and gather for a living.

Even leaving aside the exceptional cases, a typology or definition of band societies continued to be elusive. Although a proponent of typologies in 1955 (Steward 1955: 180), and although he offered a typology of bands at *Man the Hunter*, Steward eventually claimed that the year-to-year fluctuations in group composition made it difficult to define bands "either as a generic category, as a series of subcategories, or as some kind of subdivision of larger social units" (1969b: 290). He questioned whether "we have any cross-cultural types that are truly identical structurally" (1968: 322) and suggested that "minimal importance should be ascribed to a search for criteria of bands and to a construction of a typology of bands" (1969a: 187). Instead, he wrote, "it may be far more profitable to search for those processes which have brought about the distinguishing characteristics of societies under this very broad category" (1969a: 187). Steward was not waffling – he was just expressing the frustration anthropologists felt over the desire to study hunter-gatherers as a social or economic type without being able to define what that type was. This is the dilemma of essentialist thinking.

But if *Man the Hunter* tore down one model to replace it with another, it was itself soon to be dismantled, for the research it inspired rapidly produced information for which it could not account.

A question that goes to the heart of the generalized foraging model's concept of original affluence is: how much do hunter-gatherers work, and why? Reexaminations of Ju/'hoansi and Australian work effort do not support Sahlins's claim. Kristen Hawkes and James O'Connell (1981) found a major discrepancy between the Paraguayan Ache's nearly seventy-hour work week and the Ju/'hoansi's reportedly twelve- to nineteen-hour week. The discrepancy, they discovered, lay in Lee's definition of work.[15] Lee counted as work only the time spent in the bush searching for and procuring food, not the labor needed to process food resources in camp. Add in the time it takes to manufacture and maintain tools, carry water, care for children, process nuts and game, gather firewood, and clean habitations, and the Ju/'hoansi work well over a forty-hour week (Lee 1984; Isaac 1990; Kaplan 2000). In addition, one of Sahlins's Australian datasets was generated from a foraging experiment of only a few days' duration, performed by nine adults with no dependents. There was little incentive for these adults to forage much (and apparently they were none too keen on participating – see Altman [1984, 1987]; Bird-David [1992b]).

More accurate estimates of the time hunter-gatherers spend foraging and performing other chores demonstrate that some hunter-gatherers work hard, foraging for eight or more hours a day (Table 1-1; see also Hill et al. 1985).[16] But many hunter-gatherers do not spend much time foraging, and some only forage every other day or so. Why don't they forage more? Do they intend to have an affluent life of leisure?

At *Man the Hunter*, Lorna Marshall pointed out that Ju/'hoansi women may not work as hard as they could because, in gathering more than needed, a woman would soon be confronted by demands to share the fruits of her extra efforts and face accusations of stinginess if she refused. Knowing that extra labor does not benefit her family, Marshall argued, a woman intentionally restricts how much she gathers (Lee and DeVore 1968: 94). But there's more to it. Nancy Howell (2010) shows that Ju/'hoansi do not produce a caloric net gain until they are in their early twenties, meaning that children, even adolescents, are a drain on adult working capacity. But foraging in the hot Kalahari Desert is demanding, and so the Ju/'hoansi don't work harder because if they did it would kill them. Likewise, the Venezuelan Hiwi do not forage for more than two to three hours a day because their net caloric intake might actually *decrease* due to the difficulty of working during the hottest part of the day (Hurtado and Hill 1990). This could decrease a woman's fertility, a fact that Hiwi women seem to recognize.

So, do foragers have all they want because they want very little? Maybe not. Winterhalder argued that Sahlins's "Zen economy has an ecological master" (Winterhalder et al. 1988: 323) and that environmental factors affect how much effort foragers put into foraging. The concept of original affluence cannot account for variability in forager work effort and reproduction – or for conditions that lead to increased work effort and population growth (Winterhalder and Goland 1993; Blurton Jones, Hawkes, and Draper 1994; see Chapter 7).

In addition, many hunter-gatherers are also chronically undernourished and undergo dramatic seasonal fluctuations in weight and nutritional status that, for women, affect fecundity and the welfare of nursing offspring.[17] Members of that original affluent society, the Ju/'hoansi, "are very thin and complain often of hunger, at all times of the year. It is likely that hunger is a contributing cause to many deaths which are immediately caused by infectious and parasitic diseases, even though it is rare for anyone simply to starve to death" (Howell 1986b: 173–74; see Isaac 1990). In fact, pregnant and lactating Ju/'hoan women have a body mass index (weight/height^2) of 18.5, a value usually associated with chronic energy deficiency (Howell 2010). This is not just a product of contact. Archaeological data also demonstrate that prehistoric hunter-gatherers in a variety of environments lived physically demanding lives and witnessed seasonal food shortages (e.g., Yesner 1994; Larsen and Kelly 1995).

Life among some hunter-gatherers may also be more violent than previously thought (Keeley 1996; see Chapters 7 and 9). Per capita homicide rates among some hunter-gatherers, including the Ju/'hoansi, are quite high, rivaling those of large Western cities (Lee 1979: 398–9; Headland 1988; Keeley 2004). The North American rates are higher if we take deaths due to warfare into account, and some violence results when nomadic foragers are forced into large settlements with no dispute-managing apparatus, or when alcohol becomes easily available (Lee 1979; Kent 1990). Nonetheless, the Ju/'hoansi do experience violence, and many other hunter-gatherers fought and raided one another for revenge, food, and slaves.[18] Other hunter-gatherers are quite territorial, including some in the Kalahari Desert (Heinz 1972) and vigorously defend their territories, sometimes violently (e.g., Chindina 2000; Donald 2000).

The emphasis on plant food – and women's labor – in the generalized foraging model also does not apply to all hunter-gatherers. It is obviously not true of Arctic foragers, but it is also untrue for many who live at lower latitudes. Using Murdock's (1967) ethnographic atlas, Carol Ember

Table 1-1. Foraging and Work

Group	Foraging hrs/day Female (mean)	Foraging hrs/day Male (mean)	Foraging hrs/day Both	Working hrs/day Both	Reference
South America					
Ache	1.3	6.9	–	6	Hill et al. 1985; Hurtado et al. 1985
Hiwi (late wet)[a]	2.6	1.3	–	–	Hurtado and Hill 1987, 1990
Hiwi (early dry)	2.2	1.7	–	–	Hurtado and Hill 1987, 1990
Hiwi (late dry)	1.6	2.0	–	–	Hurtado and Hill 1987, 1990
Hiwi (early wet)	1.5	2.2	–	–	Hurtado and Hill 1987, 1990
Pumé	0.4	1.3	–	1.9[c]	Gragson 1989
Africa					
Ju/'hoansi	1.8	3.1	–	7	Lee 1979, 1982
BaMbuti (nets)	–	–	–	8.5	Harako 1981
BaMbuti (archers)	–	5.0	–	–	Harako 1981
BaMbuti (nets)	–	–	10	–	Terashima 1983
BaMbuti (archers)	–	8.1	–	–	Terashima 1983
Efe (men only)	–	4.6	–	6.3	Bailey 1991
≠Kade	2.4	6.3	–	9.5	Tanaka 1980
G/wi	–	–	5.2	–	Silberbauer 1981a,b
Hadza	–	–	2	–	Woodburn 1968
Hadza (dry season)	2–6	–	–	–	Hawkes, O'Connell, and Blurton Jones 1989
Hadza (wet season)	4–8	–	–	–	Hawkes, O'Connell, and Blurton Jones 1989
Hadza	4.1	6.1	–	–	Marlowe 2010, 2006
Kutse (Bushmen)[b]	–	2.6	–	–	Kent 1993
Australia					
Australia Coast	–	–	–	3.8	McCarthy and McArthur 1960
Australia Coast	–	–	–	5.1	McCarthy and McArthur 1960
Australia Interior	–	–	–	3	Curr 1886–87
Australia Interior	–	–	–	2–3	Grey 1841
Australia Interior	–	–	–	2–4	Eyre 1845
Ngadadjara	4.5	–	–	7	Gould 1980
Western Desert	4–6	–	–	–	Tindale 1972
Paliyan	–	–	–	3–4	Gardner 1972

Group	Foraging hrs/day Female (mean)	Foraging hrs/day Male (mean)	Foraging hrs/day Both	Working hrs/day Both	Reference
Southeast Asia					
Agta (male)	–	7.5	–	–	Estioko-Griffin and Griffin 1985
Agta (female)	6.2[b]	–	–	–	Goodman et al. 1985
Ihaya Agta (female)	–	–	–	4.2	Rai 1990
Ihaya Agta (male)	–	–	–	7.7	Rai 1990
Batak	2.9	4.1	–	–	Endicott and Endicott 1986
North America					
Tlingit	–	–	–	6.5	Oberg 1973

[a] Female work effort given is for non-nursing or postreproductive women; nursing or pregnant women work less.

[b] Includes hunting only, dry season; 1987–91.

[c] Women = 2.86, men = 0.89.

Note: Work includes both foraging and food processing/preparation.

(1978) showed that as a simple statistical percentage, meat was more important than plant food and, not surprisingly, that men contributed more to subsistence than women in the majority of foraging societies.[19] Brian Hayden (1981b) also found that whereas hunted food provides a mean of only 35 percent by weight in a sample of forager diets, it provides at least half of many groups' total caloric needs.

Others have found that the alleged egalitarian relations of hunter-gatherers are pervaded by inequality, if only between the young and the old and between men and women (Woodburn 1980; Hayden et al. 1986; Leacock 1978; see Chapters 8 and 9). Food is not shared equally, and women may eat less meat than do men (Speth 1990, 2010; Walker and Hewlett 1990). Archaeologists find more and more evidence of nonegalitarian hunter-gatherers in a variety of different environments (Price and Brown 1985b; Arnold 1996a; Ames 2001), most of whom lived under high population densities and stored food on a large scale. Put simply, we cannot equate foraging with egalitarianism.

By the 1980s, serious cracks had developed in the generalized foraging model. Those cracks discouraged many researchers from an approach that privileged ecology and subsistence, all the more so when they recognized that the world's living foragers do not live in a world of foraging.

The Interdependent Model, or "Professional Primitives"

One purpose of *Man the Hunter* was to help resolve what many saw as difficulties with the patrilocal band model. But, at the same time, the mid-1960s, astonishing discoveries made at Olduvai Gorge and elsewhere demonstrated the antiquity of the human species and renewed the desire to use living hunter-gatherers to help reconstruct the lives of our earliest human ancestors. Lee and DeVore explained that *Man the Hunter* was organized

> to follow logically from an earlier symposium on the Origin of Man. . . . Current ethnographic studies have contributed substantial amounts of new data on hunter-gatherers and are rapidly changing our concept of Man the Hunter. Social anthropologists generally have been reappraising the basic concepts of descent, filiation, residence, and group structure. In archaeology

> the recent excavation of early living floors has led to a renewed interest in and reliance on hunter-gatherer data for reconstruction, and current theories of society and social evolution must inevitably take into account these new data on the hunter-gatherer groups. (Lee and DeVore 1968: vii)

Although no anthropologist at *Man the Hunter* would have said that living foragers were *exactly* like Pleistocene ones, it was not clear how theories of social evolution were supposed to take into account the "new data on the hunter-gatherer groups."

The issue is critical for archaeology because modern foragers do not, in Sahlins's words, live in a world of hunters but rather in a world of Microsoft, Coca-Cola, World Bank-sponsored cattle ranches, international lumber markets, and violent insurgencies. All live physically and socially on the outskirts of societies radically different from their own. They interact with these societies through trade, marriage, employment, conscription, and the courts – and, in some cases, they have done so for a long time (Spielmann and Eder 1994). The Penan of Borneo, as well as the Batek of Malaysia, gather rattan for the world market; the Penan probably began trading with Chinese merchants nearly 1,000 years ago (Hoffman 1984; Endicott and Endicott 2008). India's Hill Pandaram are part of the caste system and are specialized gatherers of marketable forest produce (Morris 1982). In southern Africa, many Bushmen[20] were impressed into modern military forces because of their knowledge of bushlore, and some may have oscillated among pastoralism, agriculture, and foraging for centuries (Denbow 1984; Wilmsen 1989a; Wilmsen and Denbow 1990; Gordon 1992). African Pygmies were involved in the ivory trade long before Europeans penetrated the Ituri Forest (Bahuchet 1988) and, today, the Bofi pygmies trade some thirty-five percent of the bushmeat they hunt to local horticultural villagers (Lupo and Schmitt 2002). In North America, Algonquians trapped beaver almost to extinction in the sixteenth and seventeenth centuries for the manufacture of hats in Europe. The Shoshone along the Humboldt River in Nevada preyed on the livestock of mid-nineteenth-century California-bound immigrants (Clemmer 2009), and California hunter-gatherers were devastated by disease and genocide beginning in the eighteenth century. Down under, Australian Aborigines traded with Macassans from the Celebes well before British colonization (Meehan 1982: 16). And, after contact, British immigrants hunted Aborigines for sport on the mainland and in Tasmania.

In brief, long before anthropologists arrived on the scene, hunter-gatherers had already been given diseases, shot at, traded with, employed, and exploited by colonial powers or agricultural neighbors. The result in many cases (some would say all) was dramatic alterations in hunter-gatherers' livelihoods. Family trapping territories among the Canadian Naskapi and Montagnais were probably adaptations to the fur trade rather than precontact forms of land ownership (Cooper 1946; Leacock 1954, 1969, 1983). The Micmac division of labor shifted, moving men but not women into the more public and prestigious arena of trade with Europeans (Gonzales 1982). Amazonian people separated into family groups and marketed forest produce, including rubber (Murphy and Steward 1955). Other hunter-gatherers sold their labor to colonial enterprises, often with disastrous consequences (e.g., Gould, Fowler, and Fowler 1972; Krech 1983).

Foragers in the twentieth century live on cultural frontiers and shift back and forth between foraging, agriculture, pastoralism, government welfare, and wage labor (Gardner 1993; Figure 1-3). Others are deeply involved in cash economies, making crafts and gathering forest products to sell on the world market (see Peterson and Matsuyama 1991). Virtually no hunter-gatherer in the tropical forest today lives without trading heavily with horticulturalists for carbohydrates or eating government or missionary rations.[21] Some, in fact, argue that it is impossible to live in the tropical rain forest as a hunter-gatherer without the carbohydrates and iron tools provided by horticulturalists (see Rambo 1985: 31; Bailey et al. 1989; Headland and Reid 1989).[22]

Some foragers retreated into forests or deserts to avoid conscription, taxes, and the administrative arms of colonial powers (Nurse and Jenkins 1977; Woodburn 1979; Feit 1982; Gardner

Figure 1-3. A family of nomadic Mikea, seasonal foragers in southwestern Madagascar, in July 1993. In the dry season, this family gathers tubers in the forest to eat and to sell. In the wet season, they move into a semipermanent hamlet and grow maize through slash-and-burn horticulture, but they also own a home in a permanent village. They participate in that village's market and frequently work for wages. Photo by the author.

1993). Madagascar's Mikea, for example, retreated to the forest to avoid slavers in the nineteenth century and again, in the 1960s, to avoid taxation (Poyer and Kelly 2000; Yount, Tsiazonera, and Tucker 2001; Tucker 2003). Yet other foragers today forage as a way to affirm their cultural worth, as a political message that only makes sense in a world of enclaved minorities (Bird-David 1988, 1990, 1992a,b; Povinelli 1992).

There can be little doubt that all ethnographically known hunter-gatherers are tied into the world economic system in one way or another; and, in some cases, they have been linked to it for hundreds of years (e.g., Leacock 1983; Morrison and Junker 2002; Ikeya, Ogawa, and Mitchell 2009).[23] Foragers are not evolutionary relics, and using these people to interpret the archaeology uncovered in the strata of Olduvai Gorge – or anyplace else – is no straightforward exercise.

In the mid-twentieth century, anthropologists saw the effects of contact between hunter-gatherers and their neighbors' societies as something that could be eliminated or neutralized, like noise in a radio signal, allowing reconstruction of the precontact lifeway. By the 1980s, however, many argued that this encouraged a view of hunter-gatherers as "primitive and isolated – incomplete, not yet fully evolved, and outside the mainstream" (Headland and Reid 1989: 43). But others simply said that it was impossible, that the structure of hunter-gatherer systems can only be understood in terms of how foragers interact with nonforaging societies. Hunter-gatherers of today, Tom Headland and Lawrence Reid claimed, remain as hunter-gatherers "because it is economically their most viable option in their very restricted circumstances . . . [they carry] on a life-style not in spite of but because of their particular economic role in the global world in which they live" (1989: 51; see also Marlowe 2002).

This observation encouraged some anthropologists to move away from the ecological paradigm of the 1960s and 1970s. They replaced the generalized foraging model with what is called the "interdependent" or, to use the Seligmans's (1911) term, the "professional primitives" model.[24] Unlike previous models, this one has nothing to do with reconstructing an earlier stage of human evolution and instead claims that there is no role for ethnography in reconstructing the past.

Given the important place of the Ju/'hoansi in hunter-gatherer anthropology in the 1960s and 1970s, it is understandable that much of this new perspective centered on reinterpreting Richard Lee's ethnography. Briefly, Edwin Wilmsen, James Denbow, and others argued that the Ju/'hoansi and other Bushmen have not been "pure" hunter-gatherers for at least several hundred years and perhaps more than a millennium. Instead, the revisionists, as they came to be known, argued that the Bushmen have been in close contact with African and, later, European traders and have shifted among foraging, agriculture, and pastoralism in response to changes in the regional social and political reality of southern Africa (Wilmsen 1983, 1989a, 1992; Denbow 1984; Gordon 1984, 1992; Wilmsen and Denbow 1990). Bushmen society and culture are formed not only by ecology but by Africa's political economy as well. From this vantage point, some see Bushmen egalitarianism not as an adaptation to the exigencies of nomadic life in the desert but rather as a response to domination by outsiders (see discussion by Woodburn 1988). To some, the Bushmen appear to be egalitarian only if you ignore that they are actually the lowest stratum in a class society (Wilmsen 1983; 1989a; Gordon 1984).

Carmel Schrire (1980, 1984b) and Wilmsen criticized Lee for characterizing the Ju/'hoansi lifeway as "an elementary form of economic life" (Lee 1969: 73) and as "the basic human adaptation stripped of the accretions and complications brought about by agriculture, urbanization, advanced technology, and national and class conflict" (Lee 1974: 169). In his monograph on the Ju/'hoansi, Lee (1979: 2) argued that "the first order of business is carefully to account for the effects of contact on their way of life. Only after the most meticulous assessment of the impact of commercial, governments, and other outside interests can we justify making statements about the hunter-gatherers' evolutionary significance." Schrire and Wilmsen argue that such an approach is impossible, for once the effects of contact are subtracted, *there is nothing left*. Wilmsen (1989a: 57), in fact, argues that his own work with the Bushmen has nothing to say about hunter-gatherers: "in the Kalahari, we are some thousand years too late for that." Ignoring the political and historical context of the Bushmen or any foragers, Wilmsen and Schrire argue, ignores the exploitation and inequality that characterize their lives. As a result, many have redirected their attention away from the traditional anthropological interest in hunter-gatherers and toward understanding the political reality of living foragers and assisting their claims to land and political autonomy.[25]

The specifics of Bushmen history are best argued by experts on the Kalahari; I will just say that, in my opinion, the data more strongly support Lee's than Wilmsen's interpretation (Solway and Lee 1990; Lee 2002).[26] Nonetheless, this debate raises two important issues.

Who Are Living Hunter-Gatherers?

The first issue is whether the sociocultural trends observed among modern hunter-gatherers are associated with hunting and gathering itself or are a product of hunter-gatherers interacting with non–hunter-gatherers:

> There can be no doubt that, one way or another, all [ethnographies] describe societies coping with the impact of incursions by foreign forces into their territories. Anthropologists have used these studies to postulate commonalities among groups in their search for those features that are residual or intrinsic to the hunter-gatherer mode. The big question that arises is, are the common features of hunter-gatherer groups, be they structural elements such as bilateral kinship systems or behavioral ones such as a tendency to share food, a product of interaction with us? Are the features we single out and study held in common, not so much because humanity shared the hunter-gatherer life-style for 99% of its time on earth, but because the hunters and gatherers of today, in searching for the compromises that would allow them to go on doing

> mainly that, have reached some subliminal consensus in finding similar solutions to similar problems? (Schrire 1984b: 18)

These are important questions, for they go to the heart of what causes variation in human behavior. The interdependent model eschewed the utility of foragers for reconstructing the past, but it ran the same risk of constructing a new stereotype – one that considers the particular historical circumstances of ethnographic cases but that still reduces variability by focusing on allegedly common characteristics produced by contact.

But not all relations of contact are the same (Schrire and Gordon 1985: 2; Lee 1988; Spielmann and Eder 1994). Perhaps the Bushmen are egalitarian because of contact with colonists and traders. But initial contact with outsiders made Northwest Coast hunter-gatherers more warlike and socially stratified (Ferguson 1984). Likewise, the neighboring Selk'nam (Ona) and Yámana (Yahgan) of South America's Tierra del Fuego responded differently to European encroachment due to their different social organizations and environmental conditions (Stuart 1980). Encapsulation can result in sociopolitical domination or in disruptions in economies due to diseases, displacement, exchange, cash foraging, and/or the development of dependence on neighbors (Gardner 1993). Jana Fortier (2009a,b) suggests that foragers who trade in nonrenewable resources become peasants or are incorporated into the regional culture, whereas those who trade renewable resources maintain their autonomy. And not all aspects of modern hunter-gatherer organization are products of encapsulation (Woodburn 1988). We should "consider the possibility that foragers can be autonomous without being isolated and engaged without being incorporated" (Solway and Lee 1990: 110; see also Fortier 2001).

The concern with contact-induced change threatens to reduce analysis of variability among hunter-gatherers to yet another stereotype, one that focuses on issues of power and control, that treats modern hunter-gatherers as disenfranchised rural proletariat, and that ultimately denies the usefulness of the study of modern hunter-gatherers for understanding prehistory (Marlowe 2005a). This is as much an oversimplification as was the generalized foraging model. And it is as much an overstatement to claim that modern ethnography is useless to prehistory as it is naïve to suppose that the effects of contact can be easily subtracted from living foragers.

Marxist Approaches

The second issue raised by the interdependent model concerns the ecological paradigm of post-*Man the Hunter* research. With increasing interest in how foragers are encapsulated within the world system came an increased concern with political economy, the intersection of economy and politics. As a result, Marxist approaches made inroads into hunter-gatherer studies in the 1980s. Marxism is, of course, an enormous field, and we can only give a simple description of these approaches here – and note that they have lost popularity in recent years (interestingly, as others have observed, after the collapse of the Berlin Wall in 1989).

Marxist approaches rest on Karl Marx's concept of the mode of production. Briefly, the mode of production is made up of the *means of production* (land, raw materials, and labor) and the *social relations of production* (the way in which products are distributed and the labor process reproduced). Marx saw the means of production as strongly conditioning the relations of production. Marxists define several modes of production, one being the capitalist mode of production.

The capitalist mode of production divided society into two classes: owners, who owned the means of production, and workers, who owned only their labor. Workers sold their labor to the owners who sold goods on the market for profit – whatever remained after paying taxes, capital investments, and laborers. Classical economics saw profit as capital to be invested in the economy for the good of all. Marx, however, saw profit as exploitation. Since the owners control profit and pay themselves from it, maximizing profit maximizes their return. And, since labor is the most expensive element of production, owners maximize profit by reducing the cost of labor – by replacing workers with machinery, by paying workers as little as possible, or by moving to where labor is cheaper.[27] Thus, capitalism entails social relations that facilitate production to produce cheap goods, but that exploit workers.

Why do workers put up with this? Marx argued that the owners also control a society's ideology – the explicit ideas about social relations between the classes. Marx argued that the actual relations of exploitation were masked by an ideology in which owners claimed to work for the good of society and in which workers did their part by accepting the deal offered to them. Driven by the ever-developing forces of production and the increasingly constraining relations of production, the contradiction between the actual and professed social relations in a society eventually produces class conflict when the working class recognizes the discrepancy between the two. Attempts to resolve the contradiction produce class struggle, resulting in the formation of new classes, which renews the cycle until, in Marx's formulation, the establishment of communism.

Initially, it was the apparent absence of these elements from the lives of hunter-gatherers that inspired some analysts to discover a classless society in them, or "primitive communism." (Lee [1988] attributes recognition of this not to Marx but rather to Lewis Henry Morgan, whose work later inspired Frederick Engels.) Hunter-gatherers are, the argument goes, evidence of a precapitalist mode of production: the foraging mode of production. Lee (1988) described this mode of production as one in which social relations enforce equal access to resources. It includes:

- collective ownership of the means of production (land and its resources),
- the right of reciprocal access to the resources of others through marriage or other social ties,
- little emphasis on accumulation (and, in fact, opposition to hoarding),
- total sharing throughout the camp,
- equal access to the tools necessary to acquire food, and
- individual ownership of these tools (Leacock and Lee 1982a: 8–9).

Some theorists see the foraging mode of production as grounded in the lack of control over food production and the inevitable diminishing returns of foraging that produces both movement and a lack of interest in material goods and land ownership (Meillassoux 1973). Tim Ingold (1987, 1988), conversely, places greater emphasis on social relations, arguing that hunter-gatherers hunt and gather not just to eat but also to maintain a specific order of social relations: those emphasizing egalitarianism and the collective appropriation of resources.

Leacock and Lee (1982a: 1) claim that the foraging mode of production (and, consequently, primitive communism) is only applicable to band-living peoples, that is, hunter-gatherers who have egalitarian social systems. But many hunter-gatherers do not fit this model. Along with Marxist approaches has come a growing concern with describing and accounting for people who are, economically speaking, hunter-gatherers but who do not fit the definition of the foraging mode of production.

When defined in terms of social relations, hunter-gatherers are often divided into two types, egalitarian and nonegalitarian (Keeley 1988; see Chapter 9), or what Woodburn (1980) labels *immediate-return* and *delayed-return* hunter-gatherers. In immediate-return systems, no surplus is created and resources, especially food, are consumed on a daily basis. These are egalitarian hunter-gatherers and include groups such as the Hadza, Mbuti, and Ju/'hoansi. Delayed-return hunter-gatherers, conversely, are those who reap the benefits of their labor some time after investing it. This category includes hunter-gatherers who store food for later consumption. But, in Woodburn's view, it also includes Australian Aborigines because adult men give kinswomen away as brides in the expectation that their patrilineage will receive a bride back in the future; thus, men store obligations in the form of women (see also Testart 1987, 1989). Extensive food storage does appear to be associated with nonegalitarian sociopolitical organizations among foragers, although it is not clear how (or even if) storage itself necessarily results in exploitation

(Keeley 1988; Testart 1982; see Chapter 9). Delayed-return or storing hunter-gatherers do not fit the model of primitive communism.

Marxists argue that we should understand hunter-gatherer society in the same terms as class or capitalist society. They assume that hunter-gatherer society is driven by inherent relations of exploitation and by contradictions between social relations and ideology. Consequently, they focus on the social relations of production since:

> social relations can themselves establish the context for change and generate a dynamic which fuels further changes. While social relations are influenced by other variables (such as environment, demography) they have their own internal dynamics and because it is here that decisions are made they may be viewed to a large degree as primary. (Lourandos 1988: 150; see also Meillassoux 1973; Godelier 1977; Bender 1985)

Marxists also find the generation of surplus food or resources particularly interesting because these can be used in competitive activities between groups through which some individuals profit by gaining prestige from the labor of others.

There are a number of difficulties with Marxism as it is applied to hunter-gatherers (see Bettinger 1991). Since Marx's social analysis was designed with class societies in mind, one can question its applicability to many classless hunter-gatherers. Many Marxists, however, argue that classes are not necessary for a Marxist analysis to proceed since all societies contain contradictions and exploitation at some level between groups that theoretically approach classes. For hunter-gatherers, the two most obvious categories are those of gender and age (Bern 1979; Woodburn 1982). Among some Australian Aborigines, for example, old men control the distribution of women as wives; young men acquire wives by obeying older men, hunting for them, and allowing them to distribute the product of the hunt. Likewise, men who have received wives are in debt to the older men who gave them wives until they are able to return a woman as a wife. Woodburn (1982) sees this as establishing inequality and exploitation between men and women, as well as between older and younger men (although, unlike true social classes where there is no or limited social mobility, all surviving young men in a group eventually become older men).

But even if exploitative relations exist between groups approximating classes in all foraging societies, it is clear that these are not all the same. The competitive feasts of the Kwakwak'awakw (Kwakiutl), for example, are not found among the Ju/'hoansi and, even if we accept Woodburn's analysis, the nature of Australian Aboriginal gerontocracy is certainly different from Northwest Coast society (which, in places, included a slave class). Left unclear is what generates different levels and forms of inequality (see Chapter 9). It is probably true that all hunter-gatherer societies contain contradictions that mask and propagate exploitative relations and that many modern (and prehistoric) foragers constitute a class (in the Marxist sense) relative to their agricultural or industrial neighbors.

Marxism can be a powerful explanatory framework for understanding the operation of a group's internal dynamics, the relationship between foragers and their neighbors, and the manipulation of the symbols of ideology. But Marxism loses its power as an explanatory framework when it views all hunter-gatherer societies as essentially similar, whether as primitive communists or incipient capitalists, and when it offers stereotypes rather than an understanding of variability.

Hunter-Gatherers as a Cultural Type

Throughout the history of anthropological thought, the stereotypes of hunter-gatherers have changed from one extreme to another: from lives that are nasty, brutish, and short to ones of affluence; from a diet of meat to a diet of plant food; from egalitarianism to inequality; from isolated relic to rural proletariat. Anthropology sought to explain *the* hunter-gatherer lifeway by first seeking universals, usually drawn from a small sample of societies, and sometimes from only one. There is nothing wrong with seeking generalizations; in fact, this is part of a scientist's obligation. But generalizations should not mask underlying variability; rather, they should be steps toward understanding it.

At this point, my reader is probably wondering how I justify writing a book about hunter-gatherers if I see so little utility in that category. In a number of ways, hunter-gatherers as a group differ statistically from those other categories of humanity so dear to anthropology: horticulturalists, agriculturalists, pastoralists. Likewise, hunter-gatherer bands differ from tribes, chiefdoms, and states (three other treasured categories). In the past, anthropologists have felt the need to search for what is common among hunter-gatherers in contrast to these other categories, to seek what is essential to the hunter-gatherer lifeway. This search has played an important role in understanding cultural evolution by pointing to correlations that give us clues to the causal variables involved in creating cultural diversity, by identifying differences between those we call hunter-gatherers and those we give other names. Yet "it is not whether phenomena are empirically common that is critical in science . . . but whether they can be made to reveal the enduring natural processes that underlie them. . . . In short, we need to look for systematic relationships among diverse phenomena, not for substantive identities among similar ones" (Geertz 1973: 44). To search for relationships between monolithic categories such as technology and social organization, or economy and society, or hunter-gatherers and agriculturalists only obscures the mechanisms and processes that result in human cultural diversity (see E. Smith's response to Testart [1988]).

When I wrote the first edition of this book in the early 1990s, many researchers were just beginning to recognize variability among hunter-gatherers as a significant area of study (e.g., Kent 1996a). They often dealt with that variability typologically, by dividing foragers into dichotomies: simple/complex, storing/nonstoring, delayed-return/immediate-return, mobile/sedentary, foragers/collectors. My goal then, and now, was to help move the field away from such typological approaches and toward theoretical frameworks that explicitly account for variability. Marvin Harris (1979: 79) tells us why: "strategies that cannot cope with the similarities and differences found among hunter-gatherer societies suffer greatly by comparison with strategies that can cope with them."[28] In the fifteen years since the first edition of this book was published, the field of hunter-gatherer studies has taken Harris's call to heart and moved from one fascinating period of exploration into another equally fascinating period of explanation.

By critiquing the category of hunter-gatherer, I do not mean to suggest that all categorization in anthropology is useless. Anthropology is a continual process of constructing and deconstructing analytical categories. Indeed, typological thinking is probably an inescapable part of being human. But a category is useful only if it helps point to the processes at work that create the diversity that is temporarily pigeonholed (and ultimately only modestly described) by that category. The angst expressed over the category of hunter-gatherers in many forums today (e.g., Roscoe 2002) signals that the category has reached the end of its useful life in anthropology. Used self-consciously, however, there is nothing wrong with the term "hunter-gatherer" – as long as we recognize that it carries no explanatory weight, that it is only a heuristic and pedagogical device, a way to carve up humanity temporarily into some analytically manageable pieces.

Therefore, I use the traditional anthropological category of hunter-gatherer as a subject for this book in order to demonstrate the variability within that category. In focusing on variability, I hope to discourage typological approaches that proceed in a dictatorial fashion, where one model is toppled only to be replaced by another that is different, perhaps more politically fashionable, but just as restricted and restricting. I aim to give readers some of the background and means to developing theories aimed at explaining variation.

Consequently, despite the title of this book, I am not so much interested in hunter-gatherers as I am in the factors conditioning human behavior and culture – for example, constraints on foraging, factors affecting trade and territoriality, and the ecology of reproduction. It often seems that what is taken to be relevant to understanding hunter-gatherers is not relevant to other traditional social categories. The environment, for example, often figures prominently in analyses of hunter-gatherer societies but less so in studies of agricultural societies. Yet, in fact, much in this book should be applicable to other traditional cultural types in anthropology. Agriculturalists, for example, continue to hunt and gather (see papers in Kent 1989c; Kent 1996b), and the same approaches used to analyze foraging can also be used to analyze gardening (e.g., Keegan 1986; Cashdan 1990). Paul Roscoe (2002) correctly points out that the key difference between New Guinea societies that have social hierarchies and elaborate material culture and those that do not is *not* that one is made up of hunter-gatherers and the other of agriculturalists (for they are not always) but rather that one exploits dispersed resources and the other concentrated ones. Likewise, approaches to understanding variability in hunter-gatherer demography, land tenure, or kinship should be applicable to nonforaging societies. In other words, general theory should account for diversity across the conventional categories that anthropology imposes on humanity, as well as within them. But since we cannot tackle the entire world at once, we will focus attention on just one piece of it: hunter-gatherers.

Hunter-Gatherers and Ecology

I assume that adaptation to the environment plays a major (but by no means singular) role in conditioning the variability seen in foraging societies. Thus, this book emphasizes ecological approaches focusing on behavior and decision making that revolve around time, energy, and reproduction (Smith and Winterhalder 1992b). I follow Pianka's broad definition of ecology as "the study of the relations between organisms and the totality of the physical and biological factors affecting them or influenced by them" (1978: 2) but add to it a concern with human social relations, perception, and enculturation (the process whereby children learn a culture).

Many proponents of Marxist approaches or the interdependent model downplay or even denigrate the material constraints of life as having no significance beyond the banal (e.g., Eskimos cannot be agriculturalists). This is odd, for although these analyses frequently rail against the reduction of social relations to economics, they are often grounded in economic and environmental explanations.[29] Although we should remember that modern hunter-gatherers are not isolated, and that the pure hunter-gatherer cannot be distilled from the enclaved hunter-gatherer, we also should not assume that interaction and trade is all there is to modern hunter-gatherers. Although they should not be taken out of context, recent studies of foragers receiving at least half of their diet from government rations or store-bought goods have nonetheless advanced our understanding of factors conditioning hunter-gatherers' subsistence.[30] While coping with the political environment, hunter-gatherers still must eat and deal with their physical environment. Discounting ecology, especially subsistence-related issues, discounts what must have been important to prehistoric hunter-gatherers and what is obviously important to modern ones. We can examine how people make decisions and adapt to their physical and social environment regardless of whether or not they are "pure" hunter-gatherers (Blurton Jones et al. 2002).

Human interaction with the environment is not the foundation of human society, nor is it a theoretical panacea. Although human decisions are made within an ecological framework, they are also made within historical and cultural constraints. There is no perfect match between culture and environment, and ecological perspectives cannot explain the particulars of Australian Dreamtime theology, Bushmen kinship, or Kwakwak'awakw mythology. We cannot sort behaviors into those that are "ecological" and those that are "social" (see Ingold 1987, 1988). But we have to start someplace. Although an understanding of human interaction with the environment will not come easily, in my opinion it is the most straightforward task before anthropology at present. In the next chapter, we will briefly trace the development of ecological thought in anthropology, concluding with a discussion of the paradigm that guides this book: human behavioral ecology.

Chapter 2

Environment, Evolution, and Anthropological Theory

> [W]hile it is true that cultures are rooted in nature . . . they are no more produced by that nature than a plant.
>
> Anthropologist (Kroeber 1939: 1)

> We hate the lions, leopards, and spotted hyenas because they will hurt us. The antelope hate us because they see our fires at night and N!adima [God] has told them that these fires are to cook them.
>
> G/wi man (Silberbauer 1981a: 63)

There seems little room for argument with Alfred Kroeber's assertion that a society comes from more than its natural environment. Yet we also cannot deny the ecological realities that the G/wi acknowledge. These two facts drive anthropology's investigation into the relationship between human society and the environment. Although relating the environment to cultural diversity in a consistent theoretical fashion is a daunting task, anthropology has made some gains by uniting an ecological with an evolutionary perspective in a field known as human behavioral ecology. We will consider this theoretical paradigm here, but let's first place it into its historical context by considering two earlier paradigms that privileged the role of the environment – *the culture area concept* and *cultural ecology* – since some of the research and data discussed in this book were undertaken within them.[1]

The Culture Area Concept

Franz Boas laid the foundation of American anthropology in the early twentieth century. In doing so, he rejected unilinear evolutionism and emphasized the holistic study of cultures in their historical contexts. For Boas, cultural traits such as drums, shamanism, masks, recipes, or myths could originate in different cultures for different reasons. Therefore, they could only be understood within their own cultural and historical context and were not evidence of a society's position on an evolutionary scale. Rejecting the simplistic and racist environmental determinism of the time, Boas saw the source of a culture's traits as lying in independent invention, history, or diffusion. He allowed that the environment could establish possibilities or limits, especially in terms of food, but that it had no control beyond this.

Still, it was evident to even the casual observer in the nineteenth century that cultural traits tended to be geographically clustered. Otis Mason (1894) was the first to call such regions *culture areas*, and they provided a useful classification of societies for the purpose of organizing museum displays. But Boas argued that culture traits did not necessarily evolve as aggregates and so the culture areas of, say, musical instruments, social organization, or rituals could not be expected to coincide. And that meant that where one wanted to draw the boundaries of a culture area depended on which trait one used.

But when Boas's students mapped the distribution of traits among North American Indians, it became evident that Boas's "view must be doubted as contrary to the overwhelming run of the facts," for traits were indeed geographically grouped (Kroeber 1939: 4) – not perfectly but close enough that the groupings demanded attention. Two students of Boas, Clark Wissler and Alfred Kroeber, tackled the theoretical implications of these groupings.[2]

Wissler (1914, 1923, 1926) could see that culture areas, defined by a constellation of culture traits, coincided with the geographic range of a major food such as bison, salmon, wild seeds, maize, or caribou. Culture areas were, in fact, named after the primary source of subsistence – the Bison Area, for example, or the Eastern Maize Area. Wissler explained the connections between culture and environment as mediated by a subsistence technology, such as spears and pounds (fenced enclosures) for bison hunting, which was linked to a region's major food. He argued that a culture became best adjusted to exploiting a region's primary food at what would become the center of a culture area, where "ideal conditions" prevailed (although the center could be defined by historical or ethnic as well as environmental conditions; see Wissler 1926: 372). From here, culture traits diffused outward, eventually forming the culture area when they reached the geographic limits of the primary food resource.

Kroeber (1939) eventually compiled ethnographic and vegetation data and mapped out the relations between "cultural" and "natural" areas of North America (see also Kroeber 1925). Kroeber was more concerned with cultural "wholes," whereas Wissler focused on the distributions of individual traits. Although they approached their objective differently, both Wissler and Kroeber, as Boasians, aimed to reconstruct a culture's history, and so they were interested in the historical relationships of cultural elements – pottery, moccasins, and needle cases, for example. On the first page of his 1939 study, Kroeber (1939: 1) states that his aim is "to review the environmental relations of the native cultures of North America" and then "to examine the historic relations of the culture areas, or geographic units of cultures." He considered the second of these goals to be the most important. For although Kroeber (1939: 3) admitted that "every culture is conditioned by its subsistence basis" and that there are "relations between nature and culture," he only begrudgingly gave the environment any significant role in producing cultural diversity because, like Boas, he assumed that "the immediate causes of cultural phenomena are other cultural phenomena" (1939: 1).

For Kroeber, culture areas were only a means to the end of reconstructing culture history. How so? Historical data were largely missing from native North American ethnology, and archaeology was still in its infancy. In place of direct historic data, Kroeber – and Wissler (1926: xv) – employed the concept of culture area so as to use spatial distributions of traits as a proxy for historical data. For example, the *age-area* method held that the oldest culture elements were the most widespread within a culture area; less widespread elements were younger in age.

Unfortunately, the culture area approach was fraught with methodological difficulties. As Kroeber recognized (1939: 3), "the weakest feature of any mapping of culture wholes is also the most conspicuous: the boundaries." Defining a culture area was difficult since some aspects of culture (e.g., religious practices or kinship terminology) cut across what otherwise appeared to be cultural or geographic boundaries – as Boas had pointed out. As a result, different researchers came up with different numbers of culture areas. Wissler (1914) lists nine culture areas north of Mexico, whereas Kroeber lists only five (Driver and Massey [1957] list 13).

In addition, the larger a culture area, the greater the environmental and cultural diversity encompassed within it, the greater the number of possible connections between environment and society, and the greater the difficulty in sorting them out. There was no explicit method to identify the "typical" traits of a culture area, or the "ideal conditions" that gave rise to these traits, except that both should be at the area's geographic center. Obviously, preconceived notions about the adaptation of, for example, bison-hunting, played a large role in defining "typical traits."

For our purposes, what is most important is that as a research strategy, the culture area approach could not define causal links between culture and environment. Kroeber (1939: 205) attributed this partly to methodological difficulties: "the interactions of culture and environment become exceedingly complex when followed out. And this complexity makes generalization unprofitable, on the whole. In each situation or area different natural factors are likely to be impinging on culture with different intensity." As a result, the environment becomes only a backdrop, something that sets limits to a culture's possibilities. And, within a culture area, environmental variations could produce different "ecological subsistence adaptations" but these merely "result in the reduction or emphasis of common culture traits" (Kroeber 1939: 27). Kroeber did not see this variation within a culture area as worthy of serious study. Instead, variations were aspects of a culture that had to be controlled so as to answer questions about the historical relations between culture wholes – for example, did Arctic culture come from an Asiatic source or from the interior forests of North America?

My feeling is that Wissler was not as willing to throw in the towel as Kroeber. I think he suspected the existence of a mechanism to account for the similarities of different tribes living in the same ecological region, but he never found it. Instead, his reasoning became circular: once bison hunters adapted to bison hunting, they tended to consort with bison hunters and to stay within bison-hunting territory; thus, they shut themselves off to new ideas and remained bison hunters. Once adjusted to their environments, cultures changed slowly and could move beyond the boundaries of their environment only with great difficulty. When natural and cultural areas fully coincided, the cultures were at "climax" – a vague concept that referred to societies that were as finely tuned or as closely "fitted" as possible to their environments (Harris 1968: 376–77). Wissler and Kroeber noted many correlations among climate, vegetation, and the distributions of cultural elements, but, at the end of the day, their theoretical paradigm left them no choice but to ignore subsistence adaptations and to turn to the historical factors of migration and diffusion to explain change and variation in everything else.[3]

Cultural Ecology

At about the same time that Kroeber was working on culture area maps, one of his students, Julian Steward, was trying to resolve the deficiencies of the culture area concept. Steward (1955: 36) rejected the "fruitless assumption that culture comes from culture" and focused on the relationships among society, technology, and environment, an approach he eventually labeled *cultural ecology*.

The goal of cultural ecology was "to explain the origin of particular cultural features and patterns which characterize different areas rather than to derive general principles applicable to any cultural-environmental situation" (Steward 1955: 36). So, Steward saw cultural ecology as a method but, like all methods, it implied some theory. This is revealed in cultural ecology's central concept of the *culture core*, "the constellation of features which are most closely related to subsistence activities and economic arrangements" (Steward 1955: 37). Secondary features of society were built on the core and were thus affected by it, but they were also affected by historical and cultural factors, such as innovation and diffusion (Steward 1955: 37–41). These factors were primary for Kroeber but secondary for Steward. Thus, for Steward the relationships were:

Environment ↔ Technology ↔ Culture Core ↔ Secondary Features

The arrows go both ways because Steward knew that the causal relationships were not simply linear, but he was primarily interested in those arrows pointing to the right.

The "secondary features" generally included social and political organization, as well as religions or cosmological ideas, but these could be part of the culture core depending on how closely they were linked to extractive technology and food-getting behavior. As a result, Steward avoided a well-defined method to determine the culture core and secondary features, defining the core and secondary features empirically in each case. This meant that the culture core could be whatever an anthropologist wanted it to be (Harris 1968: 661). It included behaviors that were closely tied to "significant" features of the environment, such as distributions of water, plants, or game. Steward (1955: 93) defined these "significant" features impressionistically; they were simply those "to which the local culture ascribes importance" (Steward 1955: 39). And, although Steward noted that the environment was culturally perceived, he did not pursue this observation's implications.

There is a parallel to the culture core in the notion of "base" in Marxist approaches to hunter-gatherer societies, in which the "mode of exploitation of the land [is] the determining factor in a society of hunters . . . since we have deduced logically from there the economic, social and political organization, as well as their religious representations" (Meillassoux 1973: 199). It is this deterministic hierarchy that led some to label cultural ecology "vulgar Marxism," for in it, "an apparent hierarchy of institutions [implies] a determinate hierarchy of functions" (Ellen 1982: 60; see also Geertz 1973: 44). Although Harris (1968: 668) argued that Steward sought deterministic, not probabilistic, relations among environment, technology, and society, Steward (1955: 41) maintained that "although technology and environment prescribe that certain things must be done in certain ways . . . the extent to which these activities are functionally tied to other aspects of culture is a purely empirical problem." In other words, sometimes technology and environment were deterministic of other features, and sometimes they were not.

Steward (1955: 40) outlined three steps to cultural ecology: (1) analyze the interrelationships of exploitative technology and environment, (2) analyze the behavior involved in exploiting a particular environment with a particular technology, and (3) determine how this behavior affects the secondary features. Steward (1955: 37) claimed that "the core includes such social, political, and religious patterns as are empirically determined to be closely connected" with subsistence and economy, and he apparently thought the core would encompass most behaviors for hunter-gatherers:

> among the simpler hunting and gathering peoples, the nature of the social unit was determined to a very large extent by the processes of cultural ecological adaptation, that is, by the nature of social interaction required for subsistence in a given environment by means of a given technology. The social environment, as contrasted with the natural environment, is also a factor in shaping the nature of any society but its role is minimal in most of these cases. Steward (1969a: 188)

Marco Bicchieri (1969a: chart) agreed: "at the foraging level of cultural complexity, the cultural core constitutes most of the total behavioral pattern." In other words, there were no secondary features in foraging society; hunter-gatherer society was nothing but culture core!

We could complain that the methodology of cultural ecology was altogether too vague, but there is no doubt that it had a dramatic impact on American anthropology in the 1950s and 1960s (Vayda 1969; Cox 1973) – especially in hunter-gatherer studies. It was, in fact, its emphasis on the empirical determination of the culture core that encouraged detailed studies of the subsistence practices of hunter-gatherer societies (e.g., Lee and DeVore 1968; Damas 1969d; Bicchieri 1972), and it acknowledged a role for the environment in explaining human diversity.

However, few truly followed up Steward's methodology for explicitly determining the core, its link to technology and environment, and its effect on secondary features. Instead, cultural ecological studies tried to account for behaviors by showing how they were functionally linked to the acquisition of food in a particular region; for example, how they improved foraging efficiency, reduced risk, or netted the highest returns. We can see in these studies a continued reaction to the racist claims of unilinear evolution and that so-called primitive people acted out of superstition or stupidity rather than rational thought. Omar Moore (1965), for example, explained scapulamancy, the Montagnais-Naskapi's use of burnt caribou scapulae to divine the direction of a hunt, as a way to randomize hunting excursions and avoid repeated hunts to one area. He argued that this made the most efficient use of time in an area where prey is widely scattered and mobile. Likewise, David Damas (1969b: 51) argued that the size of Inuit winter camps – about 50 to 150 people – increased the number of hunters in a group and maximized the probability that a kill would be made each day since "the lone hunter or even several hunters have little chance of success." Inuit settlement size, Damas argued, is an adaptation to the environment because it reduces risk. Bicchieri (1969a,b) compared the subsistence practices, social organizations, and religions of the Bushmen, Hadza, and the net-hunting and bow-hunting BaMbuti, concluding that those hunter-gatherers who lived in "restrictive" environments had fewer options and that, therefore, the core had a greater influence on the secondary features of their societies. Sociopolitical organizations of those living in "permissive" environments, Bicchieri argued, could be affected by other cultural processes, such as diffusion. Yengoyan (1968) suggested that Australian marriage practices, which ensured that men acquired wives from distant areas, constructed social links with distant groups. This, in turn, was a response to the Australian desert environment, where people would move in with others in times of drought. Both Wayne Suttles (1968) and Stuart Piddocke (1965) saw Northwest Coast *potlatches* – large feasts at which a chief gave away blankets, coppers, canoes, or even slaves to acquire prestige – as an adaptation to population pressure and potential resource failures (see Chapter 9). The feasts were said to ensure the redistribution of goods and to construct debts and alliances to cope with times of food shortages.

The infusion of systems theory and the ecosystem concept into anthropology in the late 1960s invigorated cultural ecology by encouraging the measurement of energy flow through an ecological system that included humans (Winterhalder 1984). The application of the ecosystem approach is best known through non–hunter-gatherer studies, especially Roy Rappaport's (1968) study of New Guinea's Tsembaga Maring horticulturalists and R. Brooke Thomas's (1973) study of Andean horticulturalists/pastoralists. By tracking the flow of energy through a system, one could determine how elements of a system were interrelated. Rappaport, for example, demonstrated the intricate connections between pig and human population sizes, warfare, gardening, and rituals. His significant contribution was to show that the ritual system was not simply a reflection or validation of subsistence behaviors but rather an integral part of the system. In Rappaport's words, the Tsembaga lived in a "ritually-regulated ecosystem."

Cultural ecology stimulated similar ecological studies among many hunter-gatherer peoples, especially those of central Africa's Ituri Forest, the Kalahari, Australia, and the Arctic.[4] In his "input-output" study of Dobe Ju/'hoan subsistence, Lee (1969) quantified the energy procured by Ju/'hoan foragers by weighing the meat, mongongo nuts, and plant foods harvested during July and August of 1964. Given the caloric content of these resources, Lee computed how much energy was brought into camp each day (2,355 kcal/person). He then estimated the energy expenditure of men, women, and children using standard tables of body size and activity levels. He found that, on average, an individual Ju/'hoansi required 1,975 kcal/day. Thus, the Ju/'hoansi acquired more energy than they needed. The excess was fed to dogs, supported the social gatherings of trance dances, or was stored as body fat to be metabolized during lean periods of the year. (Incidentally, Nancy Howell [2010] would later show that the Ju/'hoan diet was not as good as Lee's initial study suggested.)

In some ways, however, cultural ecology suffered from some of the same problems as the culture area concept. Many of its studies are only "anecdotal ecology" that provide plausible accounts of how well adjusted hunter-gatherers are to their environments, but they are subjective, post hoc explanations (Wilmsen 1983). For example, Yengoyan's research on Australian section systems could not show that marriages actually *did* provide people with relations who provided assistance in times of stress (see Chapter 7). Nor did Piddocke demonstrate that differences in subsistence security accounted for differences in Northwest Coast village prestige and rank (see Chapter 9; Bettinger 1991: 54–57). To know whether competitive feasting was in fact a response to resource variability requires data covering a long time span, documenting specific relationships between competing villages. Quantitative data could test and refine ideas proposed by cultural ecologists.

Take, for example, Damas's discussion of Inuit winter camp size and breathing-hole seal hunting. Damas says only that "a large number of hunters offers great advantages in this type of hunting" (1969b: 51). But it is not clear what the advantages are: an increase in foraging efficiency (a greater per capita harvest rate), minimization of variance in per capita hunting success, or a minimization of variance in how much seal meat the average individual eats? Years after Damas's study was published, Eric Smith collected quantitative data on winter camp size and seal hunting (1981, 1991; although for a different Inuit group). He found that large hunting parties do not maximize per capita return rates, nor do large groups reduce foraging risk (1991: 323–30). Instead, he found that a camp containing about seven foraging groups, with three to eight hunters who share their kills, minimizes variance in per capita consumption. Assuming that active hunters make up about 25 percent of the population (E. Smith 1991: 327), seven foraging groups with three to eight hunters each implies a residential camp population of about 120 – within Damas' range of 50–150.

In addition to vague measures of success, cultural ecology also lacked a consistent theoretical framework (Thomas, Winterhalder, and McRae 1979). This made it difficult to see the relevance of one study to another, because individual studies focused on specific variables without reference to a wider framework. This was most clearly exemplified in characterizations of the environment. For example, it was often said that modern hunter-gatherers cannot be used as analogues for prehistoric ones because modern hunter-gatherers live in marginal environments, whereas many prehistoric hunter-gatherers lived in more benevolent ones (e.g., Keene 1981). There may be common ecological structures underlying the diverse plants, animals, and climates of the so-called benevolent environments that make it easy to get food in these places (which is what "benevolent" seems to mean, rather than referring to weather or topography) and hard to get food in "marginal" ones. But these structures are never defined, and so the cause of cultural variability among the peoples who inhabited allegedly benevolent or marginal environments is unknown. Although many prehistoric hunters did live in environments that modern hunter-gatherers do not occupy, categorizing environments with subjective terms does not help measure the complex relationships between societies and their environments. (In fact, Porter and Marlowe [2007] found no significant difference between the environments of agriculturalists and hunter-gatherers; hunter-gatherers do not only occupy lands that agriculturalists cannot use. California, for example, was occupied by foragers until contact with Europeans – yet California today is one of the world's prime agricultural areas.)

Moreover, cultural ecology found it necessary to draw a spatial boundary to each society, to put limits on energetic input-output analyses, just as culture area theoreticians had to draw boundaries through clines of cultural traits. Drawing boundaries at some level is, of course, a necessity for model building – and a perennial problem of any ecological approach, since few systems have natural boundaries. But the result in cultural ecology was to treat human societies as if they were pristine, isolated, self-sufficient units. This encouraged a nonhistorical approach to hunter-gatherer studies; it also led some to ignore a foraging society's interactions with other societies (Winterhalder 1984). Cultural change was attributed to disruptive forces from outside (primarily colonial powers, when they were mentioned at all), population growth, or environmental change and not to other factors, such as internal sociopolitical structure (as the Marxist critique would point out). Consequently, cultural ecology tended to unwittingly continue the nineteenth-century view that hunter-gatherers were relic Pleistocene populations, people who remained foragers because no external factor had driven them to become something else.

These are important methodological problems, but cultural ecology's most significant theoretical flaws lay in (1) a *neofunctionalist* concept of adaptation and (2) an implicit reliance on group selection (Bettinger 1991). By "neofunctionalist" we mean that cultural ecologists assumed that the "function" of behavior was to keep their society in balance with the environment. The term "adaptation" consequently came to refer to any behavior that seemed a reasonable way to maintain the status quo. Adaptation was seen as a state of being rather than what it is: a continual process of becoming (see Mithen 1990: 8–9).[5] This led to an important tautology: behavior is adaptive because it exists – otherwise, it would not exist. But this Panglossian view of life held an important contradiction, for it assumed that if a behavior exists because it accomplishes a goal more effectively than other techniques or strategies, then, presumably, at some time those former techniques or strategies had existed. In this regard, cultural ecologists were like culture area theoreticians, in that they assumed that societies went through changes in the past but were, at the time of study, "best" adapted to their environment. It requires an unwarranted level of confidence to assume that societies had finally figured out adaptation just as anthropologists arrived on the scene.

The implicit reliance on *group selection* comes from the assumption that people do what is best for the group and not necessarily what is best for themselves or their kin. This idea was drawn primarily from the work of ethologist V. Wynne-Edwards (1962). Wynne-Edwards argued that as population density rose and competition for food increased, the resulting stress affected various behaviors (such as mating displays) that acted to curtail reproduction, eventually bringing population back into line with the food supply and thus permitting the species to exist. With game theory and sophisticated mathematical modeling, group-selection theory has undergone resurgence in recent years but, in the 1960s, the primary argument was that by restricting their own fertility, organisms allegedly act altruistically to do what is best for their species or population.

The idea of group selection can be seen in cultural ecologists' view of hunter-gatherer demography. In the 1970s, anthropologists argued that hunter-gatherers held their population below *carrying capacity*, an environment's maximum sustainable population at a given technological level. In fact, conventional wisdom after *Man the Hunter* was that hunter-gatherers maintain their population at only 20–30 percent of carrying capacity through a variety of cultural means, including infanticide, breastfeeding, and intercourse taboos (in Chapter 7, we point out that this is not true). In so doing, they prevent overexploitation of food supplies and remain in balance with the environment (e.g., Birdsell 1968; Lee and DeVore 1968: 11). Hunter-gatherers, anthropologists thought, altruistically sacrifice their own reproductive interests (including, apparently, their own offspring) for the good of the population.

Cultural ecologists assumed that a system could impose its will on people (see discussion in Lee and DeVore 1968: 243). In so doing, they attributed to the population a decision-making capacity that really resides in the individual. The notion that group members could have different, even conflicting goals did not surface in cultural ecology. For example, in the generalized foraging model, flexibility in group membership was portrayed as either an intentional or subliminal consensus adaptation to resource fluctuation. Bettinger (1991: 162), however, suggests that flux in band membership could also be produced by tension between different needs of a group's current members (e.g., as a result of different family sizes) and, when push comes to shove, the best option for some folks is to pack up and leave.

The concept of group selection was especially important in explaining apparent self-limitations on reproduction. Anthropologists saw such limitations as a sacrifice performed for the benefit of the group. But they could also be a way to *maximize* individual reproduction by increasing the number of offspring raised to adulthood.

Ju/'hoan women, for example, produce a child about every four years, a fact often used to demonstrate that hunter-gatherers intentionally hold their populations below carrying capacity to prevent resource overexploitation (see Chapter 7). Nicholas Blurton Jones (1986, 1987, 1989), however, argued that Ju/'hoan women who produce a child every four years raise more children to adulthood than do women who have babies at closer intervals. Although their fecundity might also be limited by venereal disease (Pennington 2001; see Chapter 7), Ju/'hoan women may still be maximizing their reproduction; it just happens to be a fairly low maximum. Cultural ecology's emphasis on homeostasis and its adherence to a group-selectionist perspective caused many anthropologists to turn to alternative theoretical frameworks, such as Marxism, structuralism, and symbolism. Others, however, recognized that although cultural ecology was not entirely correct, neither was it entirely wrong. Missing from it was a Darwinian evolutionary component.

Humans are animals, albeit cultural animals, and susceptible to the same evolutionary processes that govern the nonhuman world. Evolution is simply the differential persistence of variability over time, and adaptation describes the process of selection and differential reproduction. Cultural ecology, therefore, was not evolutionary in the Darwinian sense since its functionalist stance deemphasized the potential for competition between members of a group, the importance of natural selection, and hence the importance of behavioral variability within groups. Instead, it was a "theory of consequences" (Bettinger 1991: 113–220), in which the end result, the consequence of adaptation, defined the process rather than vice versa. Like the culture area concept, cultural ecology did not specify how adaptive change occurs. When external circumstances changed, people seemed to decide that this or that way of doing things was better for the group. But the way in which these decisions were made was nebulous; and it was not clear what was meant by better (avoid extinction? increase tribal size? more offspring? stronger offspring? psychological satisfaction?). This produced some important paradoxes.

Take, for example, population regulation again. Although anthropologists assumed that hunter-gatherers kept their populations below carrying capacity, at the same time, they argued that the origin of agriculture, an artificial increase in an environment's carrying capacity, was a product of population growth. Apparently, some hunter-gatherers were not so adept at controlling growth. Why should some populations grow and others not? Why should some foragers respond to growth by limiting reproduction and others by augmenting food production? We cannot assert "adaptation" in each case and then claim to have learned something.

To overcome the theoretical paradox of cultural ecology, some anthropologists in the 1970s turned to the new field of evolutionary ecology; applied to humans, this field eventually took on the name of *human behavioral ecology* (HBE). In the following section, we cover only the highlights of current discussions to provide background for research discussed in succeeding chapters (see Smith and Winterhalder [1992b, 2003] and Winterhalder and Smith [2000] for extended discussions and retrospectives).

Human Behavioral Ecology

As one might guess from the name, evolutionary ecology was concerned with understanding the evolutionary basis of animal behavior and biology (what was collectively termed "adaptive design") in an ecological context (e.g., Hutchinson 1965; MacArthur and Pianka 1966; Orians 1969; MacArthur 1972; Charnov 1976; Krebs and Davies 1978; Pianka 1978). Human behavioral ecology is less concerned with biology and more concerned with understanding how different human behaviors are adaptive within a particular environmental and social context. Two hallmarks of HBE are the use of mathematical and graphical models to predict variation in behavior under different environmental circumstances, and the use of empirical, ethnographic data to test predictions. Researchers working within this paradigm have made important long-term field studies of foragers such as the African Hadza, Ju/'hoansi, Aka, Efe, and Bofi; Madagascar's Mikea; the Canadian Inujjuamiut and Cree; the South American Ache, Pumé, Tsimane, and Hiwi; Australia's Meriam and Martu; and Indonesia's Lamalera.

In its early days, HBE was largely concerned with foraging behavior because there is an obvious link between food and reproductive fitness: if you don't eat, you die and don't reproduce. In addition, HBE was first concerned with hunter-gatherer behavior (Winterhalder and Smith 1981). Some accuse HBE of assuming that hunter-gatherers are "closer to nature" or "less cultural" than agricultural or industrial peoples. This would make proponents of HBE no better than nineteenth-century unilinear evolutionary theorists, and that would be a damning critique if it were true. In reality, HBE was applied to hunter-gatherers in part because that was the interest of two of its first practitioners in anthropology, Bruce Winterhalder and Eric Smith; for them, and others, the utility of ecology's foraging models was obvious for human foraging studies. In the past thirty years, however, this interest in foraging has expanded to other areas of life, especially mobility, sharing, reproduction (such as mating and parenting), and social competition. Human behavioral ecology has also been applied to other kinds of societies.

I stated previously that HBE is concerned with understanding how human behavior is adaptive – which seems to make it no different than cultural ecology. Unlike cultural ecology, however, HBE makes explicit use of evolutionary theory. Where cultural ecology sought functional connections between normative descriptions of a society and its environment, behavioral ecology seeks to know how evolutionary processes, in particular natural selection, shape human behavior. Smith and Winterhalder argue that explaining what a behavior does (e.g., hunting in a particular way) does not fully account for how that behavior, rather than another potential variant, became common in a society (Smith and Winterhalder 1992a; Winterhalder and Smith 1992). *Functional* explanations, in other words, depend on *causal* explanations. And causal explanations in evolution require showing how a behavior becomes prevalent through natural selection. Cultural ecology could only appeal to rational choice to explain behaviors that appeared to be efficient: what would a rational human do under a given set of circumstances with an assumed set of goals? But rational choice presupposes not only a set of general goals (e.g., foraging efficiency) but also preferences for strategies that are likely to meet those goals. Some process must be responsible for fixing, maintaining, and altering these goals and preferences.

We see what this process is by asking: how does HBE treat variability? What prevents HBE from also seeking a stereotype of foragers? Remember that evolution is the differential persistence of information from generation to generation. For humans, most information is cultural and passed on through the social process of enculturation. This process produces variation in behavior, and what interests HBE is that variation, both within and between populations. Human behavioral ecology makes cultural ecology more complete by adding the process through which variation is channeled in one direction or another: natural selection.

Natural Selection

Although Darwin's concept of evolution through natural selection was, to put it mildly, earth shaking, its basics are fairly straightforward. Natural selection changes the frequency of *genotypes* in a population but operates directly on *phenotypes* – the visible properties of organisms that are produced by the interaction of the genotype with its environment. The frequency of genotypes changes through several mechanisms, primarily mutation, recombination, drift, and natural selection. A phenotype is judged to be more or less adaptive depending on whether it contributes more or less genetic material than other existing phenotypes in the population to succeeding generations (by an individual bringing more offspring to reproductive age than other phenotypes and/or by assisting genetically close kin to do the same).

For humans, phenotypes include cultural behaviors. And this raises the question: what is the link between behavioral and genetic variation? Proponents of the "strong sociobiological thesis" argue for a close link between genetic and behavioral variation (see review in Cronk 1991). If a behavior is genetically controlled, and if that behavior endows its bearers with greater reproductive success, then it is easy to see how that behavior could become more prevalent in a population relative to other genetically programmed behavioral variants. The problem in applying this principle to humans, of course, is that the majority of human behavior – and certainly that of traditional concern to anthropologists (differences between human populations) – is clearly not genetically determined. Borneo's Punan and Canada's Kwakwak'awakw do not behave in different ways because of genetic differences between the two populations.

The majority of behavioral ecologists, therefore, adhere to a "weak sociobiological thesis," in which people tend to select behaviors from a range of variants whose net effect, on average, in a given social and ecological context is to maximize individual reproductive or inclusive fitness. Although specific behaviors are not genetically selected for, weak-thesis proponents argue that the evolutionary process nonetheless "endowed our species with psychological predispositions, mental capacities, and physical abilities that have tended to be adaptive in the environments of human evolution, with 'environments' understood to include individuals' cultural and social situations" (Cronk 1991: 27). The weak thesis does *not* argue that behavior is genetically controlled; there is, for example, no such thing as a hunting gene or a matrilineal descent gene. It does assume that humans subconsciously evaluate the reproductive consequences of behaviors. Behaviors that are linked to greater fitness in a particular natural and social environment and that are heritable (through culture or genes) should, therefore, tend to become more prevalent in a population. Notice I said "tend to become more prevalent." Human behavioral ecology assumes there is plenty of "wiggle room" because of several factors, a notable one being human culture. We will return to this later.

Central to this debate is the concept of fitness. *Fitness* is an organism's "propensity to survive and reproduce in a particularly specified environment and population" (Mills and Beatty, in Smith and Winterhalder 1992b: 27). As Smith and Winterhalder point out (1992a), this focuses attention on adaptive design and the *potential* number of descendants, rather than on actual reproduction, since the number of offspring produced (or the percentage that survive to adulthood) can be affected by numerous factors apart from the phenotype. Thus, behavioral ecologists are interested in the mean fitness of different behavioral *choices* rather than the fitness of particular *individuals*.

To accomplish its goals, behavioral ecology employs two assumptions: methodological individualism and optimization.

Methodological Individualism

As we already noted, evolution sees the individual, rather than the group, as the primary locus of selection. Stated most generally, selection operates on variability within a population and favors individuals whose behavior enhances the opportunity to increase fitness (Foley 1985). Critics claim that behavioral ecology assumes that people act independently of their culture, but this is fallacious. The specific content of an individual's goals comes from both biological and cultural information. That is, the drive to "succeed" probably entails not only biological directives (to reproduce) but cultural directives as well (e.g., bring home as much meat as possible, spend time with offspring, produce many children, produce few children, acquire prestige, acquire wealth, be good to your relatives). Behavioral ecological analyses require that goals be defined, but there is no reason to assume a priori that all goals will be identical. Behavioral ecology only requires the legitimate assumptions that people be capable of storing knowledge and of understanding (or at least thinking that they understand) the relationship between their actions and goals. For humans, those seem to be modest assumptions.

Optimization

The optimization assumption focuses on (1) the behavior of individuals making decisions about (2) the available set of behavioral options using (3) some currency (energy, measured as calories, dominates studies) that permits the costs and benefits of each option to be evaluated, within

(4) a set of constraints that determines the options and their benefits. In hunter-gatherer studies, optimization approaches focus on several questions relevant to foraging, such as: When, where, and how long to forage? How many should forage together? How many should live together? Which food items should be selected? Which should be shared? To test hypotheses, behavioral ecologists may have to measure the fitness of individuals within different behavioral classes. A common working assumption is that foraging efficiency is a proxy measure of reproductive fitness. (We should point out that researchers rarely test this assumption; but see E. Smith [2004]).

Expressed in more specific terms, evolutionary theory suggests that the goal of a forager should be to forage optimally, that is, to maximize the net *rate* of food harvest (E. Smith 1979). This can result in a minimization of the time spent foraging or a maximization of the food gathered (see following discussion). At least four conditions could encourage a forager to maximize the rate of food harvest (E. Smith 1983: 626, 1987, 1988):

1. when specific nutrients are in short supply (increases the probability that the forager will acquire the necessary amount of the scarce nutrients);
2. when time for necessary nonforaging activities is scarce (to secure enough food while maintaining time for other activities essential to fitness; e.g., childcare, but also religious activities, prestige competition, etc.);
3. when foraging exposes the forager to risks such as predation, climatic extremes, or accidents (to spend as little time as possible foraging and thus reduce the risk of injury);
4. when excess food can be used to enhance reproductive fitness; for example, when, by sharing extra food, a forager could increase (a) mating opportunities, (b) the attention others devote to his or her children, or (c) the potential for reciprocation in the future.

These conditions will vary in importance. Some environments will be more severely limited in certain nutrients than others. In some places, humans face few predators or environmental dangers; in others (e.g., the Arctic in winter), foraging can be quite hazardous. In some societies, nonforaging activities, such as instructing children or protecting a village from raids, are important competing activities. Nonetheless, one or more of them will characterize any given environment. Therefore, all hunter-gatherers are expected to tend to forage optimally.

The optimization assumption is integral to behavioral ecological studies that direct themselves to how people allocate their time among competing activities. There are many, often conflicting demands on the time of any forager: food must be gathered, children raised, social obligations met, and so on. How do people decide how to spend their time? The contrasting cases of the Ache of Paraguay (Figure 2-1) and the Efe Pygmies of Zaire illustrate the issue. The Ache are a recently settled group of hunter-gatherers who today live in a mission horticultural settlement but who occasionally go on hunting treks in the forest.[6] The Efe, one of several major groups of BaMbuti pygmies, live symbiotically with Lese (Bantu) horticulturalists in the Ituri rain forest. The Efe hunt to provision themselves as well as to acquire meat to trade with the Lese. The Efe also work in the fields of Lese villagers, exchanging their labor for food.

Among the Ache, good hunters tend to stay out all day, hunting for more hours than poor hunters, even after acquiring game. Good Efe hunters, on the other hand, spend less time hunting than poor Efe hunters. Instead, good Efe hunters acquire the minimal amount of meat they need and then return home. Ache hunting is an *energy-maximizing strategy*, whereas Efe hunting is a *time-minimizing strategy*. Why is there a difference? What is it that Efe hunters do in nonforaging time that Ache hunters apparently do not need to do? What difference in goals makes it more important for an Ache to acquire a large supply of meat than to maximize time spent on nonforaging tasks?

One important factor lies in the difference between Ache and Efe relationships between husbands and wives. Efe men run a large risk of losing their wives (or potential wives) to neighboring Lese horticulturalists. Among the Efe, 13 percent of marriageable women are married to

Figure 2-1. Ache hunters. Chachugi (*left*) watches Kanegi shoot at a monkey; the two men are classificatory brothers-in-law because Chachugi's first cousin is Kanegi's wife. Men often hunt monkeys in pairs, one to spot while the other takes a shot. Courtesy of Kim Hill.

Lese villagers; this increases the competition for wives among Efe men since they cannot marry Lese women (R. Bailey 1988).[7] Robert Bailey (1991) showed that although hunting success is not directly correlated with marital status, it appears to be indirectly related through material wealth (e.g., pots, pans, knives, machetes). Men with many material possessions are more likely to be married than men with few material possessions, and many of these goods are acquired through trade with the Lese. Although good hunters want to acquire meat to trade, they must also allocate time to cultivating exchange partnerships with Lese villagers if they want to get married.

Ache men, on the other hand, apparently trade meat for sexual favors (not uncommon among Amazonian groups; Siskind [1973]) and future reciprocity (see Chapter 7), which seems to increase their reproductive fitness (Kaplan and Hill 1985a,b; Hill and Kaplan 1988a,b). The Ache get more utility by maximizing their catch rather than by minimizing their hunting time. Efe men have a constraint on their time that Ache men do not (note that this is due to the social and not the natural environment). Thus, Efe men get more utility from spending time cultivating trade relationships than by acquiring more meat. So Efe and Ache men both try to maximize their foraging efficiency, although for different purposes.

This example demonstrates another central tenet of HBE: that all human behaviors represent choices among alternatives, the weighing of *trade-offs*. In HBE, this choice is sometimes expressed as an activity's *opportunity cost* because devoting time to one activity usually means the loss of an opportunity to pursue another. Foraging longer means less time with offspring; choosing to collect berries means less time searching for game. Acquiring as much food as possible provides more food for offspring, but it exposes the forager to predators or other risks. Spending time searching for specific bird feathers ensures success at an upcoming feast, but it may come at the cost of additional food for the family. Foragers continually weigh the costs and benefits of the choices before them. We do the same thing, albeit with different choices.

Making a choice, however, does not always produce the "best" strategy. There are two reasons why. First, since evolution is a process that differentially transmits existing biological and cultural information from generation to generation, natural selection does not produce the single best strategy but rather the strategy that achieves goals better than other existing strategies. Optimization models are often applied to situations in which the consequence of a behavior is not affected by its frequency in a population. Here, the choice of which seeds to gather or which animal to hunt is based on perceived characteristics of those seeds or that animal (e.g., caloric content, time to locate, time to harvest) but not on how many people are going after those seeds or animal, or which resources others have decided to seek out (although the number of people may indirectly affect choices by affecting the abundance or behavior of the resources being sought). Interaction with the physical environment therefore is normally considered amenable to analysis with the optimization models we will discuss in Chapter 3.

Second, the fact that foragers make choices means that virtually all behaviors are compromises, the result of selective forces that pull a forager in different directions. Provisioning one's family with food is obviously important, but so is sharing food to build up the alliances that help in times of need. How much food a forager keeps and how much he or she gives away is a product of both of these forces. A forager might lean more strongly toward the strategy that maximizes family provisioning or toward one that maximizes food sharing depending on his or her context, but usually the outcome is a mix of both, with neither being "optimal." As a result, although optimization analyses can model the abstract predictions of selection theory and make them amenable to tests, we do not expect people to behave in the most absolutely efficient way possible.

Of special concern in this regard are behavioral choices that are affected by what others in a population are already doing. This is typical of most social interactions. For example, one individual may choose to maximize hunting success *because* others are pursuing prestige-seeking behaviors. These situations are best analyzed through *game theory* (see Smith and Winterhalder 1992a). A description of game theory is beyond the scope of this book, so suffice it to say that it predicts the frequency at which different behavioral variants (e.g., different parenting techniques) can be expected to exist within a population (given certain initial conditions) as a function of the outcomes of each variant's interaction with other behavioral variants and with its own type. This can result in a stable mix of behavioral variants that differ in their energetic efficiencies, which is labeled an *evolutionarily stable strategy*. The point here is that applications of game theory show that situations can arise in which none of the behavioral variants is as optimal as would be predicted by a simple optimization foraging model (see Hawkes 1990, 1992b, 1993b) and that more than one strategy can exist within a population without that fact violating the tenets of HBE.

This all sounds very well and good for animals – where the link between food, food-getting behavior, and reproduction is obvious. But what about humans, whose behavior is not genetically controlled but rather is a product of culture? Opponents of evolutionary approaches in anthropology argue that cultures establish their own standards of success, standards that are highly variable from one society to another. Where one society values material wealth, another values detachment from material goods; where one values pigs, another values gold. In some, polygamy is permitted; in others, it is not. And while you can find societies where individuals consciously strive to maximize foraging efficiency, prestige, or some other commodity, you would be hard-pressed to find a culture that consciously values "reproductive fitness." Behavioral ecologists recognize all this but argue that although different natural, social, and cultural environments result in different standards of success, individuals who meet these standards should manifest a behavioral variant that achieves greater fitness than other variants. Is this true? Or is HBE using evolutionary theory as a mere analogy?

What about Culture?

Many anthropologists do not find the paradigm of human behavioral ecology appealing, and for good reason. Think about your own life: are you consciously thinking about the consequences of your behavior for your reproductive fitness? Probably not. Just how subconscious can those drives be and yet still direct your behavioral choices? And how do we explain cultural behaviors that seem to go against reproductive fitness, such as vows of chastity, abortion, infanticide, or conscious limitations on family size?

The weak sociobiological thesis justifies itself by claiming that the biological *capacity* for culture must have been selected for in humanity's distant evolutionary past. All anthropologists that I know accept this without hesitation. They also all accept that the capacity for culture must have arisen through a process of natural selection. Individuals who were cultural beings, at some point in the past, became more prevalent in a population, at the expense of those hominins who were not cultural – in other words, they had greater reproductive fitness.

The foregoing leads some anthropologists to deduce that cultural behavior should be an extension of biological adaptation and should operate for similar purposes. And it is this deduction that leads many anthropologists to part company with one another.

Although the capacity for culture has a biological base and therefore most certainly arose through natural selection, culture is not a simple extension of biology.[8] Once hominins became cultural, the rules of the evolutionary game changed. It bears repeating here that evolution is the differential persistence of information – some of that information is genetic but, for humans, most of it is cultural. Cultural information is not encoded in genes but rather in symbolic communication, and it is passed on through enculturation rather than reproduction. We receive our genes from our biological parents, but we acquire our culture from many people. By being an influential role model, it is possible for a single individual to alter phenotypic frequencies in a human population and yet have no offspring. For humans, changes in genotypic frequencies rarely have a direct effect on cultural change (e.g., lactose intolerance leading away from the inclusion of dairy products in a society's dietary repertoire).

Humans pass on information between generations about kinship, subsistence, religion, morals, aesthetics, and so on. Since cultures change through time, some information is obviously not passed on, whereas some new information (brought in through diffusion, independent invention, or errors in the enculturative process) is promoted. In other words, information is selectively passed on from generation to generation, making culture analogous to genetics in that information, encoded in symbols rather than in DNA, is differentially "inherited" by one generation from the previous one. One might assume, then, that it operates according to some principles of inheritance (Boyd and Richerson 1985; Bettinger 1991).

As we noted previously, some anthropologists argue that diversity in human behavior is the manifestation of various cultural values that can only be understood within particular historical contexts. However, in any given culture, at any given time, each individual represents slight variations on a cultural theme. Some individuals, for example, may value work a bit more than others, or some may hold to religious canons more enthusiastically. Culture change is change in the frequency of these variants; for example, a change from a generation in which few people take land issues seriously to one in which many do. The question is how do behavioral variants within a society change in frequency over time? What determines whether new behaviors or ideas are accepted or rejected, whether existing behaviors become more or less prevalent?

The study of culture from the perspective of neo-Darwinian evolutionary theory, what is known as "cultural transmission theory," is just beginning, and we will not consider it in depth here (see, e.g., Cavalli-Sforza and Feldman 1981; Boyd and Richerson 1985; Bettinger 1991; Durham 1991; Shennan 2009). But we must point out that there are biological and cultural processes of inheritance, and this observation has three effects for the study of hunter-gatherers from the perspective of HBE.

First, the cultural transmission of information can be at odds with the expectations of models based solely on biological imperatives. For example, in many societies, past and present, wealthy families have the most offspring. The link should be obvious: more wealth means more food, better medical care, better housing (and, in some cases, multiple wives), and consequently more offspring raised to adulthood. But in developed nations, such as the United States and those in western Europe, this pattern has reversed in the last half-century: wealthy families have the fewest offspring (in what Eric Smith [2004] called the "yuppie fitness-depression syndrome"). The cause is linked to cultural perceptions among the well-off of what is needed to raise children to adulthood, including private schools and expensive extracurricular activities. It is also linked to cultural ideals of gender and work, as well as the perceived need to increase family income with two wage earners. As a result, and despite their resources, wealthy families see offspring as expensive and consequently have few – and so culture affects reproductive fitness although not in the direction that simple evolutionary theory would lead us to expect.

Second, since evolution operates on existing variation, it is essential that we document variation not only among different groups of foragers but also within communities. To test models of genetic and cultural transmission, we must begin with an understanding of how much behavioral variation exists in a society. Unfortunately, the greater part of the ethnographic record on hunter-gatherers was developed under a theoretical paradigm in which ethnographers recorded normal or average behaviors (or, more commonly, what informants claimed to be the normal behavior in their parents' or grandparents' day). New ethnographic investigations now collect the data necessary to evaluate behavioral ecological models by recording behavioral variation within communities.

Third, to understand cultural change, we must know how changes in adult activities affect enculturation, the process whereby children learn their culture. For example, Barry Hewlett (1991b) notes that Aka pygmy men who are not proficient at hunting spend more time with their children than do men who are proficient. How does this affect the development of the two sets of children – those of good and those of poor hunters? I do not mean biologically but rather in terms of the values held by the offspring. More generally, how does a society's range of values shift as a function of changes in the way children are raised? What role does variation in enculturation play in cultural change? Although the connection between enculturation studies and behavioral ecology has not been fully explored, we might expect that ecological factors affecting adult activities that in turn affect childrearing could play a large role in cultural change. We will speculate on the relationships among adult foraging, enculturation, and cultural change in several places in this book.

Conclusion

Interaction with the physical environment is an inescapable fact of human life – for hunter-gatherers as for anyone else. Anthropologists have recognized this for many years but have focused on patterns between the conceptual monoliths of environment and society, leaving the links unspecified. Cultural ecologists, for example, focused on the tenuous assumption that foragers try to maintain homeostasis, ignoring that it is individuals, not societies, that make decisions, and that these decisions can conflict with one another.

In my opinion, HBE offers the best research strategy for understanding the mechanism linking environment and society – the mechanism that Wissler sought but found elusive, that Kroeber thought too complex to study, and that Steward started to uncover. It offers a perspective and methodology that helps us understand how hunter-gatherers make decisions about interacting with their environment and how those decisions affect the transmission of cultural traits. And it does so with a firm grounding in evolutionary theory that seeks to explain rather than explain away behavioral variation among and within societies. No research paradigm contains all of the answers, and the best we can say about one is that it helps to move us forward. As far as

HBE is concerned, I have made my choice; but you will have to judge for yourself through the succeeding chapters whether or not it suits your needs.

Behavioral ecology begins with the assumption that people's behavior is aimed at maximizing reproductive success. This is best accepted as a provisional assumption. Based on current thinking of the relationship between biological and cultural inheritance, reproductive fitness is not the sole criterion we need to understand variation in human behavior.

As it is defined here, behavioral ecology offers a conceptual framework that helps make sense of the relationships between the abundance and distribution of food resources, decisions about how to allocate time to foraging and other activities (e.g., mate selection, prestige competition, reproduction, and childrearing), and the effect these have on the transmission of cultural information. It is a conceptual framework with which we can build theory that accounts for change as well as stasis in human societies and, since it foregrounds the relationships among human activities, reproduction, and enculturation, it is the best framework we have to understand humans for what they are: biological and cultural beings.

Behavioral ecology also offers a way out of the argument that modern hunter-gatherers are not analogous to prehistoric ones. Behavioral ecology sees environments as made up of resources whose acquisition entails costs and benefits. Behavioral ecology does not assume – and does not have to assume – that living foragers are pristine relics of the Paleolithic (which is good because, clearly, they are not). Whether food is acquired through direct procurement or by trading a nonedible forest product for it, or whether it is acquired with a spear or a shotgun, does not matter; both kinds of activities can be evaluated in the same terms (e.g., E. Smith 1991: chapter 6). This does not mean that behavioral ecologists can ignore the ways in which agricultural or industrial peoples affect neighboring hunter-gatherers or the extent to which foragers are involved in cash economies. Instead, the availability of new technologies, such as the introduction of shotguns to tropical forest hunters, or the availability of processed flour or wage labor, can actually be used to test the predictions of models (see Chapter 3).

Informed by new models of cultural transmission, HBE takes a different ecological approach to hunter-gatherers (and others) than that taken through most of the twentieth century. But it is a direction that does not leave behind its concern for the place of humans in their environment. As we will show in the succeeding chapters, the environment figures prominently in how hunter-gatherers decide what to eat, whether to move or stay, to share or to hoard, to let someone into their territory or not, to have children or not, to participate in prestigious feasts or not. Understanding how these decisions are made and how they affect the transmission of cultural information between generations is necessary to building an evolutionary anthropology.

Chapter 3

Foraging and Subsistence

> I would like to say a few words about this land. The only food I like is meat.
>
> Inuk man (Brody 1987: 62)

> Why should we plant, when there are so many mongongos [nuts] in the world?
>
> /Xashe, a Ju/'hoan man (Lee 1979)

Subsistence studies have long been prominent in the anthropology of hunter-gatherers – and why not: without food, people die. Before *Man the Hunter*, anthropologists assumed that foragers mostly ate meat. And so it is ironic that one of the conference's revelations was the importance of plant food to hunter-gatherers. Especially persuasive were Richard Lee's data on Ju/'hoan diet, 85 percent of which was plant food. And Lee argued that the Ju/'hoansi were not alone: analyzing a sample of foraging societies, he found that the mean contribution of meat to foraging diets at all latitudes is only 35 percent. This helped overturn the patrilineal-band model, with its emphasis on the male hunting of large game. In fact, some even replaced the term "hunter-gatherer" with "gatherer-hunter" (e.g., Bender and Morris 1988)!

Recognition of the role of plant food in hunter-gatherer subsistence was an important step since it exposed bias in hunting-focused models of human evolution. Nonetheless, switching the emphasis from hunting to gathering repeats the error of stereotyping and deflects attention from understanding variability among forager diets. In this chapter, we first establish that hunter-gatherer diets are systematically related to their environments by demonstrating simple correlations between gross dietary and environmental variables. We then examine optimization models that anthropologists use to account for the composition of foraging diets.

Environment and Diet

Drawn largely from the *Ethnographic Atlas* (Murdock 1967), Table 3-1 shows the range of variability in hunter-gatherer diets. Unfortunately, the methods used to estimate the amounts of gathered, hunted, and fished foods in this table are often vague and inconsistent. Gathered food, for example, consists mostly of plant food but can include small mammals and shellfish. In some cases, the relative values are based on weight, in others they are estimates of the actual calories

Table 3-1. Environment and Diet

Group	ET (°C)	PP (g/m²/yr)	Hunting (%)	Gathering (%)	Fishing (%)
Polar Inuit	8.5	45	40	10	50
Baffinland Inuit	9.3	59	5	0	95
Taġiuġmiut (Tareumiut)	8.7	59	30	0	70
Yukaghir	8.9	89	50	10	40
Ona (Selk'nam)	9.0	401	70	10	20
Angmagsalik	9.0	333	20	0	80
Sivokakhmeit	9.0	195	15	5	80
Copper Inuit	9.1	115	40	0	60
Iglulingmiut	9.5	90	50	0	50
Nunamiut	9.8	115	87	3	10
Yámana (Yahgan)	9.9	706	20	10	70
Caribou Inuit	10.0	144	50	10	40
Naskapi (Innu)	10.0	278	70	10	20
Alacaluf	10.0	535	20	10	70
N. Tlingit	10.0	633	30	10	60
Chipewyan	10.3	283	60	0	40
Tutchone	10.3	209	45	10	45
Kaska	10.4	206	40	10	50
Gilyak	10.4	482	30	20	50
Tanaina (Dena'ina)	10.4	464	40	10	50
Bella Coola (Nuxalk)	10.5	828	20	20	60
Bella Bella	10.5	828	30	20	50
Chugach Inuit	10.5	323	20	0	80
Kutchin (Gwich'in)	10.5	144	40	10	50
Slavey (Dené thá)	10.6	327	50	10	40
Ojibwa	10.7	699	40	30	30
Mistassini Cree	10.8	555	50	20	30
Ingalik (Deg Hit'an)	10.8	245	40	10	50
Nunivak	10.9	209	30	10	60
Tanana	10.9	217	70	10	20
S. Tlingit	10.9	633	30	10	60
Tsimshian	11.1	862	20	20	60
Haida	11.1	837	20	20	60
Chilcotin	11.2	354	30	20	50
Tahltan	11.2	245	50	10	40
Carrier (Dakelne)	11.2	350	40	20	40
Makah	11.3	757	20	20	60
Sarsi	11.3	283	80	20	0
Blackfoot (Siksika)	11.4	472	80	20	0
Quinault	11.5	871	30	20	50
Plains Cree	11.5	397	60	20	20
Aleut	11.6	283	10	30	60
Montagnais	11.6	456	60	20	20
Kwakwak'awakw (Ft. Rupert)	11.6	822	20	30	50

(continued)

Table 3-1 (*continued*)

Group	ET (°C)	PP (g/m²/yr)	Hunting (%)	Gathering (%)	Fishing (%)
Ute (Uintah)	11.7	278	35	40	25
Saulteaux	11.7	533	35	20	45
Assiniboin	11.7	432	70	20	10
Uncompahgre	11.8	583	50	35	15
Ainu	12.0	661	20	30	40
Wind River Shoshone	12.0	307	50	30	20
Flathead	12.1	369	40	30	30
Klamath	12.2	320	20	30	50
Washo	12.3	235	30	40	30
Puyallup-Nisqually	12.3	820	20	30	50
Twana	12.3	720	30	10	60
Wadadika (Ruby Valley)	12.4	161	30	50	20
Shuswap	12.4	450	30	30	40
Agaiduka (Lemhi)	12.5	181	30	30	40
Nuuchahnulth (Nootka)	12.6	943	20	20	60
Alsea	12.7	925	20	10	70
Coast Yuki	12.7	671	20	40	40
Sanpoil	12.7	283	20	30	50
Micmac	12.7	772	50	10	40
Sinkyone	12.8	692	30	40	30
Timpanogots (Utah L.)	12.9	432	30	40	30
Tubatulabal	12.9	391	30	50	20
Gosiute	12.9	172	40	50	10
Kidütökadö (N. Paiute)	12.9	186	20	50	30
Crow (Apsáalooke)	13.0	354	80	20	0
Yurok	13.3	713	10	40	50
Nez Perce	13.3	259	30	30	40
Tolowa	13.3	804	20	40	40
Kuyuidökadö (Pyramid Lake Paiute)	13.3	135	20	50	30
Achumawi	13.3	464	40	30	30
Tenino	13.3	464	20	30	50
Cheyenne	13.3	408	80	20	0
Umatilla	13.3	285	30	30	40
Modoc	13.3	318	30	50	20
W. Mono	13.4	303	40	50	10
Maidu	13.5	584	30	50	20
Atsugewi	13.5	550	30	40	30
Kaibab (S. Paiute)	14.0	425	30	70	0
Shasta	14.0	539	30	40	30
Kiowa-Apache	14.3	1,045	80	20	0
Comanche	14.4	706	90	10	0
Botocudo (Kaingang)	14.4	1,844	40	50	10
Kiowa	14.6	717	90	10	0
Wintu	14.6	812	30	30	40
Diegueno (Tipai-Ipai)	14.6	26	40	50	10
≠Kade G/wi	14.8	476	20	80	0

Group	ET (°C)	PP (g/m^2/yr)	Hunting (%)	Gathering (%)	Fishing (%)
Sierra Miwok	14.8	699	30	60	10
Panamint	15.0	45	40	60	0
Cahuilla	15.0	487	40	60	0
Kawaiisu	15.0	67	30	50	20
Luiseño	15.1	415	20	60	20
Walapai	15.1	144	40	60	0
Moapa	15.2	47	40	60	0
Borjeno (Baja, Calif.)	15.8	67	18	57	25
Dieri	15.9	85	30	70	0
Aranda	15.9	202	40	60	0
S.E. Yavapai	16.0	134	40	60	0
N.E. Yavapai	16.0	134	40	60	0
Aweikoma	16.5	1,286	60	40	0
Karankawa	16.6	976	30	40	30
Hadza	17.7	1,508	35	65	0
Kariera	18.0	323	50	30	20
Seri	18.3	212	25	25	50
Walpiri (Walbiri)	18.4	209	30	70	0
Ju/'hoansi (Dobe)	18.8	459	20	80	0
G/wi	19.3	476	15	85	0
Groote Eylandt	19.5	1,755	10	30	60
Wikmunkan	19.6	2,164	40	40	20
Siriono[a]	20.6	2,358	25	70	5
Chenchu[a]	20.8	1,482	10	85	5
Aeta	21.2	3,800	60	35	5
Anbarra	21.6	2,890	13	22	65
Nukak	21.7	2,613	11	76	13
Tiwi	22.6	2,450	30	50	20
Vedda[a]	23.0	2,800	35	45	20
Gidjingali	23.0	2,892	30	50	20
Murngin	23.5	2,617	30	50	20
Semang[a]	23.7	4,622	35	50	15
Mbuti	23.7	2,624	60	30	10
Onge (Andamanese)	24.4	3,884	20	40	40
Pumé	24.5	659	10	60	15[a]
Penan	24.9	5,128	30	70	0

[a] Some reliance upon horticulture, government/mission rations, and/or market foods.

The effective temperature (ET) and primary production (PP) figures were computed from climatic data given by an ethnographer or listed in climatic data compilations and maps. Diet is listed in terms of the rough percentage of food derived from hunting, gathering (including small game and sometimes shellfish), and fishing (including shellfish and sea mammals). Diet estimates are either taken from Murdock (1967) or are mine. (See Chapter 1, note 19, for comments on ethnographic atlas data.)

contributed by each category, and some are simply the ethnographers' impressions. There are also discrepancies among these data as indicators of economic activities and as actual diet. For example, some tropical forest groups have high ratings under the category of hunted food, yet much of this hunted food is traded for horticultural produce – the high hunting values reflect the influence of trade rather than what people actually eat. Nonetheless, these data still demonstrate that the hunter-gatherer diet is variable; we cannot blithely claim that foragers eat mostly plants or that they eat mostly meat.

These data also show that the hunter-gatherer diet is systematically related to environmental characteristics. To see this relationship, we must first introduce the variables of effective temperature (ET) and primary production (PP) so that we can compare environments in a consistent and measurable fashion.

Developed by H. Bailey (1960) and introduced to the anthropological literature by Lewis Binford (1980), ET provides a simultaneous measure of the intensity of solar radiation as well as of its annual distribution. Effective temperature is derived from the mean temperatures (°C) of the warmest (W) and coldest (C) months:

$$\mathrm{ET} = (18W - 10C)/((W - C) + 8)$$

ET varies from 26 at the equator to 8 at the poles; low ET values are associated with cold environments with short growing seasons, whereas high ET values are associated with tropical habitats with long growing seasons.

Primary production refers to annual net above-ground plant production ($\mathrm{g/m^2/yr}$) and is a more direct indicator of the amount of food available to herbivores than is ET. A product of effective precipitation and solar radiation, PP is computed from evapotranspiration (E) values (Thornthwaite Associates 1962, 1963, 1964; UNESCO 1974) using Sharpe's (1975) equation:

$$\mathrm{PP} = 0.0219E^{1.66}$$

Holding solar radiation constant, PP increases with increasing precipitation until the solar energy threshold is reached (at which point additional rainfall has no effect). Holding precipitation constant, PP is a function of solar radiation.

Included in Table 3-1 are estimates of the PP and ET of the environments of 126 hunter-gatherer cases. This is not a random sample, and it is biased toward nontropical cases, with 80 percent coming from the ET range of 8–15. It is also geographically biased, with 77 percent of the cases coming from North America; Europe and most of Asia are not represented (see the distribution of cases in Figure 1-1). (Since publication of the first edition of this book, Lewis Binford [2001] has published his compendium of data on hunter-gatherer societies and Frank Marlowe [2005a] has likewise created a database that includes data from the first edition of this book of more than 400 hunter-gatherer societies. These data are not included here.)

Not all PP is edible by humans. In the Arctic, most of it is lichens or moss; in the temperate desert, a larger percentage is edible seeds; and in a tropical forest, much of it is inedible primary biomass – stems and leaves. It is also hard to reach in tropical forests. For example, among the Nukak, one of the highest primary biomass cases in this sample, the women "depend on men for collecting plant products" because "most fruit grows in the canopy" and only men climb high (Politis 2007: 240).

In general, humans can eat a larger percentage of production in tropical and temperate deserts. This is where a number of ethnographically well-documented hunter-gatherers live, including the Ju/'hoansi. Thus, the generalization that hunter-gatherers rely primarily on plant food is partly the result of ethnographic bias. Understanding the relationship between hunter-gatherer diet and the environment requires that we seek systematic relationships between dietary and environmental variables, rather than a stereotype.

So, what determines how much plant food foragers eat? We might assume that foragers living in colder environments would eat less plant food simply because there are fewer plants to eat in the boreal forests and Arctic tundra – pine boughs, lichens, and moss not being especially palatable to humans. Assuming that people would substitute meat for plant food, Lee expected to find hunting increase in importance with increasing latitude. Instead, he found that "latitude appears to make little difference in the amount of hunting that people do," although he had to leave Arctic groups aside to make this claim (Lee 1968: 42).[1]

In fact, the importance of plant food *does* decline as one moves farther away from the equator (Keeley 1992, 1995) – it must, for the reasons just given. But plant food in these cold environments may be replaced by fish and marine mammals and not necessarily by terrestrial game. How would we know?

One way to start is to predict how much plant food we expect foragers to consume. The amount is obviously related to the amount of humanly edible plant food available in an environment. And this amount can be roughly measured by a combination of primary production and effective temperature. For the groups in Table 3-1, ET and PP predict the dependence on gathering ($n = 126$, $r = 0.75$, $p \ll 0.001$) but not dependence on hunted foods ($n = 126$, $r = 0.18$, $p = 0.129$). (ET and PP alone are correlated with dependence on gathered foods, although not as strongly as they do jointly; neither is a significant predictor of hunting.) Apparently, other factors result in some foragers hunting more and some less than one would expect based on these environmental data alone.

Because ET and PP only characterize the terrestrial foraging environment, two possible intervening factors are the use of aquatic resources – fish, shellfish, and marine mammals – and the effects of trade with neighboring peoples. Removing groups who depend on aquatic resources for more than 25 percent of their diet, we find that PP and ET jointly predict the dependence on plant food and hunting fairly well (for plants, $n = 58$, $r = 0.63$, $p \ll 0.001$; for hunting, $n = 58$, $r = 0.62$, $p \ll 0.01$).

Let us assume that aquatic resources are used in lieu of gathered or terrestrial hunted food. This might seem an unwarranted assumption, but bear with me. Leaving aside shellfish, aquatic resources tend to be costly, requiring ocean-going boats, nets, traps, hooks, lines, and/or weirs. This technology has a substantial up-front cost and might have impeded the intensive use of aquatic resources (see Chapter 5). Although foragers may have used marine foods as early as 125,000 years ago in southern Africa and along the Mediterranean (Klein et al. 2004; Marean et al. 2007; and possibly >1.9 million years ago [Steele 2010]), these foods probably did not figure prominently in diet until considerably later (during the Late Stone Age in southern Africa; the Upper Paleolithic in Europe). Archaeology also suggests that no matter when the intensive use of fish, especially anadromous fish, and marine mammals, such as seals and whales, began, the subsistence pattern developed from a terrestrially based subsistence pattern. If so, then it seems logical that the aquatic resources replaced some existing portion of the hunted or gathered diet.

Using the regression equation describing the relationships among ET, PP, and dependence on gathered food (for groups with less than 25 percent dependence on aquatic resources), we can predict the dependence on gathering for all 126 societies in Table 3-1. Likewise, we can use the regression equation relating dependence on hunting to ET and PP to predict dependence on hunted foods. We'll call these the "terrestrial models." If aquatic resources are used in place of gathered or hunted foods, then the dependence on aquatic resources should correlate with the difference between the terrestrial models and the actual dependence on gathered or hunted foods, respectively.

Dependence on aquatic resources correlates with the difference between the expected and actual dependence on gathering, although it does not account for much of the variance ($n = 126$, $r = 0.44$, $p \ll 0.01$). The same conclusion was reached by other studies (Keeley 1995; Cordain et al. 2000). Thus, it seems that aquatic resources are used when there are insufficient edible plant foods. Aquatic resources tend to be used more in cold than in warm climates (as we pointed out previously). This could be partly a function of our sample: from North America's Northwest Coast, we have a sizeable sample of coastal foragers who relied heavily on salmon and sea mammals. Still, an increase in marine-resource use as we move north is not unexpected because northern waters are relatively more productive than the adjoining terrestrial environment,[2] making the ocean more attractive than land as a source of food in northern environments. Hunter-gatherers in cold climates also rely more heavily on stored food than do those living in warm climates; in fact, food storage dramatically increases among hunter-gatherers in environments where the ET is less than 14 (Binford 1980, 2001). Is the need for stored food related to the difference in productivity between the aquatic and cold terrestrial environments? For those groups where the ET is less than 14, dependence on aquatic resources only accounts for a small amount of the difference between the expected and actual dependence on gathered food ($n = 81$, $r = 0.36$, $p = 0.0007$). Some dependence on aquatic resources may make up for the lack of storable plant food (Pálsson 1988; Binford 1990), but other factors must be involved.

Dependence on aquatic resources accounts for much more of the variability in the difference between the expected and actual hunted food for the entire sample ($n = 126$, $r = 0.79$, $p \ll 0.001$) as well as for the subsample where the ET is less than 14 ($n = 81$, $r = 0.85$, $p \ll 0.001$). The greater the dependence on fishing, the less hunting a group does relative to the amount predicted by the terrestrial model (Figure 3-1). This suggests that aquatic resources are making up some portion of the diet that would otherwise come from hunted foods. In the ethnographic sample, groups dependent on aquatic resources frequently live under very high population densities in small territories at high latitudes (Yesner 1980; Keeley 1988; Binford 1990, 2001). This restricts how much a society can depend on meat since hunting in cold environments requires large territories. Although many Northwest Coast societies have small territories, just over the Canadian Rockies, where marine resources are not an option, hunter-gatherer territories are quite large (see Chapter 4).

In cold, heavily forested environments, a combination of low temperatures and high primary biomass means that few plant foods can serve as dietary staples. These same factors reduce the abundance of large game and consequently require foragers to maintain large territories. Where high population density makes this impossible (or where the costs of mobility are high), hunter-gatherers turn to aquatic resources to compensate for the lack of terrestrial foods (Binford 2001: 368).

Figure 3-1 tells us even more about the foraging targets of hunter-gatherers. Those groups that lie below the horizontal line hunt more than expected based on the terrestrial hunting model. Many of these are tropical groups who trade meat for carbohydrates (Mbuti, Aeta, possibly Aweikoma) or northern groups who cannot access substantial aquatic resources and who cannot turn to plant food as a substitute (Nunamiut, Tanana). Also included are Plains hunters who, like tropical forest groups, trade meat for carbohydrates (in this sample, maize grown by the Pueblo or other horticultural peoples) and live in the interior grasslands of North America, where humans cannot eat much of the primary production, where aquatic resources are not abundant, and where the horse permits greater mobility (Kiowa, Comanche, Cheyenne, Crow, Kiowa-Apache, Sarsi, Blackfoot). The Kariera (northwest Australian coast) and Seri may be coding errors or cases in which people turn to aquatic resources in place of gathered foods (where the tropical aquatic environment provides better foraging than the plant foods in these groups' desert terrestrial environments).

Throughout this discussion, we have implied that foragers make choices about which foods to eat based on the costs and benefits of those foods – what it takes to procure different foods, and how much utility a forager gets from them. To look at this decision-making process in more detail, let us examine the optimal-foraging models of human behavioral ecology.

The Diet-Breadth Model

Optimal-foraging models were developed by ecologists interested in understanding nonhuman foraging behavior (Emlen 1966; MacArthur and Pianka 1966; Pulliam 1974; Stephens and Krebs 1986). But students of human foragers quickly saw their utility, especially since diversity in human diets cannot be attributed to differences in physical perceptual abilities, prey-capturing appendages, or predator size – all potential sources of diversity in the nonhuman world.

Optimal-foraging models include a goal, a currency, a set of constraints, and a set of options. The goal is normally maximization of foraging efficiency (food gathered per unit time), and the

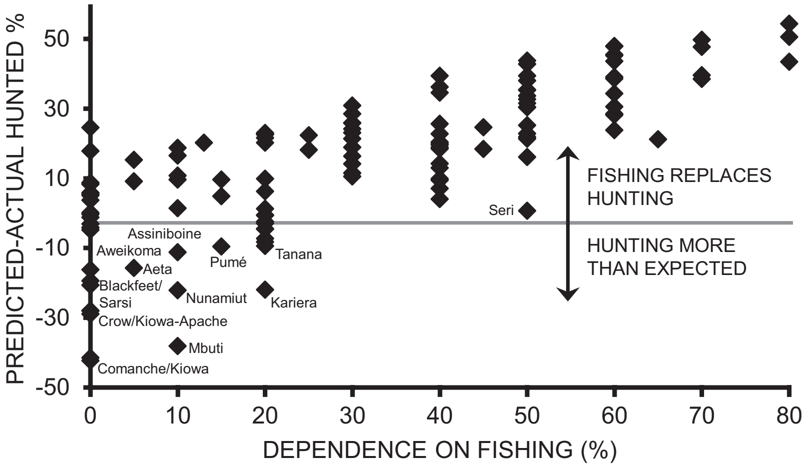


Figure 3-1. Relationship between dependence on fishing and the difference between the expected and actual dependence on hunting.

currency most often used is calories. Constraints include such things as the maximum amount of time that can be spent foraging and competing activities (e.g., caring for children). The options are the potential food resources. Given a set of resources with specified characteristics (e.g., nutritional content, harvest, and processing times), optimal-foraging models propose which resources will be harvested and which will be ignored. We will focus on the most widely applied model, the diet-breadth model (DBM).

As one might guess from its other name, the *prey-choice model*, the DBM predicts whether a forager will take a resource whenever he or she encounters it while foraging. As such, the model predicts whether a diet should be narrow, focused on a few food resources, or broad, incorporating a wide variety of the available foods – hence the name we use here. (It does not, however, predict how prevalent a particular resource will be in the diet, only its presence or absence.) As we noted in the last chapter, the model assumes that foragers will choose the set of resources that maximizes their *overall* foraging return rate. Tests of the DBM with data from several modern and prehistoric hunter-gatherer societies suggest that it is a very useful model (e.g., E. Smith 1983, 1991; Hill and Hawkes 1983; reviewed in Bird and O'Connell 2006).[3]

Crucial to the DBM is knowing how long it takes to find each food resource and how long it takes to harvest and process it once it is found; these are known as the *search* and *handling costs*, respectively. Search cost is largely a product of how abundant a resource is: abundant resources are encountered frequently, rare ones are not. The handling cost is the time it takes to harvest (or to pursue and kill, in the case of game) and process the resource once it is encountered. Handling cost goes into calculating a resource's *postencounter return rate* or, more simply, the *return rate*, usually expressed in kilocalories/hour (kcal/hr).[4] This information is based on ethnographic field data (Figure 3-2) or experimental research with reconstructed technologies (e.g., Simms 1987). Finally, the *overall foraging return rate*, which combines the search and harvesting costs, is the quantity that the forager aims to optimize – the total amount of food acquired relative to the time it takes to find and harvest it.

A simple example shows the difference among search costs, handling costs, and return rates. Let us say that a forager could expect to encounter a field of ricegrass (*Oryzopsis hymenoides*) containing an average of 1,000 kilograms of seeds for every 3 hours of searching. This means that the search cost is 3 hrs/1,000 kg = 0.003 hr/kg: to find a kilogram of ricegrass seeds requires about 0.003 hours on average – less than a minute. The handling cost is the time it takes to process the ricegrass once it is found. Steve Simms (1987: 119) found that after harvesting and processing Indian ricegrass using aboriginal technology (which includes grinding the seeds on a stone metate) for 41 minutes, he had procured 98 grams of edible food. This gives a handling cost of 0.68 hr/0.098 kg = 6.97 hr/kg. Although it takes less than a minute to find a kilogram of ricegrass seeds, it takes 7 hours to harvest and process it. Ricegrass contains 2.74 kcal/gram, so its postencounter return rate is 2.74 × 96 gm/41 min = 6.55 kcal/min, or 393 kcal/hr. (This, by the way, is a low return rate.)

Postencounter return rates are crucial to the DBM because *the model assumes that resources are added to the diet in order of their postencounter return rates*. If foragers are going to expand their diet, they do so by adding the next lowest return rate resource, then the next lowest, and so on. Why is this?

When a forager encounters a resource, he or she must decide to harvest it or search for something better. This is an example of the trade-offs we mentioned in the last chapter. The decision to harvest a particular resource depends on whether the postencounter return rate of the resource just encountered is more or less than the return from continuing to search for and harvest a higher ranked resource. A simple example can show how this works.

Consider a forager who has four food items available; we will call them A, B, C, and D (Table 3-2). The resources are ranked in terms of their postencounter return rates (here, we have used minutes instead of hours). Remember that resources are added to the diet in order of their return rate and that the goal is to maximize the *overall* return rate, the rate of return from time spent searching *and* harvesting food.

We assume that a forager is always on the lookout for resource A – because it provides the highest rate of return. It takes the forager 30 minutes to find and 10 minutes to harvest A. That effort provides 1,000 kcal and an overall return rate of 1,000 kcal/(30 min search + 10 min handling) = 25 kcal/min. But notice that the forager will encounter resources B, C, and D while looking for A because they are more abundant. When the forager does so, he must decide whether to continue looking for A or to stop and harvest the other resource. What should the forager do?

The rule is: harvest the resource if its postencounter return rate is higher than the overall foraging return rate of searching for and harvesting all higher ranked resources. The postencounter return rate of B is 30 kcal/min; since this is higher than the 25 kcal/min overall foraging rate when just taking resource A, our forager should take the time to harvest resource B. We can check this by determining the overall foraging return rate of A and B. If the forager includes resource B in the diet, then the overall foraging return rate increases to 30 kcal/min: (1,000 kcal for resource A + 800 kcal for resource B)/(30 min search time for both resources + 10 min handling resource A + 20 min handling resource B) = 30 kcal/min). Search time can be double-counted since the DBM assumes a forager is looking for all resources at the same time.

Now, what if the forager encounters resource C? Since resource C provides a lower post-encounter return rate (26 kcal/min) than that achieved by searching for and harvesting resources A and B, it should not be included in the diet – the forager should ignore resource C when encountered and keep looking for A and B. We can confirm this too. If we add C to the diet, the overall foraging return rate decreases to 28.9 kcal/min: (1,000 kcal for resource A + 800 kcal for resource B + 800 kcal for resource C)/(30 min search + 10 min handling for resource A + 20 min handling for resource B + 30 min handling for resource C). Likewise, resource D, with a postencounter return rate of 10 kcal/min, would also be ignored. The overall return rate would decline even further (even though resource D would be harvested three times) if an unwise forager were to insist on harvesting it (curve 1 in Figure 3-3). Resources C and D should be ignored *even though they will be encountered as or more frequently than resources A and B.*

What happens if resources A and B become harder to find? Search costs will increase as a resource becomes less abundant, but they can change for other reasons as well. For example, hunters rarely try to encounter an animal itself but rather look for tracks, spoor, or other sign and from them judge when the animal passed by, as well as its condition and speed. For the boreal

Table 3-2. Hypothetical Search and Handling Costs to Calculate Optimal Diet

Resource	Search Time (min)	Handling Time (min)	Kcal/ Unit Resource	Post-encounter Return Rate (kcal/min)	Units Encountered in the Time it Takes to Encounter One Unit of Resource A (kcal/min)		Overall Foraging Return Rate
A	30 (120)	10	1,000	100	1 (1)	for A:	25.0 (7.7)
B	20 (30)	20	800	40	1 (4)	for A + B:	30.0 (20.0)
C	20	30	800	26	1 (6)	for A + B + C:	28.9 (23.1)
D	10	40	400	10	3 (12)	for A + B + C + D:	18.1 (15.9)

Figure 3-2. Alice Steve, a Paiute woman, demonstrating traditional piñon pine nut (seed) processing, about 1958; she is winnowing the cracked hulls from the seeds. Photograph by Margaret Wheat or Laura Mills. Margaret Wheat Collection, Special Collections, University of Nevada-Reno Library.

forest, this means that heavy snow, especially if it has a crust, reduces moose mobility, making them easier to pursue but harder to find since they move less and thus leave less of a trail. Since Cree moose hunters search for tracks (Winterhalder 1981: 73), heavy snowfall can reduce the encounter rate for moose without altering the actual density of the resource itself.

In any case, we can model a reduction in the encounter rate with resources A and B by simply increasing the search time for each resource. In Table 3-2, the numbers in parentheses reflect changes in the number of units of a resource that are encountered and in the overall foraging return rate if the search costs of resources A and B are increased to 120 and 30 minutes, respectively. For example, where previously only one unit of resource C was encountered in the time it took to locate one unit of resource A, now six units of C are encountered in the time it takes to find one of A. Maximum foraging efficiency is now achieved when resource C is included in the diet (23.1 kcal/min; curve 2 in Figure 3-3). As expected, when high-ranked resources become rare, diet breadth expands to include lower ranked resources. In this case, even when resource A is gone, D is not included in the diet (curve 3 in Figure 3-3).

We have calculated the overall return rates here using a "back-of-the envelope" approach. Their actual calculation is slightly more complex but produces the same conclusion. Bettinger (2009) provides an excellent guide to constructing a diet-breadth foraging model (and see the next section).

Figure 3-3 also shows something very interesting about a broadening of diet breadth. The inflection point in each curve marks the "optimal" diet breadth. Notice, however, that this inflection point, the maximum overall foraging return rate, does not remain the same but declines with decreasing abundance of high-ranked resources (the change in the high point of curves 1, 2, and 3). If a forager living under the conditions of curve 2 or 3 wants to bring in the same amount of food as a forager living under the conditions of curve 1, he or she must work longer. This prediction is borne out by Hames's (1987) study of eleven foraging societies, where he shows that as the density of game declines, the amount of time spent foraging increases. Such a decline in food density increases the opportunity cost of foraging and, consequently, could encourage technological innovation, experimentation with new food resources, plant husbandry, or more extreme measures, such as controlling the efforts of another's labor (e.g., slavery). We will return to some of these options in later chapters.

A second more technical example shows the application of the DBM in an ethnographic situation, that of the Ache (Hawkes, Hill, and O'Connell 1982). As pointed out in the first example, maximizing the rate of energy acquisition means that the forager harvests a resource until the return rate of the *n*th resource (written, in this case, as E_i/H_i) and its handling cost is equal to or greater than the overall return from foraging (E/T). In other words, resources are added to the diet as long as $E/T \leq E_i/H_i$, where:

$E =$ total kcal acquired while foraging
$T =$ total foraging time (search, gathering, and processing)
$E_i =$ kcal available in a unit of resource i
$H_i =$ handling time per unit of resource i

The overall foraging return rate changes as different resources are added to the diet:

$$E/T = \frac{\sum \mu_i * E_i * T_s}{T_s + \sum \mu_i * H_i * T_s} = \frac{\sum \mu_i * E_i}{1 + \sum \mu_i * H_i}$$

where T_s is the total search time for all resources and μ is the amount of the *i*th resource. Again, if an encountered resource provides a lower postencounter return rate than the current overall foraging return rate, then it should be ignored.

The characteristics of sixteen resources consumed by Ache on sixty-one foraging days are shown in Table 3-3. These data were recorded from a total of 3,673 hours of search time and 1,024 hours of carrying time (carrying food back to camp; we'll return to the issue of transport

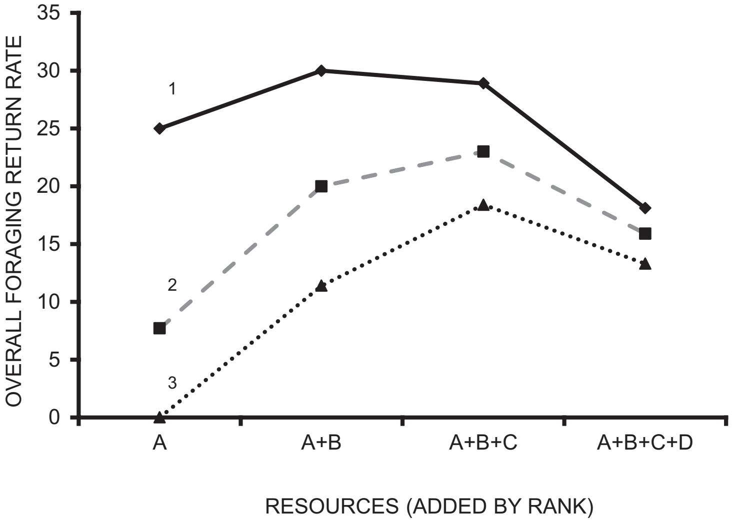


Figure 3-3. A graphic representation of how a hypothetical diet (see Table 3-2) changes with decreases in high-ranked resources. (1) With resources A and B abundant, resource C is not included in the diet. (2) When resources A and B are rare, resource C is included. (3) Although most abundant, resource D is never in the diet, even when A is extinct. Note that the highest overall foraging return rate declines as the diet expands from one of resources A and B to one consisting of A, B, and C to one composed of only B and C.

Table 3-3. Ache Diet Over Two Months

Resource	μ_i (kg)	E_i (kcal/kg)	H_i (hr/kg)	Return Rate (kcal/hr)	Total Handling Time ($\mu_i * H_i$)	Rank
Peccary[a]	232	1,950	0.03	65,000	7.0	1
Deer	300	819	0.03	27,300	9.0	1
Paca	307	1,950	0.28	6,964	86.0	2
Coati	351	1,950	0.28	6,964	98.3	2
Armadillo	386	1,950	0.33	5,909	127.4	3
Snake	10	1,000	0.17	5,882	1.7	3
Oranges	1,283	355	0.07	5,071	89.8	4
Bird	35	1,240	0.26	4,769	8.7	5
Honey	57	3,037	0.93	3,266	52.5	6
Peccary[b]	457	1,950	0.71	2,746	324.5	7
Palm larvae	43	3,124	1.32	2,367	56.8	8
Fish	189	975	0.46	2,120	86.9	9
Palm heart	171	595	0.39	1,526	66.7	10
Monkey	533	1,300	1.07	1,215	570.3	11
Palm fiber	1,377	120	0.10	1,200	137.7	11
Palm fruit	249	350	0.37	946	94.6	12

[a] Collared peccary.
[b] White-lipped peccary.
Source: Hawkes, Hill, and O'Connell 1982: table 3.

herein). In Figure 3-4, the upper curve plots the return rate (E_i/H_i) for each of the resources arrayed by their rank along the x axis. The lower curve plots the changing overall foraging return rate (E/T) as resources are added to the diet. For example, the foraging return rate for collared peccary and deer is (232 × 1,950 = 452,400) + (300 × 819 = 245,700) divided by (3,673 search hr + 1,024 carrying hr + 16 handling hr) = 148 kcal/hr. Adding paca and coati to the diet, the kilocalories increase by 1,283,100 to 1,981,200; likewise, the cost increases by 184 handling hours, which produces an overall foraging return rate of 405 kcal/hr. With incremental additions of the remaining resources to the diet, we find that the curves intersect at about 870 kcal/hr. At that point, $E/T = E_i/H_i$. The Ache should not take any resource with a postencounter return rate below 870 kcal/hr and, indeed, do not appear to do so. The DBM predicts the Ache's choice of food items while on foraging treks.

Likewise, the DBM can predict when the collection or pursuit of one resource should be dropped in order to pursue something else. For the Ache, the average overall return rate from hunting alone is 1,115 kcal/hr, including search, pursuit, and processing costs. Resources such as oranges (4,438 kcal/hr), honey (3,231 kcal/hr), and palm larvae (1,849 kcal/hr) should be and are taken by the Ache while searching for game (in patch returns here take search and handling time into account, thus the overall return rates are lower than those in Table 3-3, where only handling time is considered). Once a collared peccary is sighted, however, no other resources are sought or pursued since the potential return from the peccary (65,000 kcal/hr) is higher than that of other resources. However, the longer the pursuit continues, the lower the return rate will be if the peccary is captured and, consequently, there is a greater chance that other resources will be taken if encountered late in the hunt (Hill, Kaplan, Hawkes, and Hurtado 1987: 18).

The DBM approximates the decision-making process that a forager makes *based on the assumption that the goal of foraging is to maximize the overall energy return rate*. The model assumes that time spent harvesting precludes searching for other resources so that there is an opportunity cost to each resource as well, namely, the potential loss of energy or time entailed in choosing to pursue a resource instead of searching for another. Due to its simplicity and generality, the DBM has successfully predicted hunter-gatherer diet in a number of instances.[5]

What Is the "Right" Return Rate?

Table 3-4 lists the experimentally or ethnographically derived return rates of various resources from around the world. This table shows that some classes of foods tend to have lower or higher return rates than other classes. Seeds and roots, for example, normally have lower return rates than small, medium, or large game.[6] But within any class, there is variability, and some classes overlap one another.

Many factors enter into calculating return rates. For example, we previously calculated the return rate for ricegrass seeds, arriving at 393 kcal/hr. To do so, we only considered time as the cost factor. But some researchers subtract the energetic cost of the activity needed to harvest the resource from the total number of calories collected. This is termed the *net acquisition rate* (NAR). If Simms expended 200 kilocalories while harvesting and processing the ricegrass seeds that we described previously, his NAR would be 2.74 × 98 = 269 – 200 = 69 kcal/41 min = 101 kcal/hr.

Return rates are often established through ethnographic research. This requires that the ethnographer track how much time a forager spends looking for, harvesting, and then processing a resource. If it sounds intrusive, well, that's the nature of ethnographic work. It means following people around (never a crowd-pleaser) and then weighing everything brought back (I found this to be difficult working with the Mikea because they rarely share meat – for reasons we will discuss in Chapter 6 – and so were reluctant to let me record what they had). Ethnographers often must be both clever and persistent to collect these data in ways that are not culturally offensive.

Archaeologists have to acquire return rates through experiments because the foragers they study are long dead. They do this by foraging themselves (e.g., Simms 1987; C. S. Smith,

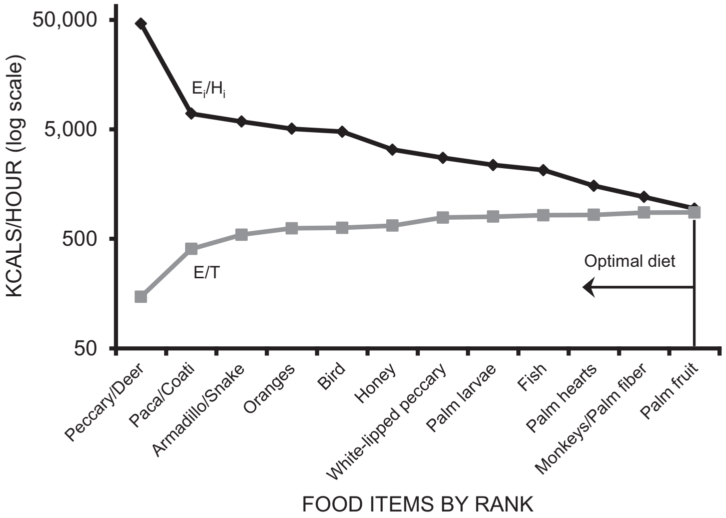


Figure 3-4. A diet-breadth model of Ache diet. The upper dark line is each resource's post-encounter return rate; the lower gray curve is the overall foraging return rate calculated for diets of different breadths (just the highest-ranking food, the two highest ranking foods, and so on). Redrawn from Hawkes, Hill, and O'Connell (1982). Reproduced by permission of the American Anthropological Association from *American Ethnologist* 9(2), figure 1, p. 390, May 1982. Not for sale or further reproduction.

Martin, and Johansen 2001). Simms's (1987) ricegrass harvesting experiment described previously is one of many that archaeologists have conducted. The obvious problem, of course, is that archaeologists are nowhere near as good at foraging as "real" hunter-gatherers. They have to practice repeatedly before they can actually collect some meaningful data.[7] And, they have to know which experiments to perform. Shoshone gathered whitebark pine nuts (actually, they are seeds) in the fall in the Rocky Mountains. But how they did it is not well known. One way may have been to copy what bears do and collect the cones from squirrel caches. It's a simple matter to scoop up the dried cones, crush them, and winnow out the seeds. We don't know if the Shoshone did this but, if so, it could increase the return rate of whitebark pine seeds considerably over collecting the cones individually from trees. The solution is to model all of the possible ways that a resource could be acquired – but, of course, the problem is in knowing whether you have come up with all of the possible ways.

Even if we did come up with all of the ways, experimental foraging is possible with plant foods – no one complains if you want to collect ricegrass seeds or dig up sego lily bulbs – but it is considerably more difficult with game (there are laws against the things we would need to do!). And what do we do about game that no longer exists (e.g., mammoths)? Although some studies rely on modern hunter statistics, these are not immediately transferable to prehistoric situations (since guns reduce pursuit time). One rule of thumb is to use body size because studies find a correlation between body size and return rate (e.g., Broughton 1999). There are a few exceptions, however. Whales, for example, have a per capita return rate lower than we might expect given their body size because they are hunted communally (Alvard and Nolin 2002), and so the return must be divided among all participants. In addition, body size does not always correlate with the difficulty of capturing an animal. Turtles and tortoises, for example, are relatively easy to capture but a similarly sized rabbit is not. Although an animal's mobility or other behavioral characteristics can affect its harvesting costs and return rate (Bird, Bliege Bird, and Codding 2009), body size is still a good rule of thumb (Hill et al. 1987; Broughton, Cannon, Bayham, and Byers 2011; see also Bird, Codding, Bliege Bird, and Zeanah 2012; Ugan and Simms 2012).

Table 3-4. Postencounter Return Rates of Various Food Resources

Name/Location/Other Information	Type	Return Rate (kcal/hr)
Australia Desert (Alyawara)[a]		
Panicum australiense	Grass seed	261–1,226
Fimbristylis oxystachya	Grass seed	261–405
Panicum cymbiforme	Grass seed	668
Chenopodium rhadinostachyum	Grass seed	652
Vigna lanceolata	Tuber	255–1,724
Ipomoea costata	Tuber	1,769–6,252
Cyprus rotondus	Root	848
Solanum chippendalei	Bush tomato	9,380
Cossidae sp.	Larvae/witchetty grub	1,486–2,834
Various species	Lizards	2,975
Varanus sp.	Lizard	4,200
Solanum centrale	Fruit	5,984
Acacia coriacea (unripe)	Tree seed	4,333
A. coriacea (ripe)	Tree seed	<676
A. aneura	Tree seed	580
A. cowleana	Tree seed	552
Other acacias	Tree seeds	538
Cyperus sp.	Tree seed	4,435
Megaleia rufa	Red kangaroo	14,382–35,281
	Wallaby (drive)[q]	1,873
	Ducks (drive)	492–867
Australia Desert (Martu)[s]		
Varanus gouldii	Sand goanna	635
Ardeotis australis	Bustard (with guns)	1,800
Macropus robustus	Kangaroo (with guns)	967
Varanus gigantius	Perentie	704
Solanum diversiflorum	Fruits	2,757
V. lanceolata, C. bulbosus	Roots, bulbs	416
Felis cattus	Feral cat	913
Endoxla sp.	Grubs	515
	Honey	5,378
Hakea spp.	Nectar	8,482
Australia Coast (Meriam)[v]		
T. gigas	Shellfish	14,100
Hippopus sp.	Shellfish	6,200
Tridacna sp.	Shellfish	3,800
Trochus (large)	Shellfish	3,900
Lambis sp.	Shellfish	3,000
Cypraea sp.	Shellfish	2,100
Trochus (small)	Shellfish	950
T. crocea	Shellfish	600
Strombus sp.	Shellfish	500
Asaphis sp.	Shellfish	400
Nerita sp.	Shellfish	300

Name/Location/Other Information	Type	Return Rate (kcal/hr)
Great Basin[b]		
M. sanguinipes (lake windrows)	Grasshoppers	41,598–714,409
Anabrus simplex (hand collected)	Cricket	2,245–20,900
Odocoileus hemionus	Deer	17,971–31,450
Ovis canadensis	Sheep	17,971–31,450
Antilocapra americana (individual)	Antelope	15,725–31,450
Antilocapra americana (drive)	Antelope	1,161–1,887
Lepus sp. (individual)	Jackrabbit	13,475–15,400
Lepus sp. (drive)	Jackrabbit	628–4,243
Thomomys sp.	Gopher	8,983–10,780
Sylvilagus sp.	Rabbit	8,983–9,800
Typha latifolia	Pollen, cattail	2,750–9,360
Spermophilus sp.	Squirrel	5,390–6,341
Citellus sp.	Squirrel	2,837–3,593
Typha latifolia	Rhizomes, cattail (winter)	3,300
Anas sp. (individual)	Waterbird, ducks	1,975–2,709
Anas sp. (drive during molt)	Ducks	561–1,317
Quercus gambelli	Seeds, gambel oak	1,488
Descurainia pinnata	Seeds, tansymustard	1,307
Pinus monophylla	Seeds, piñon pine	841–1,408+
Pinus flexilis[u]	Seeds, limber pine	191–13,437
Lewisia rediviva	Roots, bitterroot	1,237
Elymus salinas	Seeds, wild rye	266–1,238
Atriplex nuttalli	Seeds, shadscale	1,200
Atriplex confertifolia	Seeds, shadscale	1,033
Scirpus sp.	Seeds, bulrush	302–1,699
Echinochloa crusgalli	Seeds, barnyard grass	702
Lepidium fremontii	Seeds, peppergrass	537
Helianthus annuus	Seeds, sunflower	467–504
Poa sp.	Seeds, bluegrass	418–491
Oryzopsis hymenoides	Seeds, ricegrass	301–392
Typha latifolia	Shoots, cattail (spring)	200–300
Phalaris arundinacea	Seeds, reed canary grass	261–321
Muhlenbergia asperifolia	Seeds, scratchgrass	162–294
Hordeum jubatum	Seeds, foxtail barley	138–273
Carex sp.	Seeds, sedge	202
Typha latifolia	Rhizomes cattail (spring)	128–267
Scirpus sp.	Roots, bulrush	160–257
Distichlis stricta	Seeds, saltgrass	146–160
Allenrolfea occidentalis	Seeds, pickleweed	90–150
Sitanion hystrix	Seeds, squirreltail grass	91
Gila bicolor (with nets)	Minnow	750–7,514
Gila bicolor (with basket scoop)[g]	Minnow	5,200–241,000
O. clarki henshawi (basket trap)[g]	Trout	4,700–36,000
O. clarki henshawi (spear/harpoon)[g]	Trout	17,700–24,400
O. clarki henshawi (gill net)[g]	Trout	33,600–69,600

(*continued*)

Table 3-4 (*continued*)

Name/Location/Other Information	Type	Return Rate (kcal/hr)
Gila bicolor (basket trap)[g]	Minnow	4,700–38,600
Calochortus nuttalli[h]	Sego lily, bulbs	207
U.S. Plateau[c]		
Lomatium hendersonii	Roots, lomatium	3,831
Lewisia rediviva	Roots, bitterroot	1,374
Lomatium cous	Roots, biscuitroot	1,219
Lomatium canbyi	Roots, Canby's lomatium	143
Perideridia gairdneri	Roots, yampah	172
Malaysia[d]		
Dusky leaf monkey	Medium fauna	1,620
Banded leaf monkey	Medium fauna	1,550
White-handed gibbon	Medium fauna	1,490
Binturong	Medium fauna	1,290
Giant squirrels	Small fauna	1,060
Macaques	Small fauna	480–780
Squirrels	Small fauna	330–480
Birds	Small fauna	230
Tropical freshwater fishing[e]	Small fish	360–5,936
Boreal forest[f]		
Moose and caribou	Large fauna	
Winter		6,050
Spring		11,950
Summer/Fall		5,920
Fall (rut)		11,280
Net fishing	Fish	
Winter		1,060
Spring		3,180–9,680
Summer		2,260–5,320
Fall		6,390
Hare snaring	Small game	1,900
Muskrats	Small game	
Spring trapping		250–2,500
Fall hunting		1,330–2,370
Beaver	Small game	
Winter trapping		1,640–5,280
Waterfowl	Small game	
Pre-breakup		720
Post-breakup		1,980
Pre-freeze-up		1,190
Blueberries	Berries	250
Arctic[i]		
Erignathus barbatus	Bearded seal	15,000–25,700
Rangifer tarandus	Caribou	25,400
Phoca hispida	Ringed seal	10,600–16,300
Somateria mollissima	Eider duck	3,200–5,200
Lagopus sp.	Ptarmigan	2,700–3,500

Name/Location/Other Information	Type	Return Rate (kcal/hr)
Africa (Pygmies)		
Net hunting[j]	Duikers and others	110-535
Small mammal (nets)[r]	Duikers	106–215
Small mammal (spears)[r]	Duiker	3,044–6,769
Porcupine (spear)[r]	Small game	2,152
Small animals (snares)[r]	Small game	4,909
Pouched rat (by hand)[r]	Small game	561
Porcupine (traps)[r]	Small game	1,037
Rats and mice (traps)[r]	Small game	10
Mikea		
Dioscorea sp.[t] taken by:	Tubers (NAR)	
Female children		537
Male children		505
Female adolescents		1,196
Male adolescents		1,372
Female adults		1,851
Male adults		2,419
Africa (Hadza)[k]		
Cordia sp. (children)	Berries	2,223
Cordia sp. (adult)	Berries	4,018
Salvadora persica (children)	Berries	964
Salvadora persica (adult)	Berries	1,344
Eminia atenullifera (children)	Tuber	436
Vigna frutescens (children)	Tuber	267
Vigna frutescens (adult)	Tuber	1,043
North America (coastal Georgia)[l]		
Crassostrea virginica (summer)	Oysters	231–1,235
Crassostrea virginica (winter)	Oysters	209–1,096
Geukensia demissa (shucked)	Mussels	387
Geukensia demissa (unshucked)	Mussels	1,259
Mercenaria mercenaria (shucked)	Clams	2,246
Mercenaria mercenaria (unshucked)	Clams	4,379
Littorina irrorata	Periwinkle	26–138
Busycon sp., *Busycotypus* sp.	Whelk	1,231–1,381
Callinectes sapidus	Crab	310
Fish (weir)	Large (>5 kg) fish	>17,700
Fish (weir)	Large fish	7,540–18,760
	Medium fish	9,623–12,265
Fish (gill net)	Large fish	21,216–62,792
	Medium fish	19,823–25,265
	Small fish	6,714–9,894
Fish (trot line)	Large fish	16,982–42,252
	Medium fish	13,486–17,188
	Small fish	4,567–6,731
Fish (spear/harpoon)	Large fish	5,655–14,070
	Medium fish	3,206–4,086

(*continued*)

Table 3-4 (*continued*)

Name/Location/Other Information	Type	Return Rate (kcal/hr)
	Small fish	1,086–1,600
Odocoileus virginianus	White-tailed deer	12,096–19,895
Ursus americanus	Black bear	37,352–61,434
Alligator mississippiensis	Alligator	22,000
Apalone sp., *Chelydra* sp.	Softshell/snapping turtle	6,547–8,273
Procyon lotor	Raccoon	9,408–13,569
Didelphis virginiana	Opossum	6,540–12,111
Branta canadensis	Goose	6,762–12,522
Sylvilagus aquaticus	Swamp rabbit	2,942–5,248
	Small turtles	2,182–2,758
Sylvilagus palustris	Marsh rabbit	2,042–3,781
	Ducks	1,230–2,278
Malaclemys terrapin	Diamondback terrapin	1,304
Sciurus carolinesis	Eastern grey squirrel	672–1,244
Carya sp. (manual extraction)[m]	Hickory nuts	100–165
Carya sp. (crushing on nutting stone, boiled)[m]	Hickory nuts	2,030–2,233
Carya sp. (crushing in wooden mortar, boiled)[m]	Hickory nuts	3,113–3,480
Quercus virginiana[l] (collecting, shelling, leaching)	Live oak acorns	477
Quercus kellogi[n] (collecting, shelling, leaching)	Black oak acorns	1,091–1,194
Quercus sp. (collecting, shelling, boiling)[o]	Acorns	821
Amaranth[p]	Seeds	1,359
Chestnut[p]	Nuts	914
Walnut[p]	Nuts	568
Sunflower[p]	Seeds	489
Maygrass[p]	Seeds	457
Chenopod[p]	Seeds	433
Sumpweed[p]	Seeds	272
Little barley[p]	Seeds	274
Knotweed[p]	Seeds	286
Giant ragweed[p]	Seeds	110

Sources: [a]Cane 1987; O'Connell and Hawkes 1981; O'Connell and Marshall 1989; [b]Simms 1987; Madsen and Kirkman 1988; Madsen, Eschler, and Eschler 1997; Raymond and Sobel 1990 (see also Table 3–5); Jones and Madsen 1991; [c]Couture, Ricks, and Housley 1986 (processing not included; with processing, rates would be lower); [d]Kuchikura 1987; [e]Kuchikura 1996; [f]Winterhalder 1981; [g]Lindström 1996; [h]C. S. Smith et al. 2001; [i]E. Smith 1991; [j]Noss 1997; Tanno 1976; Wilke and Curran 1991; Lupo and Schmitt 2002; [k]Hawkes et al. 1995; [l]Thomas 2008; [m]Thomas 2008; Gremillion 2002; Gardner 1997; [n]Barlow and Heck 2002; [o]Gremillion 2002; [p]Gremillion 2004; [q]Satterthwait 1987; [r]Lupo and Schmitt 2005: table 2; [s]Bliege Bird and Bird 2008; [t]Tucker and Young 2005 (these are NAR – net acquisition rates, and take the caloric cost of foraging into account); [u]Rhode 2010 (hulled vs. unhulled seeds); [v]Bird and Bliege Bird 2000.

We also need to consider whether animals are taken individually or with a *mass-harvesting* technique. Taken in the "traditional" way with hook and line, fish provide fairly low return rates (and even lower if we include the cost of searching for bait, which can take hours; see Goto [1996: 28]); this can be improved if fish are taken in bulk with weirs or nets (compare the return rates for the Georgia coast in Table 3-4). But some game produce lower rates when taken communally – compare the return rates of individual and communal hunts of antelope and jackrabbits in Table 3-4. The difference lies partly in the fact that some resources, when taken in bulk, such as grasshoppers and small fish, can also be processed in bulk. Processing grasshoppers, for example, is a lot like processing seeds (large ones, with legs). But rabbits are processed no differently whether they are hunted communally or individually. Mass harvesting usually means communal hunting; and sharing the returns means that the per capita return rate is lowered (Ugan 2005).

Dogs, the earliest and most widespread of domesticated animals, can also increase return rates. Besides being food themselves and beasts of burden, dogs can assist in foraging. Dogs can increase the encounter rates with game and, by running game down and cornering it, reduce pursuit costs as well (Turney-High 1941: 70; McCarthy and McArthur 1960: 150; Goodale 1971: 167; Dwyer 1983; Brosius 1991; Koster 2008; Turov 2010: 33; Lupo 2011). In some cases, especially in the Arctic, dogs must be fed and thus can be costly to keep (Schnirelman 1994). But, in many cases, the cost of keeping dogs is minimal since they scavenge for themselves or feed on garbage (I never saw the Mikea feed a dog).

Return rates can also change, often quite dramatically, as a result of different technologies – for example, by using woven paddles to beat seeds from plants rather than stripping them by hand (Simms 1987), by using a net rather than a leister or hook and line to catch fish, or by using a shotgun in place of a bow and arrow. This raises the issue of whether we need to consider the cost of manufacturing equipment in calculating the return rate (Bailey and Aunger 1989a). We will return to the issue of technology and its relationship to foraging return rates in Chapter 5.

Specific environmental conditions also affect return rates. Digging tubers in the sandy sediment of the Mikea Forest in Madagascar is much easier and quicker (<5 minutes) than digging tubers in the rocky soil of the Hadza's territory (10–20 minutes).

Return rates will also depend on what is considered an "edible portion." Most of us might think that the only edible portion of an animal is the flesh, but foragers will frequently eat many of the internal organs, as well as bone marrow – and sometimes the bone. Madagascar's Mikea, for example, cook and then eat *tambotrike*, hedgehogs that are smaller than your fist, in their entirety (after scraping off the quills), starting at the nose and working back to the stubby tail. Australia's aborigines consumed lizards whole, after pounding them into paste. Many foragers boiled bones to render their grease.

Return rates can also change with the seasons through seasonal changes in animal body fat or in animal behaviors that alter search or handling costs. The Mikea track *tambotrike* in the wet season by looking for their burrows and tracks. But in the dry season, the hedgehogs aestivate in tree hollows. Hunters search for them by tapping on likely trees with their axes and listening for the scratching of quills as the hedgehog drowsily turns over. With a trained ear, the hunter locates the hedgehog and removes it by chopping a hole in the tree (the hedgehog is "sleeping," so it is not killed but simply tossed in a net bag and stored in a wooden container back at camp). Mikea find hedgehogs easier to catch in the dry than in the wet season, when the creatures return to their burrows in the ground and are mobile. Note also the seasonal difference in large-game return rates in the boreal forest in Table 3-4; this is partly a product of the animal's condition – animals are fatter in the fall than in the spring.

Return rates can also differ from person to person, depending on the person's skill or age (more on that later), or even from day to day for the same person. In Australia's Western Desert, return rates of foragers searching for lizards vary from 114 to 8,580 kcal/hr; even for the same individual, return rates in one study varied from 1,030 to 8,580 kcal/hr (Cane 1987: table 22). Experimentally derived return rates should be considered only relative measures, and, where possible, we should use averages of numerous observations.

The separation of search from handling costs is an important characteristic of the DBM because it allows us to evaluate the effects of changes in a resource's density or search techniques independent of changes in a resource's handling (e.g., changes in processing or procurement technology). It is important that both aspects of resource acquisition be considered when evaluating a resource's utility. For example, Lee's data on mongongo-nut use suggests a return rate of 1,900 kcal/hr – not bad for a nut. But Lee did not account for the time required to break open mongongo nuts and pound the nut meat into a digestible form (Hawkes and O'Connell 1981, 1985). Ju/'hoan women and children spend many hours sitting in the shade at camp, socializing and breaking each individual nut open by placing it on a stone "anvil" and crushing it with another stone; they then pick through the detritus for the nut meat (I have watched Mikea do the same with *sakoa*, a similar kind of nut). When handling time is accounted for, the return rate for mongongo drops by nearly two-thirds, from 1,900 to 670 kcal/hr, making mongongo less attractive than Lee originally suggested. If the time spent processing mongongo is time that could be devoted to collecting more mongongo (or other foods), then it should be included in calculating its return rate. However, if the time spent processing mongongo would have otherwise been spent in socializing, then perhaps it should not be included.

Importance of the Diet-Breadth Model

The DBM reaches several nonintuitive conclusions, the most important of which is that a resource's abundance alone cannot predict whether it will be used. No matter how frequently the Ache encounter a resource with a return rate below 870 kcal/hr, they are not expected to harvest it. More specifically, the model points out that *the decision to include a resource depends on the abundance of higher ranked resources*. This is because, as we discussed previously, the decision to include a lower ranked resource is a function of the search costs of higher return rate resources. At *Man the Hunter*, Joseph Birdsell wondered why it was that hunter-gatherers do not concentrate on resources such as mice, which in terms of sheer biomass are more abundant than deer (Lee and DeVore 1968: 95). The answer should now be clear: the return rate of harvesting a tiny, burrowing animal is so low that there are many far more efficient resources to be used, even if they are less abundant. Similarly, Martin Baumhoff (1981) once argued that California's acorn crop could have supported some 1.9 million aboriginal inhabitants. Although California did support high population densities of hunter-gatherers, 1.9 million is sixty to seventy times higher than population densities reconstructed for the precontact population. Why didn't acorns support a large population? The answer is that acorns contain tannin (eat one raw acorn and your mouth will go instantly dry from the acid; eat a lot and you'll become quite ill). The tannin is removed by first cracking the nuts and removing the meat from the shell fragments, then pounding and drying the nut meat and rinsing it several times (see Goldschmidt [1974] for a description). This high processing cost makes acorns, although abundant, a low-ranked resource (see Table 3-4); consequently, it was used by some but not all California foragers – and those who did use them did so fairly late in prehistory, after population growth had depleted higher ranked resources (Basgall 1987).

The DBM also forces us to consider the actual return rates of different resources and can thus help us overcome our own ethnocentrisms. Take insects, for example. Some hunter-gatherers consume significant numbers of insects (Hayden 1981b). Australia's Western Desert Aborigines relished the witchetty grub, and Aborigines living in the southeastern Australian highlands collected the fat-rich bogong moth (Flood 1980). Columbia's Nukak likewise collect and eat palm grubs (Politis 2007: 263). The Mono and Paiute of the southern Sierra Nevada in California harvested caterpillars (Fowler and Walter 1985), whereas elsewhere in the Great Basin, Paiute and Shoshone gathered fly larvae (*kutsavi*) and grasshoppers from the shores of lakes, where they washed ashore forming long windrows (Heizer 1950; Sutton 1985; Madsen and Kirkman 1988). Some Shoshone, Paiute, Cheyenne, and Assiniboine held grasshopper drives. We have only a few experimental and ethnographic studies of these resources, but they suggest that, at times, insects can provide remarkably high return rates. Under certain conditions, for example, grasshoppers provide more than 270,000 kcal/hr (Madsen and Kirkman 1988), placing them high above other food resources.[8]

The DBM predicts diet diversity, but it does not predict how frequently a food will be in the diet. For example, although collared peccary is the highest ranked resource in the Ache's menu, it does not comprise the bulk of Ache diet. And Winterhalder (1981) found that the overall amount of a resource harvested by the Cree in the boreal forest did not correlate with the total biomass of that resource. The DBM only proposes that all high-ranked items will be taken when encountered, but if they are encountered rarely, then they will make up a small portion of the diet.

The DBM assumes that if a food resource is not taken, it is because its postencounter return rate is too low. But what if this is not the case? What if a resource is eschewed for some other reason, such as a taboo? To test the DBM, we need data on resources *that may not be in the diet*. For example, what if there are resources in the Ache environment that provide return rates higher than 870 kcal/hr but that are not taken because they are tabooed? If so, the Ache could violate the DBM without the researcher being aware of it (Hill et al. 1987: 4). Unfortunately, if a resource is not used, an ethnographer will not have information on that resource's search and handling costs. The resulting DBM could then appear to be accurate when in fact it is not.

This dilemma can be overcome in two ways. The first is to obtain return rates for all possible food resources. Unfortunately, this is often not practical, as I found when working with the Mikea. Although many foragers eat grubs, the Mikea think they are disgusting (and when I asked if they were edible, they were astonished at how stupid this foreigner was). And, if the Mikea do not harvest grubs, then, no matter how knowledgeable they are of their environment, they won't know how to collect or process them, making any data from "forced" experimental foraging worthless.

A second approach uses experiments set up under field conditions to answer questions about the trade-offs between food resources that are in the diet but rarely used. Hawkes, O'Connell, and Blurton Jones (1991) used this approach in a study of African Hadza subsistence. Hadza men normally hunt or scavenge large game for an average postencounter return rate of about 4,000 kcal/hr. Do they maximize their return rate by ignoring small game? Since they do not normally take small game, the question cannot be confidently answered with data from routine Hadza foraging. But Hadza men do know how to hunt small game. Therefore, Hawkes and her colleagues asked some experienced Hadza men to spend time only taking small game with traps and snares. The data from this experiment showed that the average return for most small game was significantly below 4,000 kcal/hr: Hadza hunters maximize their return rate by ignoring small game.

We can also test the DBM by asking how it predicts diet changes under different technological circumstances that affect search or processing costs. Although some criticize the analysis of foraging trips that make use of shotguns or a researcher's vehicle (Dwyer 1985a), such forays can actually provide the researcher with a convenient test. The Ache's researchers did exactly this when they loaned shotguns to Ache hunters. Shotguns do not require as uncluttered a line of sight as does an arrow or blowgun in the forest, allowing the hunter to take game more quickly. By decreasing pursuit time, shotguns increase the return rate, raise the E/T curve (refer to Figure 3-4), and reduce diet diversity. As expected, Ache hunters ignore monkeys and birds, and their diet breadth contracts when a shotgun is used instead of a bow and arrow (Hill and Hawkes 1983). Likewise, Winterhalder (1981) showed that as search time decreased with the use of snowmobiles, Cree diet became more specialized; resources that the Cree would have pursued while hunting on snowshoes were ignored when snowmobiles permitted rapid travel to good moose-hunting areas.

Likewise, we can test the DBM by seeing if it accurately predicts diet under different seasons or climates (Hill et al. 1987: 24–26). Ache diet changes in predictable ways from season to season as the abundance of specific resources (and thus their search costs) changes (Hill, Hawkes, Hurtado, and Kaplan 1984). Similarly, O'Connell and Hawkes (1981, 1984) used the DBM to predict that seeds should drop out of Australian Aboriginal diet as soon as commercial flour becomes available, due to the high processing costs of the indigenous seeds. They also predicted that seeds should enter and leave the diet as droughts alter the availability of higher ranked resources. This is, in fact, what happened when the Gunwinggu acquired flour and sugar as government rations (Altman 1984). Likewise, seeds entered and left Ngadadjara diet as a result of climate-induced changes in the availability of higher ranked resources (Pate [1986]; although Pate found that the relationship between drought and resource availability was not quite as O'Connell and Hawkes expected, their prediction was nonetheless upheld).

In sum, the DBM holds up well as a way to predict foragers' targets.

The Patch Choice Model

Another model, one less frequently used than the DBM, is the *patch-choice model* (PCM). The PCM assumes that resources are found in patches rather than homogeneously across a landscape. It still assumes that patches are encountered sequentially and randomly, in direct proportion to their frequency in the environment. The model also assumes that a forager does not return to a patch until its resources are rejuvenated, and that travel time between patches is nonproductive (in terms of foraging). The PCM asks, which resource *patches* (as opposed to resources) should be included in a foray? As you can see, the PCM is similar to the DBM, but now patch types rather than resources are ranked in terms of the energetic return per unit time. At the same time, foraging *within* a patch is expected to conform to the DBM (Smith 1991: 207).

The PCM suggests that foragers should choose the highest return rate patches given their environmental knowledge. E. Smith (1991) found some support for this version of the PCM in that the Inujjuamiut tend to use the resource habitat or patch (saltwater, freshwater, sea ice, inland) that provides the highest return rate at a given time of the year, whether data are aggregated by season or by month. However, these tests were not conclusive because the correlation between time spent in a habitat or patch and mean seasonal or monthly return rate was not very strong. Rather than selecting patches or habitats, Smith argued, the Inujjuamiut allocate their time to *hunt types*, such as ocean netting, summer canoe hunting, rod fishing, or winter caribou hunting. Hunt types can be considered resource patches since a decision to conduct a certain kind of hunt limits the range of resources by limiting where a hunter goes and the equipment he carries. Aggregating the data by season and considering hunt types to be patches, Smith found support for the hypothesis that the Inujjuamiut allocate more time seasonally to hunt types that provide the higher return rates.

An assumption of the PCM is that travel time between patches is nonproductive. This may, in fact, be true only rarely. Winterhalder (1981) found that the Cree, who hunt for moose in forested patches, do not search their environment patch by patch but rather, where possible, travel between potential hunting patches searching for moose tracks, which they then follow into a patch. Additionally, game density in different patch types does not predict Cree use of the patch types because other characteristics of a patch affect prey density. Patches with thick brush in them, for example, are ignored because although moose may be there, the Cree cannot move through them without making noise and scaring the moose away. For all intents and purposes, these patches contain no game. Consequently, Winterhalder found that the Cree did not make as generalized a use of different habitat patches as the PCM predicted. This does not point to a theoretical deficiency in the PCM as much as it points to a methodological problem in making the model realistic. And that point brings us to potential problems with optimal foraging models.

Problems with Optimal-Foraging Models and Their Solutions

Optimal-foraging models are ultimately aimed at reconstructing the on-the-ground decision-making process of foraging (Mithen 1989, 1990). But the DBM was first used to help explain the behavior of grassland sparrows (Pulliam 1974), which are a far cry from human foragers. As a result, the DBM incorporated some assumptions that make sense for sparrows but not for humans. At first glance, these assumptions appear serious but, in fact, they are not insurmountable.

Randomness

The DBM assumes that food resources are randomly distributed across a landscape and that the forager searches the environment randomly; the same is true of the PCM (although the search is for food patches). The result is that a forager encounters food resources in proportion to the density of those resources. For example, if small monkeys make up 25 percent of all resources in an environment, then 25 percent of all food encounters should be with small monkeys.

These assumptions, of course, are rarely true for human foragers (B. Smith 2009). Food is usually distributed in patches – berries here, grass seeds over there, deer up in the hills. And foragers never wander about the landscape randomly (e.g., Brown, Liebovitch, and Glendon 2007). They know where they are going and what resource(s) they expect to find there. While foraging, men and women note the presence of plants, animal tracks, spoor, water sources, burrows, and nests and later share this information with others.[9] In northern Australia's Arnhem Land, men out hunting took account of "trees with bee hives in them, and those bearing fruits or nuts. They told the women about these later" (McCarthy and McArthur 1960: 153). On the basis of various signs around camp, Mistassini Cree hunters told Adrian Tanner "the sex and age of [an] animal and where it would be found two days before the hunt occurred" (Tanner 1979: 55). In the spring, the Nunamiut search widely to determine the future whereabouts of caribou (Binford 1978: 169), and the Chipewyan and Cree make trips specifically to search for signs of large game to determine when and where to move camp (Heffley 1981; Winterhalder 1981; see also Whallon 2006) and even where to hunt in years to come (Tanner 1979: 133). These accounts tell us what should be obvious: foragers know what's going on in their environment.

However, foraging for a particular food is based partly on the likelihood of encountering that food – which is largely a function of its abundance. Although the DBM's assumption of random encounter is unrealistic, it nonetheless approximates the end result of a forager's decision-making process. If foragers know that deer numbers have declined, then they will focus their efforts on the next highest ranked food, which is what the DBM would predict.

Pursuit of Resources

Another issue is that human hunters pursue game differently than do nonhuman predators (Hill et al. 1987: 17). Carnivores decide very quickly (often within moments) whether or not they will pursue a prey since carnivores are sprinters, not long-distance runners. Humans, however, have been known to run game down over several hours, a practice known as "persistence hunting" (Liebenberg 2006). William Strong, for example, recounted a time that a Naskapi man, wearing snowshoes, ran down six caribou over a day and killed them each with only a knife (Leacock and Rothschild 1994: 114). Hunters can also follow game for hours as poison or bleeding from an arrow or spear slowly weakens the animal (most bows and arrows or spears do not kill large animals quickly). This means that human hunting involves longer pursuit times and higher opportunity costs. But as long as these pursuit times are built into the return rates, then the fact that humans pursue prey longer than do other carnivores should not matter.

Processing of Resources

As we have seen, the DBM emphasizes not only the cost of pursuing and harvesting a resource but of processing it as well. The assumption is that processing a resource takes time away from collecting more of it. However, foragers can process food at times when they can't forage, for example, after dark, in the heat of the day, or during inclement weather (Hill et al. 1987: 17). And someone other than the forager may process that food. It is not uncommon for hunters to make a kill, then send someone back to camp to bring others to do the butchering and carrying (whether or not the hunters do this depends on the size of the animal, the distance back to camp, and the number of potential bearers there). As far as the hunters are concerned, the handling cost for the resource is low or nonexistent – and, consequently, its postencounter return rate is higher for the hunters than we might otherwise estimate.

Cooking is a particular aspect of processing that is usually not included in calculating a resource return rate because foragers can pursue other activities while food is cooking. But cooking cannot be ignored because it often increases food's nutritional value by increasing its digestibility. Meat's value is enhanced by cooking (Wrangham 2009); likewise, the return rate of many geophytes (tubers, bulbs, corms, roots) is raised by cooking because heat converts the carbohydrates into more easily digestible sugars.[10] Often, cooking does not preclude doing other activities; bark can be twisted into fiber, for example, while sitting around a fire waiting for tubers to cook. But some cooking may be time-consuming and if it precludes other activities, it should be included in the return rate calculation. For example, some foragers boil water in watertight baskets or skin-lined pits by heating stones in a fire, removing them with tongs, and dropping them into the container. As the rocks cool, they are replaced with new ones, and the now cool stones are reheated. This can boil water – faster than one might think – but it precludes doing other things and might be considered in calculating the return rate.

Who Is Foraging?

The DBM assumes a generic forager – one who searches for and has the potential to take all possible foods. But not everyone in a foraging society forages for the same foods. There are differences in competence, but the most important differences lie between adult men and women and between adults and children. As we will discuss in Chapter 8, foragers have a fairly strong division of labor in which women gather more reliable foods, such as seeds and tubers (along with some small game and shellfish), while men hunt less reliable large game. Although both may walk through the same forest, they do not target the same foods. Consequently, we can't model their diets with the same set of possible resources (Jochim 1988).

Likewise, children often forage, contributing to their mother's efforts or feeding themselves (Blurton Jones, Hawkes, and Draper 1994a,b; Hawkes, O'Connell, and Blurton Jones 1995; Bird and Bliege Bird 1997, 2000, 2002, 2005; Tucker and Young 2005). During berry season, for example, Hadza children can provide most of their own food (Marlowe 2010: 115).

Children also have different foraging targets. Since they walk more slowly than adults, they will encounter high-ranked (but rare) resources less frequently. Relative to adults, the DBM predicts that children should take more low-ranked resources more frequently – and this is what happens (Bird and Bliege Bird 2002, 2005). Their return rates will also be different because of their different physical capacities and experience. Mikea children, for example, cannot harvest tubers as quickly as adult men and women. The reason is that the tubers lie about 75 cm below the ground – about the distance from an adult's armpit to his fingers. With shorter arms, children must dig a larger hole, in some cases literally burrowing down to the tuber – and that takes more time (or they dig smaller tubers that are closer to the surface). We'll return to this issue in Chapter 7, looking at the demographic consequences of children's foraging. For now, what matters is that we can cope with this issue by constructing different models for men's, women's, and children's foraging targets.

How Do People Eat?

Optimal-foraging models were intended to model the behavior of animals that feed-as-they-go. But humans are better described as *central place foragers*. Although they may snack on some of the foods they collect in the field, foragers will transport a large portion back to a central location, where it will be processed and shared. Marlowe (2010: 128) estimates that the Hadza eat half of all berries and honey, a quarter of the tubers, and 15 percent of meat out of camp – the rest is brought back. In deciding whether or not to bring food back to camp, foragers also decide how much food is processed in the field. Should they simply sling an antelope over their shoulder or butcher it? Should they crack mongongo nuts and extract the nut meat in the field or back at camp? To consider this problem, let us first consider another of optimal-foraging theory's core models.

The Marginal Value Theorem

Early in the creation of optimal-foraging models, especially that of the PCM, the question arose as to how foraging animals decide when to quit searching one patch and move on to another. The answer to this question lies in Eric Charnov's (1976) *marginal value theorem* (MVT), a simple, elegant, and powerful model that has found uses far beyond its original intent. We introduce it here, but the model appears in later chapters when we discuss mobility as well as technology.

Consider a forager who enters a berry patch. As the forager begins to collect berries, the harvest rate is high. But as he gathers berries, the encounter rate declines; it becomes harder and harder to find berries, and the return rate declines. Soon, the forager finds himself pulling up branches, reaching deeper into the brambles, and scratching himself badly to pull off a single berry. If the forager insists on staying in the patch to search for that last elusive berry, he will have to eat the berries he has picked to keep going. The return rate is now *negative*, and the forager is operating at a net loss. These facts are portrayed in Figure 3-5, where the returns from two different patches are portrayed. The *y*-axis shows the cumulative returns and the right-hand *x*-axis is the time spent in a patch. The curves depict the net returns over time from foraging in two different berry patches. Patch B is more productive than patch A but, in both patches, returns initially rise quickly as the easy-to-reach berries are picked, then level out as more time is devoted to retrieving each berry. If the forager stays long enough, the curves will decline, as our forager eats his berries while continuing to pick the remaining few.

The question is: when should the forager leave the patch and move to another? Moving takes time, time that could be devoted to picking berries in the current patch. This is one of those trade-offs we mentioned. Charnov found that to maximize the overall foraging return rate, *foragers will move out of a resource patch when the rate of harvest in that patch reaches the average rate for all potential resource patches, with travel time included, and not when the return rate in the current patch has fallen to zero*. This is the MVT.

Although the solution is derived mathematically,[11] Figure 3-5 gives an idea as to how the MVT predicts when a forager should leave a patch. In the figure, the slope of the solid line is the mean environmental return rate, the average of the resource-return rates for all patches in the environment after taking travel time between patches into account. The two curves show the change over time in the net returns in two patches with different initial return rates. If we recall our calculus, we will remember that the rate of return – the increase in y over x – of any point along these curves is the slope of a line tangent to the curve at that point. The point of intersection between a line that is parallel to the mean environmental return rate but tangent to one of the curves predicts the length of time a forager should spend in a patch. Thus, the vertical dashed lines indicate (on the x-axis) the length of time a forager should stay in patch A or B. We can see that foragers would remain longer in patch B (up to T_b) than patch A (leave after only T_a). If they stayed longer in either patch, their return rate (the slope of a line tangent to the curve at some point beyond T_b or T_a) would be lower than the mean for the environment, including travel time. Although the forager would remain longer in patch B than in patch A, in both cases, *they would leave before resource exhaustion occurs*.[12]

Central Place Foraging

We can now return to the fact that humans do not feed-as-they-go but instead harvest food in the field and then return to camp. This fact means that we must consider the cost of transporting food, as well as the cost of searching, harvesting, and processing it. Zoologists developed *central place foraging models* to help model the behavior of "refuging predators," birds and carnivores that bring food back to their young (Orians and Pearson 1979). Anthropologists have found them useful, and they are of special interest to archaeologists because they can be modified to predict how much a resource should be processed in the field, which has implications for what kind of remains, such as animal bones, would be left behind at processing sites versus residential camps (e.g., Jones and Madsen 1989; Rhode 1990, 2011; Metcalfe and Barlow 1992; Barlow and Metcalfe 1996; Bettinger, Malhi, and McCarthy 1997; Bird and Bliege Bird 1997; Kelly 2001; Bird et al. 2002; F. Thomas 2002; Zeanah 2002, 2004; Marlowe 2006; D. H. Thomas 2008).

The question is: how much should food be processed in the field in order to maximize the utility of the load being carried, and how might that affect resource choices?[13] This is again a matter of trade-offs. Imagine a forager collecting piñon pine seeds. One way to collect them is to pull the cones off the tree with a long hooked stick while they are still green, before they've popped open and spilled their seeds into the duff below the tree. The green cones are then roasted in a fire until they pop open. Then, you break each individual cone open with a stone and remove the nuts, which are contained in a thin hull. The hulls are then cracked open on a grinding stone and winnowed from the seeds by gently tossing them on a basketry tray (see Figure 3-2). You could process the cones in the piñon grove or could put the cones into a burden basket, carry them back to camp, and process them there. If you choose the former option, then you spend time processing cones when you could be pulling down more. But if you choose the latter option, you transport not only the nuts but also the worthless cone and hulls in your basket. What should the wise forager do?

You probably can intuit that it depends on how far it is back to camp, how much you can carry, and how much time it takes to process the food. Hadza hunters, for example, will field dress an animal if it weighs more than 15 kg *and* it is more than a two-hour walk back to camp (O'Connell, Hawkes, and Jones 1990). Returning to our example, if camp is 10 meters from the piñon grove, you might as well cart the cones back to camp; but if camp is 10 km away, you would opt to process the cones. But how much?

The MVT plays a role in answering this question because "how much should we process a resource in the field" is similar to the question of "how long should we forage in this patch?" Consider Figure 3-6. In both A and B, the y-axis measures the percentage of a basketload of transported food that is edible; the right-hand x-axis is the amount of time spent harvesting and processing a resource, and the left-hand x-axis is the round-trip time from the food's location to camp. (We say "round trip" because we assume that a forager is carrying unprocessed food back to camp and then returning to gather more; but this could just as easily be the one-way distance back to camp.) A difference between this model and that used for the MVT is that the difference between processing and not processing is an either/or decision, producing a stepped rather than a continuous change in returns over time (Figure 3-6B). How does this model help us predict how much a resource should be processed in the field?

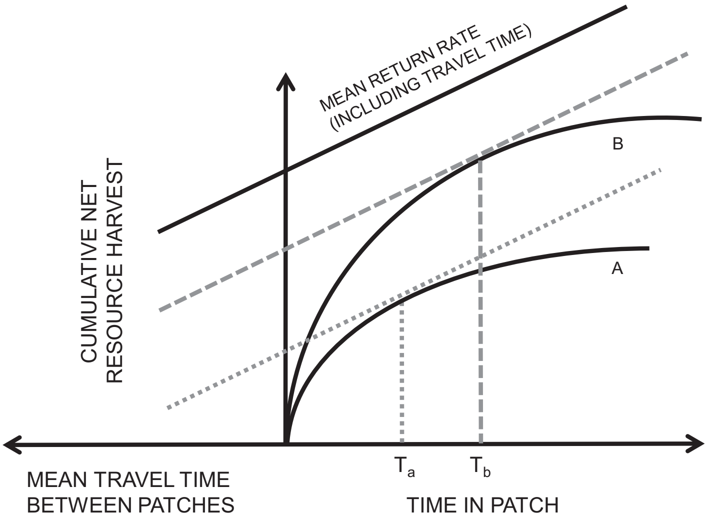


Figure 3-5. Graphic representation of the marginal-value theorem. The mean return rate is the average net return rate for the environment *including* travel time between patches. The two curves (A and B) show the change in returns for two foraging patches over time; B is more productive than A. The marginal-value theorem predicts that a forager should spend less time in A than in B but, in either case, would leave long before a patch is completely depleted of food.

Let us say that a basketload of unprocessed piñon pine seeds is 70 percent cone – waste from the point of view of the forager – and 30 percent nut. It takes less time to harvest and load up a basket of unprocessed piñon (x_0, y_0) in the field than a processed load (x_1, y_1), although a processed load is 100 percent usable. There is, once again, a trade-off here. Our forager could simply gather up basketloads of pine cones, scurry back to camp, dump them, return to the piñon grove, and repeat. He would move many loads, although only 30 percent of each load would be food. The alternative is to process the cones in the field and transport nothing but seeds. But since a forager who is processing cones is not collecting more cones, when should the forager switch from the first to the second strategy?

The answer: switch when the rate of return, taking travel time to and from camp into consideration, is greater for processed than for unprocessed pine nuts. That point is defined by a line that passes through points (x_0, y_0) and (x_1, y_1); where such a line intersects the left-hand x-axis, a point that we will call z, marks the maximum round-trip travel time that the *unprocessed* resource can be transported (Figure 3-6B). If the round trip is longer than z, it pays to process the resource in the field. More complex models account for the fact that processing may not be an either/or proposition but rather staged (e.g., Bettinger et al. 1997). For example, piñon seeds, as we described previously, have three processing stages: (1) remove the seeds from the cones, (2) remove the seeds from their hulls, and (3) grind the seeds into flour. (In case you are wondering, if you are transporting piñon more than 100 meters or so, you will always remove the cone; but you have to transport it a few hundred kilometers before removing the hull or grinding is worthwhile.)[14]

So, how do we know what z is for a specific resource? It is not difficult. The slope of the line that intersects the x-axis at z can be described as $y_0/(z + x_0)$ or $y_1/(z + x_1)$ and, therefore:

$$\frac{y_0}{z + x_0} = \frac{y_1}{z + x_1}$$

where

z = the round-trip travel time between a camp and a food-collecting location;

x_0 = the time to procure a load of unprocessed food;
x_1 = the time to procure and process a load of food;
y_0 = the utility of a load of food without processing; and
y_1 = the utility of a load with processing.

Solving the equation for z, we have:

$$z = \frac{y_0 x_1 - y_1 x_0}{y_1 - x_0}$$

The difficult part is figuring out the values for the x's and y's. As with return rates, these can be established through ethnographic fieldwork or experiments. In the Great Basin of the western United States, archaeologists have measured the volumes of ethnographic burden baskets and experimented to see how many kilocalories worth of piñon, ricegrass, cattail rhizomes, and so on can fit into one after different levels of processing. Ethnographic accounts can point to ways that food might be carried without baskets. Small game might be simply tucked underneath a belt, or large game might be carried, unbutchered, on a pole or strapped to someone's back. After killing very large game, the Hadza strip off long pieces of meat and then wrap them around their shoulders and torso, forming what James O'Connell calls a "meat shirt."

In general, central-place foraging models mean that the distance back to camp helps determine which resources are worth collecting. The y-axis in Figure 3-6 only asks what percentage of a basketload of food is edible. We could convert this percentage to kilocalories and determine the return rate by adding in the time it takes to carry the food back to camp (in addition to the harvesting and in-field processing time).[15] Doing so, we would find that low-ranked foods cannot be transported very far at all before the forager operates at a net loss. The farther a forager travels from camp, the higher the postencounter return rate must be to make the additional cost of transporting the food worthwhile. This means that the range of foraging targets narrows the farther a forager travels from camp. Resources that might be collected at short distances from camp are ignored at long distances.

This model assumes that all foods are transported by foot on someone's back. Where transportation technology is available, such as canoes, dogsleds, or horses, a greater volume of resources can be moved. Looking at Figure 3-6, we can surmise that by effectively reducing the cost of transport (as measured by the left x-axis), transportation technology reduces the need to field-process many resources. This, in turn, means that most food processing occurs at the residential camp and, contrary to what we just stated, that lower ranked foods can be more profitably gathered at longer distances from a camp. This suggests that any pressure to gather low-ranked food resources at distances from camp that are unprofitably transported on foot would spur foragers to invest time and energy in transportation technology (see Ames 2002; see also Chapter 5).

Other Factors to Consider

Risk

No environment is constant. In addition to seasonal variation, there are changes from year to year. Winters may be mild one year and severe the next; summers may alternate between wet and dry; migratory species, such as salmon or caribou, may arrive late or not at all. Foragers, just like all other people, must cope with *risk* in their lives.[16]

The term *risk* can refer to several different phenomena that all concern a resource's abundance over time and space (see also Chapter 5). Resources can vary in their intensity (variance over time in a resource's abundance), frequency (how frequently a resource's abundance fluctuates below or above a given level; e.g., two standard deviations from the mean abundance), spatial extent (how large an area is affected by a particular resource's fluctuations), and predictability (how much can

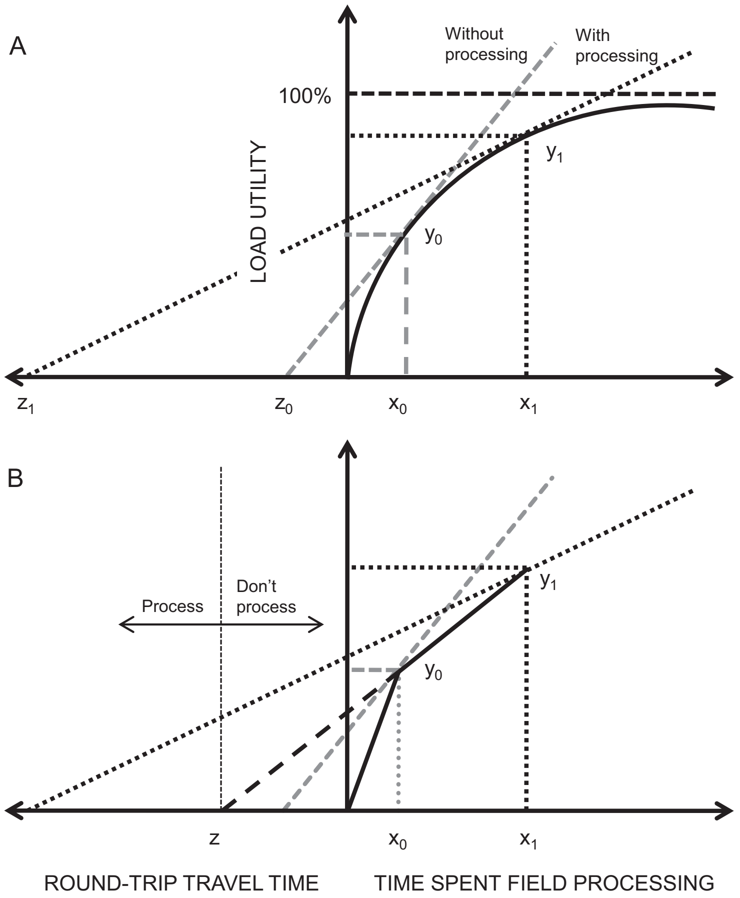


Figure 3-6. A field-processing model based on the marginal value theorem. The y-axis is the percentage of a load that is edible food; the right-hand x-axis is the time spent harvesting and field processing a resource, and the left-hand x-axis is the round-trip time between camp and the field location. A: With no field processing, a forager spends less time (x_0) in the field to acquire a transportable load that contains a low percentage of food (y_0) due to attached "waste" (e.g., pine cones). With processing, a forager spends more time in the field preparing a transportable load (x_1) but brings home a load that is a higher percentage of edible food (y_1); we show two cases here, one where home is close (z_0) and one where it is far (z_1). B: At what distance from home should the resource be processed? Recognizing that the relationship of processing to time spent foraging is not a continuous function (as in A) but stepped (one either does or does not process), processing is required for any home base that is farther than point z on the left-hand x-axis; z is defined by a line that intersects both x_0, y_0 and x_1, y_1.

be known in advance about a resource's future condition; this could be broken down into both temporal and spatial categories). When many authors refer to risk, they often use an amalgam of these different dimensions. Usually, they mean the chance of not having enough food for a long enough period of time for the shortfall to produce some undesirable result (see Cashdan [1992] for a review).

To prepare for risk, Brian Hayden argued (1981a,b) that hunter-gatherers diversify their resource base, making it stable and reliable. With a variety of resources in the diet, if one fails, a forager will have the knowledge and skill to substitute another. Hayden sees the appearance in prehistory of broad-based economies as a product of our species' continual struggle to increase subsistence reliability through technology that permits diversification (e.g., seed grinding, fishing technology, storage).[17] The DBM, however, argues that diversification does not result from a conscious desire to reduce risk but rather from a reduction in the availability of high-ranked resources.

However, risk does play a role in the decision-making process that optimal-foraging models approximate. Humans rarely have perfect information about their environment. This means they never really forage optimally but instead base decisions on their best guesses. Depending on conditions, foragers may want to minimize the time spent foraging, maximize net returns from a day of foraging, or reduce the risk of coming home empty-handed. In some circumstances, foragers may even intentionally target the most risky food resources (see Chapter 8).

Steven Mithen (1989, 1990) used a simulation that contains elements of the DBM but that included the conflicting demands of increasing long-term returns and reducing the risk of going without any daily return. In his simulation, the ability to make decisions about food selection is affected by the forager's own expertise and knowledge of local conditions combined with the knowledge of others. The individual forager is the unit of analysis in Mithen's computer simulation, and activities are modeled on a minute-by-minute basis. The forager's goals can change as the day goes by depending on what has happened earlier in the day and on the forager's long-term goal. The model simulates the activities of several individuals who share information among themselves, all of whom try to increase long-term return rates while reducing the risk of going without any food on a daily basis. Therefore, a forager in the model decides to harvest a resource based on (1) how much food has already been acquired that day, (2) whether the resource can be procured given the amount of time remaining in the day and the forager's knowledge of the energetic cost of pursuing the resource (as opposed to searching for and possibly pursuing other foods in the time remaining), and (3) a desire to bring back at least a minimal amount of food each day. Applying his model to the Valley Bisa of east Africa, Mithen found a close agreement between the ethnographic data and a model containing both a long-term goal of increasing individual foraging efficiency and a short-term goal of reducing the risk of going without food completely.

This is not unexpected. As we noted previously, we can treat a specific foraging activity as a "patch." When the return rate from the patch falls below the mean for the environment – again, taking travel time into account – we expect the forager to abandon that "patch" (e.g., stop pursuing an elk in the waning light of day) and instead gather the berries just encountered. In sum, diets modeled by risk-reduction approaches generally can be expected to be predicted by simpler foraging models (see Winterhalder 1986a).[18]

Why Only Calories?

Optimal-foraging models generally use only energy – kilocalories – as currency. But you might be saying to yourself, "sure, calories matter, but what about all those vitamins and minerals I've been told are crucial?"

To survive, humans need five basic nutrients: carbohydrates, lipids, proteins, minerals, and vitamins. However, it is not clear *how much* of these nutrients are needed. Many human populations are consistently deficient (or overindulging) in calories or certain minerals or vitamins, according to standardized measures, such as the U.S. recommended daily allowances or those of the World Health Organization (WHO). For example, according to WHO standards, the Efe consume 26 percent more calories and 138 percent more protein than needed (Bailey and Peacock 1988). Dietary standards suggest that the proportion of calories contributed by protein should be about 8 percent (Keene 1979: table 16.4; at present, the American Dietetic Association recommends 0.8 g protein/kg body weight/day) and not more than 35–40 percent, but protein in many forager diets provides up to 50 percent of calories (Cordain et al. 2000).

Hunter-gatherers also often consume large quantities of one particular resource. After a large animal kill, foragers will gorge themselves on meat, or they may eat an excessive amount of

Table 3-5. Adult Caloric Consumption and Mean Body Size

Group	Males Ht. (m)	Wt. (kg)	Females Ht. (m)	Wt. (kg)	Mean Per-Person Daily Kcal Consumption	Reference
Ache	1.61	59.6	1.50	51.8	3,827	Hurtado and Hill 1987, 1990
Hiwi	1.54	59.0	1.45	48.0	2,043	Hurtado and Hill 1987, 1990
Ju/'hoansi	1.60	49.0	1.50	41.0	2,355	Hurtado and Hill 1987, 1990
Anbarra	1.70	59.9	1.60	47.4	2,150	Meehan 1977
Onge[a]	–	–	–	–	1,740	Bose 1964
Efe[b]	1.45	42.9	–	–	2,848	Bailey and Peacock 1988
Efe[b]	–	–	1.36	37.8	2,509	Bailey and Peacock 1988
≠Kade G/wi	1.59	54.6	1.49	49.6	1,800–2,300	Tanaka 1980
Hadza	1.62	53.0	1.50	46.3	3,003[c]	Marlowe 2010

[a] For entire population of forty-one during a one-month period.
[b] For dry season only, based on mean caloric intake per kg body weight for population as a whole.
[c] Mean of married adults; males = 2,990; females = 3,016 kcal.

honey on discovering a large hive. The long-term physiological consequences of this behavior are unknown.

For the most part, a reasonably diverse diet of sufficient calories probably provides enough nutrients. And people readily know when they are not getting enough calories – they become hungry. For this reason, calories might be the most parsimonious and realistic dietary currency. However, human daily caloric requirements are not known with certainty; 2,000 kcal/day is often used as a basic adult requirement, but the actual amount depends on age, sex, body size, activity level, pregnancy or lactation, and environmental parameters such as average daily temperature. Caloric intake can vary seasonally as well, sometimes quite dramatically (Lee 1979; Meehan 1982; Wilmsen 1982; Hurtado and Hill 1990). Table 3-5 provides some idea of the variability in hunter-gatherer mean daily caloric intakes.

The Importance of Fatty Meat

Humans have a pronounced desire for meat, and especially fatty meat. Even where plant food provides the bulk of calories, foragers still refer to the lack of meat in camp as a time of hunger and starvation (see Silberbauer 1981b: 494; Shostak 1981). Even though hunting frequently provides meager returns (Table 3-6), all foragers value meat highly (Dwyer 1985b). Despite the importance of plant foods to Bushmen diet, for example, the Ju/'hoansi "eat as much vegetable food as they need, and as much meat as they can" (Lee 1968: 41; Figure 3-7). In some Australian societies, young men acquire religious knowledge from older men by exchanging meat for it. This gives them considerable motivation to hunt because men cannot become full-fledged adults and marry if they do not acquire sufficient ritual knowledge. Hunting success correlates with quantity of ritual knowledge as well as with secular status in Australia (Sackett 1979; Altman 1984, 1987). Gunwinggu men are divided into *maihmak* (men good for animal flesh) or *maihwarreh* (men rubbish for animal flesh; Altman 1987). In fact, hunting among many foragers often takes on strong symbolic meanings since it takes the life of beings that are, as the Cree point out,

Table 3-6. Meat Consumption and Hunting Success

Group	Consumption Kg/Day/ Person	Kg/Hr/ Hunter	Kg/Day/ Hunter	Success Rate (%)[a]	Reference
Etolo	1.23	0.2–0.3	–	–	Dwyer 1983
Ache	1.78	–	1	–	Hill et al. 1985; Hurtado et al. 1985
Ache (bow)	–	0.53	–	–	Hill and Hawkes 1983
Ache (shotgun)	–	1.60	–	–	Hill and Hawkes 1983
Ache (hands)	–	0.27	–	–	Hill and Hawkes 1983
Yanomamo (bow)	0.21–0.49	0.48	3.9	–	Hames and Vickers 1982
Yanomamo (shotgun)	–	1.35	–	–	Hames and Vickers 1982
Ye'kwana	–	–	13.3	–	Hames and Vickers 1982
Siona-Secoya	–	–	16.8	85	Vickers 1989
Bisa	–	–	25	9–33	Marks 1976
Cuiva	–	–	3.6	–	Hurtado and Hill 1987
Hadza	–	1.0	4.6	27	Hawkes et al. 1991
Ju/'hoansi	0.46	0.66	2.6	23	Lee 1979, 1982
≠Kade G/wi (snares)	–	–	0.48	20	Wilmsen and Durham 1988
≠Kade G/wi (archery)	–	–	2.9	16	Wilmsen and Durham 1988
≠Kade G/wi	0.30	–	–	–	Tanaka 1980
Kutse Bushmen	–	–	–	38	Kent 1993
Efe (monkey hunts)	0.42[b]	–	–	30	Bailey 1991
Efe (ambush hunts)	0.20[c]	–	–	11	Bailey 1991
Efe (group hunts)	0.26[d]	–	–	–	Bailey 1991
Efe (archery)	–	–	0.33	–	Terashima 1983
BaMbuti (nets)	–	–	0.12–0.39	–	Ichikawa 1983
BaMbuti (nets)	–	–	0.12	–	Terashima 1983
BaMbuti (archery)	–	–	0.11	–	Terashima 1983
BaMbuti (nets)	0.45	0.22	–	–	Hart 1978
BaMbuti (archery)	0.11–0.17	–	–	52	Harako 1981
BaMbuti (nets)	–	0.37	–	61	Harako 1981
BaMbuti (nets)	1.06	0.38	2.6	100	Tanno 1976
BaMbuti (spears)	0.22	0.63	–	–	Harako 1981
Bofi (nets)	–	0.32	–	–	Lupo and Schmitt 2002
Aka (nets)	–	–	0.45–2.1	–	Noss and Hewlett 2001
Anbarra	0.55	–	–	–	Meehan 1977b, 1982

Group	Consumption Kg/Day/ Person	Kg/Hr/ Hunter	Kg/Day/ Hunter	Success Rate (%)[a]	Reference
Ngadadjara	0.56	–	–	–	Gould 1980
G/wi	0.29	–	–	–	Silberbauer 1981a, 1981b
Agta (male)	–	–	–	17	Estioko-Griffin and Griffin 1985; Goodman, Griffin, Estioko-Griffin, and Grove 1985
Agta (female)	–	–	–	31	Estioko-Griffin and Griffin 1985; Goodman et al. 1985
Agta (mixed)	–	–	–	41	Estioko-Griffin and Griffin 1985; Goodman et al. 1985
Agta (Upper Palanan)	–	–	–	63	Griffin and Griffin 2000
Agta (Cagayan)	–	–	–	29	Griffin and Griffin 2000
Agta (Cagayan)	–	–	–	16	Griffin and Griffin 2000
Batek	0.2	–	–	59	K. Endicott 1981
Semaq-Beri (villages)	–	0.41	3.3	43	Kuchikura 1987, 1988
Semaq-Beri (camps)	–	0.5	2.8	33	Kuchikura 1987, 1988
Nukak (wet)	0.09–0.56	–	–	–	Politis 2007
Nukak (dry)	0.20–0.27	–	–	–	Politis 2007
Pumé	–	0.51	2.38	75	Greaves, Kramer, pers. comm.
Evenki	6.5–7	–	–	–	Turov 2010

[a] The percentage of hunting trips during which any kind of kill is made, regardless of size.

[b] Standard deviation = 0.464; mean return is 0.319 if time to manufacture arrows is taken into account.

[c] Mean return is 0.185 if time to build hunting perch is taken into account.

[d] Standard deviation = 0.274; there is a 70–96 percent chance that a man will not kill an animal while hunting communally.

These are only averages over varying lengths of time. There is also seasonal variability in meat intake. The daily per capita meat intake of the G/wi, for example, varies from only 0.06 kg in September to 0.57 kg in January (Silberbauer 1981b).

"like humans" (Tanner 1979). An ecological approach to diet, however, must initially assume that an activity's value is related to its material consequences. Why is meat so highly desired in all hunter-gatherer societies?

One obvious reason is that meat contains high-quality proteins, the nine essential amino acids that the human body cannot synthesize. High-quality proteins are essential for normal metabolic function. (Meat is also more nutrient-dense than plant food, providing essential minerals, such as iron and zinc, vitamins such as B_{12}, and glucose in an easily digestible form.)

However, although ethnographic accounts abound with references to the importance of meat, they equally convey the importance of fat in assessing the quality of game (Jochim 1981: 78–87; Hayden 1981b; Speth and Spielmann 1983; Abrams 1987). Among the Kaska, for example:

> Meat itself is ranked in order of preference . . . Fat is greatly relished and all meat is improved if it contains fat. From October, when the moose begins to run, and throughout the winter, bulls are tough and their meat contains little fat. They then are regarded as "no good eating," in comparison to the cow, which is rich and succulent with fat. (Honigmann 1949: 104; see Speth 2010: 70–72 for more accounts)

Animals that generally have little body fat are often considered secondary resources or even starvation food. During a time when no large, fat-rich game was available in the Canadian subarctic, for example, a Hare man wearily moaned that it was "back to choking rabbits" (Savishinsky 1974: 25). It may therefore be fat rather than protein that drives the desire for meat in many foraging societies. Animal fat is important as a source of linoleic acid (although not as good a source as oil-rich seeds) and is important for the absorption, transportation, metabolism, and storage of fat-soluble vitamins. There is, therefore, a physiological reason for humans' preference for fatty foods.

But do foragers desire meat for protein and fat or for calories? Protein and fat are both a source of energy. At 4 kcal/gm, the protein in meat provides the same amount of energy as carbohydrates, and fat provides even more – 9 kcal/gm. To derive energy from protein, however, the human body must raise its metabolic rate by 10 percent over that required to process energy from carbohydrate or fat (Noli and Avery 1988: 396). The rate of oxygen uptake by the liver limits the proportion of an individual's energy need that can be derived from protein to about 50 percent – about the maximum seen in hunter-gatherer diets (Cordain et al. 2000; the Ache, e.g., derive about 39 percent of their energy from protein; Hill 1988). Experimental studies show that consuming large amounts of lean meat leads to clinical symptoms of protein poisoning, signs that the kidneys and liver are overloaded: nausea, a sense of uneasiness, dehydration, and diarrhea. In extreme cases, this can lead to death (through what is known as "rabbit starvation" among explorers of the north: eat all the rabbits you want in the spring – you will still die because rabbits at that time are extremely lean). Excessive use of protein as an energy source can also lead to toxic levels of ammonia in the blood, calcium loss, and lean-tissue loss, even over the short term, and it may be especially damaging to pregnant women (see Speth and Spielmann 1983; Spielmann 1989; Speth 1990, 2010). Lean meat is not only a problem in the Arctic but also at any time that animals go through a lean season that requires them to metabolize their own fat deposits (Speth 2010: 72).

In addition, human energy needs must be met before protein needs. A diet high in protein and low in carbohydrates or fat results in the body using protein as energy, rather than as protein, meaning that a diet high in lean meat could result in protein deficiency (Speth and Spielmann 1983: 13). Carbohydrates and fat spare protein from being used as a source of energy. All things being equal, wise foragers will want a certain amount of carbohydrate or fat in their diet to free up the protein in the meat they consume. We could be justified in using calories as the only currency in foraging models if the caloric and protein contents of foods are correlated, as Hawkes and O'Connell (1985) show to be true for the foods consumed by the Ju/'hoansi.

This perspective on calories, protein, and fat makes some sense out of several practices of foraging societies. It accounts for the so-called fat and grease "obsessions" of maritime hunter-gatherers, such as those of the Northwest Coast, where eulachon fish oil was highly prized (see Noli and Avery 1988). It also accounts for meat gorging among Plains hunter-gatherers (Speth and Spielmann 1983) and the trading of meat for carbohydrates between foragers and

Figure 3-7. A Kua Bushman near Mosetlharobega butchers the rib portion of a scavenged eland in April 1978. Meat can be sought after, through hunting or scavenging, as a source of calories, protein, and/or fats. Courtesy of Robert Hitchcock.

horticulturalists (as noted in Chapter 1; see also Spielmann 1991). And it sheds light on the nature of tropical-forest subsistence. Anthropologists have attributed village warfare and hunting taboos in the tropical forests (especially the Amazon) to the difficulty of acquiring sufficient animal protein (see review in Sponsel 1986).[19] However, some studies suggest that tropical foragers acquire a substantial proportion of calories from meat; for example, 68 percent for the Hiwi (Hurtado and Hill 1990). Tropical hunter-gatherers may have an excess of protein but be deficient in carbohydrates (Milton 1985; Sponsel 1986; Hill et al. 1987). The Efe, for example, trade meat for Lese agricultural produce containing two to five times the meat's caloric content (Hart 1978; Bailey and Peacock 1988). Tropical horticulturalists, however, may have a surfeit of carbohydrates but inadequate protein (e.g., Keegan 1986). Foragers may need the carbohydrate resources of neighboring horticulturalists, and hunting may be the most cost-effective means of acquiring them.

Conclusion

This chapter began by considering global patterns in gross diet categories, which revealed that hunter-gatherer diet cannot be stereotyped and that it is related in a fairly straightforward fashion to gross environmental characteristics. We saw that the use of aquatic resources may be related to low hunting returns or the inability to store an adequate amount of plant food or meat for a lean season.

But these are only speculations based on patterns. Explanations of variability in subsistence lie in the economic decision-making process of hunter-gatherers. The optimal-foraging models described here aspire to model that process and have had some success in doing so. Expressed in the terms of optimal foraging, we could say that when the overall return rate from hunting is lower than the return rate from fishing, then foragers will forgo hunting for fishing. In areas where plant collection provides low return rates, such as the tropical forests or grasslands, and there are no fish resources, foragers may devote more time to hunting in order to trade with horticulturalists for carbohydrates as a way to obtain sufficient calories.

The characteristics of food resources themselves set the initial conditions of the subsistence decision-making process. Foragers most likely rank foods in terms of energy (kilocalories), but under some conditions, in terms of protein or fat. In extreme cases, they may even select resources in terms of specific nutrients, but this is unlikely to be a factor in explaining large-scale dietary patterns. Current applications of the diet-breadth and patch-choice models demonstrate that human hunting and gathering can be modeled fairly well with modified models of evolutionary ecology. These models assist in understanding the variables important to human foraging and in modeling foraging as an explicitly human decision-making process (see Mithen 1990).

A frequent criticism of optimal-foraging models is that what constitutes food is culturally defined and that optimal-foraging models cannot cope with resources that are taken or excluded for nonenergetic reasons. Men can be motivated to go hunting to seek prestige (Dwyer 1974, 1985a,b) or to collect furs or feathers; some resources may be tabooed, perhaps because they are sacred or considered inedible. Some foods may be overlooked or, alternatively, preferred because of taste (e.g., Koster, Hodgen, Venegas, and Copeland 2010). How can optimal foraging account for resources that are or are not taken for nonsubsistence reasons?

Foraging models do not claim to duplicate reality; instead, they claim to model reality at some level of specificity *if* hunter-gatherers are behaving according to a model's set of goals and conditions. Optimization models are heuristics; they do not provide a priori answers and explanations. By predicting which resources a forager will take if resources are ranked only in terms of their search costs and postencounter return rates, for example, the data collected to test optimal-foraging models can flag those resources that are taken or ignored for reasons other than energetics. For example, when Mithen (1989) applied his foraging model to Africa's Valley Bisa, he predicted that zebra should be included in the diet. Yet the Bisa rarely hunt zebra. It is unclear whether this is for legal reasons or because zebra fall outside what the Bisa deem edible resources. (Coincidentally, the G/wi in Botswana also do not hunt zebra, which Silberbauer [1981a: 293] found inexplicable.) In either case, the fact that the model predicts zebra to be in the diet, when in fact it is not, suggests that the decision not to eat zebra probably has little to do with energetic factors.[20] Thus, a foraging model helps point to which resources are or are not taken for nonsubsistence reasons.

Some thirty years after they were first introduced to anthropology, optimal-foraging models provide the best way to understand variation in hunter-gatherer diet. They do so by providing empirically testable models and by opening productive avenues of thought into the relationships among foraging strategies, diet, technology, men's versus women's foraging, children's foraging, and foraging for goals not related to energy. As such, we will see in subsequent chapters that they link foraging to issues such as childcare, reproduction, and social competition and help us understand hunter-gatherer behavior beyond the simple realm of food.

Chapter 4

Mobility

> When I'm a kid we're always moving. Never stay around one place for long. We got to move, otherwise we find no food. Even then sometimes there's no food for a while, so people in camps go hungry. Wherever there's food, well, we got to move to that place.
>
> Kutchin man (Nelson 1986: 273)

> [We do not like] sitting one place all the time like white men.
>
> Kaska man (Honigmann 1949: 102)

There is hardly a more romantic image in anthropology than that of a small band of hunter-gatherers setting off through the dunes and scrub, their few belongings slung over their shoulders – people who are attached to all places but none too strongly. This image is one of the first that students associate with hunter-gatherers, and it is significant for professionals as well. At *Man the Hunter*, Lee and DeVore (1968: 11) defined hunter-gatherers as people who "move around a lot" and whose lives are strongly determined by this fact. And they were right; mobility does indeed exert a strong influence over other elements of foragers' lives. Marcel Mauss, for example, linked the Eskimos' moral and religious life to their seasonal mobility (Mauss 1904–05), and Sahlins (1972) saw mobility as conditioning hunter-gatherers' laissez-faire attitude toward material goods.

In the 1970s, archaeologists became interested in the *seasonal rounds* of hunter-gatherers, those movements that foragers make from one place to another as resources come and go with the seasons (e.g., Thomas 1973; Bettinger 1977).[1] The Great Basin Shoshone, for example, spent the winter in villages in the piñon and juniper forests of the mountains (Figure 4-1). As spring came, they moved down to the valley floors and gathered tubers, bulbs, and the first seeds of spring; later, they moved upslope as seeds ripened there. In the summer, they might move to a river where trout were running, or to a marsh where they could hunt waterfowl and gather bulrush seeds. In the early fall, they would move back into the mountains, establish winter camps, and collect piñon nuts while hunting deer and bighorn sheep.

Hunter-gatherers move in different ways. Some do indeed "move around a lot" but others move hardly at all. (And hunter-gatherers are not the only ones who move; many horticulturalists, and virtually all pastoralists, are also mobile.)[2] As in subsistence, there is considerable variability in how, and how much, hunter-gatherers move (Table 4-1).

Our purpose in this chapter is not to document variability in seasonal rounds – there's remarkable variation there – but rather to describe the relationships between individual foraging and camp movement that help produce that variation. We first discuss concepts and ethnographic data that demonstrate relationships between mobility and the environment. We then present a simple foraging model that considers how different foraging environments could result in longer or shorter individual forays and more or less frequent group movement. Following this, we discuss *sedentism* – the lack of residential movement. Sedentism receives special treatment because, in my opinion, the transition from a nomadic to a sedentary existence was the crucible of significant, pervasive, and permanent changes in the social and political lives of hunter-gatherers (which we return to in Chapter 9). Finally, we continue anthropology's tradition of understanding how nomadism influences other aspects of life by looking at three issues linked to mobility: a mobility ethos, *enculturation*, how children learn their culture, and whether hunter-gatherers intentionally conserve resources.

Mobility and the Environment

Hunter-gatherers can indeed "move around a lot" and anthropologists have long recognized variability in how they do so. One early scheme divided hunter-gatherers into four categories: *free-wandering* groups, which have no territorial boundaries and are characteristic of colonizing populations; *restricted-wandering* groups, which live under higher population densities and are constrained by territorial boundaries; *central-based wandering* groups, which seasonally return to a specific village; and *semipermanent sedentary* groups, which occupy a village year-round but move it every few years (Beardsley et al. 1956).

Murdock (1967) later modified these categories into *fully nomadic*, *seminomadic*, *semisedentary*, and *fully sedentary*, respectively. Using effective temperature (ET; see Chapter 3) as a measure, Binford (1980) showed a systematic relationship between environments and Murdock's settlement types (Table 4-2). Hunter-gatherers in the tropical forests and the extreme Arctic tend to be very mobile. In temperate forests and deserts, mobility is seasonally constrained, especially as the use of stored food during the winter becomes more important or as the distribution of water constrains the movements of desert foragers. In doing so, Binford ushered in a renewed round of interest in hunter-gatherer mobility, especially among archaeologists.

Binford described the variability he saw in hunter-gatherer settlement systems with the concepts of *foragers* and *collectors*. These, in turn, rested on the concepts of *residential mobility*, movements of the co-residential group from one camp to another, and *logistical mobility*, movements of individuals or task-specific groups out from and back to a residential camp. Foragers move consumers to food resources through residential mobility and thus map onto a region's resource locations (Figure 4-2). Collectors move residentially to key locations (e.g., where water or firewood is available) and use logistical forays to bring food to camp (Figure 4-3). In general, Binford argued that foragers have high residential mobility and invest less effort in logistical movements, whereas collectors make few residential moves but frequent, and often lengthy, logistical forays. Foragers move consumers to food; collectors move food to consumers.

But not all foragers (as Binford defined them)[3] are highly mobile, nor are all collectors nearly sedentary. Binford's typology focuses not on the frequency of movement but on the organization of camp movement relative to individual foraging. The Anbarra of North Australia, for example, move only a few times a year but make frequent, relatively short forays to hunt and fish and to collect shellfish, roots, and water (government rations provide about 50 percent of their calories). The Malaysian Semang make frequent residential moves, but they too usually make only daily forays from camp. Both, however, are foragers in Binford's sense because they move consumers to resources. The difference in the frequency of movement is related to the food density of their

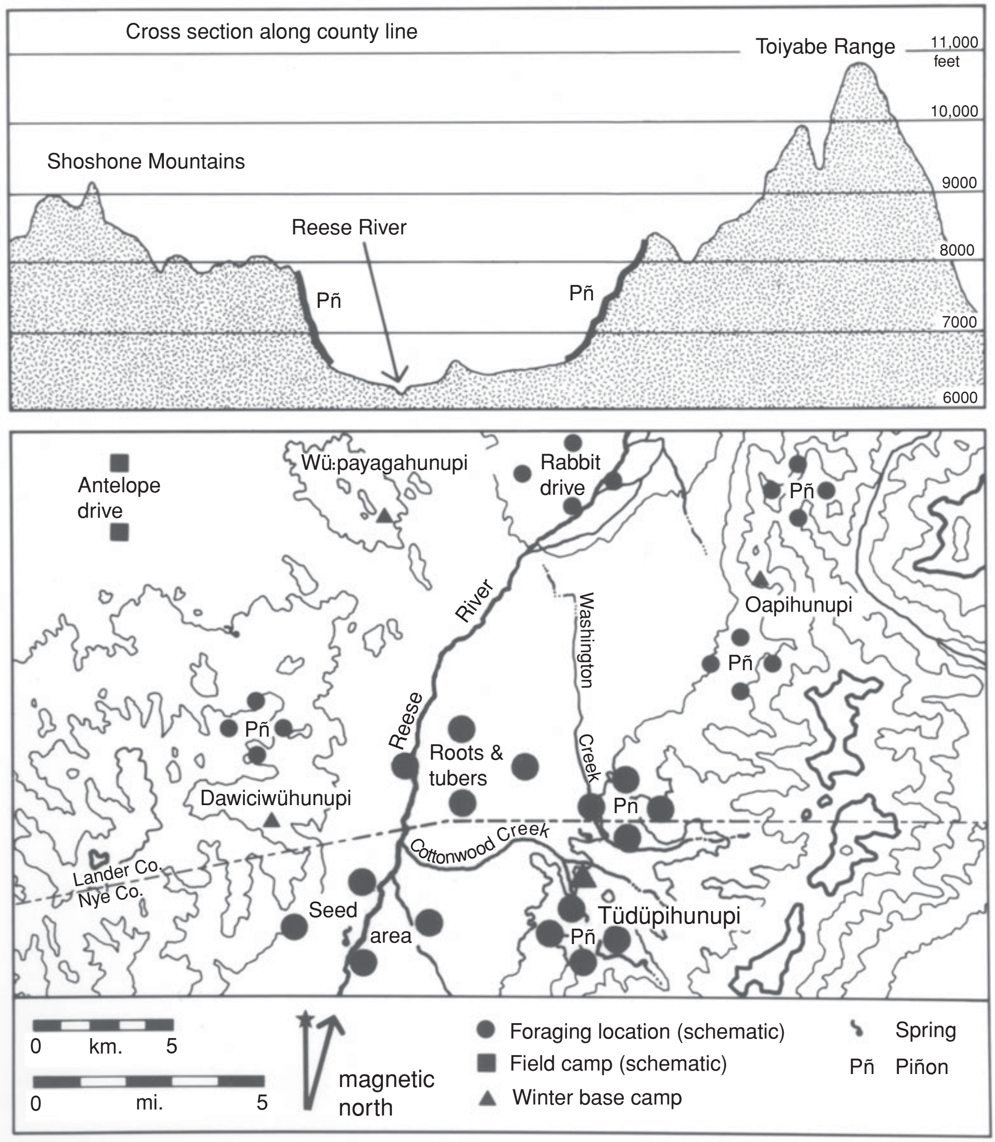


Figure 4-1. Settlement pattern of the Tüdüpihunupi, the Reese River Valley Shoshone. From Steward 1938 (figure 8) as redrawn by Dennis O'Brien, in Thomas 1981. Courtesy of the Division of Anthropology, American Museum of Natural History.

respective environments, but the relations between the individual forager and group movement remain the same.

Binford did not intend that his two settlement system types be used to pigeonhole ethnographic or archaeological cases.[4] Instead, he saw foragers and collectors as the ends of a continuum. This continuum measured foragers' responses to how food resources were distributed across space and throughout the year. Where resources are homogeneously distributed and where food is available more or less year-round, a forager pattern is more likely; where the opposite conditions hold true, Binford expected a collector pattern. In general, resources become more aggregated in space and more constrained in their seasonal availability as we move from the equator to the Arctic (except, perhaps, for the high Arctic, where some groups cannot access migratory fish or

Table 4-1. Hunter-Gatherer Mobility

Group	Residential Moves/yr	Average Distance (km)	Total Distance (km)	Total Area (km^2)	Logistical Mobility (days)	Primary Biomass (kg/m^2)	Reference
Baffinland Inuit	60	12	720	25,000	–	0.27	Hantzsch 1977
Ona (Selk'nam)	60	–	–	–	–	8.6	Gusinde 1934; Stuart 1972
Netsilingmiut	14	16.8	237	6,000	–	0.027	Balikci 1970
Nunamiut	10	69.5	725	4,200–20,500	–	1.11	Amsden 1977; Binford 1978
Chilkat Tlingit	>2	–	8–80	2,500	–	29.6	Schalk 1978; Mitchell and Donald 1988
Nuxalk (Bella Coola)	–	–	–	625	–	30.1	Schalk 1978
Owikeno Kwakwak'awakw	–	–	–	639	–	33.6	Schalk 1978
Mistassini Cree	10	–	510	3,385	–	11.9	Rogers 1963, 1967a,b; 1972
S. Tlingit	3	–	–	1,953	–	29.6	Schalk 1978
Berens River Ojibwa	–	–	320	–	–	8.5	Rogers 1967a,b; 1969b
Grand L. Victoria Cree	–	–	–	2,890	–	19.8	Rogers 1967a,b; 1969b
Pikangikum (Ojibwa)	–	–	–	650	–	8.5	Rogers 1967a,b; 1969b
Evenki (reindeer herders)	–	–	200–400	–	1–2	–	Turov 2010
Haisla	–	–	–	4,000	–	32.2	Schalk 1978
Tsimshian	3–5	–	290–450	–	–	32.0	Schalk 1978; Mitchell and Donald 1988
Haida	–	–	–	923	–	32.9	Schalk 1978; Langdon 1979
Makah	2	7.3	15	190	–	34.1	Schalk 1978
Quileute	–	–	–	185	–	34.3	Schalk 1978
Blackfoot (Siksika)	–	16–24	–	700	–	3.9	Ewers 1955
Quinault	–	–	–	110	–	34.7	Schalk 1978
Kwakwak'awakw (Ft. Rupert)	3–4+	13.6	35	727	–	33.6	Schalk 1978
Kwakwak'awakw (Ft. Rupert)	–	–	252–276	–	–		Mitchell and Donald 1988

Waswanipi Cree	–	–	–	4,870	–	12.8	Rogers 1967a,b; 1969b
Aleut	1	–	–	–	32	8.6	Coxe 1804 [1787]; Laughlin 1980
Montagnais	50	64	–	2,700	–	7.7	Tanner 1944; Leacock 1954
Chinook	–	–	–	118	–	35.1	Schalk 1978; Kroeber 1939
Ainu	2	4.3	8.6	171	48	21.5	Watanabe 1968a,b; 1972
Klamath	11	7.5	84	1,058	27	15.3	Gatschet 1890; Spier 1930; Barrett 1910
Twana	4	–	48–70	211	–	35.2	Mitchell and Donald 1988; Elmendorf 1960
Puyallup-Nisqually (S. Salish)	–	–	–	191	–	23.8	Schalk 1978
Upper Skagit (S. Salish)	–	–	–	203	–	23.8	Schalk 1978
Nuuchahnulth (Nootka)	>3	10	5–55	370.5	–	34.9	Drucker 1951; Mitchell and Donald 1988
Squamish (C. Salish)	0–4	–	0–320	–	–	18.5	Mitchell and Donald 1988
Other Gulf Salish	3	34.9	77	631	–	23.8	Schalk 1978
E. Saanich (C. Salish)	4–5	–	75–110	58	–	28.8	Schalk 1978; Mitchell and Donald 1988
W. Saanich (C. Salish)	3–5	–	165–320	–	–	28.8	Schalk 1978; Mitchell and Donald 1988
Nooksack (C. Salish)	–	–	–	356	–	28.8	Schalk 1978
Micmac	–	56	–	1,000–5,200	–	17.9	Wallis and Wallis 1955; Denys 1908; LeClerq 1910; Speck 1921
Sanpoil	10	–	–	–	–	5.7	Ray 1932
Tasmanians, N.W.	–	–	400	376	–	34.8	Jones 1974
Wiyot	0–2	–	–	32	–	19.7	Schalk 1978
Kidütökadö (Surprise Valley Paiute)	40	–	–	–	29	5.8	Kelly 1932
Crow (Apsáalooke)	38	19.2	640	61,880	32	4.5	Nabokov 1967
Tasmanians, S.W.	–	–	400	476	–	34.8	Jones 1974
Nez Perce	–	16–24	–	2,000	–	11.3	Haines 1955
Cheyenne	33	12	396	–	–	6.5	Gussow 1954

(*continued*)

Table 4-1 (*continued*)

Group	Residentail Moves/yr	Average Distance (km)	Total Distance (km)	Total Area (km^2)	Logistical Mobility (days)	Primary Biomass (kg/m^2)	Reference
Tolowa	2?	–	–	91	–	35.9	Schalk 1978; Cook 1976
Yurok	0–2	–	–	35	–	35.0	Schalk 1978; Cook 1976
Maidu	–	–	–	455–3,255	–	6.7	Dixon 1905; Beals 1933
Tasmanians, Oyster Bay	–	–	160	572	–	12.0	Jones 1974
Karok	–	–	–	30	–	18.1	Schalk 1978
Tasmanians, Big River	–	–	480	1,114	–	12.0	Jones 1974
Kaibab Paiute	–	–	–	706	–	3.2	Leland 1986; Kelly 1964
Kiowa	–	16–24	–	–	–	11.4	Kroeber 1939
≠Kade G/wi	17	25	300	906	10	1.5	Tanaka 1980
Kua (mobile)	11	–	–	990	6	2.0	Hitchcock and Ebert 1989; Hitchcock 1982
Walapai	–	–	–	588	–	2.1	Kroeber 1935
Pitjandjara	–	–	–	–	5–6	0.7	Tindale 1972
Ngadadjara	37	43	1,600	2,600	8–16	0.6	Gould 1968, 1969a,b; Pate 1986
Borjeno	–	–	–	–	26	1.0	Aschmann 1959
Aranda	10	–	–	260	–	0.8	Spencer and Gillen 1927
Worora	–	–	–	743	–	9.5	Peterson and Long 1986
Guayaki	50	5.9	295	780	–	31.6	Clastres 1972
Hadza	27	8	216	2,520	3–4	11.3	O'Connell, Hawkes, and Blurton Jones 1988; Woodburn 1968, 1972
Hadza	4–20 (6.5)	11–12	–	78	–	11.3	Marlowe 2010
Seri	–	–	248	–	–	0.6	McGee 1898
Pumé	7	2.1	46	124	–	0.66	Greaves (2006)
Ju/'hoansi (Nyae Nyae)	–	–	–	–	6–10	2.0	Hitchcock and Ebert 1984

Ju/'hoansi (Dobe)	6	23.6	142	260–2,500	10	2.0	Hitchcock 1987a,b; Lee 1979
/Aise (sedentary)	0	–	–	–	2–10	2.0	Hitchcock and Ebert 1984
Kua (sedentary)	0	–	–	–	7–46	2.0	Hitchcock and Ebert 1984
Alyawara	–	–	–	1,500	7	0.8	O'Connell, Latz, and Barnett 1983
Dorobo	6	–	–	–	–	25.7	Huntingsford 1929
G/wi	11	25	275	782	8–24	1.5	Silberbauer 1972, 1981a,b
Mlabri	24	19	196	2,826	1	35.7	Pookajorn 1985, 1988
Birhor	8	10.3	90.3	130	5–6	13.8	Williams 1974
Mardudjara	–	–	–	–	15	0.5	Cane 1987; Tonkinson 1978
Siriono	16	14.4	230	780	–	18.3	Holmberg 1950; Stearman 1984
Chenchu	4	11.2	39.5	–	–	15.6	Furer-Haimendorf 1943
Umpila (Nesbitt R., Cape York)	–	–	–	35–70	–	9.1	Chase and Sutton 1987
Hill Pandaram	45	4	144	79.8	–	3.9	Morris 1982
Aeta (Cagayan)	22	12.8	281.6	3,265	–	26.9	Vanoverbergh 1925
Agta (Isabela)	20	5	107	–	–	23.6	Rai 1990
Batak	17–26	–	–	–	–	30.3	Eder 1978; 1987
Anbarra	3	3.2	7	56	1–4	9.8	Meehan 1982
Aka	8	7	60	400	–	25.4	Bahuchet 1979, 1988, 1992
Nukak	70–80	5.75	400–500	400–500	1	46.2	Politis 2007
Mirrngadja (Glyde River)	5	3.5	14.2	–	–	10.1	Peterson 1973
Vedda	3	11.2	36.3	41	–	17.2	Seligman and Seligman 1911
Mbuti	5–11	5–8	57	120–780	–	33.1	Bicchieri 1969b; Tanno 1976; Harako 1976; Turnbull 1972; Bahuchet 1992
Semang	26	11.3	203.8	2,475	–	50.3	Schebesta 1929
Andamanese (Onge, inland)	8	2.4	40	8	–	57.3	Radcliffe-Brown 1922; Cooper 1990

(*continued*)

Table 4-1 (*continued*)

Group	Residential Moves/yr	Average Distance (km)	Total Distance (km)	Total Area (km^2)	Logistical Mobility (days)	Primary Biomass (kg/m^2)	Reference
Andamanese (coastal)	–	–	–	25	–	57.3	Cooper 1990
Penan	45	8.5	384	861	–	56.6	Harrison 1949
Shasta	–	–	–	3,255	–	19.3	Dixon 1907
Owens Valley Paiute	–	–	–	1,964	–	1.0	Steward 1933
Washo	–	–	–	2,327	–	4.4	Downs 1966

Note: It is difficult to acquire these data from ethnographic sources. A residential move in the original study (Kelly 1983) was defined as any change in the residential locus made during the seasonal round. Even if a single location is seasonally reoccupied (such as winter villages on the Northwest Coast), the group is considered to be residentially mobile as long as most of the group leaves the location seasonally. To ensure comparability, fine-grained data must often be made more coarse-grained; for example, a residential move was sometimes counted as a single move although, on the way, the group may have stopped for two or three days in an intermediate spot (e.g., Clastres 1972; Williams 1974; Kozak, Baxter, Williamson, and Carneiro 1979). This could raise estimates for tropical, boreal forest groups and horse-equipped Plains hunters. Many of the data in this table were not given explicitly in an ethnography but instead were derived by piecing together indirect references to when or how far a group moved. Many cases describe an entire seasonal round, but some of the data are normative, inferential, or extrapolated from one season to another where I thought it appropriate. Most of these data are derived from a specific band for a specific year (except where ranges are given). No case should be taken to be representative of all years for all bands within an ethnographically defined group. For example, the Ngadadjara data come from Richard Gould's fieldwork, and they are not necessarily identical to other foragers of Australia's Western Desert or even to that of other bands of Ngadadjara. See Footnote 8 for comments on the Baffinland Inuit's mobility and territory.

Table 4-2. Biotic Zones and Murdock's Settlement Patterns

Zone	ET Range	Nomadic	Seminomadic	Semisedentary	Fully Sedentary	Mean
Tropical forests	26–21	9 (75)	2 (16.7)	1 (8.3)	0 (0)	1.33
Tropical/ subtropical deserts	20–16	9 (64.2)	4 (28.5)	1 (7.1)	0 (0)	1.42
Temperate deserts	15–14	3 (9.3)	21 (65.6)	3 (9.3)	5 (15.6)	2.31
Temperate forests	13–12	4 (7.5)	32 (60.3)	12 (22.6)	5 (9.4)	2.33
Boreal forests	11–10	5 (11.1)	21 (46.4)	12 (26.6)	7 (15.4)	2.46
Arctic	9–8	5 (41.6)	4 (33.3)	2 (16.6)	1 (8.3)	1.91

Numbers in parentheses are row-wise percentages. The mean is the mean score of the values given to the four settlement-pattern categories (Fully nomadic = 1, Sedentary = 4).
Source: Binford 1980: table 2.

large migratory caribou herds; see discussion of Netsilingmiut and Baffinland Inuit later in this chapter). Therefore, the pattern Binford observed in Murdock's categories and ET suggests the expected parallel between the forager–collector continuum and resource distribution.[5]

Binford's forager–collector continuum makes the case that mobility is related to the environment. Ethnographic data also demonstrate this point.

Ethnographic Data on Mobility

Rather than rely on a typological scheme, I use five variables to measure dimensions of mobility: (1) the number of residential moves made each year, (2) the average distance moved, (3) the total distance moved each year, (4) the total area used over the course of a year, and (5) the average length of a logistical foray (Kelly 1983; see Table 4-1). We'll examine some empirical patterns between the mobility variables here and then consider how they are generated from the relationships between individual foraging and camp movements.

I examine these dimensions of mobility in relation to the gross abundance and distribution of food, using ET and primary biomass for their measurement. We defined ET in Chapter 3; *primary biomass* is an environment's total amount of standing plant matter. For the most part, humans eat the reproductive parts of plants (nuts and seeds) or their stored carbohydrates (tubers, rhizomes, bulbs, and corms). In areas of high primary biomass (such as tropical forests), plants invest more energy in structural maintenance and the capture of sunlight, relative to reproductive parts or storage, resulting in primary production (PP) that is largely inedible or difficult to reach (i.e., at the tops of trees or at the ends of branches). In areas of low primary biomass, plants invest less energy in structural maintenance and growth and relatively more in reproductive tissue (seeds). In addition, many plants of dry, low primary biomass environments have large subsurface tubers (an adaptation to droughts and range fires). Therefore, primary biomass is, in general and within limits, inversely correlated with the effective abundance of edible plant food. It is also inversely related to faunal abundance and distribution since animals in high primary biomass settings tend to be small (so they can feed in tree tops) or, if large, few in number and widely spaced. Coupled with ET, primary biomass provides a rough relative measure of the potential return from foraging in a given environment. I employ Binford's (2001) primary biomass calculations for the groups used here.[6]

Residential mobility data are difficult to collect. Short of living an entire year with a nomadic band, ethnographers extrapolate from their field records to the entire year; we assume that

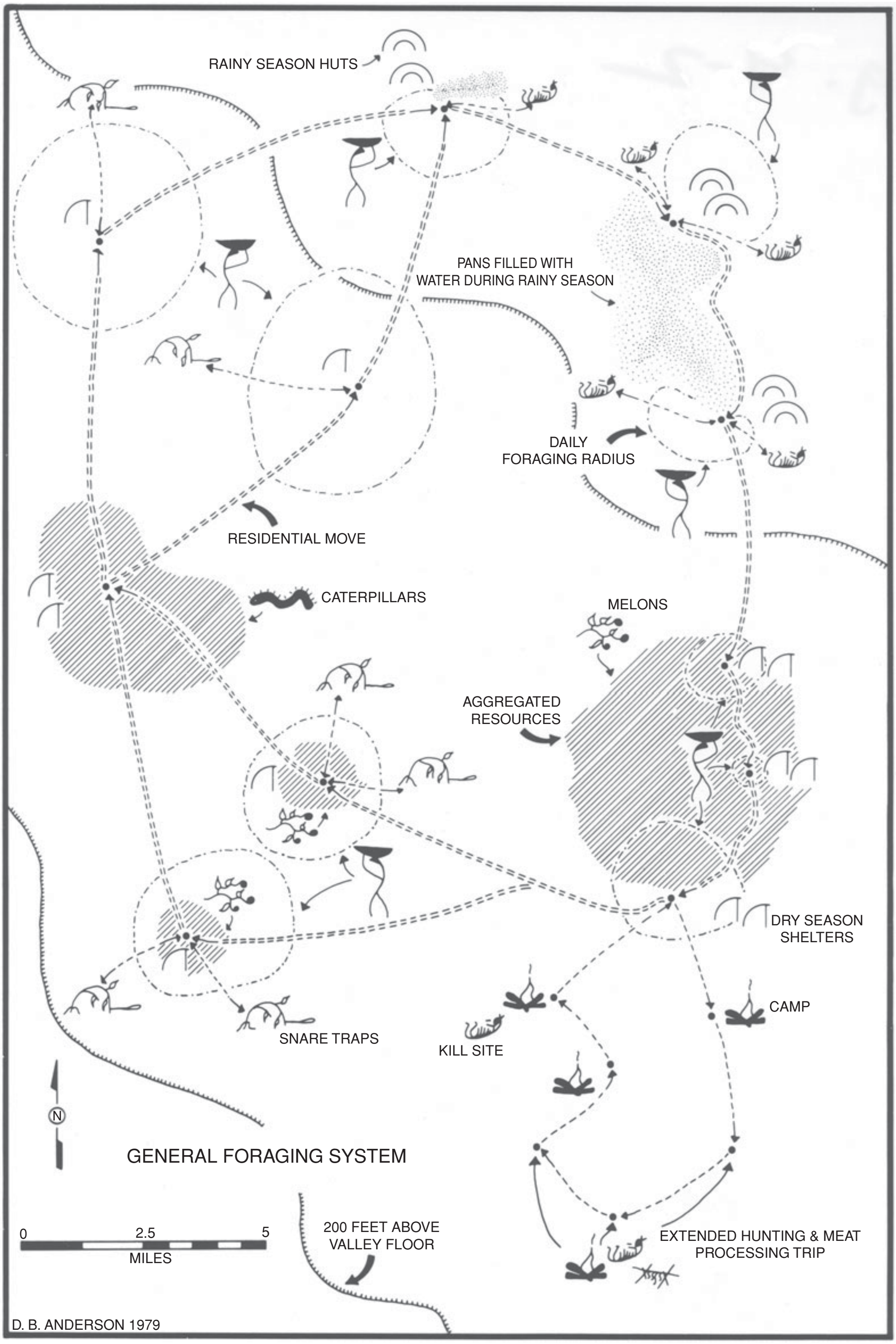


Figure 4-2. Characteristics of a foraging subsistence-settlement system. From Binford 1980, drawn by Dana Anderson. Reproduced by permission of the Society for American Archaeology from *American Antiquity* 45(1), 1980.

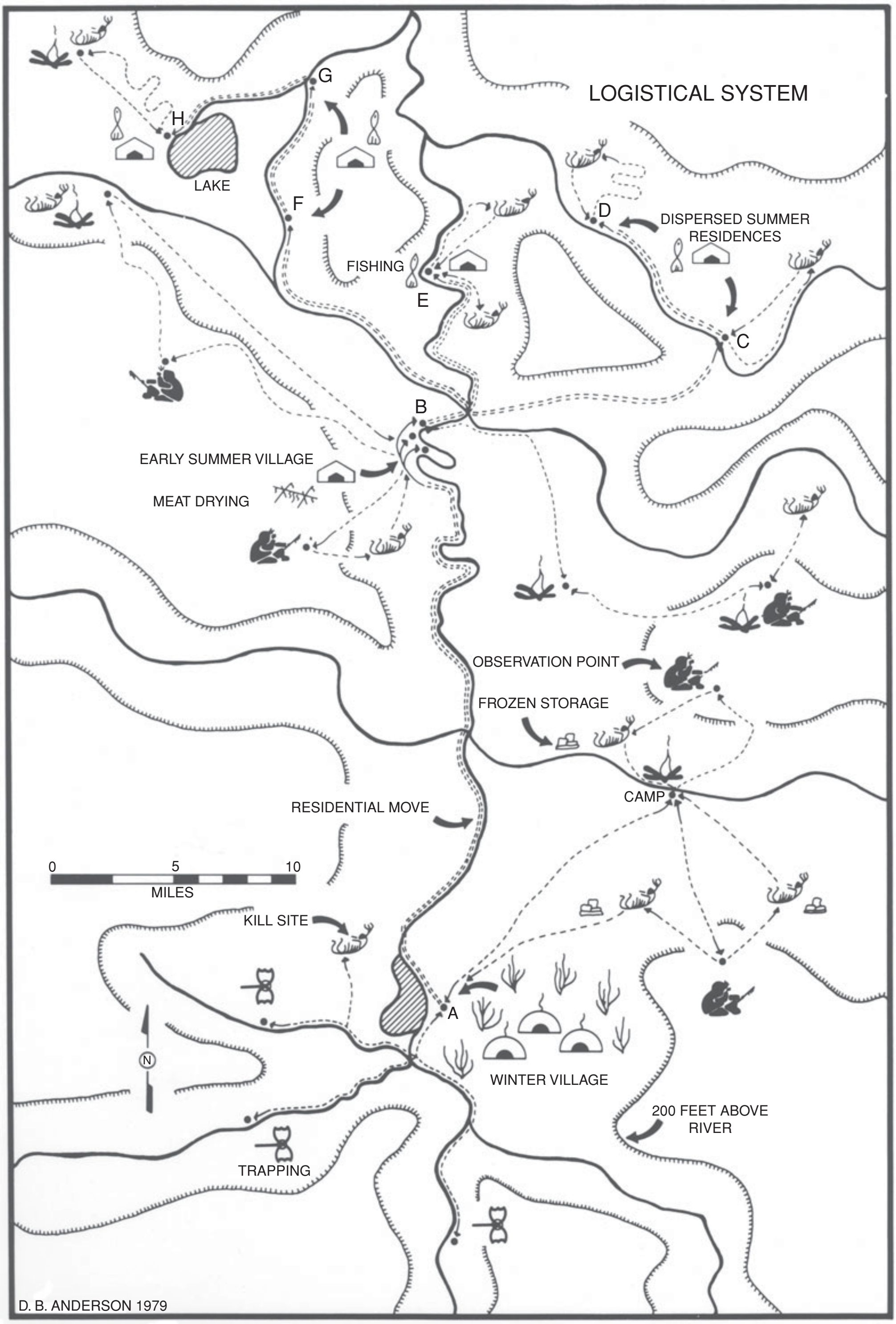


Figure 4-3. Characteristics of a collector subsistence-settlement system. From Binford 1980, drawn by Dana Anderson. Reproduced by permission of the Society for American Archaeology from *American Antiquity* 45(1), 1980.

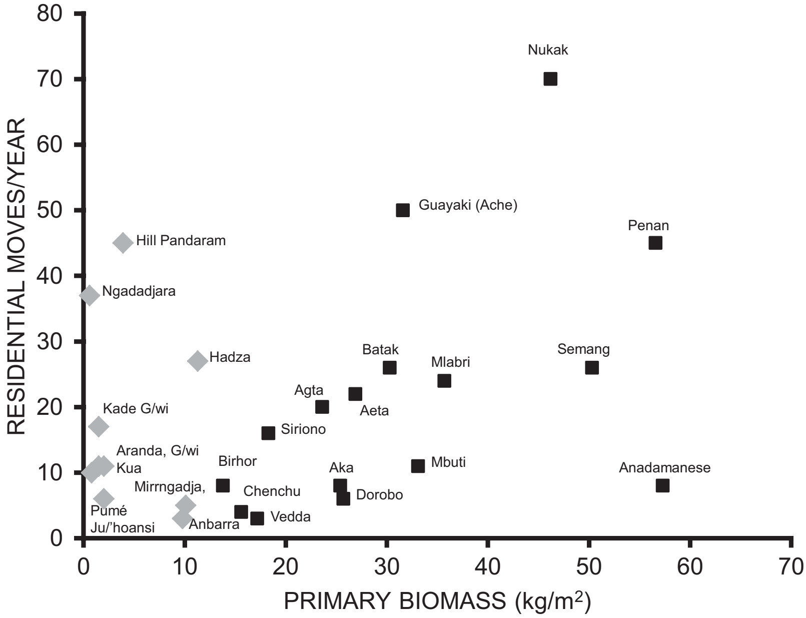


Figure 4-4. Number of residential moves per year plotted against primary biomass as a proxy measure of resource density for tropical (*black squares*) and subtropical (*gray triangles*) foragers.

extrapolation is correct, but it could be off if there are seasonal differences in residential movements (which there often are). And, in some cases, a group may move from one camp to another, making a few stops along the way for a night or more. Some ethnographers count each of these stops as a move, whereas others see them as only waystations between camps; the former method produces a high and the latter a low count of moves. It is hard to calibrate these different estimates from the ethnographies, and we use them here only as a rough guide.

Number of Residential Moves per Year

There is a limit to how frequently a pedestrian foraging group can move in a year – at the most, 365 times. But, in reality, the limit is probably far less – I would guess not much more than once a week (e.g., Pookajorn 1988: 186). We might also expect that residential moves would be somewhat related to the availability of food – as attested to by the Kutchin man in this chapter's epigraph. I argued in the preceding paragraphs that primary biomass provides a rough measure of terrestrial food density, with food being both less abundant and less accessible in high as opposed to low primary biomass environments. Therefore, in high primary biomass areas, the number of residential moves per year should increase as primary biomass increases. Figure 4-4 shows that this seems to be true for our largest dataset, the tropical forest ($n = 16$, $r = 0.51$, $p < 0.04$). Those groups who depend on aquatic resources (e.g., the Anbarra, and especially the Andamanese – whose mobility is limited since they live on a fairly small island), state-provided rations (e.g., Anbarra), or horticulture (e.g., Mbuti; the Chenchu and Vedda also do some agriculture and are linked to villages) would probably move more frequently were these resources not available.

For many tropical hunter-gatherers, camp movement also serves as a foraging trip. This often limits group movement, reducing the distances between camps. Among the Malaysian Semang, "a whole troop, with children, cannot, of course undertake long marches in the day, for the

Figure 4-5. A family of Penan walking through the Sarawak forest in 1985, moving their campsite to a better sago palm foraging area, about a three- or four-hour walk from their last camp. The men had gone out the day before to locate a camp and blaze the trail. Courtesy of Peter Brosius.

group is compelled to look for food en route. Sometimes they stop by the river bank to fish, sometimes in the forest to search for edible roots" (Schebesta 1929: 150). Among the Philippine Agta, "travel is leisurely unless a game animal is encountered to provoke a hunting spree. Frequent stops are made to chew betel nut, fish, gather or cook and even to nap" (Rai [1990: 59]; see also Pookajorn [1988] on the Mlabri). The Hadza move about 11 km on average, a distance that one could easily cover in three hours – but the Hadza take six or seven (Marlowe 2010: 107).

Although most of our data come from tropical forest groups (Figure 4-5), boreal forest groups, such as the Selk'nam, Micmac, and Montagnais, also move frequently (Figure 4-6). With low primary productivity and moderately high primary biomass, we can expect that food is not abundant in the terrestrial environment of the boreal forest and that foragers here would also be highly residentially mobile. This appears to be the case. The Micmac "remained encamped in a place only so long as they found the means of subsistence for their families" (LeClerq 1910: 100). Wintering with a group of Montagnais in 1633–34, LeJuene recorded that the group moved twenty-three times between November 12 and April 22, or about once a week (Leacock 1954; see also Turner 1889; Helm 1972; Rogers 1972). The Tasmanians, living in a temperate, evergreen forest, "daily removed to a fresh place," at least during part of the year (Backhouse, in Roth 1890: 104; see also B. Hiatt 1967, 1968). Among the Ona (Selk'nam) of Tierra del Fuego's interior forests, "the family hastens restlessly after the game animals [guanaco] and settles down for a few days at just that spot at which booty fell to it. After using up the supply, it again moves on and constantly changes its dwelling site" (Gusinde 1934: 276). Among the Beaver Indians of northern Canada, camp movement is essential because unproductive hunting can be exhausting in cold climates:

> The first day a hunter without food starts out with a fair prospect of being able to kill a moose. He is able to travel twenty or thirty miles and has a good chance of finding the track of a moose, which he may follow to success. The second day the chances are considerably less and by the third or fourth day the exertion and cold without a supply of food has completely worn him out. (Goddard 1917: 215)

In nontropical high primary biomass environments, the number of residential moves per year does seem to be correlated with primary biomass, as long as a group does not depend heavily on aquatic resources (Table 4-3). Dependence on aquatic resources is almost always associated with low residential mobility (Yesner 1980); in fact, the few available data suggest that if a group is heavily dependent on aquatic resources, the number of residential moves is inversely correlated with primary biomass (Kelly 1983: 292). In Chapter 3, we suggested that aquatic resources may be used in lieu of terrestrial game. In temperate and especially in cold settings, where primary production is lower than in the tropics, game become more important to diet and a more important determinant of mobility. In the same environments, however, large game become more dispersed and less abundant as primary biomass increases and/or temperature decreases. Dependence on aquatic resources should increase along a gradient of increasing primary biomass as the cost of hunting increases. Note that in Table 4-3, dependence on aquatic resources does increase with increasing primary biomass for those groups less than 50 percent dependent on aquatic resources. For groups heavily dependent on aquatic resources, those living in lower primary biomass settings (e.g., Sanpoil) are more mobile than those in high primary biomass settings. All groups with heavy dependence on aquatic resources and low residential mobility live in high primary biomass settings. (Most of the cases in this dataset, however, come from a single area, the Northwest Coast of North America, and thus are not conclusive.[7])

Although hunter-gatherers frequently do move campsites on the basis of foraging conditions, they also take into account such things as firewood, tree boughs for bedding, shelter, water, mosquitoes, and how dirty a camp has become (e.g., Politis 2007: 169; Marlowe 2010: 41). The location of other groups of people can also condition movements, either by attraction or repulsion, depending on the nature of the relationship.

Deserts present a special problem in this regard. Humans need water daily, and it is heavy – and difficult to transport. It's not surprising, then, that water, more often than food, determines a camp's location in deserts. Pumé women, for example, don't like to carry water more than 700 meters (Greaves 2006). During the dry season, the Mikea live in small foraging camps located on patches of *babo*, a water-engorged tuber. There is no surface water throughout much of the Mikea forest in southwestern Madagascar; nonetheless, like other desert foragers, the Mikea camp on their water source (although, in this case, they literally eat their water). Tension and anxiety permeate Anbarra camps in northern Australia as water becomes more scarce and must be carried from longer and longer distances; movement of camp is often predicated on the severity of these arguments (Meehan 1982). Hadza move when a nearby water hole dries up (Marlowe 2010: 41). Walter Taylor labeled groups whose movements are restricted by water sources as *tethered foragers* (1964, 1972).

Since a number of local factors can determine the availability of water (such as rainfall, geology, topography), we expect variability in subtropical mobility with no real correlation to primary biomass (see Figure 4-4).

The Dobe Ju/'hoansi and G/wi demonstrate the effect of water on desert mobility. One of the key differences between these two groups is that the Ju/'hoansi's environment contains extensive pans that hold water during the dry season. The geomorphology of the G/wi's habitat prevents

Figure 4-6. An Ahtna camp in central Alaska, about 1902. The ephemeral shelter indicates high residential mobility, although the Ahtna lived in substantial pithouses in villages during the winter. Photograph by the Miles Bros. Courtesy of the National Anthropological Archives, Smithsonian Institution, 03002800.

the formation of such water pans. Data in Table 4-4 show the nature of Ju/'hoansi movements during the late wet and early dry seasons. The Ju/'hoansi are less mobile during the dry season, preferring to make long foraging trips from campsites near water pans. During the wet season, however, families become more mobile, making longer foraging treks from Dobe since surface water is more available (Yellen 1976); villages near Dobe, the source of material goods and horticultural produce, also encourage the Ju/'hoansi to remain at the water hole. Conversely, the G/wi are mobile during the dry season, obtaining water from the rumens of game animals and tsama melons (Silberbauer 1972, 1981a,b; Tanaka 1980); to ensure a constant supply, the G/wi move camp more frequently than the Ju/'hoansi during the dry season.

Where water sources are localized in deserts, we could expect foraging efficiency to be sacrificed in favor of remaining close to a water source. Consider Australia's Western Desert, where several thousand square kilometers may contain only a handful of water sources (Cane 1990: 157). Here, the Ngadadjara tend to stay at a water hole until it dries up. They also tend to use water sources in increasing order of reliability so that they always know that the next water source is more dependable than the one they are currently using, in case the season should be hotter and drier than expected (Gould 1991). Unlike other foragers, tethered foragers may make full use of all exploitable resources within foraging distance of the water source, leaving only when net returns reach zero. It is my impression that water-tethered foragers forage farther from their camps for

Table 4-3. Mobility Among Temperate and Boreal-Forest Groups

Group	Primary Biomass (kg/m²)	Dependence on Fish (%)	Annual Residential Moves
Kidütökadö	5.8	30	40
Cheyenne	6.5	0	33
Crow	4.5	0	38
Ona	8.6	20	60
Montagnais	7.7	20	50
Mistassini Cree	11.9	30	10
Aleut	Low	60	1
Klamath	15.3	50	11
Sanpoil	5.7	50	10
Chilkat Tlingit	29.6	High	>2
Other Gulf Salish	23.8	High	3
E. Saanich	28.8	High	4–5
W. Saanich	28.8	High	3–5
Ainu	21.5	40	2
Wiyot	19.7	High	0–2
Yurok	35.0	50	0–2
Twana	35.2	60	4
Makah	34.1	60	2
S. Tlingit	29.6	60	3
Tolowa	35.9	40	2?
S. Kwakwak'awakw (Ft. Rupert)	33.6	50	3, >4
Tsimshian	32.0	60	3–5
Squamish	18.5	High	0–4
Nuuchahnulth	34.9	60	>3

resources (including plant food) than do nontethered desert foragers. The Ju/'hoansi, for example, forage 10 km or more from camp, whereas the G/wi tend to forage no more than 5 km.

The diet-breadth model suggests that tethered foragers may exchange lower foraging efficiency for security in their water supply due to local depletion of high-ranked resources. Among the

Table 4-4. Tethered Foraging Trips of the Dobe Ju/'hoansi

Trip	Days	Camps	Mean Duration of Camp Occupation (Days)	Days at Dobe upon Return
1	24	6	4	17
2	22	10	2.2	11
3	17	4	4.25[a]	26
4	16	6	2.6	14
5	19	6	3.1	–

Period covered is from January 27 to July 11, 1968. Trips 3 and 4 were 35 and 40 km in length (Yellen 1976: map 5), respectively, for an average move distance of 7 and 5.7 km per move.

[a] One camp occupied for 12 days.

Source: Yellen 1976: table 3.

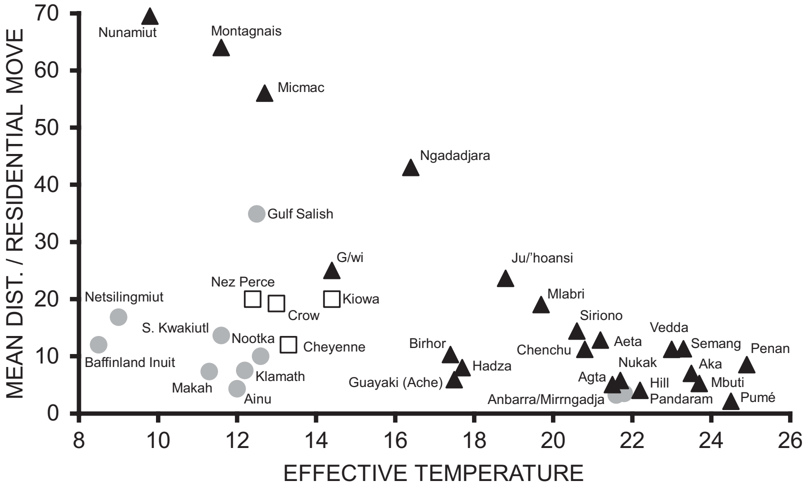


Figure 4-7. The average distance moved per residential move plotted against effective temperature as a proxy measure of the distance between resources.

Bororo of the central Baja California desert, "as water sources dried up, forcing the concentration of population at a few springs, hunting on most of the game ranges was reduced to the vanishing point. The accessible districts would be essentially hunted out before exhaustion of the vegetal resources were evident" (Aschmann 1959: 96). In this case, as game became scarce, men turned their efforts to collecting plant food alongside the women. Bororo diet as well as mobility was affected by the need to reduce the energetic cost of acquiring water.

Many contemporary hunter-gatherers follow a pattern of tethered foraging. Along with water, however, living hunter-gatherers are frequently tethered to agricultural plots (their own or those of sedentary neighbors), sources of wage labor, cigarettes and alcohol, government agencies and welfare rations, or mission posts. In this respect, many contemporary foragers are similar to tropical horticulturalists, such as those in the Amazon, who periodically make treks into the forest that last from a few days to several weeks in order to collect forest products and food, especially meat (see papers in Hames and Vickers 1983).

Average Distance per Residential Move

Residential mobility enables hunter-gatherers to position themselves relative to food and other resources. We could deduce that the average distance moved between residential locations should be related to the distribution of food resources *for terrestrial foragers*. In general, resources tend to become more spatially segregated along a gradient of decreasing temperature; therefore, there should be an increase in the average distance per residential move with decreasing ET. The relationship between the two variables is depicted in Figure 4-7.

Groups that have a primarily terrestrial adaptation (*black triangles* in Figure 4-7) fit the expected pattern ($n = 22$, $r = 0.75$, $p < 0.01$). For our purposes here, terrestrial foraging can include fishing from freshwater sources, excluding the harvesting of anadromous fish. Inclusion of the Klamath and the Micmac are questionable since both exploit fish heavily. Removing them only strengthens the relationship ($n = 20$, $r = 0.83$, $p < 0.01$). The others in this graph are equestrian hunters of the Plains and groups heavily dependent on marine resources, notably marine mammals such as seals and anadromous fish. These groups do not move very far residentially although they live in environments with low to medium ET.

The two Arctic groups are interesting cases. Unlike many other Arctic groups, the environments of neither the Netsilingmiut nor the Baffinland Inuit offer herds of caribou.[8] Instead, these Inuit hunt solitary animals, fish small streams, or, during the winter, live on the frozen surface of the ocean and hunt seals through breathing holes in the ice. The resources they exploit are dispersed, and their distribution resembles more that of resources in the tropical forest than that of other Arctic regions. Like hunter-gatherers in the tropics, those of the extreme Arctic exploit dispersed resources around their camp, then move so that they are at the center of a new foraging area. While hunting seals in the winter, the Copper Inuit (a neighbor of the Netsilingmiut), for example, hunt an area 8 km in radius. After the area is depleted, the group moves about 16 km to a new hunting area (Damas 1969a,b, 1972, 2002), a move of twice the foraging radius. It is not surprising, then, that the Netsilingmiut and Baffinland Inuit have short residential moves, resembling those of tropical foragers.

Plains bison hunters used horses to move camp frequently but not always very far in a single move. An 1805 account (Larocque's journal, Ewers 1955: 147), for example, shows that the Crow moved forty-seven times in seventy-six days, moving a median distance of 15 km, but with a range of 5–38 km per move. Dunbar traveled some 640 km with the Pawnee during a winter hunt of 1834–35 that lasted 156 days. During this time, the Pawnee made thirty-three camps for an average of 20 km per move (Roper 1991). By taking resources that were mobile and dispersed, Plains hunters were in one respect similar to Arctic and tropical forest foragers: they must have experienced rapid drops in foraging returns soon after occupying a camp. Consequently, Plains groups moved short distances frequently. Factors other than bison distribution, such as the availability of firewood, plants, forage for the horses, or the presence of enemies, undoubtedly affected camp movement, but the horse probably lowered the cost of moving so that Plains groups could afford to move more frequently and for shorter distances than we might expect.

Many northern fishing societies move short distances because they are territorially constrained and cannot move very far without trespassing. Living in small territories with high population densities, they move from winter villages, often located near the coast at the mouths of rivers, to nearby spring/summer fishing, shellfishing, or plant-gathering camps, then back to the winter village. Figure 4-7 suggests that if these coastal societies were not territorially constrained or relying on aquatic resources, they would move very long distances, perhaps especially in winter.

These exceptions show that although ET is not a perfect measure of resource distribution, it nonetheless points to foraging considerations as significant factors in structuring hunter-gatherer residential mobility.

Grove (2009) also examined the relationships between the average distance per move and environmental variables using Binford's mobility data (2001: table 5.01). That dataset contains the number of residential moves and the total distance moved per year, so the average distance moved is the latter divided by the former. For this dataset, then, the choices are to move short distances frequently or long distances infrequently.

Dividing his sample into the major subsistence categories of "hunters," "gatherers," and "fishers," Grove found that habitat quality, as measured by mean annual rainfall and ET, were the primary determinants of the average distance per move. For both his "hunters" and "gatherers" categories, he found that as mean annual rainfall decreased, so did the average distance per move. Concomitantly, the number of moves must increase. In other words, *as overall habitat quality declines, foragers, whether dependent on hunted or gathered foods, move shorter distances more frequently*. This mirrors the argument we made earlier for the number of residential moves.

For fishers, Grove found that as ET increased (as we move from the Arctic to the equator), the average distance per move decreased. Foragers who depend heavily on marine resources in the tropics make frequent but short moves; groups who depend on marine resources in temperate or cold environments make longer but fewer residential moves. Part of the reason for this is that foragers who rely on marine resources often rely on stored food – so they cannot move without facing the problem of what to do with many kilograms of dried fish (which is bulky and costly to

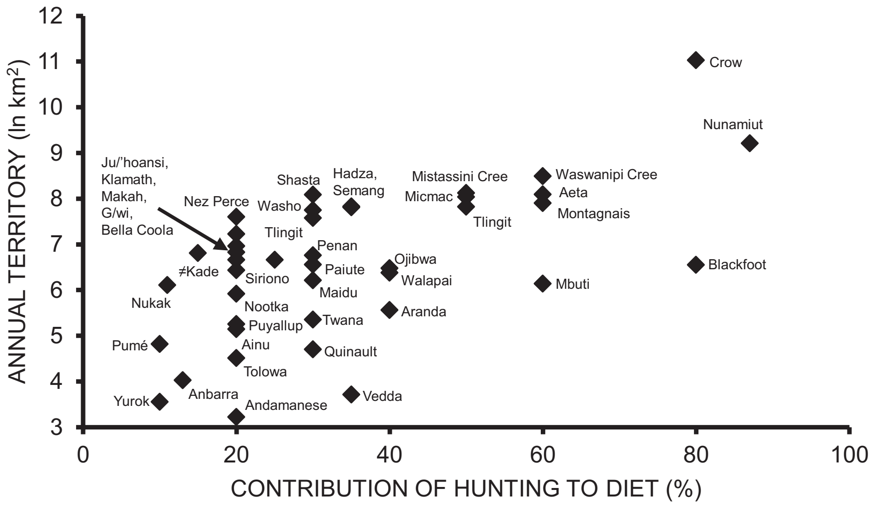


Figure 4-8. The size of foragers' annual ranges plotted against the percent dependence on hunting (from Table 3-1). As the dependence on hunting increases, so does the size of the exploited territory.

transport; Kelly 2001). But their mobility also reflects the increasing distances between resource extraction locales as we move from warmer to colder habitats.

Logistical Mobility and Territorial Coverage

To this point, we have only discussed movements of the residential camp. Yet, if we were to track an individual's movements, we would find that the majority of the time he or she spent moving was not spent in moving camp but rather in logistical forays to hunt and gather. Although foragers also make trips to procure raw materials or firewood, to visit, or to gather information (Whallon 2006; Whallon, Lovis, and Hitchcock 2011), these tasks are often embedded in food-getting forays (Lee 1979: 211; O'Connell and Hawkes 1981; Binford 1982). In this section, we assume that food collection is the primary purpose of logistical forays from camp.

Given the general trophic pyramid, carnivores normally use larger territories than do herbivores. Holding other factors constant, we expect to see an increase in the area of land exploited by hunter-gatherers as dependence on hunting increases. Figure 4-8 shows that there is a relationship between the relative dependence on hunting and the total area exploited ($n = 41$, $r = 0.62$, $p \ll 0.01$). Since the y-axis is a log scale, the relationship between the two variables is curvilinear: as dependence on hunting increases, the size of the territory increases very rapidly. The same factors that act on the average distance per residential move affect the total area exploited since hunting becomes more important toward the poles and since herbivores need large territories to support themselves at higher latitudes (since PP is so low). Logistical mobility also increases with increasing dependence on large game because it increases the frequency of encounter with mobile prey and hence reduces some of the risk associated with hunting (Grove 2010). Foragers who depend on large game can have high residential and logistical mobility.

Although our data are not adequate for analysis, group size could also factor into the equation, with larger groups needing larger ranges. However, as discussed in Chapter 7, both empirical data and theoretical argument suggest that there is an upper limit to residential group size of about twenty-five people for pedestrian, nomadic foragers. And, where local group size is large as it is, for example, on the Northwest Coast, territories are often small and subsistence focuses on aquatic resources. As a group grows in size, it will either fission or alter its settlement and subsistence strategy. Thus, group size may be a less significant factor than food source in determining range size (see also Grove 2009).

Hunter-gatherers who depend on hunting may use a large range annually, but they do not necessarily cover that range as thoroughly through residential mobility as groups who depend on plant food. As we will see, the distance at which a resource can be gainfully procured is related to the resource's return rate (and its transportability). High return rate resources can be procured at longer distances from camp than can low return rate resources. In general, large game provides high return rates. In economies dominated by gathering, foragers cannot gather resources at long distances and therefore should move shorter distances than do groups that rely heavily on hunting. Hunters should use long logistical forays and cover less of their territories through residential mobility; gatherers should cover their territory more thoroughly through residential mobility.

We can calculate a rough coverage index from Table 4-1 by dividing the total distance moved residentially by the total area exploited each year. These indices are grouped according to the dominant subsistence category (hunting, gathering, fishing; from Table 3-1) with the following results: for groups dependent on gathering, mean = 0.54 ($n = 10$; mean = 0.65 if Hadza and Semang are excluded); for groups dependent on hunting, mean = 0.05 ($n = 6$). In other words, gatherers cover a greater percentage of their range through residential mobility than do hunters (see also Binford 2006).[9] Conversely, hunters probably cover more of their range and spend more time moving individually about the landscape. Hunter-gatherers who rely heavily on aquatic resources also do not cover their ranges through residential mobility ($n = 6$, mean = 0.08) but instead make long logistical trips; since many are made in boats, however, these are not directly comparable to terrestrial forays.

This survey of ethnographic data assumes that the nature of foraging affects the movement of a residential group. We now need to examine this assumption in more detail.

Individual Foraging and Camp Movement: A Central Place Foraging Model

In *Stone Age Economics*, Sahlins pointed out that the day-to-day economy of hunter-gatherers is

> seriously afflicted by the *imminence of diminishing returns*. Beginning in subsistence and spreading from there to every sector, an initial success seems only to develop the probability that further efforts will yield smaller benefits. This describes the typical curve of food-getting within a particular locale. A modest number of people usually sooner than later reduces the food resources within convenient range of camp. Thereafter, they may stay on only by absorbing an increase in real costs or a decline in real returns: rise in costs if the people choose to search farther and farther afield, decline in returns if they are satisfied to live on the shorter supplies or inferior foods in easier reach. The solution, of course, is to go somewhere else. (Sahlins 1972: 33; emphasis in original)

Ethnographic literature demonstrates this link between individual foraging and camp movement quite clearly. In the central Kalahari, for example, ≠Kade women

> begin to gather food near the campsite [and] they can complete their work in a trip of 1 to 2 km during the first few days of their stay. Then, gradually, as they consume the plants near camp, they must go farther. If the round trip for gathering food plants exceeds 10 km or so, convenience dictates that they move themselves with all their belongings to virgin territory. (Tanaka 1980: 66)

The Mbuti move when foraging becomes difficult within 5 km of camp (Harako 1981: 535). Williams (1974: 74) found that 91 percent of Birhor camp moves were for foraging reasons; specifically, the Birhor moved camp when hunting within a 5–6 km radius fell below acceptable levels. The Australian Pitjandjara move when women complain of walking too far to forage (Tindale 1972: 244–45). Although the Hadza can forage for roots up to 8 km from camp, they generally do not go beyond 5 km (Vincent 1984), and so camps move when women complain about walking too far to collect tubers (Marlowe 2006, 2010). They move

> primarily because food and water are less readily available than they would like; and even where some other motive is present, they will of course at the same time try to improve their access to food and water. However, movement normally takes place long before shortages have become in any way serious. (Woodburn 1968: 106)

For the G/wi, "migration to the next campsite is timed to occur before the resources of the last become depleted to the stage at which interhousehold competition might arise to threaten cooperation and dislocate coordination" (Silberbauer 1981a: 250–51). When Malaysian Batek women find themselves walking an hour to find yams, they consider it time to move camp (Endicott and Endicott 1986: 149). In Thailand, Mlabri women gather only within a kilometer of camp (Pookajorn 1988: 190). Agta move before all local resources are used (Rai 1990: 59). Although it may be possible to hunt large game at very long distances from camp (Grimstead 2010), a 20–30 km round trip appears to be the maximum distance hunters will walk comfortably in a day in a variety of habitats.[10] Thus, the distances walked by many hunter-gatherers in daily food-collecting trips are normally less than the maximum possible walking distance. Hadza women, for example, walk an average of 5.5 km and Hadza men 8.3 km while foraging (Marlowe 2010: 121). Nukak adults make roundtrips that average 8.4 km (Politis 2006). The Pumé travel 11.4 km when hunting, 5.4 km when fishing, and 1.6 km when gathering (Greaves 2006). Evenki men travel 10–15 km per day while moose hunting in the fall (Turov 2010: 34).

Recall that the marginal value theorem (MVT) we discussed in the last chapter predicts that foragers will leave a camp before consuming everything within reach of that camp, when the current return rate equals the environment's overall average rate, taking travel time into account. The "environment's overall return rate taking travel time into account" encompasses several variables. To see the effect of those variables, let's look at the problem in a way that allows us to put ourselves into the sagebrush sandals or sealskin mukluks of a forager.

The maximum distance at which a forager can procure a resource at an energetic gain is limited by the return rate of that resource and by how much the forager must gather. Figure 4-9 shows the results of a simple central-place foraging model (Kelly 1990, 1991). In this model, two foragers collect food for their family each day. We will assume that the family requires about 14,000 kcal/day, that the forager walks at a leisurely pace of 3 km/hr (see Craig and Chagnon [2006: 54]; this is perhaps a little slow: Hadza move at ~3.5 km/hr; Marlowe [2006, 2010]), at a cost of 300 kcal/hr, and that the cost of walking increases by 30 percent when returning home with food (Jones and Madsen [1989]; see Grimstead [2010] for more detailed methods of calculating walking cost). We will also assume that foraging activities, including the time to travel to foraging areas, as well as the time to harvest and process the food resource, are confined to eight hours a day.[11] The daily net return to foraging is simply:

$$\text{Net Return} = [(8 - 2t)r] - (300t + 390t)$$

where:

t = travel time to foraging patch (distance/3 km/hr)
r = mean overall return rate (varied here from 1,000 to 4,000 kcal/hr; think of these as four different environments or, alternatively, four different resources in the same environment).[12]

For any of the four environments or resources, the net return from foraging decreases farther from camp as the forager spends more time and energy traveling to and from the foraging area relative to the time spent collecting and processing food resources. As we might expect, the net return also decreases with a concomitant decrease in return rate (r). The two horizontal lines

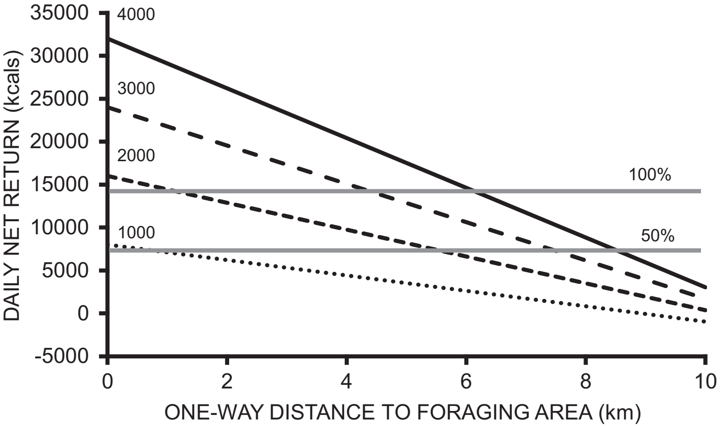


Figure 4-9. The relationship between the daily net return from foraging and distance to the foraging area as a function of the mean foraging return rate. The horizontal lines indicate the calories that a forager must provide: 50 percent if a family has two foragers, 100 percent if only one. As foragers expend more time and effort in traveling to a foraging area, the mean daily return declines. As a forager provides for more of the family's food needs, and/or as the return rate from the environment declines, the distance at which he or she can forage from camp at a net gain becomes shorter.

indicate the amount of energy needed by the family on a daily basis, depending on whether the forager is gathering 50 or 100 percent of the family's total caloric need.

The distance at which the forager brings home at least a day's worth of food, the intersection between the sloping net return lines and one of the horizontal caloric needs lines, becomes shorter as the return rate decreases and/or as the individual forager's workload increases. Let us say that our forager lives in an environment providing a mean return rate of 2,000 kcal/hr. We also stipulate that this forager is responsible for 50 percent of the diet. Therefore, he or she can collect food up to about 5.75 km from camp. If, for some reason, the need for the resource increases so that it makes up 100 percent of the diet (e.g., if a spouse becomes ill), then it can only be collected at a net gain up to about 1.5 km from camp. The *effective foraging radius*, therefore, is largely a product of the return rates of the available resources and the degree of dependence on them (which is a function of how many people are foraging for each family, family size, and per capita caloric needs). As average return rates decline (as would happen if lower ranked resources are added to the diet) and/or as the amount of food a forager must bring back increases, the effective foraging radius becomes shorter, and the family will probably move more frequently and for shorter distances.[13]

The relationship between return rate and the effective foraging radius affects diet. Central-place foraging models (see Chapter 3) suggest that the farther a forager travels from camp, the more restricted his or her choice of resources becomes. Foragers can only take high return rate resources at long distances from camp; hence, they can harvest a greater diversity of food close to camp (Kaplan and Hill 1992; see Vickers [1989] for an ethnographic example and Speth and Scott [1989] and Broughton [1999] for archaeological examples).

However, a resource's transportability figures in here. We described in Chapter 3 how processing affects the distance that a resource can be transported. Some foods that provide high return rates cannot be transported very far. Under the right conditions, grasshoppers, for example, can be collected at very high return rates, but they cannot be transported very far because a relatively small amount of grasshoppers by weight takes up a rather large volume (Jones and Madsen 1989). Dried fish present the same problem.

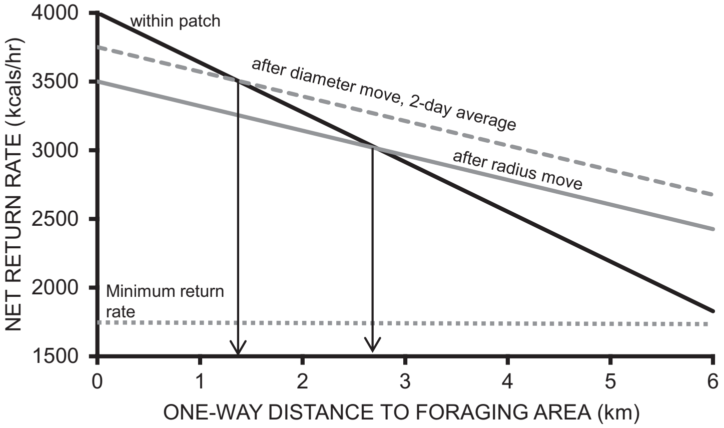


Figure 4-10. The relationship between the return rate experienced within a foraging area (*black line*) relative to that of the day of a move to a camp located at the edge of the current foraged area (*gray solid line*). The model predicts camp movement at the point at which foragers are traveling about 3 km from camp (half-radius foraging pattern) in order to find food. The dashed gray line is the average of the day's return rate after moving twice the foraging radius and the following day (when return rate = 4,000 kcal/hr). With such averaging, we expect the foragers to move after foraging within a complete radius of only 1.5 km of camp.

So far, we have discussed foraging as if the decision to move is based only on the nature of foraging around the immediate camp. However, as Sahlins pointed out, hunter-gatherers weigh the cost of remaining where they are and foraging farther out (or using progressively lower return rate resources nearby) against the potential benefit of moving to a new area.

Imagine a family living in an environment where a 4,000 kcal/hr resource is homogeneously distributed across the landscape. For the sake of simplicity, let's say each family has one active forager who must collect 14,000 kcal/day to feed the family. Assuming an eight-hour workday, this means that the forager must gather the resource at a minimum daily return rate of 14,000/8 = 1,750 kcal/hr. Making the same assumptions as earlier, the net return rate (R) decreases with increasing one-way foray distance and reaches 1,750 kcal/hr at a distance of about 6 km from camp (Figure 4-10):

$$R = \frac{4{,}000\,(8 - 2t) - (300t + 390t)}{8}$$

This creates a foraging patch with a radius of 6 km.

We can also compute the return rate if the family were to move to a new foraging area after exploiting the resources within a given radius of the camp. Since food is homogeneously distributed, and since we assume that the foragers aim to minimize effort, they only have to move the distance of the current foraging radius to position themselves on the edge of their currently foraged area. The after-move return rate of the individual forager, allowing an hour for camp breakdown and setup (more on this variable in the following discussion), is figured as:

$$\text{After Move } R = \frac{4{,}000\,(7 - t) - 300(t)}{8}$$

The after-move line in Figure 4-10 shows the daily return rate if the forager were to move camp after foraging within 0, 1, 2, 3 . . . 6 km of camp. Note that at a return rate of slightly less than 3,000 kcal/hr, achieved at a foraging distance of about 2.6 km, the net after-move return rate is equal to the within-patch return rate. This means that after foraging within about 3 km of camp, the family would do better to move to the edge of the currently foraged area (3 km away). Even

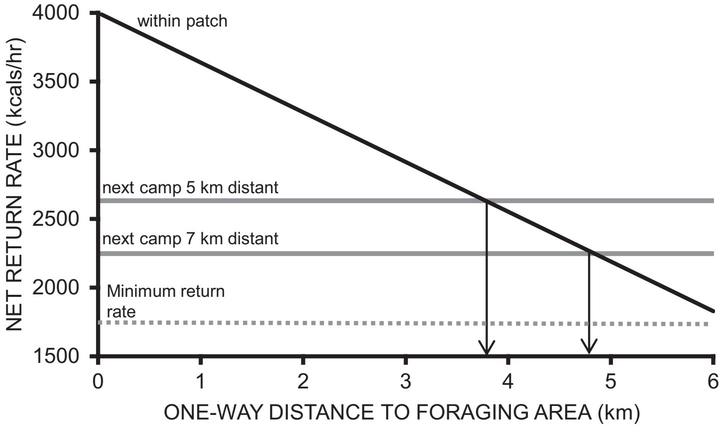


Figure 4-11. The relationship between the return rate experienced within a foraging area relative to that which could be expected if the foragers' only choice is to move to a new camp 5 or 10 km away. As the distance to the next patch increases, foragers occupy the current patch for longer periods of time.

with devoting time to the move, the forager would achieve a higher return rate for that day than if the family had not moved – and return to 4,000 kcal/hr the following day. This simple model and the ethnographic cases cited previously suggest that if foragers aim to maximize foraging return rates, then central-place foragers should try to minimize daily travel time (Orians and Pearson 1979).

We might expect, however, that foragers would move *twice* their current foraging radius where food resources are homogeneously distributed, to position themselves in the middle of a new foraging area. If we run the model with this assumption, however, the after-move return rate is always less than the within-patch return rate (this was, incidentally, an error in the first edition). According to the model used here, this would mean that the forager should not move until completely depleting the 6 km radius foraging area around camp. This is clearly not supported by the ethnographic data cited at the beginning of this section or expected from the MVT.

But what is the relevant time frame? Would foragers be willing to take a loss for a day knowing that they would return to a high rate the next day? Foragers almost certainly evaluate resource returns over some period of time, and that period is almost certainly closer to days or weeks rather than an hour. Moving twice the current foraging radius may lower the return rate for a day, but foragers may accept this loss knowing that the day after the move the return rate will jump back up, in this case, to 4,000 kcal/hr. In Figure 4-10, we have also graphed the return rate that is an average of the full foraging diameter after-move rate and the rate of the following day, 4,000 kcal/hr. Here, we see that foragers would move after foraging only within about 1.5 km of camp.

At the heart of the relationship between daily foraging and group movement are the perceived costs of camp movement and foraging. In the preceding model, we assumed that the location of the next camp was a function of the foraging radius of the current camp. But campsites can be determined by many different factors, such as water sources, firewood, shade, shelter, insects, and so on. In Figure 4-11, the distance to the next patch is not a function of the current foraging radius, as it was in Figure 4-10, but instead is held constant at 5 km and, for comparative purposes, 7 km; thus, the slope of each after-move line is zero, since the cost of moving is now constant rather than a function of the size of the foraged area. As we would expect, if the next camp is 5 km away, a forager should forage within almost 4 km of camp before moving; if the next camp is 7 km away, he or she should forage within nearly 5 km of camp before moving (creating

Figure 4-12. Inuit coming down Tree River by sled in the Northwest Territories (Nunavut); women and dogs pull the sleds. The cost of moving is affected by the terrain to be crossed, the weather, the amount of material to be carried, and the type of housing. Canadian Museum of Civilization, J. J. O'Neill, October 1915, 38571.

some overlap in foraging areas). The predicted differences in foraging distance may seem minor. But note that increasing the effective foray distance from, say, 3 to 4 km (a 33 percent increase) increases the foraging area and the length of time a camp can be occupied by 77 percent (assuming homogeneous resource distribution).

Distance to the next patch, however, is only one variable affecting the cost of moving. The difficulty of traversing the terrain also figures into the calculations (Figure 4-12). For example, 10 km of muskeg in the spring is harder to cross than 10 km of shortgrass prairie. In the Arctic and subarctic winter, long, dark days and sudden storms make movement difficult in that season (Leacock and Rothschild 1994: 120; Jenness, in Damas 2002: 329). Increasing the moving cost to (a very high) 1,200 kcal/hr in the model while leaving the foraging cost at 300 kcal/hr predicts camp movement after foraging a 4-km rather than a 3-km radius. If the walking cost of both foraging and moving is 1,200 kcal/hr, then the group should move after foraging within only about 2.25 km of camp. Thus, group mobility responds to the cost of group movement, as well as to foraging effort. The terrain matters here but also the availability of draft animals and transportation technology (e.g., dogsleds, horses, canoes; see Binford 1990). A moving cost of 1,200 kcal/hr is excessive, but I chose it to make a point: as the cost of moving increases relative to the cost of foraging, residential mobility is expected to decrease. Although we have discussed the cost of moving in terms of the physical movement of people and belongings, the cost could also include whether the anticipated next campsite is already occupied. If so, then the cost of moving could include displacing current residents, which could carry the very high potential cost of violence (see Chapter 9).

Housing also affects the cost of moving. The time required to break down and set up camp is seldom discussed in the literature. I employed a one-hour camp breakdown/setup time in the model based on what little information was available (Peter Brosius, personal communication, 1989; Robert Hitchcock, personal communication, 1989). Camp breakdowns may be quicker for many tropical groups but could be slower for Arctic peoples due to differences in the amount of goods carried. (Some Arctic groups can set up camp in about an hour [Burch 1988:107] but it

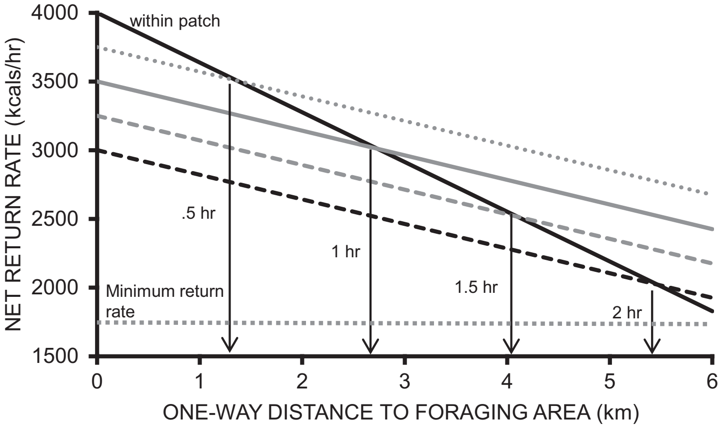


Figure 4-13. The relationship between the return rate experienced within a foraging area relative to that which could be expected if the foragers moved the foraging radius to a new area at different camp-move times, from one-half hour to two hours. As the cost of camp breakdown and setup increases, so does the length of time the current camp is occupied.

can take the subarctic Naskapi most of a day [Leacock and Rothschild 1994: 64].) Hadza women build a wet season hut in two to three hours (Marlowe 2010: 107).[14] We can see, however, that increasing or decreasing this time greatly alters the mobility solution by changing the length of the working day (Figure 4-13): a camp breakdown time of two hours means that it is not worthwhile to move before exhausting nearly all food within a 6-km radius, whereas a breakdown/setup time of one-half hour predicts movement at a 1.5-km foraging radius. It appears, then, that as the movement of camp becomes more difficult and time consuming, hunter-gatherers may remain in their current foraging area for longer periods of time (cf. Grove 2009). Conversely, if a group must be mobile for energetic reasons (low return rates that result in a short effective foray distance), then their housing should be tailored to their mobility needs. Housing and mobility then are expected to be systematically related to each other (see Chapter 5; Binford 1990).[15]

This simple model also sheds light on whether men's or women's foraging determines camp movement. Agta camp members, for example, discuss for hours or days whether to move, and foraging efforts of men versus women play a role in these debates (Rai 1990: 59). The effective foraging distance for plants is shorter, in general, than it is for large game since many plant foods provide lower return rates than those of large game. Since large game is usually procured by men (see Chapter 8), women's foraging should normally determine when and where camp is moved. Among the Agta, "[since] hunting depends on mobile animals, it is not an important consideration [in determining moves]. Men and women freely voice their opinion on residence change, but women, who must carry out the most gathering, have the final say" (Rai 1990: 59).

Risk

The model used here also assumes that hunter-gatherers have a perfect knowledge of the environment. This is not always true, and so the cost of moving should include a risk factor. If the anticipated resource is not a certain one, then the cost of moving will be, in effect, higher, and we could expect hunter-gatherers to stay longer in their current camp. Many desert foragers elect to remain at a water source at the expense of decreasing foraging return rates because they are uncertain of the condition of other water holes; they may remain at the current water hole either until it runs out or until they ascertain the status of other water sources. Some Australian

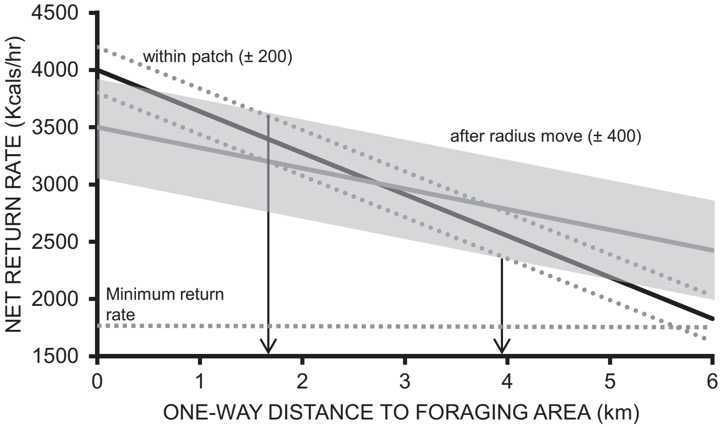


Figure 4-14. The effects of return-rate variance on decisions to remain in the current camp or move. To maintain as high a return rate as possible, the forager should remain in the current patch until the lower variance limit of the radius after-move rate equals the lower variance limit of the within-patch rate. Alternatively, to seek risky resources, the forager may move sooner, when the upper variance limit of the after-move rate exceeds that of the within-patch rate.

Aborigines, in fact, will accept extremely low return rates and forage up to 15 km from camp rather than move from a secure water source (Gould 1969a; Cane 1987).

One way to measure risk is in terms of return-rate variance. As noted in Chapter 3, holding resource type, density, and even forager capabilities constant, there usually is variance in day-to-day return rates. How might this affect foragers' decisions to move?

First, this is a question about perception. Given that foragers do not carry iPads, how low must an average return rate be before they decide to move, knowing that variance in the after-move return rate can also be expected (see Gragson 1993)? Figure 4-14 shows the within-patch and after-move return rates depicted in Figure 4-10 but with a ±200 kcal/hr variance limit around the within-patch line and a ±400 kcal/hr variance limit around the after-move line. Note that at a foraging radius of just over 4 km, the lower variance limit of the within-patch return rate is about equal to that of the mean after-move return rate. In this case, foragers may exploit resources within a 4-km radius of camp before moving, since at that point, they know they are guaranteed to do better than in the current camp. The higher the perceived variance in the after-move return rate, the longer that foragers are predicted to remain in the current camp.

Conversely, if foragers seek resources that can occasionally provide very high returns, they may intentionally go after resources with high variances (see Chapter 7). If so, our forager would move when the highest possible return rate after moving is higher than the highest possible return rate of foraging from the current camp. Referring to Figure 4-14, this would be at a foraging radius of less than 2 km, implying a relatively short occupation time.

Storage

Linked to the issue of variability is that of storage. Storage results in the accumulation of food at one or more locations, thus increasing an environment's "patchiness" and possibly encouraging decreased residential mobility. Recall from Chapter 3 that the volume of stored resources increases significantly where the ET is less than 14 (Binford 1980; see also Keeley 1988). This suggests that food storage is principally a way to cope with resource seasonality. The decision to reside at the location where food is stored or to transport the resources to another location depends on the return from moving one set of resources (which depends on their transportability) versus the return rate expected from each potential location's foraged resources (Jones and Madsen 1989; Rhode 1990). In general, however, I expect the transport of stored food to be more costly than the transport of freshly procured food. Thus, storage should reduce residential mobility.

Stored food could also reduce residential mobility in a second way. If a forager knows how much food was cached and the time it will take to travel to the cache, the return rate from retrieving cached food is known and not variable. Figure 4-15 suggests that foragers may move to or remain at the camp with the least variance in return rates – which is the camp with the stored food. It may also follow that if resource variability increases over the long term, hunter-gatherers could invest more in storage and, hence, decrease mobility (see Rowley-Conwy and Zvelebil 1989).

Other Factors

As we noted previously, not all residential movements are related to food concerns. People also move for firewood, raw materials, or because insects have become intolerable at the current camp. Spending a winter with the Naskapi, Strong wrote in his notes that "a tent that is kept warm and lived in too long melts the snow under it to the ground. It then gets too hot and makes people sick – which is one reason for their frequent moves" (Leacock and Rothschild 1994: 137). Movements can be socially or politically motivated as well, as people seek spouses, allies, or shamans, or to distance themselves from sorcery. A death, in fact, is a common reason for moving (e.g., Pookajorn 1988: 186; Politis 2007: 169; Marlowe 2010: 41).

People may move to relieve social tension, to visit friends and relatives, trade, gamble, participate in rituals, or just catch up on news.[16] Movements made for social reasons, however, may ultimately be related to foraging. For example, during a period of drought, /Xai/xai Bushmen stated that they were going elsewhere to trade, but this decision followed two weeks of bickering over food (Wiessner 1982b).

Sedentism: Why Stop Moving?

To this point, we have discussed the factors that keep hunter-gatherers moving. Yet archaeological data tell us that many foragers settled down and ceased to move residentially. The origins of sedentary communities is an important question in anthropology, for sedentary communities are largely associated with nonegalitarian sociopolitical organization: social hierarchies and hereditary leadership, political dominance, gender inequality, and unequal access to resources, as well as changes in cultural notions of material wealth, privacy, individuality, and cooperation (Wilson 1988). We examine the relationships between sedentism and sociopolitical organization in Chapter 9. In this chapter, we are concerned with understanding the cause(s) of sedentism.

The term *sedentism* means different things to different people.[17] For the most part, sedentism refers to the process "whereby human groups reduce their mobility to the point where they remain residentially stationary year-round" (Hitchcock 1987a: 374) or as settlements where "at least part of the population remains at the same location throughout the entire year" (Rice, in Rafferty 1985: 115). Sedentism is often thought of as a relative rather than a static condition, thus settlement systems are "less mobile than previously" or become "increasingly sedentary over time" (Kelly 1992). Definitions frequently conflate several dimensions of mobility, including seasonal movement of the residential base camp, movement of individuals around and between residences, movement of a group's yearly range or aggregation site (e.g., winter villages on the Northwest Coast or wet-season villages in seasonal tropical forests), and the permanence of facilities such as houses and fish weirs (Stark 1981; Eder 1984; Rafferty 1985; Ingold 1987).[18] Remember that mobility has several interlinked components – individual foraging (logistical movements), residential movements, and long-term territorial shifts.

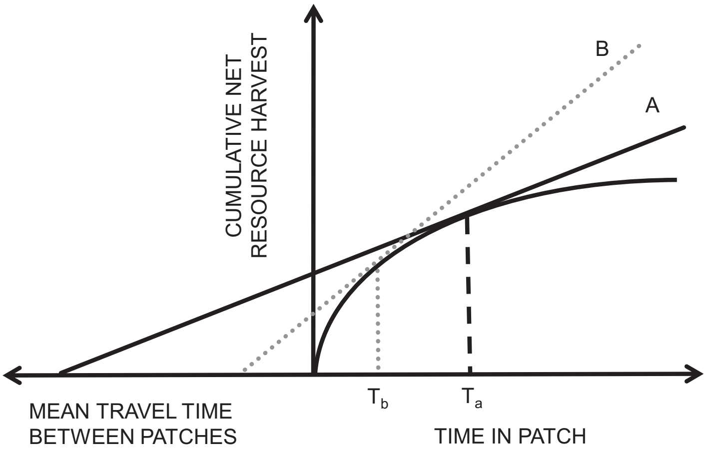


Figure 4-15. The curve in this illustration depicts a general depletion curve: the marginal return rate decreases the longer a forager remains in the patch. Recalling the marginal value theorem (MVT), in which the mean environmental return rate is low (the slope of line A), the forager should remain in the current patch longer (T_a) than when the mean environmental return rate (line B) is high (T_b).

Ethnographic data on the Philippine Batak show the interplay between residential and individual movements. The Batak maintain a central settlement at which someone is almost always present throughout the year (Eder 1984). They move this central settlement every seven to ten years. An individual family, however, spends only about 25 percent of the year in the central settlement. The rest of the time is spent in field houses and forest camps. Moving among a limited number of locations, a Batak family changes location about ninety times a year, moving about 3 km each time for a total yearly residential mobility of about 270 km. Individuals make foraging trips into the forest from these camps, adding to overall individual mobility. In other words, the Batak "shifted the burden of that [residential] mobility off of the local group as a whole and onto lower levels of social organization" (Eder 1984: 851). As residential mobility is reduced, logistical mobility increases (Binford 1980). Likewise, as Bushmen become sedentary (due to government coercion or the attractions of wage labor), men make longer logistical forays (Hitchcock 1982; 1987a,b; Hitchcock and Ebert 1984, 1989). The Kalahari's residentially mobile Kua, for example, might not travel more than 6 km from camp, whereas members of sedentary Kua villages make trips of up to 50 km.[19]

There is a trade-off between the costs and benefits of residential movements on the one hand and individual logistical movements on the other: sedentism does not save energy, it reorganizes it. Why?

For many years, the reigning view in anthropology was that a nomadic lifestyle was not something any right-thinking individual would want. "We have taken for granted," wrote the participants of a 1955 seminar in community patterns, "that in general sedentary life has more survival value than wandering life to the human race, and that, other things being equal, whenever there is an opportunity to make the transition, it will be made" (Beardsley et al. 1956: 134). Anthropologists thought that the opportunity was either agriculture or resource abundance. They assumed the former was the more likely cause and that sedentary hunter-gatherers, such as those of the Northwest Coast, were favored anomalies. However, we now have many archaeological cases in which agriculture preceded sedentism or where sedentism preceded agriculture (see Price and Brown 1985b; Kelly 1992). In addition, there are many horticulturalists who are seasonally mobile (e.g., the Raramurí of Mexico; see Hard and Merrill 1992), who make long foraging treks (e.g., many Amazonian societies) or who shift residence every few years in response to soil depletion or a decline in hunting returns (see Vickers 1989). Thus, the relationship between agriculture and residential mobility is not straightforward.

Binford (1983) challenged the idea that foragers become sedentary when resources are abundant – what he derided as the Garden of Eden argument and the Slug Principle. Hunter-gatherers remain mobile, Binford argued, not because they lack the opportunity to settle down but rather to maintain information about resources that they may need as backups in case the expected staple food is not available (see Whallon 2006). Maintaining knowledge of current and potential future states of resources – the status of a water hole, signs of game, and plant food – is critical for group planning. In the early spring, Nunamiut men "travel widely attempting to find moving caribou . . . [and] to gather information as to the number of animals and the probable timing of movement so they may plan their intercept strategy" (Binford 1978: 169). The Arctic's Netsilingmiut and the Australian Aranda do much the same thing (Horne and Aiston 1924; Balikci 1970). The Kalahari G/wi use this information to assess various alternatives, as in a game of chess:

> in assessing the cost of exploiting resources, the band considers not only its next move but the whole series of migrations in the foreseeable future . . . the aim is not to plot the coming season's itinerary in detail but to work out a series of moves that will permit the band the widest choice of subsequent sites. (Silberbauer 1981a: 249)

Consequently, many hunter-gatherers maintain knowledge of enormous areas (see Kelly 2003) – 250,000 km^2 for the Nunamiut (Binford 1983: 206) and 52,000 km^2 for Australia's Pintupi (Long 1971); the G/wi had intimate knowledge of 20,000 km^2 and some knowledge of up to 200,000 km^2 (Silberbauer 1981: 95).[20] No one in any of these groups uses all of this territory in a single year – a Nunamiut, in fact, may personally use only one-tenth of it in his or her lifetime. Mobility also helps hunter-gatherers to maintain the social ties that form insurance networks of affinal kin and trading and religious partners and that instruct children in a region's resource geography.[21]

The extent to which hunter-gatherers *must* maintain information about other areas is related to the degree of temporal and spatial variation in their resources. No environment is stable, but environments fluctuate on different scales. We could expect some variability in the need and ability to maintain information or social ties relative to the degree of resource fluctuation (see Chapter 9). Where resources are constant and reliable, mobility is not needed to gather information. Also, maintaining knowledge of other areas does not require residential movement – it helps, but sedentary horticulturalists maintain information networks without moving their villages. Leaving aside the issue of information, then, we return to the relationship between foraging and residential mobility and ask: is sedentism a product of resource abundance?

Recall the foraging model discussed previously (see Figure 4-10). Exactly how long a forager could remain in the 6-km radius patch depends on the density of food within the foraging area. Assuming a caloric yield of 0.25 kcal/m^2, 25 people (at 2,000 kcal/day) could occupy the 6-km radius foraging area for 565 days – well over a year. But if the foragers leave after eating everything within a 3-km half-radius of camp, they occupy it for only 70 days. Foragers are not expected to take full advantage of resource abundance.[22] It would seem that even in a Garden of Eden, and leaving aside other factors that could encourage movement, foragers should still move.

In fact, this model suggests that in an environment of homogeneously distributed resources, *the only reason hunter-gatherers would not move is if there is no place to which to move*. The most likely impediment would be high population density and residential groups inhabiting every habitable place on the landscape. Such a situation could encourage sedentism since the alternative would require displacing a group. Where resources permit a high rate of population growth (see Winterhalder and Goland 1993; Chapter 7), a landscape could become filled with people and constrain residential movements. The prehistory of places that eventually became home to sedentary foragers, such as the Northwest Coast, demonstrates that foragers were mobile for thousands of years before the appearance of sedentary communities (e.g., Ames and Maschner 1999).

What about environments where resources are not homogeneously distributed? Recall from our discussion of the MVT that foragers are expected to leave a patch when the return rate in the patch equals the mean environmental rate of return, taking travel time into account. The MVT predicts that foragers leave before patch resources are exhausted.

Now consider Figure 4-15. Here, we see a foraging curve similar to that of Figure 3-5 – returns initially rise quickly, then level off, and eventually decline as the marginal return rate steadily decreases. Instead of two different patches (as in Figure 3-5), we have two different environmental contexts for this one patch. Line A indicates an environment with a lower overall return rate (again, taking travel time into account) than that suggested by Line B. Note that Line B is tangent to the curve at a shorter residence time (T_b) than Line A (T_a). Although it may seem counterintuitive, in an environment with a high mean return rate, the forager would leave the patch *sooner than if the overall return rate were low* (see also E. Smith 1991: 255). This same patch would be occupied for a shorter period of time in an "abundant" as opposed to a "depauperate" environment.[23]

We stated earlier that as more effort (energy or time) is needed to move camp, relative to the cost of foraging at the current camp, the camp is occupied for longer periods of time. The frequency of residential movements decreases as resource patches become more spread out, whereas the length of logistical forays increases. We have already discussed several factors that are important here: the distance to the next camp, the terrain to be crossed, the amount of material that must be carried, the time required to construct housing, and the anticipated return rate and variance of resources at the next location. Nonetheless, these variables all converge on the trade-off: what is the cost (and benefit) of staying in one place versus the cost (and benefit) of moving somewhere else? From our models, we can deduce that hunter-gatherers should stop moving residentially if the anticipated return rate of the next patch minus the cost of moving is less than the anticipated return rate of the patch currently occupied.

For hunter-gatherers to be sedentary and not become horticulturalists, there must be an adequate supply of food year-round or sufficient food in one season to produce food stores to carry a population through a lean season. This is why sedentary communities often appear on coasts or rivers, where the local resource base is harder to deplete (see Roscoe 2006). However, *such a situation is a necessary but not sufficient condition for sedentism*. The decision to become sedentary is based on regional, not just local, resource conditions. It is not enough for resources to be abundant in one place because if they are equally abundant elsewhere, then we expect movement, even if infrequent, simply as a product of foraging-related depletion. Stated in the vernacular, *sedentism is a product of local abundance in a context of regional scarcity*.

In Chapter 9, we will see that this fact is important because it means that sedentary villages will be associated with control of a resource-extraction point. It also means that sedentism has a domino effect. When one group becomes sedentary, for example, at the mouth of a productive salmon stream, they remove a resource patch from others. This makes the environment more patchy and increases the cost of moving. Once established, then, a single sedentary village encourages its neighbors to become sedentary – similar to a game of musical chairs (Rosenberg 1998). Therefore, we might expect sedentary communities to occur in batches rather than singly.[24]

Foraging, Mobility, and Society

The Mobility Ethos

Many nomadic foragers value movement. Members of modern or formerly mobile hunter-gatherer societies often express a strong desire to move around to visit friends, to see what's happening elsewhere, or to relieve boredom. In the subarctic, traveling is "something of an end in itself" (Savishinsky 1974: 120), and "to travel to see new things is good in itself" (Slobodkin 1969: 84; see Boas 1888: 166–67). Although Australian Aborigines prefer to travel where they have relatives, they too consider it good to see "a bit of the world" (Beckett 1965: 19; see Gould 1969b: 87; Myers 1986: 44). Among the Hare, traveling is a metaphor for freedom (Savishinsky 1974: 120), and the Kaska did not like "sitting one place all the time like white men" (Honigmann 1949: 102).[25] Although unlikely to account for large-scale evolutionary changes, cultural ideals that value movement might encourage higher rates of mobility than expected. They may help perpetuate cultural and niche differences between populations of horticulturalists and neighboring foragers, since mobility can be a strategy to maintain autonomy and to assert cultural identity.

To claim that hunter-gatherers are mobile because they value mobility, however, begs the question of why they value mobility. We pointed out that mobility helps to maintain knowledge of large areas, as well as social ties. But the first forager quoted at the beginning of this chapter points to the primary cause of a mobility ethos among hunter-gatherers: they have to move to find food, so they value movement. If selective pressures have anything to do with the evolution of human society, and if foraging efficiency is a proxy measure of fitness, then there should be strong selective pressure on foragers to value mobility culturally. Although we could expect variability in the strength of a mobility ethos as the need to move to forage changes, it should not be surprising that residentially mobile foragers value a mobile lifestyle.[26]

Foraging and Enculturation

Hunting and gathering, of course, is not all that hunter-gatherers do. They also spend time in religious activities and prestige competition, in family life, socializing, trading, defense, and tool manufacture. Spending time foraging means that one or more of these activities is left undone. The amount of time an individual devotes to foraging must balance the costs and benefits of foraging and nonforaging activities (Winterhalder 1983, 1987; Hill 1988). This is a difficult topic, for although we can reduce assorted food resources to a common set of measurements, it is more difficult to do so for the utility of activities as various as childcare, tool manufacture, and socializing.

Nonetheless, we should consider the potential impact of adult foraging decisions on one especially important area, the rearing of children. The study of childrearing has a lengthy history in anthropology, but it is only recently that it has achieved some prominence in hunter-gatherer studies.[27] Given that there is variability in how much time foragers devote to getting food, we can expect variability in how much time they devote to their children. The greatest variability may be in fathers' attention to children, given that a child needs to be with his or her mother to breast-feed. Hewlett (1992a,b), for example, shows that 22 percent of the time that Aka fathers are in camp they are holding an infant, but for Ju/'hoan fathers it is only 2 percent of their camp time (West and Konner 1976); Efe, Gidgingali, and Hadza fathers likewise hold infants less than 6 percent of the time they are in camp (Hamilton 1981; Winn, Morelli, and Tronick 1990; Marlowe 1999b, 2010). How much time adults devote to children is significant in that it affects enculturation and thus cultural evolutionary change. Here, we are especially concerned with the effect of changes in adult foraging activities that occur with the inception of sedentism. Changes in enculturation probably play a role in the dramatic cultural changes that occur as mobile people become sedentary; we will return to this fact in Chapter 9.

There are two basic forms of enculturation: parental and peer group (Draper and Harpending 1987). In the first, a child's primary caretaker is its parents, especially its mother. The mother is a predictable and consistent provider of resources, beginning obviously with breast milk, but including affection, attention, and protection. The child learns that desirable things, such as food, are held by one or two individuals. As a child grows and can fend more and more for itself, its parents become less giving. Although its demands may become more insistent, the child is eventually cut off by its parents. Pat Draper and Henry Harpending (1987: 220) argue that the child learns that resources and desirable goods are limited and hard to obtain. This leads the child to become more assertive and independent, which could lead to a proclivity to select foraging activities largely on the basis of return rate and to depend on technology rather than social favors to acquire goods (Schlegel and Barry 1991). Such training is more common among hunter-gatherers than among agriculturalists (Barry, Child, and Bacon 1959). Boys in nomadic societies de-emphasize male–male competition and focus more on manipulation of the natural world through technology (Schlegel and Barry 1991). Additionally, where children are parent-reared, there may be a larger amount of intragroup variation in beliefs and behaviors than when children are peer-reared (Cavalli-Sforza and Feldman 1981; Hewlett and Cavalli-Sforza 1986; Hewlett 1991b).

Peer-rearing produces different results. At about two years of age, a peer-reared child finds him- or herself in the care of an older sibling (often an older sister) and a member of an age group. This group becomes the child's primary locus of social interaction. Status and power differences among its members, however, are not as large as between a child and its parents. As the children move among a village's residences, children learn that there are many sources of food and desirables other than their parents. Children raised in a peer group learn to network and learn that they can acquire resources by manipulating social relations. "What is important is who the individual knows, who these people are, what they have, and how they are disposed toward the child" (Draper and Harpending 1987: 223). These children learn that resources are not scarce and can be acquired through persuasion. Additionally, since children in peer groups acquire their culture from each other more or less simultaneously, there could be less intragroup variation among adults who were peer-reared than among adults who were parent-reared.

The decision to raise children in peer groups may be related to the activities of parents. If these activities change as hunter-gatherers become sedentary, then childrearing may also be altered, and this could be responsible for some of the ensuing cultural change. The longer a camp is occupied, the greater the distance foragers must go to procure resources. And, the longer a camp is occupied, the greater the depletion of high-ranked foods and, consequently, the more time must be devoted to the harvesting and processing of lower ranked foods. Assuming that men hunt and that women gather lower return rate resources, sedentism means that men will generally spend more time away from children and that women will invest more time in resource acquisition and processing. This describes what has happened for some Bushmen groups as they have become sedentary (e.g., Hitchcock 1982, 1987b; Draper and Cashdan 1988). When parents, especially young mothers, devote much time to foraging and resource processing, or when fathers are away on long foraging trips, even six-month-old children may be passed to an older sibling for care, setting up peer-rearing. This change in the mode of cultural transmission may account for why sociocultural change seems to occur so quickly once hunter-gatherers become sedentary (see Chapter 9).

Parental versus peer-rearing has different effects on girls and boys (Draper 1985). In societies in which children are peer-reared, girls are more frequently the assigned caretakers of younger children, and this contributes to girls having attitudes favoring nurturance and prosocial behaviors moreso than do boys, as well as more restricted spatial ranges (see Draper and Harpending 1982; Draper and Cashdan 1988: 340). In such societies, fathers may be away for extended periods of time, and this is associated with boys who have poor attitudes toward females, who are aggressive and competitive toward other males, and who, when grown, give little attention to their offspring, ensuring a continuation of peer-rearing (Draper and Harpending 1982).

Adolescent boys' peer groups are of greater importance in sedentary than in mobile societies, in which initiations are more violent and where punishment is also more likely to be harsh (Schlegel and Barry 1991; see Knauft 1991). These competitive groups define a boy's success in life more than in mobile societies where, presumably, fathers are more often present. Peggy Sanday (1981: 60–64, 67, 90) also found in a cross-cultural survey (not limited to foragers) that when men spend a lot of time with their offspring and cooperate in childrearing, there is less cultural emphasis on competition. In societies in which men spend time away from children, there is a general physical separation of male and female tasks, and competition among men is encouraged. Partially as a response to male behavior, peer-reared girls show expression of sexual interest and assumption of sexual activity early in life, while also showing negative attitudes toward males and a poor ability to establish long-term relationships with one male (Draper and Harpending 1982, 1987). There are obviously many other factors involved in determining modal personality, but it is clear that changes in adult labor patterns between a nomadic and a sedentary existence are expected to have dramatic effects on enculturation and hence on cultural change.

Foraging and Resource Conservation

Prior to *Man the Hunter*, foragers were seen as giving no thought to the future, unconcerned with the impact today's actions might have on tomorrow. A significant result of Sahlins' portrayal of hunter-gatherers as "affluent," however, was to overturn this perception. By the late 1960s, anthropologists saw foragers as intentionally managing their resources (see papers in Williams and Hunn 1982; Feit 1973; Gowdy 1998). Optimal foraging theory acknowledges and can accommodate foragers' intentional or unintentional modifications of their environment (contra B. Smith 2009).

Some foragers increase their land's productivity by intentionally sowing wild seeds, by simple irrigation of wild stands of grass, or by burning last year's dead growth (Steward 1938; Lawton, Wilke, Decker, and Mason 1976; Keeley 1995; Fowler 2000; Politis 2007). The Mikea often put a piece of tuber back into an excavated hole so that it might regenerate, and native peoples of California left behind the root crown of soaproot to regenerate (Anderson 2005: 302). The Iñupiat would open up weirs for half of each fishing day to ensure a future population of fish (Burch 2007a). Foragers may also control their food supply by culling game animals selectively; by placing restrictions on hunting, which have the effect of creating a closed season; by using vegetable resources with discretion; by extracting only part of the honey from wild bees' nests so that the bees do not desert the hive; and by many similar techniques of conservation (Woodburn 1980: 101; for a thorough review of Native Californians' methods, see Anderson [2005]).

Conservation ethics are reflected in spiritual beliefs as well. The G/wi believe that N!adima (God) will be angered if they do not leave enough plants behind for regeneration. The Waswanipi Cree look upon animals as *chimiikonow*, or gifts, because animals are "like persons," who act willfully and intelligently, and who give themselves over to a hunter who has lived up to standards of reciprocity (Feit 1973: 116, 1994: 433). The Cree and Naskapi believe that improper acts, such as killing more animals than needed, ignoring obligations to share, or treating the remains inappropriately, result in retaliation by game, who might not allow themselves to be captured (e.g., Leacock and Rothschild 1994: 148).[28]

At the same time, however, we can point to instances in which foragers did indeed overhunt their prey. For example, after Alaska's Iñupiat exterminated caribou and mountain sheep in one part of their range, they simply moved to another part, where they did it again (Burch 1994b: 179). Foragers nearly hunted beaver to extinction in eastern Canada during the seventeenth-century fur-trade frenzy. When the Nuvugmiut of northern Alaska would drive molting birds into nets, they would fill their umiaks with the adults while "thousands of downy young are . . . thrown away" (Nelson 1899: 135; see Krupnik 1993 and Krech 1999 for more examples).

Of particular importance to this chapter is the role mobility might play in the conservation of resources. In our discussion so far, we have covered only dimensions of mobility that pertain to a single seasonal round. However, there is another dimension to movement: long-term mobility, or shifts in the annual range. Many hunter-gatherers shift the size of their annual range or territory every few years. The size of Nunamiut annual territory, for example, can shift from 4,000 km^2 to more than 6,000 or even as much as 22,000 km^2 as a result of fluctuations in the size of the caribou population (Amsden 1977; Binford 1980, 1982). Likewise, the area used by the Dobe

Ju/'hoansi can change from as little as 260 to more than 2,500 km^2, and that of the G/wi from 700 to 4,000 km^2. Ranges can shift in location as well as size. The Nunamiut shifted their annual range about every eight years. In a study of Cree hunting-territory use, Harvey Feit (1973) found that of twenty-two territories, only six were used both winters of his study. These patterns of land use permit plant and animal populations to replenish themselves. And yet, among Labrador's Naskapi, Strong found "no idea among any of the northern bands of consciously allowing certain areas to lie fallow for the game to increase" (Leacock and Rothschild 1994: 89).

Another example: Politis (2007) argues that in the course of collecting palm fruit, the Nukak leave many seeds scattered on the ground in their camps. He argues that the Nukak "move to produce" and that they are intentionally more nomadic than they might otherwise be in order to spread the palm fruit seeds in cleared areas so as to increase their production and distribution. However, as Figure 4-4 shows, the Nukak's high level of residential mobility is predicted by the high primary biomass of their environment. It may be that their high mobility results in the spread of palm trees, but is it intentionally to spread palm trees?

And, finally: foragers periodically burn land, ostensibly to attract game by promoting young growth (Jones 1969; Mills 1986; Lewis and Ferguson 1988; Lewis 1989, 1991). The Alaskan Tanana, for example, burned hillsides to promote the growth of willow shoots as forage for moose (McKenna 1959: 49). Likewise, native Californians claimed that burning increased the size and abundance of tubers (Anderson 2005: 301; Gamble 2008: 33). In fact, Anderson (2005: 136) claimed that fire was "the most significant, effective, efficient, and widely employed vegetation management tool of California Indian tribes."

The question is whether these behaviors that allegedly conserve resources are *intentionally* directed at resource conservation or whether conservation is an unintentional (although real) consequence of optimal foraging by low-density human societies (Smith 1983; Alvard 1993). Shifting hunting territories may permit game to rebound, and burning may promote growth and biodiversity, but is that why foragers shift their hunting territories or burn their land?

Bird et al. (2005) found no evidence to support the claim that people burn their land to promote resource growth in Australia's Western Desert. Instead, they found that the Martu burn vegetation to locate the tracks and burrows of small burrowing animals, that is, to decrease search costs. Likewise, in Madagascar, I watched Mikea men burn off scrubland. Sometimes the explanation was to find animal burrows, but once it was simply "it will be easier to walk back when we return" (and they were correct).

As we pointed out in Chapter 3, the MVT predicts that hunter-gatherers will stop using a patch before food there is exhausted. Foragers do exactly this. The Cree, for example, change their hunting territory when a drop in sightings, animal signs, and success rate all indicate that the territory is being overhunted (Feit 1973: 122). The difficulty is that both the MVT and foragers-as-altruistic-conservationists predict the same behavior: switch patches when the return rate drops below an acceptable level because hunting has become inefficient, or switch patches because harm is about to be done to the environment. Foragers might be "prudent predators, with a rational conservation strategy" or "lucky predators, with a nonrational strategy that produces the same result" (Burch 2007a: 130). Discovering which principle guides foragers' behavior is not easy (Hames 1987). And yet, the difference is crucial.

Michael Alvard (1993, 1995) approached this issue by asking whether an optimal-foraging model or a resource-conservation model best accounts for the game hunted by the Peruvian Piro. The resource-conservation model predicts that game with low maximum rates of increase should be periodically eschewed even if encountered while hunting, to permit the population to survive. The diet-breadth model (DBM), conversely, predicts which resources should *always* be taken when encountered based only on their caloric yields and search and handling costs. A resource-conservation model implies that hunters would be willing to take a loss in their daily foraging return in exchange for a long-term gain. But the DBM predicts that foragers will always try to maximize their short-term return rate no matter what the long-term consequence. In brief, Alvard found that the DBM predicted Piro hunting behavior better than a resource-conservation model (see also Hawkes, O'Connell, Hill, and Charnov 1985). The Piro took animals that have low rates of increase whenever those animals were encountered.

The Piro are not "natural" conservationists; in fact, no one is. But it is also clear that many former foragers do indeed think about the connection between today's actions and tomorrow's consequences. One has only to look at their feelings toward the development projects on their ancestral lands to understand this. Seeing hunting territory disappear beneath mammoth dams and reservoirs, Canada's Cree were puzzled and saddened by what they see as the wanton and irreversible destruction of resources that belong to future generations (Feit 1994). Robert Brightman (1987) suggests that a widespread ethic of resource conservation among North American boreal forest peoples is a post-fur-trade phenomenon, replacing an ethic in which to not kill an animal when encountered would result in a lack of game in times of need – since the hunter is "refusing" the animal's gift of itself. But it is unlikely that conservation was an ethic imported from Western society (the culture that brought us Love Canal, global warming, and extinction of the passenger pigeon).

The question is not whether foragers conserve their resources. Some do and some do not. The question is: under what conditions would we expect to see behaviors that *intentionally* manage and conserve resources, as well as cultural concepts that encourage such behaviors (Alvard 1995; Zavaleta 1999; Smith and Wishnie 2000; Hames 2007)?

People tend to discount the future – as exemplified by the old saying, "a bird in the hand is worth two in the bush." Leaving aesthetic issues aside, the degree to which resources are conserved is related to how much greater the reward will be if resources are conserved as opposed to the gains made by "investing" in resources taken today. Some models can help determine when resources should be conserved, or when foragers should shift from hunting and gathering, with its immediate returns, to agriculture, with its delayed returns (see Tucker 2006). This is a subject that deserves greater attention than we can give here. My point is that mobility, diet, resource-conserving behaviors, and cultural notions of proper resource use are interrelated. Resource-conserving behaviors (or the lack thereof) cannot be understood outside of their foraging context.[29]

Conclusion

We began this chapter by considering some concepts used to classify hunter-gatherer societies in the past. Through this discussion, we saw that mobility is a property of individuals who may move in many different ways: alone or in groups, frequently or infrequently, over long or short distances. Some individuals may move more than others (e.g., men vs. women, parents vs. nonparents, young vs. old, good vs. poor foragers); these movements occur on daily, seasonal, and annual scales. It is not useful to think of mobility in terms of either a single dimension of group movement or as a dichotomy (mobile vs. sedentary). Ethnographic data demonstrate that residential and logistical movements are related to the environment in systematic ways that point to the importance of the relationship between foraging and group movement.

We then developed a simple model of foraging to determine the effect of different variables on foragers' decisions either to remain in the current camp or to move to a new one. The cost of moving (which is related to the terrain to be crossed but includes the nature of housing), the distance to the next camp (which can be affected by nonfood variables, such as water and firewood), the difference between the mean and variance of the current and anticipated return rates, and storage all enter into decisions to move.

We then examined the issue of sedentism. We argued that no society is wholly sedentary; if foragers reduce their movements as groups, they increase their movements as individuals. Returning to the foraging model, we saw that even in those instances where it is possible to remain in a single location, optimization theory and foraging models predict that a forager should still move a residence if he or she wishes to maximize his or her daily return rate. There appear to be two major contexts for the appearance of sedentary communities. First, they appear in areas where population growth has resulted in group packing, such that the cost of moving entails the cost of displacing someone who already occupies the targeted location. Second, they appear, even under low population densities, where the cost of moving is high relative to the cost of remaining in the current camp. This may play a role in some instances of sedentary settlement along Arctic coasts (e.g., see Renouf 1991). Although other factors are involved in the origin and development of sedentary communities, it is likely that local resource abundance is a necessary but not a sufficient condition for hunter-gatherer sedentism.

Ethnographers quickly see the effects of mobility on foraging societies. Although these are many and varied, we have only touched on three effects in this chapter: a mobility ethos, enculturation, and resource management. In succeeding chapters, we will discuss others – demography, land tenure, and sociopolitical organization. Our brief discussion in this chapter of the relationships between mobility and childrearing, and mobility and resource management, points to the importance of further research on the impact of changes in mobility on changes in other aspects of hunter-gatherer society. It is especially important as the world's few remaining mobile peoples are forced to become sedentary and undergo dramatic changes in their lives.

Chapter 5

Technology

> The main activities requiring skill, patience, and the expenditure of a vast amount of real labor were the building of canoes and houses. With nothing beyond a few bone and stone tools they built large, fairly comfortable carpentered houses of planks and hewed large seaworthy canoes from massive logs.
>
> (Olson 1936: 66, on the Northwest Coast Quinault)

> Lacking nails, bolts, and screws, and having little to use for adhesives, the Paiute Indians tied their world together. They tied their wood and willows in bundles to carry them into camp; they tied small game onto their waist bands; they tied the tules to make boats, and cattails to make houses; they tied babies in baskets, and arrowheads to shafts. They used cords in place of buttons and safety pins, to make traps, to catch fish and hang them to dry. In addition to the tough rope of cattails and sagebrush bark, they made strong string of sinew and human hair.
>
> (Wheat 1967: 55, on the Toedökadö Paiute)

We began this book with Thomas Hobbes's famous seventeenth-century description of human life in a time before "society." It is not a pretty image, and we will repeat the less well-known portion of it here: "no place for Industry . . . No navigation, nor use of the commodities that may be imported by Sea; no commodious Building; no Instruments of moving, and removing such things as require much force; no Knowledge of the face of the Earth; no account of Time; no Arts; no Letters; no Society . . . " Although Hobbes did not even know of the existence of "hunter-gatherers" when he wrote *Leviathan* in 1651, his memorable passage came to typify nineteenth- and early twentieth-century definitions of foragers. And part of that definition was that hunter-gatherers lacked things: *technology*.[1]

Many hunter-gatherers do indeed survive with few material possessions. The aboriginal Tasmanians' food-getting technology consisted of unmodified throwing stones and sticks; a straight, sharpened stick served as a spear; bark torches lit their way at night; bark ropes were used to climb trees; simple baskets were used to carry shellfish and simple traps to catch birds. McGrew (1987, 1992), in fact, showed that Tasmanian technology was just slightly more diverse and complex than that of chimpanzees! This comparison is not meant to denigrate the Tasmanians; instead, it shows just how little some hunter-gatherers need to get by.

Until the 1960s, scholars attributed foragers' paucity of technology to the severity of the food quest, which left no time for the intellectual development that was thought necessary for creating complex tools (to say nothing of the arts and sciences). As described in Chapter 1, anthropology cast this explanation aside after the *Man the Hunter* conference. In fact, foragers have quite a bit of downtime, and they devote a substantial portion of this to making tools, clothing, and houses – the technology needed to live (e.g., Marlowe 2010: 97). Recall Marshall Sahlins's Original Affluent Society: if foragers have a cavalier attitude toward material goods, it is because goods must be carried and hence are annoyances.

Although Sahlins was not entirely right about foragers' desires – the Mikea asked me for everything I carried – he was correct that foragers trade-off the cost and benefits of technology, of having useful things and carrying them. Sahlins opened the door to a productive question: when is technology worth the trouble of acquiring, manufacturing, maintaining, and transporting it?

In archaeology, where technology is obviously of keen interest, the search for an answer to this question resulted in a discussion of the *organization of technology*, the "spatial and temporal juxtaposition of the manufacture of different tools within a cultural system, their use, re-use, and discard and their relation not only to tool function and raw-material type and distribution, but also to behavioral variables which mediate the spatial and temporal relations among activity, manufacturing, and raw-material loci" (Kelly 1988: 717).[2] That's a mouthful, but the purpose was to see technology as not simply a set of tools with functions but also as part of the adaptive process. As a result, efforts to answer the question of "when is technology worth the trouble" also led to a focus on *design theory*, understanding "the variables that meet the specific strategies or mixture of needs for which a tool is intended" (Nelson 1997: 376; Bleed 1986), which concerned tool properties of maintainability, versatility, reliability, and use-effectiveness. This research pointed out that tool type and form is not simply a matter of function but also of its relationship to the rest of the foraging lifeway. In this chapter, we will focus not directly on specific tool designs but rather on large-scale patterns in forager technology and on how technology is linked to foraging.

What Is Technology?

For our purposes, we will differentiate between "soft" and "hard" technology. Soft technology refers to the knowledge that foragers need to survive, whereas hard technology refers to the material things that foragers put between themselves and their environment to achieve a goal – be it acquiring and cooking food, staying warm, keeping the rain and snow off their heads, making social contacts, or impressing the neighbors. It should go without saying that ethnographically known foragers have an awesome knowledge of their worlds, and there is no relationship between the volume of soft technology and the amount, or complexity, of hard technology. The Seri of northwestern Mexico, for example, survived with a simple hard technology, but they could name some 350 to 400 different indigenous plants, with most having known uses as food (for both humans and animals), building material, medicine, musical instruments, cleaning agents, and so on (Felger and Moser 1985; see also Mason and Hather 2002; Anderson 2005). In this chapter, I expose my bias as an archaeologist and focus on hard technology.

There are many ways to look at hard technology. One important component is not simply the "stuff" itself but also the techniques used to produce things and the social process involved in their production and dissemination (see Pfaffenberger [1992] and Lemonnier [1993] for reviews). Technology consists of objects, and objects carry a symbolic weight that communicates something about the technology's bearer and user; this symbolic weight can influence the perceived trade-offs. However, in keeping with the approach of behavioral ecology, we will focus on the energetic trade-offs of technology.

Humans are by no means the only sentient beings who employ hard technology: birds make nests and beavers make dams; chimpanzees use stones to crack open nuts and twigs to "fish" for termites; even some octopi carry coconut halves around to use as shelter. But no other species uses as much hard technology as we do or is so dependent on it for survival. Technology is what allowed humans to colonize the globe; without the needle, for example, humans could not have manufactured the clothing necessary to survive in Siberia and the Arctic (and hence colonize the New World). The construction and maintenance of hard technology is a consuming aspect of human life. It entails significant opportunity costs and an important trade-off: time spent making things is time not devoted to using things.

We can divide hard technology into many different categories. To date, systematic anthropological analysis has focused on food-getting technology (Oswalt 1973, 1976; but see Hayden 1998), such as digging sticks, bows and arrows, traps, fishing nets, watercraft, and the like. In addition, there is housing, which for hunter-gatherers includes everything from humble windbreaks to massive cedar-plank houses; clothing; ritual gear, such as shaman's "medicine" pouches; and "prestige" items, such as ornaments. We focus on food-getting technology in this chapter because of its obvious links to foraging. And, to start, we compare the material culture of the Ju/'hoansi and the Nuvugmiut, highlighting their food-getting technology, to show the range of variation among foragers.[3]

Ju/'hoan Technology

We start with a vignette of the formerly nomadic life of the Ju/'hoansi (Lee 1979). Seasons in southern Africa are primarily differentiated in terms of rainfall and, consequently, in the availability of surface water. The Ju/'hoansi obtain some 85 percent of their food from about 100 species of plants, including nuts, tubers, seeds, and fruits; hunted game makes up the rest. During the cool, dry winter (May–August), groups of up to fifty people congregate around water sources; in the hot, wet summer, these camps break into groups of two dozen people, who move among seasonal water sources. Although summers are hot, the winters can see some nighttime freezing.

If we were to walk into a Bushmen camp, the first piece of material culture we would probably notice is the houses. These are simple affairs. The Ju/'hoansi fashion them from a set of saplings set shallowly in the ground in a circle. These are then pulled together to form a dome and lashed with strips of bark. Stringers are tied to the uprights and grasses are tied in bundles to these, laid in courses like shingles to ward off rainfall. A house such as this is made in a few hours.

Around that house, we would see various implements, the tools that Bushmen use to pursue their livelihood. Although constructed with skill and ingenuity, the food-getting implements are relatively modest (Figure 5-1). The main piece of plant-gathering gear is a meter-long digging stick, sharpened at one end. This implement is made in an hour and lasts some six months (Table 5-1). Also needed are the *kaross* (which serves as clothing and blanket) and skin bags of various sizes. Ostrich eggshells are fashioned into canteens.

Hunting technology is slightly more complex. The bow, about a meter long, is fashioned from a particular wood species (*Grewia flava* or *G. bicolor*), bent by repeated heating in sand warmed beneath a fire, and equipped with a bowstring of antelope sinew. Arrows have four parts: a main shaft of cane, into one hollow end of which is fit a short polished bone; a tubular wooden joint fit onto the bone's other end, and a metal arrowhead (fashioned from fence wire) fit into the other end of the wooden joint. The bow is weak, with a pull of only about 9 kg. But the arrows are made lethal with poison, fashioned from the pupal stage of one of a few beetle species. Arrows are carried in a quiver fashioned from bark, with hide caps on either end. Some men carry a metal-tipped spear and a metal adze, the head mounted in a wooden handle with pitch, as well as a throwing stick. Men may also carry a springhare pole, 4 meters long and fashioned from several flexible saplings held together with pitch and sinew, with a curved metal hook attached at one

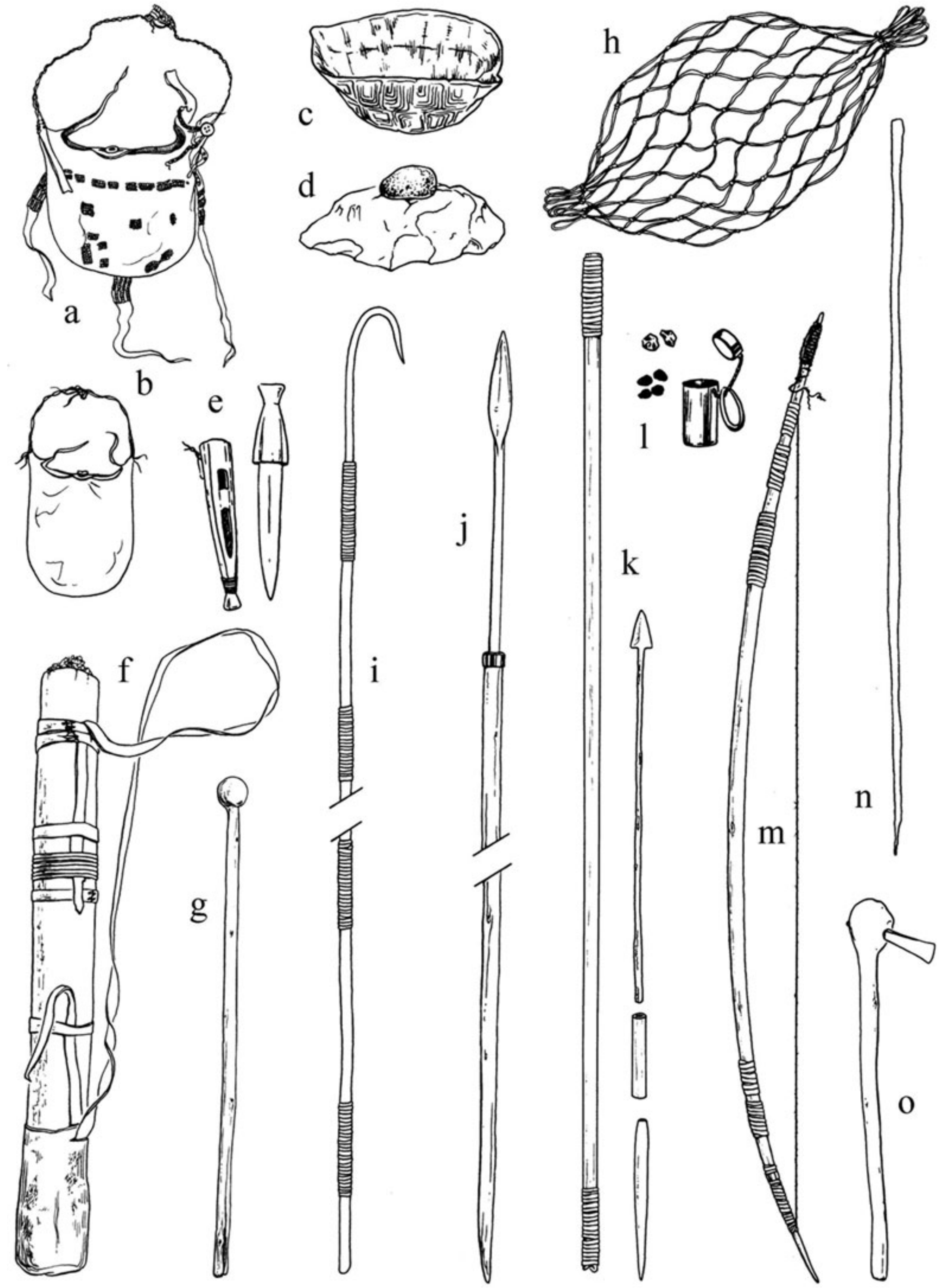


Figure 5-1. A selection of Ju/'hoan technology: a, b-carrying bags; c-tortoise-shell bowl; d-nut-cracking stones; e-knife and sheath; f-quiver; g-throwing stick; h-men's carrying net; i-springhare pole; j-spear with metal point; k-arrow (main shaft with two-part foreshaft and metal point); l-fire-starting kit; m-bow; n-digging stick; o-axe, with hafted metal head. From Lee 1979: 125, 132, 140, 145, and 152.

Table 5-1. Ju/'hoan Technology

Item[a]	Manufacture Time min	Use Time days	Maintenance Time min	Frequency of Maintenance days	Total Maintenance[b] min
Yoke	15	5	0	0	0
Stomach canteen	60	180	0	0	0
Digging stick	60	180	15	30	90
Baby carrier	60	365	30	30	365
Skirts	140	1,825	15	30	913
Fire tools	180	365	30	30	365
Biltong rack	180	60	0	0	0
Cloth	180	365	15	75	73
Shirt	180	365	30	60	183
Shorts	180	365	30	60	183
Clearing and bedding	180	90	1	1	90
Storage rack	225	180	15	30	90
Bags (4)	240	1,825	20	30	1,217
Chuana	240	730	15	30	365
Poison and kit	300	180	30	4	1,350
Club	300	1,095	60	180	365
Flint-and-steel kit	300	1,825	10	1	18,250
Oracle disks	300	5,475	0	0	0
Tortoise shell	300	730	15	30	365
Eggshell canteens	360	730	0	0	0
Sandals	360	1,825	15	75	365
Quiver	600	1,825	30	180	304
Spear	600	3,650	30	30	3,650
Probe	600	1,825	60	30	3,650
Rope snares	600	365	60	30	730
Adze/ax	600	1,825	10	5	3,650
Mortar and pestle	600	1,095	30	30	1,095
Basins, spoons	600	1,095	15	30	548
Kaross	900	1,825	120	60	3,650
Net	900	3,650	60	180	1,217
Bow	900	1,825	10	5	3,650
Arrows (15)	900	365	30	5	2,190
Iron cooking pot	900	1,825	30	30	1,825
Hut	900	90	5	1	450
Knives (2)	1,200	1,825	10	5	3,650

[a] Averaging men's and women's efforts; flint-and-steel kits not included.

[b] Total maintenance time = (use time/frequency of maintenance) × maintenance time.

Source: Lee, 1979: table 9.10.

end. Thrust deep into a burrow and then spun, the twisting hook catches onto the springhare's fur and the hunter pulls the animal out. Men carry much of their gear, including perhaps a metal knife and fire-making equipment, in a woven sinew carrying net.

In camp, food is processed with nut-cracking stones and, more recently, a wooden mortar and pestle (see Figure 1-2), a variety of metal pots (or tortoise shells), bowls, and spoons. There are also personal ornaments, mostly beads, obtained in trade. Everything that a Ju/'hoan family owns can be packed in a *kaross* or net bag, slung onto one's back, and carried from camp to camp. Lee (1979: 277) estimated that Ju/'hoan men average a little more than an hour a day on the manufacture of subsistence tools, clothing, and housing, and Ju/'hoan women, about three-quarters of an hour.

Nuvugmiut Technology

We see a strikingly different technology among the Nuvugmiut, who live at Point Barrow on Alaska's northern coast (Murdoch 1988[1892]; Spencer 1984). They were primarily whale and seal hunters, living in large (250–300 person) settlements on the coast. Although families moved out during the short summer, inhabiting tents along the shore or traveling inland to trade with interior peoples, the winter settlements were more or less permanent for a number of years.

The volume and complexity of Nuvugmiut gear is staggering. Whereas Figure 5-1 shows most of the technology of nomadic Bushmen, Figure 5-2 shows only a portion of the Nuvugmiut inventory. It begins with their semi-subterranean houses. You enter the house through a tunnel; off to one side, just before reaching the house's threshold is a side chamber, the cooking area. From here you stand up and crawl into the house. The roof is made of beams and driftwood; covered with sod, the roof is quite heavy and so it is held up by several large posts. There is a sleeping platform across from the entrance. The walls are dirt or short upright wooden slabs. Since there are no trees near the village, the wood is either driftwood, picked up along the shore, or acquired from the mountains, during long trips made there. These houses are a considerable investment of time and energy, and they are intended to last for several years.

Crawling into one of these houses, you would be amazed at the sheer volume and diversity of stuff. There would be wooden pails; carved wooden bowls and soapstone lamps; heavy stone mauls; slate and metal knives; *ulus* (women's knives); adzes; chisels; saws made of deer scapulae; sheep-horn dippers; wooden spoons; horn ladles; and a variety of fishhooks, sinkers, fishing line, leisters, and fishing nets. You would also find bow drills, ivory-tipped awls, whetstones, and wooden boxes with cord for hinges to hold harpoon heads and other tools. And there would be scrapers, stone or metal bits fit into wooden handles that were carved to fit a particular person's hand.

The Nuvugmiut had an abundance of clothing as well: boots and leggings of waterproof sealskin or deerskin, wooden snow goggles, belts, hooded caribou-hide coats fringed with fur, and deerskin mittens. Although not directly linked to food-getting, warm, waterproof clothing is obviously essential to any outdoor foraging in the Arctic.

Also in and around the house, we would find driftwood bows for hunting, probably shorter than a meter, and arrows, fletched, about 75 cm long. We might see four kinds of arrows in a quiver, each designed to kill a particular prey – bear, deer, large fowl, and small birds. These might have stone points as tips, barbed antler tips or, in the case of bird arrows, bunts. Along with these are bird darts, thrown with an atlatl, with barbed antler or ivory tips and three forward-facing ivory barbs on the shaft; there would be ivory-ball bolas and a variety of snares to trap fur-bearing animals, and carved ivory meat-cache markers.

There would also be seal harpoons. In the winter, seals were taken through their breathing holes. As the sea freezes, seals create breathing holes by breaking through the ice. As the surface ice thickens, seals return to these same holes, breaking through the new sheet of thin ice. Snow eventually covers the holes, making them hard to detect; the Inuit used their dogs' keen sense of smell to find them. The snow cannot be cleared away because then the seal will become suspicious and avoid the hole. So, to detect a seal, the hunter inserted a small, lightweight, T-shaped rod into the snow. The hunter waited, often for hours, bent over the hole, his spear ready. If the seal arrived, it pushed the rod up, and the hunter thrust his harpoon through the snow (other Inuit used feathers or hair to detect the seal's breathing).

Struck by the spear, the seal would dive. But the harpoon has a *toggling* head, designed to detach from the shaft and pivot in the blubber beneath a seal's skin. The head was attached to a long sinew cord that the hunter then used to rein in the seal. As the seal tired, it would drown, and then the hunter began the long process of chopping the ice away with an ax to make the hole large enough to haul his catch out. Seals were also taken with nets strung below the ice.

In warmer weather, seals bask on the surface of the ice. As they roll about, their claws scratch on the ice and the sound attracts other seals. The Nuvugmiut exploited this fact, and, in the spring, a hunter might carry a carved seal "scratcher," designed to imitate the sound of a basking seal and thus lure seals to a waiting hunter.

Along with the seal harpoons, there are those for walrus and whale as well. For these, however, a stitched sealskin bladder, its one opening plugged with a carved wooden stopper, was attached to the harpoon head with cord. With the bladder attached to him, a walrus or whale could not dive far and would, after a chase, tire and be dispatched by the hunter.

And chased in what? Unlike the Ju/'hoansi, the Nuvugmiut needed transportation, especially to hunt sea mammals. The Nuvugmiut had kayaks and 20- to 30-foot long *umiaks* (whaling boats). Ingeniously made from numerous pieces of wood, fitted precisely and stitched together with baleen, they were covered in blind-stitched sealskins. For land travel, the Nuvugmiut used snowshoes as well as two kinds of sledges made of driftwood, pegged and lashed together, with runners of whale mandibles.

Obviously, the Nuvugmiut not only had a lot of equipment (and we've not given a complete inventory) but also many pieces were complex. Why is Nuvugmiut technology so different from that of the Ju/'hoansi?

What Conditions Food-Getting Technology?

Several ethnographic analyses of hunter-gatherer food-getting technology build on data compiled by Wendell Oswalt (1973, 1976).[4] He defined *subsistants* as tools used in the food quest; these he divided into *artifacts* and *naturefacts*, the latter being unmodified stones, wood, and the like. Artifacts were divided into *implements* and *facilities*. A spear or bow is an implement; facilities are traps, stationary fishing nets, or weirs (a wooden, dam-like fence across a stream that channels fish through one opening). Facilities can be *tended* and *untended*; a snare can operate without anyone tending it constantly, but a weir only "works" if someone is present to harvest the fish channeled through the weir's opening. Implements could be *instruments*, such as digging sticks, used to act on foods that are "incapable of significant motion" (Oswalt 1973: 27), or *weapons*, such as spears or a bow and arrow, used against sentient beings.

Oswalt (1976: 38) described facilities and implements using the concept of *technounit*: "an integrated, physically distinct, and unique structural configuration that contribute to the form of a finished artifact." A Ju/'hoan digging stick, for example, has one technounit: the stick itself. But a Nuvugmiut walrus harpoon has ten: (1) the slate (or metal) harpoon head, attached to a (2) bone or ivory toggling head, (3) the ivory foreshaft, (4) the line attaching the foreshaft to the main shaft, (5) the main shaft, (6) the line attaching the toggling head to a float, (7) the float, (8) binding on the spear to hold the foreshaft in place, (9) a finger rest on the spear, and (10) binding to hold the finger rest onto the shaft.

Oswalt also divided tools into *simple* and *complex*. Simple tools have parts that "do not change their position relative to each other during use" (e.g., a weighted digging stick[5]), whereas complex tools do (e.g., the toggling harpoon we just mentioned, since the head detaches from the shaft during use). By dividing a food-getting inventory's total number of technounits by the total number of subsistants, Oswalt obtained a rough measure of the overall *elaborateness* of a particular group's technology. Theoretically, a technology's number of subsistants and their elaborateness are independent of one another (Read 2008) but, in reality, they are correlated: foragers with complex tools tend to have many such kinds of tools.

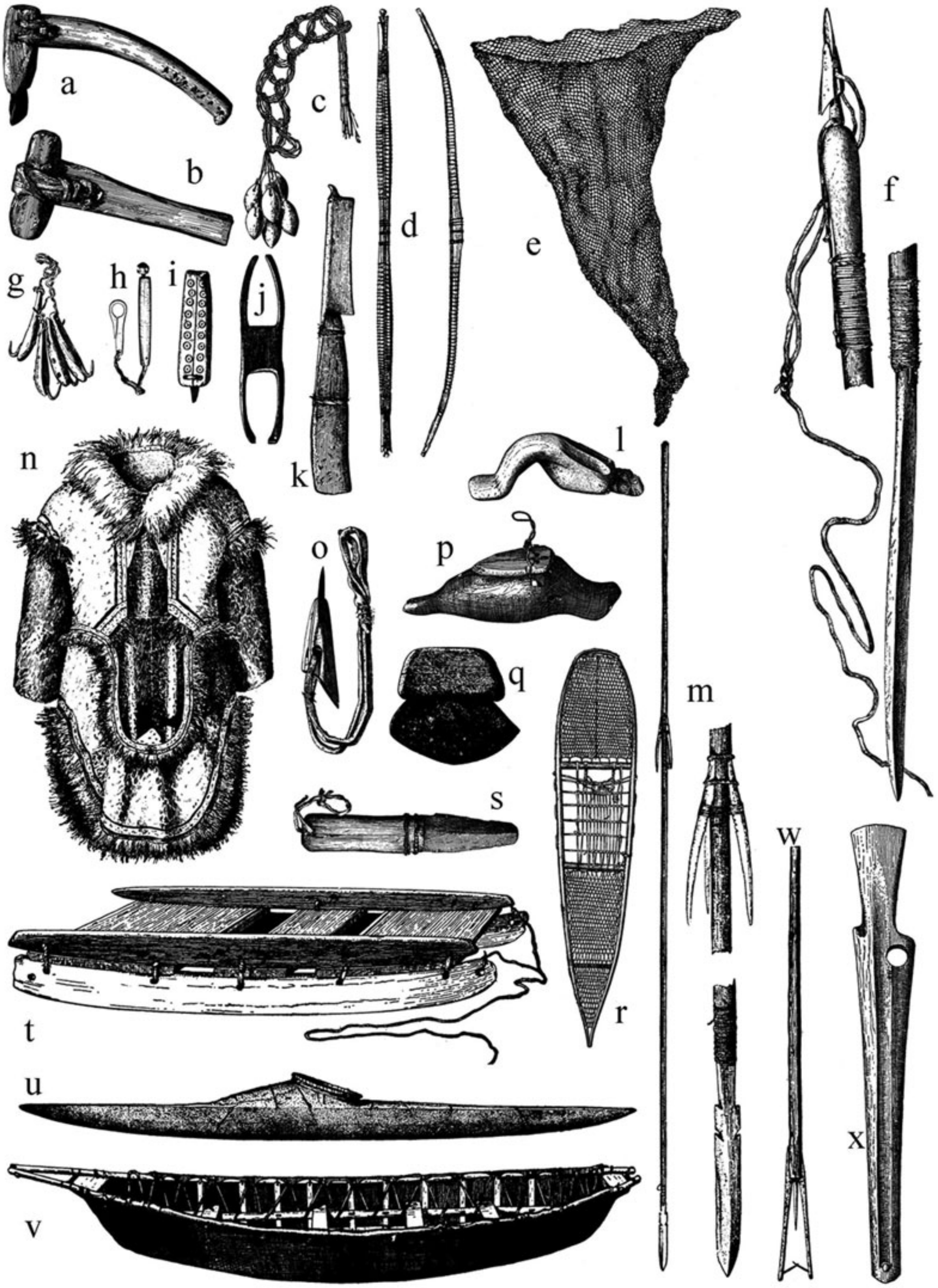


Figure 5-2. A selection of Nuvugmiut technology: a–adze; b–maul; c–bird bola; d–bow; e–fish net trap; f–toggling seal harpoon; g–fish hooks; h–needle case; i–metal-tipped awl; j–netting needle; k–netting mesh gauge; l–hafted stone scraper; m–bird dart; n–women's coat; o–walrus harpoon head; p–wooden harpoon head case; q–ulu; r–snowshoe; s–hafted slate knife; t–sledge; u–kayak; v–umiak; w–fish spear; x–atlatl (spearthrower). From Murdoch 1892: 95, 118, 151, 162, 170, 173, 198, 211, 217, 227, 232, 245, 249, 280, 285, 286, 297, 313, 314, 320, 329, 340, 345, and 355.

But if many foragers, such as the Tasmanians, can survive with a simple technology, why do some foragers invest heavily in tools? Why elaborate technology? Efforts to answer these questions draw attention to three factors.

Function

First, certain types of food require more elaborate technologies. Digging tubers requires little more than a stout, sharpened stick because the forager can work "up close" to the tuber without risking injury or loss of the target. That seems so obvious that it hardly needs stating. We do so, however, to contrast it with large game hunting, which is successfully accomplished with technology such as an atlatl or bow, something that permits the hunter to not only acquire the prey but also to acquire it from a distance to reduce the chance of scaring the prey and permitting its escape (and to reduce risk to the hunter – a wounded animal can be quite dangerous). Hunting technology is more complex than tuber-digging technology because hunting technology must do something more – perform its function at a distance.

Risk

The second factor is risk, which we discussed in the previous chapter. Here, the concept of risk has three elements. Two of the most salient are the probability of coming home empty-handed and the severity of that fact. In general, gathered foods are less risky than hunted foods in the first sense of the term. Either food, however, can be risky in the second sense depending on its importance to diet. A Ju/'hoan hunter can come home empty-handed (as he often does), but he will find tubers, berries, and mongongo nuts there collected by his wife. Conversely, a Nuvugmiut hunter who fails to kill a seal in the winter may place his family in grave danger. A third element of risk is the cost of foraging. Not simply the cost of walking and carrying food but also the ever-present risk of harm to the forager – from a fall, a poisonous snakebite, a sudden storm, and so on. Environments differ in this regard, depending on temperature (extreme cold or heat), the length of daylight, and predators. A fall into a river in the tropical forest may be nothing more than a chance to have a good-natured laugh at someone's expense; such a fall in the Arctic winter could mean death.[6]

Several analyses point to risk as a major element conditioning forager technology.[7] In general, technological innovation is most likely under conditions where risk is high because that is where people have the most to gain from effort invested in new technologies (Fitzhugh 2001). As any element of risk increases, but perhaps especially the second (the severity of coming home empty-handed), technology must become more reliable. In addition, we assume that if foragers wish to maximize their foraging return rate, then they will always be on the lookout for more efficient technologies (but, as we will see, they need to balance the cost of those technologies against their benefit).

Mobility

The third factor is the one that Sahlins identified: mobility. This is most clearly seen in the area of housing, for sedentary people invest more time in houses than do nomadic ones (Service 1966: 11; Binford 1990; Diehl 1992; Kelly, Poyer, and Tucker 2005, 2006). Sedentary foragers also have a vast inventory of material culture (such as the Nuvugmiut; see also Hudson and Blackburn [1982–87] on the Chumash). But whereas mobile peoples are expected to carry fewer tools than sedentary peoples (and lightweight ones, which usually means simple tools), analyses of Oswalt's data disagree on whether mobility alone determines the diversity or elaborateness of nomadic forager technology (e.g., Shott 1986; Collard, Kemery, and Banks 2005).

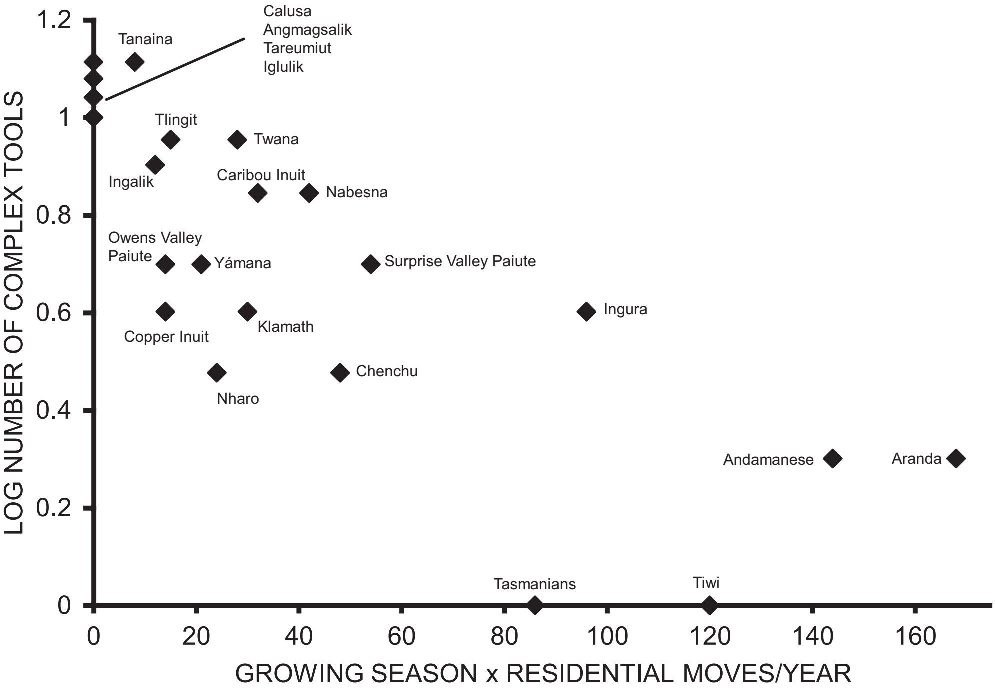


Figure 5-3. Relationship between number of complex tools and Read's (2008) measure of risk: length of growing season times the number of residential moves per year. Redrawn from Read 2008; y-axis converted to log scale; reproduced by permission of the Society for American Archaeology from *American Antiquity* 73(4) 2008.

Dwight Read (2008) dealt with this problem statistically by combining both mobility and risk into a single measure. He did so by multiplying the length of the growing season by the number of residential moves per year for the set of foragers covered by Oswalt's dataset. The number of residential moves per year obviously is a measure of mobility. The length of the growing season is a rough measure of risk because a shorter growing season reflects a colder environment, one that can expose foragers to more risk in the winter while foraging. Cold environments are also ones that have lower primary productivity and overall less food than warm environments. Foragers in cold environments store food, and this means that there is a serious lean season. In these places, the risk of coming home empty-handed is both more likely *and* carries more severe consequences.

Read's result is shown in Figure 5-3. This shows a nonlinear relationship between the number of complex tools and his combined measure of risk ($n = 22$, $r = 0.78$, $p \ll 0.01$). Read also found a linear relationship between the elaborateness of a technology and his measure of risk, meaning that highly mobile foragers who live in environments with long growing seasons have fewer complex tools and a less elaborate overall technology than do sedentary foragers who live in environments with short growing seasons.

It might seem obvious that sedentary foragers can invest time and effort in more kinds of tools and more complex tools because they do not have to concern themselves with the cost of transporting them. This ability to accumulate stuff, one that is well illustrated by the Nuvugmiut, makes a complex, elaborate technology possible, but it is probably not the *cause* of that elaborate technology. The reason why is that even if things do not have to be transported, they still have to be made. The construction and maintenance of technology entails a cost, and elaborate technology entails a large cost. Incurring the cost suggests there is a benefit.

Look, for example, at Table 5-1, which contains data compiled by Richard Lee on Ju/'hoan technology. The table includes the use-lives of various pieces of material culture and the time needed to manufacture and maintain the items. As we might expect, there is a correlation between the time it takes to manufacture an item and its use-life ($r_s = 0.55$, $p = 0.001$, $n = 35$).[8] Similarly, there is also a correlation between the total time needed to maintain an item over its use-life and the length of its use-life ($r_s = 0.68$, $p \ll 0.001$, $n = 35$). Although it makes sense that an object that takes a long time to make and that demands upkeep would be used for a long time, this raises the question of the trade-off involved. In fact, many elaborate Inuit tools were not used for long periods of time but are elaborate and overdesigned so that they are guaranteed to work (Bousman 1993). A forager can spend more time harvesting food with a less elaborate, less efficient technology, or he or she can spend time manufacturing and maintaining a more elaborate technology and then spend less time harvesting food with a more efficient technology. What determines the choice?

Why Elaborate Technology?

We need to model the decision-making process of technology, just as we modeled the decision-making process of food choice and camp movement. To understand this, let's consider the diet-breadth model (DBM) again. You will recall that this model predicts which foods foragers select of all the possible choices an environment presents. Three variables are important to the model: the encounter rate of a resource (which is largely a product of its abundance), the postencounter cost of harvesting it, and the value (in some currency, usually calories) of the resource itself. The time needed to harvest a resource in light of its value produces the *postencounter return rate*, the return per unit time of harvesting and processing a food. Low-ranked resources have *low* return rates, in large part because of their *high* postencounter harvesting and processing costs. Diet breadth is narrow or broad depending on which array of food choices maximizes the *overall* foraging return rate. Lower ranked foods are added to the diet as high return rate resources become rare and consequently entail higher search costs.

Technology enters into this equation. For example, to test the DBM, we gave as an example the Ache's use of shotguns: when the Ache use shotguns, the postencounter cost of small monkeys goes down and the resources taken while foraging narrows. Exchange the shotguns for bows and arrows, and the postencounter cost goes up (because of greater stalking costs) and the diet broadens. Why not hunt with shotguns all the time? In the case of the Ache, the answer is obvious: while a shotgun has benefits, the up-front purchase price and the continuing cost of shells is prohibitive. Likewise, consider the Nuvugmiut hunter who is looking for seals. Although it is possible to hunt seals by walking along the coast and grabbing any you find with your bare hands, it is probably not very effective (to say the least). It would only take a day of this before you found yourself thinking about a boat and some kind of harpoon. *Food-getting technology aims to reduce the search or harvesting cost of resources.*

Search costs are generally reduced through soft technology, by knowing where plants or game are likely to be found at certain times of the year under different weather conditions. This requires an encyclopedic knowledge of animal behavior and plant responses to climate.

Conversely, food harvesting and processing costs are generally reduced through hard technology. For example, ceramic vessels are rarely found among hunter-gatherers. It's not that foragers cannot see the virtue in having pots. In fact, metal pots (and, later, plastic containers) quickly became popular trade items as soon as Europeans arrived on the scene. And it is not that foragers do not need vessels in which to carry or store small things. In fact, a good portion of hunter-gatherer material inventory consists of things to hold things (Figure 5-4). So, to answer the question, "why not pottery?," we have to consider the costs and benefits of pottery.

The initial benefit of pottery, apparently, was that it could be used to boil seeds, a generally low return rate food (e.g., Eerkins 2004). Along with grinding stones, pottery increases the food

Figure 5-4. Some Mikea containers, 1995. On the left is a gourd, grown especially as a container; in the middle is a "fanny pack" woven from cordage produced from bark; on the right is a lidded container carved from a single large block of wood. Photo by the author.

value of seeds and raises their return rate over that of unprocessed seeds. (Grinding breaks down the seeds' outer coats, which often cannot be digested by humans; likewise, boiling converts the carbohydrates into more easily digestible sugars.)

But pottery has a manufacturing cost. Foragers generally made pottery in one of two ways. A lump of clay can be simply molded into a pot, or rolled into a long snake, coiled into the form of a pot, and then smoothed by hand. The pot's temper (material added to the clay to give it strength) can be little more than some heavy sand, moss, or small gravel. Once formed, the pot may be baked by setting it near a fire or simply dried in the sunlight. These pots tend to be thick-walled, unevenly fired, and easily broken. They do not transmit heat very well, but they will do the job, and their construction cost is minimal.

At the other extreme are pots made from carefully chosen clay that has been pounded and sifted to remove impurities, with fine sand added for temper. These pots are baked in a kiln, with the temperature controlled and the firewood carefully chosen. Pots made with such care will have thin, hard walls that do not break easily and that transmit heat well. They cook food efficiently, but take a lot of time to make.

Why choose the thick-walled, poorly fired pottery if thin-walled, well-fired pottery does the job better? Nomadic foragers rarely make pottery; instead, they boil food, when boiling is necessary, by stone-boiling in a skin-lined pit or a tightly woven, pitch-covered basket.[9] The reason for boiling in this manner is obvious: because the likelihood of breakage is high during camp moves, mobile foragers would be foolish to invest the time needed to make thin, hard-walled pottery (instead, nomadic foragers are often expert basket-makers). The "maintenance" of the crude pottery generally means making a new vessel rather than repairing a broken one. When foragers do make pottery, it is intended for short-term use and hence it is "poorly" made (e.g., Simms, Ugan, and Bright 1997; Bright, Ugan, and Hunsaker 2002). Less nomadic foragers, however, and those who redundantly use particular places (the "tethered foragers" we mentioned in Chapter 4) where pots could be cached, make "better" pottery (Eerkins 2003). Pottery is a late invention in many parts of the world. In North America's Great Basin, for example, it does not appear until about 1,000 years ago. The DBM suggests that foragers did not invest effort in pottery (or, sometime earlier in the Great Basin, grinding stones) until the depletion of high-ranked resources forced a broadening of the diet that demanded new technologies to help raise the return rate of low-ranked resources, such as seeds. How does this perspective help us understand the pattern discovered by Read?

Nomadic peoples are nomadic because residential movement is perhaps the least costly way to cope with the risk of local resource shortfall. As foraging depletes a patch, the risk of coming home empty-handed increases and, at some point, foragers move (depending on the variables we discussed in the last chapter). This means that we cannot easily separate the effect of mobility and risk on technology. (And this is why Read found such a clear relationship when he combined mobility and risk into a single variable.) Foragers weigh the cost relative to the benefit of moving camp, as we discussed in Chapter 4. Although several variables enter into this decision, *anything that constrains movement increases the risk associated with foraging*. By lowering overall foraging efficiency (see Chapter 3), an increase in diet breadth brought about by a reduction in mobility makes a foraging system more unstable; this is especially true in "risky" environments. So why does increasing risk result in more complex tools?

Risky environments are risky in large part because they contain few sources of food. In such places, if the primary source fails, there is little to fall back on – and so the forager cannot afford to fail. If the Pumé of Venezuela fail to encounter the game that they are looking for by noon, they turn to harvesting some other (lower-ranked) food (e.g., Greaves 1997). But the Nuvugmiut often don't have this luxury. When hunting seals in the winter, there simply is nothing else that they can turn to; although they stand by a seal hole for hours, a Nuvugmiut hunter may only get one shot. For seal hunters, failure is not an option. In such situations, technologies are tailored to a specific food resource or even, as is true for the Nuvugmiut, specific to a particular food at a particular season of the year. Tools associated with the acquisition of "risky" resources must be *reliable* by being overdesigned and/or *maintainable* by being quickly repairable through interchangeable parts (Bleed 1986). Both efforts result in complex and elaborate tools. Technology enters the food-getting equation as an up-front cost in terms of raw material procurement and construction and a continuing cost of maintenance.

As mobility is reduced, high-ranked resources become locally depleted. According to the DBM, foragers will expand their diet breadth, adding resources that, although perhaps abundant, are more costly to harvest and process. Take, for example, trapping technology. Many foragers take game through traps (Cooper 1938; Holliday 1998; Sasaki 2009), including deadfalls, spring-pole snares (Figure 5-5), or faux-floor pits; they are usually but not always aimed at small game. Traps are usually placed where a forager expects an animal to encounter them. For example, in the Mikea forest, some species of waterbirds prefer to walk around rather than surmount even a low barrier. The Mikea take advantage of this behavior and build low (less than 12 inches high) brush walls around small shallow lakes, leaving a short break in the wall. Across that break they lay a stick, about 6 inches above the ground. Hanging from the stick are many small "hangman's" nooses, placed so that a bird is likely to walk through one. As it does, the noose tightens about its neck or body; the more the bird struggles, the tighter the noose becomes (see also Rippen 1918).

It should come as no surprise, then, that trapping technology is more prevalent among sedentary than nomadic foragers (Holliday 1998). Traps reduce search costs by allowing hunters to search for and pursue other resources while the trap is "pursuing" another. And they also reduce processing costs by killing or containing the animal without direct input from the hunter. Nomadic foragers use traps, but Holliday (1998) found that they do so where the game population mimics the situation created by sedentism – high search costs to pedestrian hunting and low postencounter

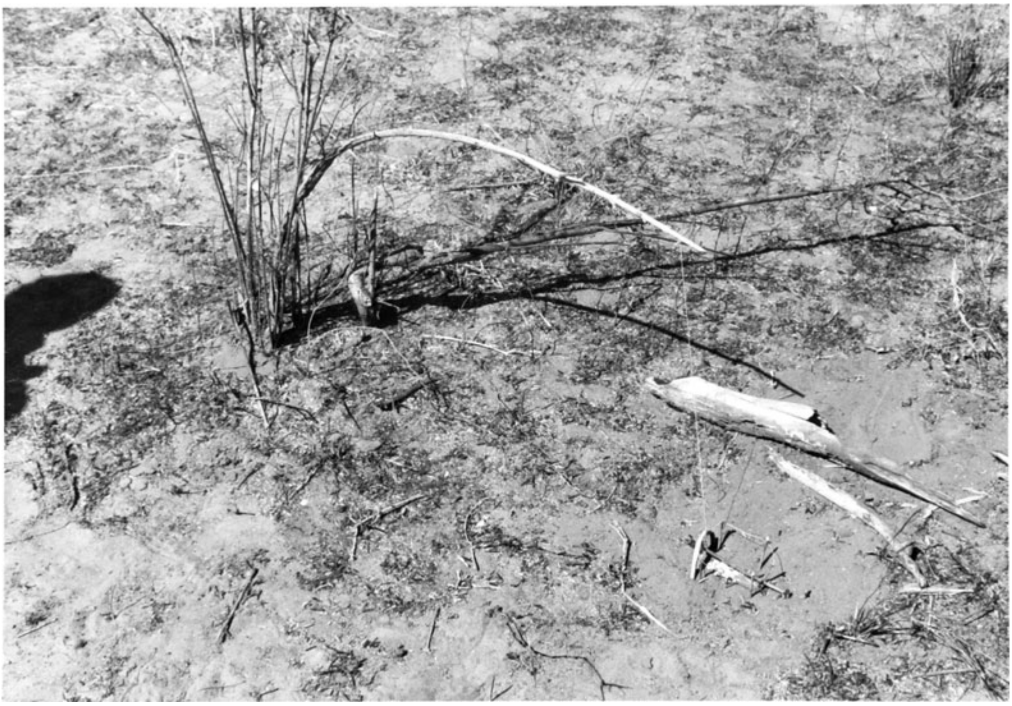


Figure 5-5. A Mikea snare, 1994. Photo by the author.

return rates. Some of these traps are very simple but others can be quite complex and time-consuming to build, especially for larger game (see examples in Cooper 1938).

There are two additional elements to the process of sedentism as well. Most ethnographically known sedentary foragers are coastal peoples who rely heavily on fish and/or sea mammals. In these circumstances, foragers operate under additional constraints because they must procure animals from one medium – the ocean – while operating from another – dry land or boats. Simple spears function less well than multipronged leisters in water, in part because of the refractory properties of water. In many circumstances, fishing requires foragers to work "blind" – as in deep water, silt-laden lakes or streams – and thus demands nets or hooks and lines. Foragers hunt large land mammals with a projectile and then track the prey while poison or bleeding weakens it. But sea mammals can't be tracked in the water, and these require a "catch-and-grab" technology (Kelly 1996) – such as toggling harpoons attached by lines to floats, a boat, or the hunter himself – that grab and "hold" the animal. (When the Point Barrow Eskimo first used guns, they suffered high loss rates because wounded seals escaped below the ice where they died but could not be retrieved; see Sonnenfeld 1960.) So, in addition to ocean-going boats, which are themselves a complex piece of technology (Arnold 1995a, 1996a, 2007), sea-mammal hunting requires additional elements to the projectile because it must perform a function that terrestrial hunting technology does not.

Second, sedentary foragers must store food, and if they are on a coast, which is likely, then they must harvest and store fish in large numbers. In all likelihood, the temporal window of opportunity to harvest and process a storable resource is small, putting pressure on foragers to devise ways to harvest a large amount of a resource quickly. This requires mass-harvesting technologies such as weirs and nets, and mass-processing technologies such as drying racks to process fish. In sum, sedentary coastal foragers in cold environments "elaborate" their technologies to reduce the risk produced by low mobility, to harvest food in bulk for storage, and to meet the special additional needs of fishing and marine-mammal hunting.

Technologies that meet the demands of an expanded diet breadth can elevate resource harvesting rates through "mass collecting" technologies (such as fishing nets; Hayden and Gargett 1990). Mass-capture devices such as weirs or hunting nets permit groups of people to collect large numbers of fish or game at one time with fewer people (and hence with a higher per capita return). And yet, such mass-collecting technologies appear relatively late in prehistory (Hayden 1981a; de Beaune 2004). Why do they not appear sooner?

The up-front costs of complex tools and elaborate technologies can be enormous. Weirs and hunting nets can require large investments of time in their initial construction (Olson 1936; Bailey and Aunger 1989a). Some large Australian hunting nets, for example, require months to manufacture (Satterthwait 1987). That time increases when we add the time to collect the raw material for the cord and the time to manufacture it (see Olson 1936: 74; Satterthwait 1987: 615; Lindström 1996).

Once made, complex facilities and tools require maintenance until they wear out. In many cases, maintenance is probably a minor expense compared to the up-front manufacturing cost since it might be done in what otherwise would be down time. Among the Naskapi, for example, Strong found that "when men are not hunting and are loafing in the lodges, they nearly always attend to the nets" (Leacock and Rothschild 1994: 84). Older Mikea men and women would often sit around the fire in the evening rolling strips of bark into cord on their thighs. But the maintenance of some other technologies may entail a significant opportunity cost. Fish weirs, for example, are often rebuilt every season, and that cannot be done while relaxing around a fire at night (Olson 1936: 29).

The time it takes to manufacture complex technology is a potentially large opportunity cost to a forager who could spend that time acquiring food (Elston 1990; Bright et al. 2002; Ugan, Bright, and Rogers 2003), albeit with a simpler, less efficient technology. Noss (1997) and Lupo and Schmitt (2002), for example, show how African communal net hunting competes directly with other activities that use simpler technologies, such as individual snare hunting. So, when does an "expensive" technology replace an existing "cheap" one? What makes a forager decide to invest time in a net or a ceramic vessel rather than in acquiring food with a simpler, less efficient technology?

A Technological Investment Model

To answer this question, we can turn back to the marginal value theorem (MVT) (Bettinger, Winterhalder, and McElreath 2006; see also Read 2006). For this model to make sense, it is important to realize that the increase in return rates produced by slightly more elaborate forms of the same basic technology is probably small and incremental but that the difference between major kinds of technology is more likely to be a significant leap, such as the difference between a simple fishing spear versus a large dip net, or hunting seals with a hand-held spear versus a toggling harpoon. We see this fact depicted in Figure 5-6A; the two curves are similar to those used in our discussion of the MVT, as well as the transport and patch-choice models (see Figures 3-5, 3-6, and 4-15) because, in fact, a very similar principle is at work.

In this case, the two curves represent two different (and hypothetical) technologies that accomplish the same function: fishing with a spear versus a large gill net.[10] The right-hand x-axis is a measure of time invested in initial manufacture and then improvement of each technology; the y-axis is the net return rate from each technology; and the left-hand x-axis measures the length of time a technology is to be used. Each curve rises with an increased investment in the technology because we assume that additions and embellishments make the tool function more efficiently. For example, we could begin with a simple spear, nothing more than a sharpened stick. We could increase its effectiveness by adding a barb to the end. We could then give the spear a detachable head, with a line attached to it. Likewise, for our gill net, we could start with

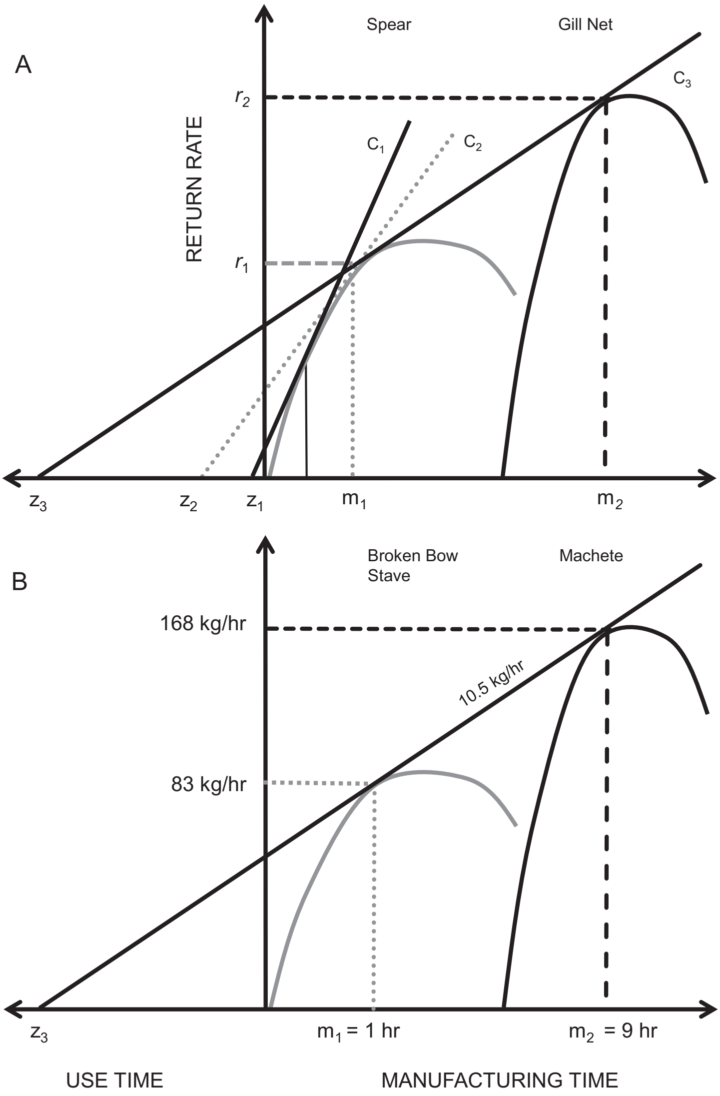


Figure 5-6. A: Diagram showing a hypothetical relationship between spear and gill-net fishing return rates (based on Bettinger et al. 2006). The two curves depict changes in the return rates from spear and gill-net fishing with embellishments within each technology type. The right-hand x-axis is time devoted to making and improving each technology; a gill net provides a higher return rate than a simple spear but requires more time to manufacture (m_1 versus m_2). The left-hand x-axis reflects increasing use times of the technology, from z_1 to z_3. Lines C_1 through C_3 are declining marginal return rates that include manufacturing time (just as the MVT includes travel time between patches). As the use-time of the spear increases (e.g., in this example, as fish become more important to diet), the left-hand x-axis intercept shifts from z_1 to z_2 to $z_{3,}$ and the benefit of technological improvements to the spear declines relative to their return. At some point in this process (line C_3), the marginal return rates of the low- and high-investment technologies are equal and, with its higher return rate, it makes sense to invest time in the more expensive technology. B: An example depicting the relationships between harvesting tubers with a bow stave versus a machete (based on Hurtado and Hill 1989). The machete produces greater returns, but since its purchase would require working for cash and since the bow stave produces a high rate of return (83 kg/hr), the machete's up-front cost will prevent it from replacing the bow stave as the digging tool of choice until the return from improvements to the bow stave drops to 10.5 kg/hr, taking "manufacture" time of those improvements into account.

a mesh of 400 cm^2 (20 × 20 cm), then add additional lines to reduce that to 100 cm^2. We could then add weights to the net's bottom edge and floats to the top.

In general, we expect each additional embellishment to have less and less effect. Figure in the time it takes to add those embellishments, and we see that the marginal return rate (relative to manufacturing time) will steadily decline (just as it steadily declines as a forager slowly exhausts food density in a foraging patch). If we go so far as to add functionally useless additions to our technology – elaborate painting to our spear, for example – the marginal return may become negative. It is important to remember here that the marginal return rate is *relative to manufacturing time*.

The technological investment model argues that we can predict when a technology will be embellished or, more important, when a more elaborate, "expensive" technology replaces another (see Bettinger et al. [2006] for the mathematical proof). Imagine a forager who is going to fish only for an afternoon. He or she might invest an hour in making a spear but not days in making a gill net (recall the relationship between manufacturing and use time of Ju/'hoan technology described previously). A gill net can bring in a greater harvest *but at a lower initial return rate if we add the net's construction time into the calculation*.

Let us imagine that our forager finds that he must spend more time fishing (perhaps higher ranked resources have been depleted). He starts by taking the large fish that are easier to strike with his spear. But as he depletes the supply of large fish, his diet expands to include increasingly smaller species or individuals. He adds embellishments to his spear, but the effects of these are increasingly minor. As a result, the marginal spearfishing return rate relative to manufacturing time declines. This is depicted by the (decreasing) marginal return rate lines, C_1 and C_2. He could invest more time in his spear but, at some point, the marginal return rate from additional investments is equivalent to that of initial investment in the gill net (line C_3) and, with that added expense, the gill net provides a higher return rate. So, the forager switches from a spear to a gill net.

The point at which line C_3 crosses the left-hand x-axis marks the point (z_3) at which we expect foragers to change from spears to nets. You might have already guessed that the equation to predict this point is the same as that used to predict how much a forager should field-process a resource (see Chapter 3, central-place foraging). There is actually nothing mysterious in all this; in fact, we make similar decisions all the time (e.g., in deciding what sort of computer to buy, our up-front cost is based in part on how much time we think we will spend on the machine).

Bettinger and his colleagues point out that this technological investment model leads to three insights: when technology changes, it is expected to change (a) quickly, because the decision to invest in a new technology is normally of the either/or type; (b) pervasively across a population as the benefits of a new technology become obvious and its manufacturing specifications known; and (c) usually irreversibly, because it alters knowledge of the net return that is possible with a new technology, and maintenance/construction becomes embedded in other activities and downtime.

The model also suggests that no more than two variants of a technology are likely to exist in a population. Why? We can imagine that as we reach the marginal return rate defined by line C_3, both the spear and gill net might be in use jointly because some families or groups feel the need to increase their net return more than others. For three or more technologies to exist, however, all of them would have to share a single marginal return rate tangent to all three functions – and that is highly unlikely.

This model can help explain technological changes. For example, the Amazonian Machiguenga normally dig and peel manioc with a broken palm-wood bow stave – similar to the unadorned digging sticks used the world over by foragers to dig wild tubers. Hurtado and Hill (1989) showed that the Machiguenga can double their efficiency (168 as opposed to 83 kg/hr) by using metal machetes instead of bow staves. But 83 kg/hr is apparently already so high a rate that the enhanced returns from a machete do not offset the initial cost of obtaining one (we have no information on what it takes to obtain a machete, but it probably involves some amount of wage labor). Hurtado and Hill estimate that the return rate from a machete as a digging tool is unlikely to surpass an unadorned digging stick until the overall return rate from digging tubers drops below 10.5 kg/hr (which would happen if tubers became rare). The possible relationships between machetes and bow staves in this example are shown in Figure 5-6B. For the sake of argument, let's assume a one-hour "cost" to making a bow stave serviceable as a digging stick and that the 83 kg/hr rate is pushing the limits of that technology. Remember that z is the time devoted to collecting a resource and that the solution for z uses the same equation as we used when calculating resource field processing. A marginal return rate of 10.5 kg/hr means that a machete would "cost" about nine hours of work (a line tangent to both curves at points 1,83 and x, 168 with a slope of 10.5 would have an x value of about 9). Plugging these numbers into the equation, we have:

$$z = \frac{(83)\,(1) - (168)\,(9)}{168 - 83}$$

and $z = -16.81$. If a Machiguenga woman is going to dig tubers for (a very long) 17 hours at a time, it pays to spend nine of those first obtaining a machete because: $16.81 - 9 = 7.81$ hrs $\times$ 168 kg/hr = 1,312 kg. If she spent that time working with a bow stave, the return would be $16.81 \times 83 = 1{,}395$ kg – very close to the same return. And, in the future, the machete would produce higher return rates and either decrease the time spent digging or allow a woman to increase the amount of tubers collected. So why don't Machiguenga women take the time to get machetes? Since they can obtain enough food with bow staves in only an hour to feed twenty-five people for a day, they have little incentive to put in the up-front time to acquire the more efficient machete.

The model could also shed light on a perennial issue in hunter-gatherer anthropology: net versus bow and arrow hunting among pygmy peoples of the Congo Basin. We discuss this more in Chapter 7, where we will be concerned with men's and women's foraging activities. Here, we are concerned with the different technologies that are used, the bow and arrow as opposed to the net. In both cases, animals may be driven into a line or semicircle of hunters. In one case, those hunters may be armed with bows and arrows; in the other, they may be standing along woven nets stretched through the undergrowth. Game animals become entangled in the net where an attendant clubs them.

Nets catch larger numbers of animals and, for this reason, many anthropologists assumed they were more efficient. But studies show that once the larger number of people involved in net hunts is accounted for, the rates are about the same (Terashima 1983; Wilke and Curran 1991; Noss 1997; Noss and Hewlett 2001; Lupo and Schmitt 2002). In fact, this is exactly what we would expect: the technological investment model predicts that two coexisting technologies aimed at acquiring the same resource should have similar return rates. Netting technology may exist where the demand for bushmeat is high (Wilkie and Curran 1991; some of the game caught in the nets is sold to travelers and horticultural villagers) and where women's labor is not needed in nearby village fields (Bailey and Aunger 1989; see Chapter 7). Women often make up more than half the net-hunting group, and sometimes the group is only women (Noss 1997; Noss and Hewlett 2001). It may be that men join the women because the return rate from net hunting is the same as the return from bow and arrow hunting.

Very complex technologies require innovation in many areas and feed innovation in others. The Chumash's massive plank canoe, for example, must have required considerable experimentation with hull and gunwale shape and size to create a vessel with a two-ton carrying capacity that could be paddled 40–50 km through waves and swells and also negotiate beaches without capsizing (Arnold 2007). It also required ancillary technologies such as paddles, bailers, adhesives, and woven fibers, as well as tools to cut, plane, and drill the planks. Undoubtedly, these technologies found their way into other areas of Chumash life (just as the technologies developed by NASA's space program find uses in other areas).

Part of the reason for the development of new technologies is captured in the adage "necessity is the mother of invention." But to invent something, one must have ideas, and since ideas are generated by people, the more people who interact with one another, the more ideas are generated. Large populations increase the rate of new ideas (Henrich 2004; Richerson, Boyd, and Bettinger 2009); conversely, a reduction in the size of an interacting human population, as might occur when islands are colonized, can result in the loss of some ideas and technologies. If new technologies increase the net return, and if that translates into increased population growth (see Chapter 7), then it follows that new technologies set off a positive feedback loop and, hence, increasingly rapid technological change (Richerson et al. 2009). This is certainly what the world has witnessed in the past 15,000 years as marine resources, domesticated plants and animals, and long-distance trade became crucial to human diet.

Performance Characteristics

The technological-investment model demands knowledge of different tools' manufacturing costs and "performance characteristics" (Schiffer and Skibo 1987; see Kelly 2000). It needs quantitative data on the effectiveness of different technologies (e.g., fishing spears versus gill nets) and, in fact, the effectiveness of different technologies with different embellishments (e.g., our simple pointed-stick fishing spear versus a barbed one). Unfortunately, such information is rare in the existing ethnographic literature. Politis (2007), for example, provides information on Nukak blowgun manufacture, and Marlowe (2010) provides such information on various pieces of Hadza material culture. Other accounts contain descriptions of projectile, fish weir, and house construction; fish traps; and twine, rope, and hide preparation.[11]

Unfortunately, these ethnographic data are not always sufficiently detailed to provide us with the information needed for the technological investment model. Ethnographers rarely discuss the time it takes to make tools or provide measures of a tool's effectiveness. This means that experimental programs and ethnographic research aimed specifically at material culture is essential. Relying on indirect data or impressions will almost certainly lead us astray.[12]

Simms and Russell (1997), for example, show that sickles do not always increase the efficiency of wild wheat harvest over that of hand harvesting. The reason is that hand-harvested plants are normally yanked from sandy soil or their dry stems snapped off. The plants are then threshed to remove the seeds. However, sickles are more efficient at harvesting green wheat, as well as wheat grown in clay-rich soils that hold the roots fast. Where wild wheat played a larger role in diet, sickle-wielding foragers could increase their net return (a) by harvesting wheat early, while it is still green and none of the seed has fallen to the ground, and (b) by harvesting wheat growing in hard soil, plants that formerly might have been ignored because they provide a low return rate when harvested by hand.

Or, consider the pygmy nets mentioned previously. It may take as many as two to four months to gather all the material needed to make a modest net and another three to five days to actually manufacture the cord and weave the net (Lupo and Schmitt 2002). The Mbuti spend an average of eighty minutes a day making and maintaining nets (Bailey and Aunger 1989). The more elaborate traps that the pygmies use are manufactured, start to finish, in less than three hours but simple traps are made in less than ten minutes; poles to snag pouch rats from their burrows are made on the spot from a handy sapling in less than five minutes (Lupo and Schmitt 2002). We suggested that the up-front cost of net manufacture is higher than that of making a simple spear; the Mbuti data suggest that this is correct, but we need more data for the myriad forms of technology that foragers use.

For example, how effective are weighted digging sticks compared to unweighted ones? Is the bow and arrow more accurate or deadly than the atlatl (spearthrower) (Raymond 1986; Churchill 1993; Shott 1993)? What is the return from fishing with a hook and line versus nets (Lindström 1996)? How well does bow technology fare in heavily forested versus desert conditions (Roscoe

1990; Bartram 1997)? What conditions stone-projectile-point durability (Christenson 1997; Ellis 1997; Cheshier and Kelly 2006)? What is the return on stone-quarrying activity (Jones and White 1988)? How much does heat treatment improve the "return" on flintknapping (Bleed and Meier 1980; Cooper 2002)? Is it more efficient to butcher with hand-held flake tools or hafted bifacially flaked knives (Tomka 2001a)?

Given their need to reconstruct the past from material remains, it is archaeologists who have tackled, and who will most likely continue to tackle, these and similar questions. And they are likely to acquire the answers from new ethnographic and, especially, experimental data. For example, in many places, hunters used antler or bone points rather than ones of stone to tip projectiles; in some places, both were used. Points of antler and bone generally take longer to manufacture than ones of stone (Knecht 1997), but stone tools entail the large cost of quarrying, which requires traveling to the quarry and the labor-intensive process of quarrying (see, e.g., Hampton 1999). Bone/antler points penetrate as deeply as stone points (Waguespack and Surovell 2009), but stone points may be more lethal because they continue to cut tissue and encourage bleeding (which weakens the animal and provides a means to track it). Stone points, however, break far more easily than bone/antler points (Knecht 1997) and are normally good for only one, possibly two shots (Cheshier and Kelly 2006). Ethnographically, stone-projectile points are commonly used on large terrestrial game, whereas bone and antler points are used on small game (Ellis 1997). Why?

These patterns in projectile-point choices make sense in light of the technological investment model. Stone points are useful because their sharp edges cut (and they often break, increasing internal damage) and bleed an animal. This is almost necessary with primitive projectiles, especially arrows that may not deliver much shock but kill by bleeding or by delivering poison. But small game can be killed by shock, not by bleeding. A stone point, with its high up-front cost and breakage rate, is not worth using on small game. All that may be needed for small game is a projectile that can deliver sufficient shock. But to know if this is correct requires more experimental or ethnographic data.

Similar issues enter into considering projectile-delivery technologies as well – the atlatl, the bow, and thrusting spears (Yu 2006). Ethnographically, the atlatl was used in few places by foragers – most notably in Australia and among some Inuit peoples (where they were often used to hunt birds but also seals). Many variables may come into play in determining whether hunters use the bow and arrow, such as vegetation, terrain, prey size, or the need to stalk game (e.g., Churchill 1993; Bartram 1997; Greaves 1997; Hitchcock and Bleed 1997). Experiments suggest that whereas atlatls and bows are both most accurate and effective at 10–25 m, the atlatl can throw a projectile much farther than a primitive bow (180 m as opposed to 100 m) and is usually tipped with a much larger projectile point (Yu 2006). Consequently, the atlatl delivers a projectile with much more force than a bow and arrow.

But the hunter can launch an arrow with minimal movement, whereas an atlatl normally requires that the hunter be standing (although Inuit hunters used them from kayaks, and I have seen enthusiasts who throw darts while lying supine) and that he make more motion as he launches the dart with a swing of his arm.

We do not know which technology is more expensive to produce; given the greater number of parts, we might presume that it is the bow and arrow. The transition might have to do with diet expansion: when large game declines in abundance, small game makes up a larger portion of the diet. Large game can be taken communally in drives, where the greater motion required in delivering an atlatl dart can be an advantage since that motion scares game and channels its movements. But where small game composes more of the diet, large game may be taken more frequently by a solitary hunter, who might launch projectiles from a blind or after carefully stalking the prey. In these cases, a bow and arrow might provide a higher success rate (and a higher overall foraging return rate) than an atlatl that requires the hunter to move in the open and risk scaring the game. An atlatl might rely on shock as the primary way to kill, whereas a bow and arrow might rely on bleeding and/or poisons. If an atlatl is a "cheaper" weapon, then it might continue where shock weapons are necessary (e.g., birds or seals, where the goal is to plant a toggling harpoon deeply into the animal where poisons are not available) *and* where the need to minimize motion is not important. Conversely, the bow and arrow may not be related to hunting animals at all but rather to warfare and the need to fire from a position of security. Obviously, several factors enter into the decision to use a bow and arrow rather than an atlatl, and the beginning is to know the cost and benefits of each technology.

Technology, Gender, and Prestige

To this point, we have only discussed food-getting technology, and we have discussed it primarily in terms of its function: getting food. But there is more to technology, even food-getting technology, than its obvious material function. Technology is embedded in a social web that gives technology meaning and that helps direct choices (Pfaffenberger 1992). Mikea men, for example, carry spears with quite large metal tips, even though the largest animals they normally hunt are small hedgehogs – and the spears are not used on them.[13] When I asked young men why their spears are tipped with such large spearheads, they replied, "It's what men carry." There has been far less research in this area than in the functional and adaptive aspects of food-getting technology.

It is probably safe to assume that people are always tweaking existing technologies and creating innovations. But how, and whether, a new technology becomes prevalent will depend in part on its effect on other areas of human life. For example, men and women target different resources while foraging, and Waguespack (2005) shows that as hunted foods become more important to diet, women do more of the activities that are not directly related to subsistence (see Chapter 8) – gathering firewood and water, tending to children, making clothing, and so on. This means that men and women operate under different technological demands and that these demands change with changes in diet. And this means that the behavior of men and women will be differently impacted by new technologies (e.g., Hurtado and Hill 1989).

Consider the bow and arrow again and the fact that, in most regions, it replaces the atlatl after that weapon's successful use for millennia. The concept of a bow is not terribly difficult (although we don't know how hard the entire technology is to learn and create), nor does it require substantial antecedent technologies, so why should it appear so late?

The bow may be a more "efficient" hunting weapon, although no solid data yet support this; in fact, handheld spears may provide higher return rates (Shott 1993; although this may be because they are used on very large animals). We still need data comparing the production costs and efficiencies of bows and atlatls.

But another factor may be the social context of each technology. We pointed out that atlatls require the hunter to make himself known, to move, and hence to scare game. Atlatls can be used by individual hunters, but they are also suited to communal hunting, where hunters' movements are intended to channel game into the path of other hunters. A bow can also be used in communal hunting, but it also allows a hunter to remain hidden and to make little movement to release a projectile. Bow hunting, therefore, is more conducive to individual hunting from a blind (and, for the same reason, it may also be a better weapon in warfare). Thus, perhaps we cannot understand the shift from spearthrower to bow without also asking under what conditions individual hunting would be selected over group hunting.

Individual hunting allows men to single themselves out and signal their value to others (perhaps women, especially) by focusing on high-risk/high-return large game (a behavior referred to as "costly signaling"; we discuss this in the next chapter). In general, individual hunting has a higher failure rate than communal hunting (e.g., Lupo and Schmitt 2002). *If* the switch to the bow and arrow is linked to a reduction in large game, then women might be directly procuring more of the diet (as, e.g., seeds and tubers) and hence bow technology may reflect men trying to catch the attention (through meat sharing) of high-producing women as mates or of other men as political allies. It is linked to a change in diet breadth but perhaps also indirectly through a social process.

Hayden (1998) also argues that material culture can be divided into "practical" and "prestige" technologies. So far, discussion in this chapter has focused on the former. The latter entails items of material culture whose purpose is to display wealth, rather than accomplish some practical task, and includes such things as copper axes, massive obsidian bifaces, or beads. But the search for prestige can also include technological innovations that are intended to mass-collect food to be used at a competitive feast. For example, men used net hunting in Australia to provision social gatherings; they considered nets to be sacred, and ranking senior men controlled their use (Satterthwait 1986, 1987). Hayden argues that many technologies that became central to subsistence began as prestige technologies, including ceramics (to cook foods for feasts), open-ocean watercraft (see Arnold 1995a, 2007; Arnold and Bernard 2005), and textiles.

The reader might logically ask how we would know when a technology is functioning only to acquire food and when it is functioning primarily to acquire prestige. The answer is similar to the one we gave when considering noneconomic effects on subsistence, such as whether a food is ignored because it is tabooed or not considered food or, conversely, taken for its nonfood value, such as for pelts or feathers. The answer is that the technological-investment model provides a basis for knowing when a technological change has to do with simple cost–benefit issues and when it does not. When it does not, we know to look for the answer in some other realm of human behavior.

Conclusion

Humans adapt to their environments through both soft and hard technology. The amount of variation that exists in forager hard technology is one of the most dramatic dimensions of variation among foragers; it is almost certainly more variable than soft technology – the detailed knowledge that foragers use to survive in their worlds. Some foragers manage to survive quite well with a limited set of simple tools, whereas others, such as the Inuit or sedentary foragers, need a variety of often complex tools. In this chapter, we employed the perspective of human behavioral ecology and specifically the technological investment model to explain ethnographic patterns in food-getting technology.

Other areas of technology deserve similar attention because they too reflect trade-offs in time and benefits. Take clothing, for example. Some foragers use very little clothing, with tropical peoples often eschewing anything more elaborate than a pubic apron and sometimes not even that (and not just tropical foragers: the Yámana of cold and wet Tierra del Fuego got by with very little clothing; see Orquera and Piana 1999). But in a warm environment, foragers have no need for clothing other than that required for culturally defined modesty. Inuit, obviously, have a more serious need for clothing. Although clothing is not directly involved in acquiring food, it is obvious that an Inuit man who went seal hunting in a pubic apron would probably put his reproductive fitness at risk, so to speak. The technological-investment model, suitably modified (because it is difficult to translate clothing into a simple return rate as a measure of benefit), may help understand the costs and benefits of obtaining the materials and investing time in clothing manufacture.

Technology, and especially food-getting technology, is of special interest to archaeologists since it is one of the primary areas of human life that they can recover, and some form of an evolutionary approach should be a crucial part of its historical study (Kuhn 2004). The technological-investment model offers the possibility of testing hypotheses of technological change by linking changes in technology to changes in diet.

But there is a cautionary tale here. The archaeology of foragers primarily appears as stone tools, but stone tools are only a small portion of the total technology. Look back at Figures 5-1 and 5-2. Now think about what those figures would look like if we removed all but the elements that were traditionally fashioned from stone. The difference between the two cases would be far less dramatic. There is more variation in the organic portion of hunter-gatherer technology than in the stone portion (because there are few ways to flake stone but many ways to work organic materials). Ancient hunter-gatherers were probably far less fascinated by stone technology than are modern archaeologists. They may have been far more concerned with acquiring the right kind of wood for a digging stick or bow stave, the right kind of bark for cord, or the right age of wood for basketry splints than they were in acquiring the right kind of stone for a projectile's tip. Archaeologists would do well to keep that fact in mind.

Chapter 6

Sharing, Exchange, and Land Tenure

> My country is the place where I can cut a spear or make a spear-thrower without asking anyone.
>
> Western Desert Aboriginal man (Tindale 1974: 18)

> You know we are not /xai/xai people. Our true *n!ore* is East at /dwia and every day at this time of year we all scan the eastern horizon for any sign of cloud or rain. We say, to each other, "Has it hit the *n!ore*?" "Look, did that miss the *n!ore*?" And we think of the rich fields of berries spreading as far as the eye can see and the mongongo nuts densely littered on the ground. We think of the meat that will soon be hanging thick from every branch. No, we are not of /xai/xai; /dwia is our earth. We just came here to drink the milk.
>
> Ju/'hoan man (Lee 1976: 94)

During fieldwork among the Mistassini Cree, Eleanor Leacock found herself and her informant, Thomas, some distance from camp with very little food. They encountered two acquaintances in the forest who were very hungry and who asked for something to eat. Thomas gave away the last of his flour and lard to them:

> This meant returning to the post sooner than he had planned, thereby reducing his possible catch of furs. I probed to see whether there was some slight annoyance or reluctance involved, or at least some expectation of a return at some later date. This was one of the very rare times Thomas lost patience with me, and he said with deep, if suppressed anger, "suppose now, not give them flour, lard – just dead inside." More revealing than the incident itself were the finality of his tone and the inference of my utter inhumanity in raising questions about his action. (Leacock 1969: 13–14)

Experiences such as this helped to establish sharing as the *sine qua non* of hunter-gatherer culture in the minds of anthropologists (Figure 6-1). Anthropologists said that, among foragers, "generosity is almost universally valued, inculcated in the young, and sanctioned by myth and tradition" (Dowling 1968: 503) and that foragers are people who "give things away, they admire generosity, they expect hospitality, they punish thrift and selfishness" (Service 1966: 14). Sahlins (1972) proposed that *generalized reciprocity*, nonimmediate gift exchange with no systematic effort to ensure that gifts are equivalent, was the primary mode of exchange among hunter-gatherers. Participants at *Man the Hunter* repeatedly emphasized the importance of sharing within foraging bands, and soon afterward, sharing, and in particular the sharing of meat, became central to reconstructions of hominin evolution.

It is disappointing to burst this bubble. Sharing among hunter-gatherers varies along a continuum, from treating resources as if they were common property to individual ownership (Hayden 1981b; E. Smith 1988: 245–46). Although in the Cree language there may be no words equivalent to "property" or "to own" (Scott 1988: 37), in Australia, "notions of material and intellectual property are well developed . . . in the one case associated with land and in the other with rights in songs, myths, paintings, dances and esoteric knowledge" (Altman and Peterson 1988: 76). Generalized sharing occurs within families among northwest Alaskan Eskimos, but not between families, where different forms of exchange exist (Burch 1988). In fact, an unforeseen ethnographic bias may have helped crystallize the idea of sharing as the primary mode of exchange among hunter-gatherers:

> The north-west Alaskan data also suggest why it is so easy to conclude that sharing was ubiquitous in traditional times. "Everyone in the village used to share" is a view that is often expressed by native elders today. But of course everyone in most villages used to belong to a single local family, which is the precise context in which generalized reciprocity (or diffused ownership) did occur. (Burch 1988: 109; see also Burch 2006: 276–77)

Hunter-gatherers also share the right to use land in different ways and to varying degrees. The Great Basin Shoshone, for example, had vague territorial boundaries, and individual movement was quite high (Fowler 1982); but some Great Basin hunter-gatherers were seasonally more territorial than others, depending, in part, on changing resource densities and predictability (Thomas 1981). The Ju/'hoansi and many desert Australian Aborigines related individuals to specific tracts of land and had social mechanisms, often quite elaborate ones, to regulate access to one another's territories. Northwest Alaskan Eskimos had social controls on group membership and reciprocal access to resources (Burch 1988, 2005, 2006), but even tighter group control is found among Northwest Coast hunter-gatherers, where Kwakwak'awakw *numayms* (extended patrilineal households) controlled specific hunting grounds and berry fields, and Tlingit and Tsimshian matrilineal households owned stretches of beach, halibut- and cod-fishing grounds, and berry fields (Codere 1950; Boas 1966; Richardson 1982). In northern California, Yurok or Tolowa individuals owned specific trees or even particular branches (Gould 1982; Richardson 1982). Meanwhile, the southern California Chumash fought wars over territory and to avenge trespass or an insult (Gamble 2008: 258). We will use the term *land tenure* to refer to these different ways of regulating people and land. The layman's term is "territoriality," but that term specifically means the exclusive use of a defended area and is only one aspect of a range of behaviors that regulate resource use.

Gift giving, food sharing, and land tenure are such an integral part of the foraging lifeway that it is hard to sort these behaviors into separate categories. And perhaps we should not do so, for land tenure, exchange, and sharing are all permission-granting behaviors whereby hunter-gatherers regulate access to resources. They operate on different scales, entail individuals acting sometimes on behalf of themselves and sometimes as representatives of groups, and incorporate different kinds of exchange, but we should be able to understand them within the same theoretical framework.

Sharing

The ways of exchanging food, material goods, and prestige are various and intricate. Among the Dobe Ju/'hoansi, for example, credit for a kill goes to the owner of the arrow that killed the animal. Since Ju/'hoansi trade arrows, a man could intentionally choose someone else's arrow from his quiver and, in so doing, give that other hunter a claim to some of the meat. In Australia, young men hunt and give their kills to older men, who distribute the meat (e.g., Altman 1987:

Figure 6-1. A group of Ju/'hoansi in the Tsodilo Hills, Ngamiland, resting, working, and cooking near a hearth in April 1976. One man prepares a bow and arrow. The food in the pot came from a nearby Mbukusku (agricultural) group. Scenes such as this helped establish sharing as an essential characteristic of the foraging lifeway. Courtesy of Robert Hitchcock.

142). In return, the young men receive religious knowledge and have their marriages arranged. The wives of Chipewyan and Kootenai men distributed the meat acquired by their husbands; men did not take meat from another's kill but instead sent their wives to acquire it from the successful hunter's wife (Turney-High 1941: 52; Sharp 1981). Similarly, Yukaghir hunters gave their kills to the clan elder's wife, who then distributed it, often with the aid of the hunter's wife (Jochelson 1926).

Food sharing is an essential and integral part of the foraging lifeway. Howell (2010), in fact, shows that Ju/'hoansi parents who have more than two children cannot consistently provide enough food to feed themselves and their dependent offspring. She concludes that sharing was essential to keeping Ju/'hoansi children alive.

Children in foraging societies are enculturated into the idea of sharing at an early age. Ju/'hoan children, for example, begin learning to trade at the age of six months and give gifts on their own by the time they are five years old. The importance of giving gifts and sharing is reinforced throughout life until it becomes deeply embedded in a person's personality, as Leacock's Mistassini informant testified. And the act of sharing is often valued as much, if not more, than what actually is shared (Myers 1988a; Bird-David 1992a,b; Bodenhorn 2000; Burch 2005) and plays a crucial role in maintaining an egalitarian social order, or at least its appearance (Gardner 1991; Kent 1993; see Chapter 9). Among many hunter-gatherers, the failure to share, in fact, results in ill feeling – not so much because one party fails to obtain food or gifts but rather because the failure to share sends a strong message to those left out of the division. And such failures to share can result in social punishment, such as ostracism, gossip, or public berating (Wiessner 2009).

Hunter-gatherers are not "naturally" more generous than anyone else. In fact, "a Bushman is the stingiest being on earth," one Ju/'hoan man has said, "a bag with no opening" (in Wiessner 2009: 137). For the Ju/'hoansi, "it was not altruism or saintliness that reinforced sharing . . . but an unending chorus of *na*, *na*, *na* ('gimme, gimme, gimme')" (Howell 2010: 43). The Ju/'hoansi are masters of verbal abuse and jesting, much of it intended to encourage adequate reciprocity, especially of meat (Marshall 1976).

So-called demand sharing is common among hunter-gatherers (Lee 1979:372; Altman and Peterson 1988; Peterson 1993). Anthropologists who work among the Bushmen quickly become exhausted by the constant dunning for gifts (Draper 1975; Tanaka 1980: 97). While working with the Mikea, my wife and I took no extra clothing into the bush so that we could legitimately counter the endless demands for it by claiming "it's all that we have." The Ju/'hoansi themselves feel that their friends and relatives "kill them" for gifts (Wiessner 1982b: 80; see Altman [1987: 147] on the Gunwinggu). And yet, once someone gives a gift, he or she has the right to make demands, to ask for things in return. The Ju/'hoansi accept a certain amount of dunning as reasonable behavior: "Most !Kung agreed that it was bad to have too many or too few [trading] partners, the former causing a person to be *g//akwe*, a poor person, and the latter leading to many squabbles over giving and sharing" (Wiessner 1982a: 656). Within a social system that is predicated upon giving and sharing as a primary mode of social interaction, pleas of hunger and even starvation are legitimate idioms in which to ask for food (Bird-David 1992b) because they forcefully ensure sharing: who can deny food to a "starving" person?

But sharing strains relations between people and, like anyone else, foragers try to avoid its demands. On occasion, members of one Gunwinggu band in northern Australia lie to members of another to mask their success in hunting and to deflect demands for sharing (although at other times, they go to lengths to share food with kinsmen in other bands; Altman and Peterson 1988: 88–89). Mikea cook meat inside their huts; or, when in foraging camps with no structures, at hearths that are widely spaced and cloistered in the bush to reduce demand-sharing. Hadza and Gunwinggu hunters consume some of a kill at a hunting camp, ignoring ideal sharing regulations (e.g., Altman 1987: 131). Pintupi men hide cigarettes so that they will not be asked to share them (Myers 1988a); Mikea did the same with pouches of tobacco – and then they demand-shared some from me.

I do not mean to suggest that foragers are stingy but only that sharing is not simply a reflection of foragers' big hearts. There is a calculus to sharing, some thought behind how much, what, and with whom to share (Winterhalder 1996, 1997). The meat of large game, for example, is virtually always shared, but it is not always shared equally. Table 6-1 lists some of the differences in the ways meat is shared among some foraging and horticultural societies. Many game animals are divided according to specific cultural rules, with certain parts always going to certain relatives of the hunter. Among the Gunwinggu in Northern Australia, for example, the head and one of the forequarters of kangaroos and wallabies go to the hunter, the other forequarter to the hunter's companion or brother. The rump and tail go to the hunter's mother's brother's son or his mother's mother's brother's daughter's son. Each hindquarter goes to a senior man, while the heart, liver, tripe, and other internal organs go to the hunter and senior men or to other men present at the kill (Altman and Peterson 1988; Altman 1987; likewise, see Bird and Bliege Bird [2009: 35] on macropod sharing and Burch [2006: 161–64] on the division of a bowhead whale). The Copper Inuit had a similar practice in relation to ringed seals known as *piqatigiit* (Damas 1975a). Men became meat-sharing partners and always gave one another the same portions of their seal kills. For example, men might be *taliqatogiik* and always share the flippers, a choice part, with each other.

These cultural rules reduce the need to negotiate every single cut of meat and, without them, "it is likely that cooperative behavior would collapse in response to high transaction costs"

Table 6-1. Hunter-Gatherer Meat Sharing

Society	Description of Meat Sharing
Ache	Families keep about 10 percent of game, whether the game is large or small; remainder is shared equally to other families, taking family size into account; no control over game during forest treks, but control maintained in settlements; close kin receive more than distant kin, also those who can reciprocate with meat, as well as the poorest families.
Mamainde	Meat is equally distributed among the families in a band after controlling for family size.
Yanomamo	Large game is shared more than small game; families of hunters receive about twice the amount of meat from a kill as others; strong kin bias in meat distribution.
Yora	Hunters keep for their families about 40 percent of the game they acquire.
Hiwi	Families keep about 60 percent of small game, 40 percent of medium-sized game, and 20 percent of large game; close kin receive more than distant kin.
Gunwinggu	Hunters keep for their families about one-third of game they acquire; sharing rules account for 50 percent of division of macropods.
Hadza	Game is evenly distributed among families in camp, with up to twice as much going to hunter's family; older men consume *epeme* meat – certain internal organs and choice portions of large game.
Yuqui	Hunters keep about 70 percent of meat acquired within family.

Sources: Altman and Peterson 1988; Hill and Kaplan 1993; Hames 2000; Hawkes, Hawkes, O'Connell, and Blurton Jones, 2001a; Gurven et al. 2001, 2002; 2000a; Marlowe 2010.

(Alvard 2002, 2003: 152; Alvard and Nolin 2002) – that is, the bickering would simply overwhelm the social relations. And yet, negotiation still happens. When a game animal is butchered in a ≠Kade camp, a senior man may "shout out directions like: 'You should cut a little off that rib meat over there and add it to this pile'" (Tanaka 1980: 95). And cultural rules are always malleable. In Australia, the number of people present, the status of the hunter, the number of animals killed on a particular day, and the relationship of the hunter to the owner of the hunting weapons and the land on which the animal was killed can all alter the "ideal" sharing rules (Gould 1968; White 1985; Altman 1987: 136–37). And, in this specific case, the rules only apply to kangaroos and wallabies, not to the animals that make up about 50 percent of hunted foods.

Because fat is differentially distributed on an animal, sharing rules may result in some people receiving more of it than others. In Australia, the rules of meat division may have directed the fattiest pieces to men (Speth 1990, 2010; see also Hetzel 1978; White 1985; Walker and Hewlett 1990). Among the Ju/'hoansi and Hadza, men often eat the fatty parts of a kill, including the marrow, before returning to camp, where they distribute the remainder. The Hadza call this *epeme* ("adult male") meat,[1] and they eat it in seclusion, away from women and young men. Among the Tlingit, the male elders and household heads – all men – received the most desirable, fattiest portions (Oberg 1973). These different sharing patterns could create gender inequality in nutrition by decreasing the amount of fat that women receive, which may affect the physiology and nutritional well-being of women (but see Speth 2010; high amounts of protein can have a deleterious effect on pregnancy).

There are also limits to sharing. In Australia's Arnhem Land, for example, food is shared after much demanding, but "there are limits to the demand for generosity. These limits are found at the household level" (Altman and Peterson 1988: 93). Large game is shared more than small game, and young unmarried men are expected to give more away than married men since unmarried men have fewer familial obligations. Food is shared beyond the family only when possible, and people know which resources can be shared in such a way and therefore which resources can be successfully obtained through demands. These limits to sharing depend very much on context. South American Yora and Ache share more while on treks in the forest than at their central settlement (Hill and Kaplan 1993). Mikea would deny having any game and would share meat from small hedgehogs only after extensive demand-sharing.[2]

Sharing pays back past acts of generosity but it also creates indebtedness. It is a way to bank favors and obligations, rather than food and goods, through "social storage" (O'Shea 1981). Marcel Mauss (1990 [1924]) showed that gifts contain power that compel a recipient to return something of comparable value in the future. In 1875, John Simpson noted that among the Iñupiaq of northwest Alaska, "it is not too much to say that a free and disinterested gift is totally unknown among them" (Burch 1988: 109), and an Inuk man put it more bluntly: "with gifts you make slaves just as with whips you make dogs" (Freuchen 1961: 109).

Sharing, and especially unconditional generosity, is a way to disengage people from property, to reduce the potential in property to create dependency (Woodburn 1998). Such generosity is part of the culture of many foragers, and it helps to maintain egalitarian social relations (Bird-David 1992a,b; Kent 1993). However, many foragers condone *not* sharing with people who have been stingy in the past. Hadza move away from "bad people" who do not share (Marlowe 2006). The G/wi assume that "something must be given in return for something that is received" (Silberbauer 1981: 463). A wealthy Iñupiaq, or *umialik*, might give meat away because "it was better to give [it] away and incur a debt of gratitude than have [it] rot in a cache" (Burch 2006: 316). Constant tension between a desire to hoard and a need to share produces the anxiety of sharing so often recorded by ethnographers; a Ju/'hoan man, for example, may complain that his trading partners demand too much while he is dunning others for gifts and accusing them of stinginess. So, although unconditional sharing may be an ideal, foragers keep a mental ledger of debts (Hawkes 1992b). Some resources are more widely shared than others, some individuals share more than others, and not all persons have the same claim on another's resources. What conditions this variability?

After *Man the Hunter*, anthropologists saw sharing as a way to reduce the risk of foraging. Sharing, Richard Gould (1982) argued, exists in highly variable environments like that of the Ngadadjara of Australia's austere Western Desert because it builds social bonds that can be called upon in times of need; and, conversely, in more benign environments, sharing is restricted to a much smaller social radius. The Tolowa, of North America's western coast, he suggested, shared less than the Ngadadjara due to the fact that they live in an environment where resources are reliable and abundant. "The more suitable a given habitat is for maximization of resources," Gould argued, "based upon strategies of individual family exploitation, the smaller and more restrictive [the social network] will be, with aggrandizement of resources at the heart of a system based upon increasing degrees of familial self-sufficiency" (1982: 88; rather than share excess resources, Tolowa men use them in prestige competition and to acquire wives through bridewealth payments; see Chapter 9). But if sharing creates indebtedness, if gifts compel a receiver to return the favor, do the differences between the Tolowa and Ngadadjara reflect only the *need* to share or also the *ability*? What we need is a theoretical framework to anticipate variability in sharing.

Why Share?

Bruce Winterhalder began work on such a framework in the 1980s by building on the observation that meat from large game is the most commonly shared (and demanded) food among foragers.

Returns from foraging are never constant, and so there is always the risk that a person or family could go hungry for a day or longer. This risk can be reduced by increasing diet breadth, storing surplus for a rainy day, exchanging surplus, or sharing surplus and creating a social debt. Each of these strategies has costs and benefits. Recall from Chapter 3 that foragers often ignore common but low return-rate foods while foraging. By taking these foods, foragers could guarantee bringing home something and, in so doing, decrease the likelihood of going hungry; however, by taking such foods, foragers decrease their overall foraging efficiency (recall our discussion in Chapter 3). Through sharing, a forager takes advantage of someone else's windfall but could expect to repay the favor in the future; conversely, the successful forager risks sharing with someone who might not reciprocate. How do foragers balance these costs and benefits?[3]

Using a computer simulation, Winterhalder (1986a,b) compared the costs and benefits of sharing versus diet diversification. His simulation showed that expanding diet breadth by a single new food item results in only an 8 percent reduction in the standard deviation of the net rate of food intake – only a small reduction in the risk of going hungry. It also resulted in a 6 percent reduction in foraging efficiency. Conversely, two foragers with the same diet breadth who pool resources can maintain their high foraging efficiency while reducing their pooled variation in the rate of food intake by 58 percent. Obviously, it is better to share than to expand diet breadth if your goal is to reduce variance in food intake. But this way to reduce risk only works when there is variance in an individual's average return rate from foraging – when some days the forager comes home loaded with food, and some days he or she comes home empty-handed. If there is no variance in a forager's day-to-day return rate, then there is no *need* to share.

In addition, sharing reduces risk only if foragers' efforts are not synchronized; that is, if one forager does well while another does poorly. When foragers all do just as well or just as poorly, there is no *ability* to share because when one forager needs food, no one will have surplus to share. Resources that come in large packages and that not every forager procures at the same time (e.g., large game) should be defended, and others should try to demand-share them. Resources that come in small packages and that everyone more or less has at the same time (e.g., seeds or tubers) will not be defended because they will not be demand-shared.[4]

From such observations, Winterhalder speculated on how foragers might respond to four different scenarios defined by high versus low *variance* in individual forager returns and a high versus low *correlation* among the returns of individual foragers (Figure 6-2):

- *Case A*. Here, foragers have variable daily returns – they are able to gather more than needed some days, less on others – but all foragers do the same each day. Foragers' return rates will be similar when all depend on the same resource, such as salmon runs. There is little incentive to share in this case, for when a forager has an abundance of food, so does everyone else; and when a forager has a shortfall, so too does everyone else. Instead, Winterhalder suggested, foragers are expected to store resources at the household level to tide them over in times of need or to migrate during shortfalls. The decision to store or move depends on how long the shortfall is expected to last and the cost of moving to a new foraging area (see Chapter 4).
- *Case B*. When there is high variability in returns, but when some foragers do well on days when others do poorly, sharing should occur. Winterhalder demonstrated that as the degree of correlation between foragers' returns decreases, sharing results in a larger reduction in variance of the group as a whole. This accounts for why meat is shared more than plant food: hunting is a riskier venture than plant collection and, in the case of large game, produces more food than is immediately needed.[5]
- *Case C*. When there is low variance in individual returns and a high correlation between foragers' individual returns, and assuming that the population is in balance with foraging returns (see Chapter 7), Winterhalder expected there would be little reason or incentive to share, since no one needs someone else's food.

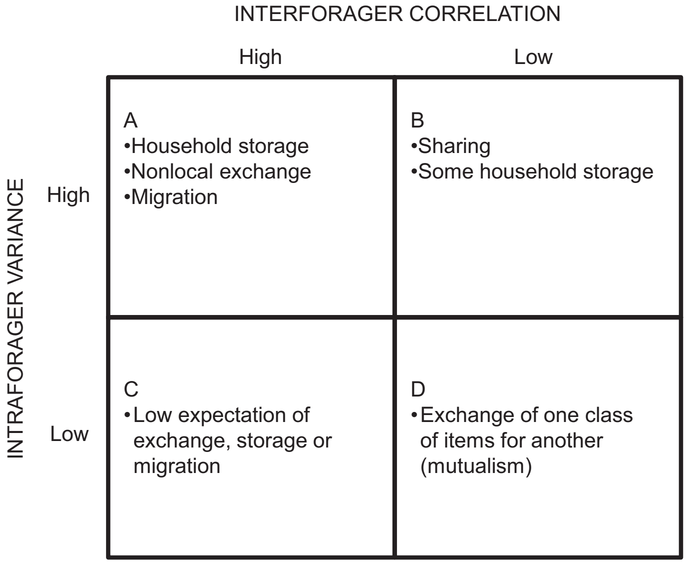
- *Case D.* Finally, when both the variance in individual returns and the degree of correlation between forager returns is low, differentiated exchange (sharing) might occur if foragers are specialized collectors of different products. This can explain the division of labor, in which women share their gathered foods for the meat that their husbands provide (see Chapter 7). This case may also describe mutualistic relations; for example, between hunter-gatherers and agriculturalists, when meat is exchanged for carbohydrates (Spielmann 1986).

Group size factors in here as well. As group size increases, demands cannot be easily met, the potential for daily face-to-face interaction between two individuals decreases, and the frequency of "free-riders" (people who benefit from sharing but who do not contribute) could increase (Smith and Boyd 1990). At the same time, as group size increases, there is no further reduction in foraging variance, but there is a continual reduction in mean returns as the effective foraging area becomes depleted (Winterhalder 1986a). This could mean that as residential group size increases, so too does hoarding and, consequently, social tension. For example, Fred Myers (1988a: 58–59) found that as Australian Pintupi group size increased, so did the perceived stress on the sharing networks – too many people asking for too much, with too much pressure to reciprocate, and too few resources to go around.[6]

Risk reduction makes a lot of sense for small foraging groups. But does it explain what foragers do? When Winterhalder created his model, the received wisdom was that only meat was shared, and that everyone who benefitted also contributed. Yet, empirical studies since the mid-1980s show that women share gathered foods as well – food that is not expected to be shared from Winterhalder's model (although foragers themselves focus on the sharing of meat). And, if sharing makes such sense for all parties concerned, then why is it reinforced through demand-sharing? Several studies also found that hunters who do not contribute meat to the community are still part of the sharing network (although free-riders will eventually be excluded from sharing; see Gurven et al. [2000b]; Bird-David [1992b]).[7] The Mikea hide small game and honey and yet give in to demand-sharing of those foods (Tucker 2004). Is there something else at work in addition to risk reduction?

Ethnographic tests of the risk-reduction explanation of sharing led anthropology to consider four other major explanations of food sharing: kin-selection, reciprocal altruism, tolerated theft, and costly signaling. This research has led to two strains of research into sharing. One of these entails the use of "games." With names such as "the ultimatum game" and "the dictator game," these are designed, speaking most generally, to discover sharing norms (e.g., Marlowe 2004c,d, 2009; Henrich et al. 2006; Gurven, Zanolini, and Schniter 2008; Gurven and Winking 2008; Lamba and Mace 2011; Henrich et al. 2012). For example, in the ultimatum game, a person is given some amount of cash and told that he or she can divide it with the other player any way he or she wishes. If, however, the other player rejects the amount offered, then neither player gets to keep any money. To the hardened capitalist, then, the question for the first player is: how little can I give my opponent and still walk away with the rest? For the second player, the issue is whether to walk away with some free money, however small the amount may be, or to punish the first player for his stinginess.

These are games, of course, and are not, as Wiessner (2009) puts it "the game of life." Sharing occurs within a web of kinship, debts, and past acts as well as of cultural norms. It is unclear if a game conducted outside a living context tells us anymore about sharing norms than does the reader's playing the board game "Monopoly" with friends. In fact, two studies show that the games' outcomes do not predict how people behave toward one another in real life (Marlowe 2004d; Wiessner 2009). The games reveal differences between societies of different economies or between villages of the same culture (e.g., of the Tsimane; Gurven et al. 2008), although the cause of those differences may be linked to issues of demography (e.g., village site) and local ecology (Lamba and Mace 2011; Henrich, Boyd, McElreath et al. 2012) rather than social norms. (The Hadza, in fact, appear quite stingy in these games when, in fact, they share widely. Marlowe



INTRAFORAGER VARIANCE / INTERFORAGER CORRELATION	High	Low
High	A •Household storage •Nonlocal exchange •Migration	B •Sharing •Some household storage
Low	C •Low expectation of exchange, storage or migration	D •Exchange of one class of items for another (mutualism)

Figure 6-2. Four sets of relationships between foragers defined by different combinations of interforager correlations in return rates and intraforager variance in day-to-day return rates. Redrawn from Winterhalder (1986a) with permission from Elsevier.

[2004c,d] suggests that they may do so under the cloak of anonymity that usually characterizes these games because they must share so heavily in real life.) The question is whether humans make decisions based on individual learning and circumstances (e.g., degree of wealth, group size) or on social norms; the answer is almost certainly a combination of the two (Tucker 2012; Gurven and Winking 2008).

I prefer to focus on the second strain of research: the analysis of quantitative data on sharing collected in an ethnographic context. This research may not reveal a group's norms of sharing, but it does demonstrate the conditions that promote sharing and those that do not. Although we can expect norms to exert power at any given moment, we can also expect that those norms are, in large part, collectively produced by the individual decision-making process of whether to share. This research is also, in my opinion, one of the best examples of the cyclical nature and power of hypothesis-testing in anthropology. We will describe four major explanations of sharing and then consider which one, if any, is *the* explanation.

Kin Selection

From an evolutionary point of view, foragers are expected to provide resources to individuals in proportion to how closely related they are to them biologically. *Kin selection* argues that kin should receive more food than nonkin, and close kin, such as biological offspring, should receive more than distant kin, such as cousins. One expectation of this explanation is that foragers should keep most of their food within their own household. And this appears to be true (Gurven 2004a; Tucker 2004; Allen-Arave et al. 2008; Kaplan and Hill 1985a,b; see summary in Gurven [2004a]). We assume that this means parents are sharing food with their offspring.[8]

There is, however, variability in how long parents provide that food. Hadza children, for example, begin collecting upward of half their own daily food by the age of five. But Ju/'hoan parents feed their children until they are much older (Blurton Jones, Hawkes, and O'Connell 1989; see Chapter 7). The ease and safety of foraging, the size of resources harvested, and the types of mating and childrearing systems all have an effect on the amount and duration of parent-to-child sharing.[9]

Reciprocal Altruism

Although there are limits to how far one can "sponge off" others, some men do contribute more to the soup pot than others without holding it against anyone. In his original formulation of generalized reciprocity, Sahlins (972: 194) noted that the "failure to reciprocate does not cause the giver of stuff to stop giving." Iñupiaq hunters knew who the unproductive people were and yet, "when times were good and food was plentiful, the disparity was recognized but ignored" (Burch 2006: 272). Why do good hunters do this?

One answer is that those good hunters receive a benefit at a future time that is more valuable than the food given away at the moment. Winterhalder's risk-reduction model is one specific form of *reciprocal altruism*: men give away meat when they have a surplus in return for the expectation of meat at a time when they have none. The problem with this explanation is that there are free-riders, people who take but who do not contribute meat. So, perhaps benefits come back to good hunters in another form, and this is where reciprocal altruism is a broader explanation than risk reduction. Hawkes (1990, 1991, 1992b) argued that the benefit for good Ache hunters comes in the form of extramarital affairs, with meat traded for sex. The exchange could also come in the form of more attention to the hunter's offspring (e.g., feeding them or watching them a little more closely than other children to prevent injury), or as assistance when a productive hunter is ill or injured (Gurven et al. 2000b; Allen-Arave, Gurven, and Hill 2008). It appears that free-riders are not free-riders as much as they are poor hunters who find another way to compensate a good hunter for his largesse.

Tolerated Scrounging

Tolerated scrounging (or, as it was originally labeled, *tolerated theft*) tries to make sense out of demand-sharing, sharing that results from badgering and solicitation rather than from reminders of the requester's past generosity (Blurton Jones 1983, 1987). It predicts that food sharing is expected when the cost of defending a resource exceeds the benefit of keeping it (Figure 6-3). Imagine, for example, the hunter who brings an entire elk into camp – perhaps 400 kg of food. He and his family can only eat so much in one sitting. The rest either rots or is dried and stored. In either case, the hunter has an obvious surfeit of food while others in the camp may have none, and so the potential for conflict is high. From the hunter's perspective, the *immediate* value of the remaining meat is not worth fighting over but it is from the perspective of someone who is hungry. Sharing the meat avoids the potential cost of fighting over a resource that has little immediate value to its owner.

Tolerated scrounging is likely to be found when food occurs in large packages (e.g., large game), such that a forager has no choice but to acquire the food in an amount larger than immediately needed. However, the need to store food can be a mitigating factor because virtually all stored food might have the same value to the forager.

We might think that tolerated scrounging would predict frequent contests over food, men tussling in the dirt over a shoulder of deer, but such events are virtually nonexistent. However, the lack of visible contests does not mean there are no bad feelings about the division of a particular resource (see Tanaka [1980: 109] and Altman [1987:147] for examples). The Mikea, for example, consider themselves to be generous and condemn stinginess (Tucker 2004); they often call out *mandroso sakafo* – come and eat! – when cooking maize in front of their houses. And yet, with the exception of livestock killed for ritual events, they share very little meat. One reason is that their hunted game is quite small – usually hedgehogs the size of a softball or, at best, a house cat. The Mikea hide these foods and cook and eat them inside houses or in sequestered hearths

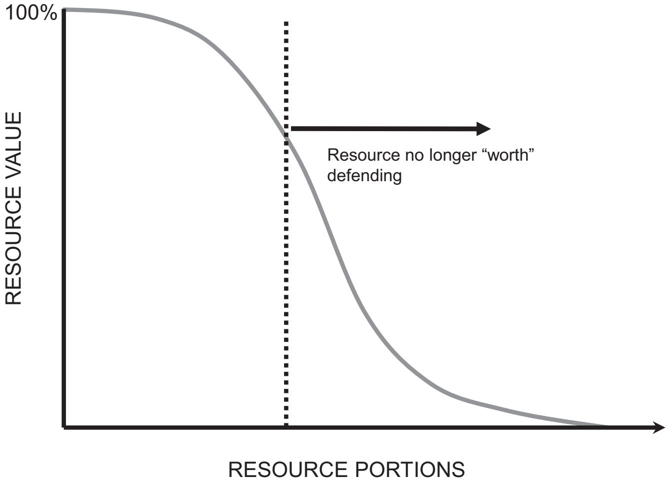


Figure 6-3. Tolerated scrounging. A resource has an initially high value but, through consumption, additional portions of that resource have less and less value to the consumer; the precise shape of the curve is hypothetical. At some point, the cost of defending the resource is less than the benefit to the sated consumer. At that point, it is better to give the remaining portion of the resource away rather than try to keep it.

in foraging camps; the same is true for honey (Tucker 2004). These desirable foods are too small to divide – the third or fourth "portion" of a fist-sized hedgehog is as valuable as the first portion (all the more because both can also be stored and sold in a market).[10] These are precisely the kinds of resources that foragers are not expected to permit to be demand-shared. And yet, several experiences among the Mikea told me that while men tried to hide their hedgehogs and honey from others, they would share them if they were caught "red-handed" (see also Tucker 2004). For the Mikea, to be labeled *matity*, stingy, is worse than losing a hedgehog or some honey. There is a social cost to being stingy, and that cost may be higher than *any* food brought into *any* foraging camp.

Foragers exploit this fact. Tolerated scrounging is common in the animal world, and its potential to cause harmful contests over food may be what, in the distant reaches of human evolution, motivated other forms of sharing that benefit the person who shares (Blurton Jones 1987). Hunters can game the system, in fact, and target shareable foods (notably, large game), even if it diminishes their overall foraging return rate, in order to acquire the social benefits of sharing. And that proposition brings us to the final explanation of sharing.

Costly Signaling

Darwin used sexual selection as a way to explain the appearance of what are otherwise "wasteful" biological elements, such as the male peacock's tail. By virtue of this extravagant and metabolically expensive appendage, the peacock says to potential mates: "I can invest a lot of energy in my tail and yet it does me no harm. I am physiologically stronger than other males. Pick me." *Costly signaling* moves this idea to the realm of behavior.[11]

Costly signaling hypothesizes that selection has produced the proclivity for men to "signal" their attributes (genetic or otherwise) through "costly" displays (Zahavi 1997). For costly signaling to work, a behavior must be costly to an individual, otherwise it is not signaling a person's capacity; this is known as the *handicap principle*. It also has to be honest and not easily faked. It is kept honest through links between the display and the attribute(s) it advertises. Hunting can accomplish this by bringing in a large amount of tasty, nutrient-dense food at one time; by sharing meat, observers receive a benefit, and that increases the communicative power of the display (Hawkes and Bliege Bird 2002: 58).

Costly signaling has been used to explain "wasteful" behaviors such as monumental architecture, body modifications (e.g., tooth removals or scarification at coming-of-age ceremonies), expensive public rituals, inefficiently gathered foods (e.g., truffles, caviar), and what Thorstein Veblen (1899) famously called "conspicuous consumption" – mansions, imported clothing, expensive hobbies, and so on.

For costly signaling to be the explanation of sharing, there can be no direct tit-for-tat reciprocity and yet, the person must eventually receive some fitness benefit. The information transmitted has to be of such a kind that the audience will respond in a way that benefits the signaler. Thus, the audience must receive information that it finds useful. A generous hunter sacrifices the nutritional benefit of meat in exchange for his reputation as a hunter, leader, or provider, a reputation that makes him desirable to potential wives and/or male collaborators. Universally, foraging men who are good hunters enjoy prestige. Good, generous Australian Aboriginal hunters, for example – what the Martu call *mirtilya* – are highly ranked by their compatriots in terms of religious knowledge (necessary to obtain a wife) as well as general secular status (Sackett 1979; Altman 1984; Bird and Bliege Bird 2009).

We will return to costly signaling in subsequent chapters, where we discuss men's and women's foraging efforts and the evolution of hierarchy. For our purposes, costly signaling as an explanation of sharing implies that men receive some benefit from generously sharing meat; in this regard, costly signaling is difficult to disentangle from reciprocal altruism. The key difference is that men whose behavior is a costly display will accept a lower overall foraging return rate (violating the diet-breadth model) to acquire foods that will then be considered "public goods" – property that men will disengage from in order to garner some potential reproductive advantage (e.g., through more mates, early marriage, wives who are the best foragers, or alliances with other good hunters).

Costly signaling may be most important for activities that have a low success rate and, consequently, where success would honestly signal special effort and capacity. In this case, it might explain why men focus on hunting. Costly signaling does not necessarily entail "risky" behaviors, but it might do so where game is small and not amenable to sharing and/or where hunting success is high (hence, men may seek out rare, large game or more difficult or dangerous foraging tasks; Sosis 2000; Lupo and Schmitt 2004). Meriam men, for example, participate in sea turtle hunts that provide food for feasts that accompany the unveiling of tombstones. The men who organize these hunts, which require a boat, fuel, and other participants, demonstrate their skill, leadership, knowledge, and, perhaps most important, their ability to absorb the cost without it doing them harm. Young men participate in these hunts and may dive off the boats to capture the turtle, displaying their physical attributes.

What Explains Sharing?

So, which is it? As is true for most cultural behaviors, sharing operates on multiple levels at the same time – for straightforward economic reasons, as a response to the potential long-term social cost of being labeled stingy, and as social communication. A hunter who brings an elk into camp may share portions to simultaneously (a) alleviate the possibility of a contest over surplus food that has little immediate worth to his family (tolerated scrounging); (b) pay back a previous meat-sharing instance or create a debt to be paid back at some unspecified time and in some unspecified and yet beneficial way (risk reduction or, more generally, reciprocal altruism); (c) provide for his offspring and assist kin with theirs (kin selection); and (d) communicate his abilities to potential mates and other hunters (costly signaling). In other words, there is probably a sound evolutionary explanation for a cultural standard of generalized reciprocity: generosity (Cashdan 1997; Wiessner 2002). People internalize this norm; and it should come as no surprise that people who live up to their culture's standards of proper behavior – and generosity is valued among nomadic foragers – are rewarded for doing so, and those who violate such standards are generally punished in such a way (e.g., ostracism) that the punishment is not very costly for any particular individual – this is the value of cultural conventions (Wiessner 2005).

Foragers participate in generalized reciprocity in part because much of their behavior is public and because, like everyone else in the world, hunter-gatherers rely on social connections and the fulfillment of cultural conventions for their well-being throughout their lives. Thus, it makes sense that generalized reciprocity, with its immediate benefit for the recipient and its inherent promise of a future benefit to the giver, should be prevalent among foragers and that surplus-producing, hard-to-procure, nutritionally significant resources such as large game should be the focus of sharing. Still, is one explanation more likely than another to be at work?

We noted previously that most food in most foraging societies remains within the family that procured it. This suggests that kin selection is strongly at work in the distribution of a good portion of food. In fact, W. D. Hamilton (1964) argued long ago that if the value of the food to the giver, C, is less than the benefit, B, to the receiver times the receiver's fraction of relatedness, r, that is, if $Br > C$, then the giver benefits more by giving the food away than by keeping it. For siblings and offspring $r = 0.5$, for biological cousins $r = 0.125$, and so on. The other values (B and C) are in fitness terms and are not easily measured. Nonetheless, they suggest that if kin selection explains sharing, then sharing should decrease as biological relatedness decreases. This appears to be true in controlled studies (Gurven, Hill, Kaplan, Hurtado, and Lyles 2000a; Gurven, Allen-Arave, Hill, and Hurtado 2001); parents especially share with their offspring. But since it is not surprising that parents feed their children, anthropologists have focused more on sharing between rather than within households.

Although successful hunters do keep more meat for their families than other families receive, meat given away still has some value to their own offspring. Why give it away? One possibility is that it is to benefit the offspring of a hunter's siblings (and hence increase his inclusive fitness). But closely related kin may also be more likely to reciprocate simply because they are likely to be long-term acquaintances; thus, sharing between relatives may be due to reciprocal altruism rather than to kin selection.

It is difficult to test this hypothesis since, in small foraging communities, nearly everyone is some kind of biological relative of everyone else. A study that controlled for relatedness, however, found that Ache give preferentially to those kin with *the highest probability of paying back the favor*, and households that give to one another have a high degree of correlation in gifts, suggesting some level of contingency: much of what the Ache give, they give to people who will reciprocate – and some of them happen to be relatives (Gurven et al. 2001; Gurven, Hill, and Kaplan 2002; Gurven 2004a,b, 2006; Allen-Arave et al. 2008). Kin selection beyond the nuclear family may be an epiphenomenon of behavior that is governed more directly by reciprocal altruism (see also Nolin 2010).

However, the Ache also give food to households with the *lowest* net returns, regardless of kin ties (Gurven 2004). These are people who are the *least* likely to reciprocate because they are least likely to have a surplus. This could be evidence of tolerated scrounging. But, often, the food given away was known to be excess when it was collected in the field – that is, a good Ache forager went to the trouble of collecting more food than needed, knowing that it would be given away (Allen-Arave 2008: 315). This is not tolerated scrounging because the excess food *when collected* had little value to the forager. Many ethnographic references suggest that those who are not generous are eventually cut out of the sharing network (Gurven 2004a: 551); however, my guess is that these accounts describe those who *will not* rather than those who *cannot* share. People who cannot share in kind may still receive food because they will reciprocate in the distant future, albeit perhaps in some currency other than food. For example, good Ache hunters who are generous receive more food and attention when they are injured or sick compared with those who produce and/or share less than others (Gurven et al. 2000a; see also Hames 2000).

At the same time, single Ache men produce the most and are the most consistent in their production (Kaplan and Hill 1985). And it is young unmarried men who are most likely to be sea turtle hunters among Australia's Meriam (Smith and Bliege Bird 2000). These men share the most and receive the least in return. What do they gain? Costly signaling may be the best explanation here, as men try to signal their hunting prowess, stamina and strength, and their capacity to be generous in an effort to win the affection of potential spouses and lovers and the attention of male collaborators (Smith, Bliege Bird, and Bird 2003). This explains why Ache men with dependent offspring prefer to forage in groups with good hunters; conversely, young men, or men without dependent children, prefer to forage in groups with young, eligible women, whom they can impress with their hunting skills (Wood and Hill 2000). Hawkes argues that such behavior continues even after marriage as a way to acquire extramarital couplings and increase reproductive fitness. She shows that Ache males who are good hunters have significantly more surviving children,[12] when extramarital children are included, than do men who are poor hunters (Hill and Kaplan 1988a,b; Hawkes 1990). (Although meat is commonly exchanged for sexual favors among Amazonian cultures [Siskind 1973] including, it seems, the Ache, this practice is not documented in other ethnographic cases.)[13]

Good hunters acquire prestige by being good hunters. Even if his efforts are lampooned, and even if "the hunter may end up with no control over the distribution of game, he will always acquire prestige. People are acutely aware of who the successful hunters are and of the frequency of their success" (Altman and Peterson 1988: 80; Bird and Bliege Bird 2009). One might see how this could matter to men, but how could it matter to women if their good-hunter husbands give away their kills? The social attention that accrues to good hunters may have fitness benefits of kinds that could be more valuable in some circumstances to their spouses than the increased food a "provider" husband could acquire (e.g., increased attention to the welfare of a good hunter's children). Indeed, for the few cases with appropriate data, good hunters, and their wives, have higher reproductive success than do poor hunters and their wives (Alvard and Gillespie 2004; Smith 2004).

One problem that confronts research into sharing is that virtually all studies are short term, and yet sharing's benefits may only be manifested over the long term. Remember, for example, that good Ache hunters are provided for in sickness. How do good hunters fare over a lifetime?

Foragers are most proficient at foraging during middle age and become less so as they age. Middle-aged Ache men, for example, have higher return rates than either young or old men (Hill, Kaplan, Hawkes, and Hurtado 1987; see also Dwyer 1983; Ohtsuka 1989). Older men benefit from the experience of age, but they also suffer from eye problems and arthritis that compromise their hunting abilities. Women's foraging efforts, conversely, seem to decrease much less in old age. Elderly Ju/'hoansi and Hadza grandmothers continue to gather after equally aged men have ceased hunting, although they too eventually retire from foraging.[14]

Over their lifespan, then, individual foragers (and perhaps especially male foragers) will have high variance in their overall return rates. In this light, let us consider Winterhalder's model (see Figure 6-2) as applying to a hunter's lifespan. Doing so, we see that cases C and D do not apply since the "variance" in a hunter's return will always be high over his lifetime. This means that a hunter is left with two options: store food for one's old age – obviously, an unrealistic option – or store up favors through sharing to be repaid in old age.

Hunter-gatherers' social security networks are the relationships they establish when young. Much of the behavior that is recorded in ethnographic accounts – accounts that by their nature record only short-term behavior – may reflect behavior that anticipates what people know will eventually happen if they live long enough. It may not be conscious, but foragers "plan" for retirement by sharing in their youth and middle age. Among the Ju/'hoansi, for example, older individuals "who have carefully tended their kin-based webs of trading and mutual-aid relationships have ensured that favors and gifts are owed to them as they grow old and can no longer provide for themselves" (Biesele and Howell 1981: 93). Draper and Buchanan (1992)

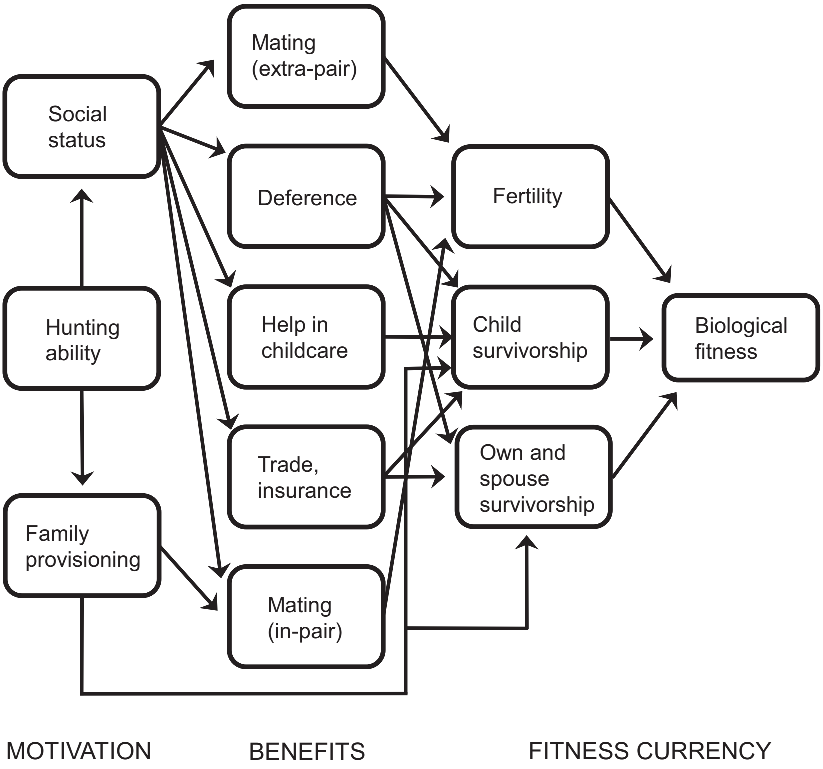


Figure 6-4. The complex relations among the factors that enter into sharing decisions. Redrawn from Gurven and Hill (2009: 61), University of Chicago Press, © 2009 by The Wenner-Gren Foundation for Anthropological Research. All rights reserved.

found that having two or more children promoted their mothers' survival to an old age; men may rely on networks beyond the immediate family.

Data from thirty-four years of study of the Ju/'hoansi show that men use meat sharing to build social and political relationships (Wiessner 2002a) that benefit those men later in life. Men who were good, generous hunters find themselves living in large, socially cohesive groups comprised of their kin; poor hunters live in small groups with fewer kin. Generous hunters, then, live in groups that provide them with more assistance in rearing their offspring and that exert an unchallengeable claim to land. And good Ju/'hoan hunters have more material goods (through greater numbers of *hxaro* exchange partnerships; we return to *hxaro* exchange later). Good hunters achieve these outcomes mostly through the judicious and "generous" distribution of meat (Wiessner 2002a). As a result, good Ju/'hoan hunters raise more offspring to adulthood than do poor hunters. Men benefit both reproductively and personally by being generous.

The degree and kind of sharing found among hunter-gatherers is related to several variables and motivations. Reduction in the variance inherent in hunting accounts for some sharing but not all of it. Tolerated theft explains some, as does reciprocal altruism and costly signaling. All explanations can be operating simultaneously or serially as a person's circumstances change through life (Figure 6-4). One thing is clear, though: generous people do better in the long term than stingy people.

Land Tenure

We can expand this discussion of sharing to shed light on how hunter-gatherers share access to land, a subject linked to the concept of territoriality. To understand where anthropology is today in understanding hunter-gatherer land tenure, let's first review the development of thought on this subject.

Recall from Chapter 1 that Lewis Henry Morgan (1877) argued that humans "evolved" through several stages, the earliest of which was "savagery." Morgan claimed that the notion of property evolved in tandem with the increase in utensils and tools and in response to changes in social organization. During the period of "savagery," in which we could place many hunter-gatherer societies (if we were inclined to use his classifications), Morgan argued that property, including land, was held in common by all members of a tribe.

Frank Speck (1915) challenged Morgan's view when he discovered that individual Algonquian families in northeastern North America held exclusive use rights to specific family hunting territories. Trespass on lands was punishable, even by death, although use of the land could be granted to outsiders with the expectation that the favor might be returned in the future. Territorial boundaries were not very fluid or negotiable; among the Penobscot, pictorial representations of totems were blazed on trees along boundaries, and natural landmarks were known by all as marking the edge of a family's land.

Like many anthropologists of his time, Speck assumed that the widespread distribution of a trait was indicative of its antiquity. Even in the northeastern United States, Speck observed, land held for generations by Euroamericans, and off-limits to indigenous peoples, was divided into hunting territories by the Penobscot. For Speck (1915: 290), such tenacity indicated very ancient beliefs and that the "whole territory claimed by each tribe was subdivided into tracts owned from time immemorial by the same families and handed down from generation to generation."

There were differences in the size of these family hunting territories (e.g., territories on the frontiers were larger than those nearer the center of a tribe's range), but Speck did not speculate on the reasons for those differences. He must have suspected some relationship between family size and food resources because he argued that one of the primary functions of the territories was to permit resource conservation. (Davidson [1928] and Hallowell [1949] later argued that the size of a territory was a function of game density and that the territory was no larger than was necessary to provide a family with a year's supply of food.)

Speck argued that this territorial system was pre-Columbian in the Algonquian area. He also took it to be an inherent characteristic of hunter-gatherer societies in general, and he and others soon discovered hunting territories in other parts of the world (Davidson 1928; Cooper 1939; Speck and Eiseley 1939).

Although later research suggested that Algonquian hunting territories were a seventeenth-century adaptation to the fur trade (see Bishop 1970; Leacock 1954), the idea that hunter-gatherers were territorial became entrenched in anthropological theory.[15] Both Radcliffe-Brown and Davidson saw local patrilineal hordes or clans as owning exclusive cell-like territories (Davidson 1926, 1928; Radcliffe Brown 1930–31).[16] Likewise, the early notions of patrilineal and patrilocal bands (see Chapter 1) were both predicated on the assumption that hunter-gatherers were territorial.

The idea that all hunter-gatherers lived in tightly circumscribed areas, suspicious of outsiders, contributed to the notion that humans are, by nature, territorial. Once this idea entered popular literature, it took on an importance that few anthropologists anticipated: since humans were innately territorial, the argument went, war and national aggression were unavoidable (a point made most famously by the playwright Robert Ardrey in his 1966 book, *The Territorial Imperative*).

Participants at *Man the Hunter* reacted strongly against this claim and, after the conference, it seemed that hunter-gatherers went where they pleased, when they pleased, and were welcomed by all. Lee and DeVore (1968: 157) noted that "all of the hunting peoples we have been discussing have institutionalized means for moving from group to group. So if we find boundaries in a given case, we should not commit the frequent error of assuming that they enclose a defended and exclusive territory." Local groups fluctuated in both size and composition, as individuals moved in and out of the camp to visit relatives and friends, trade with partners, or simply for a change

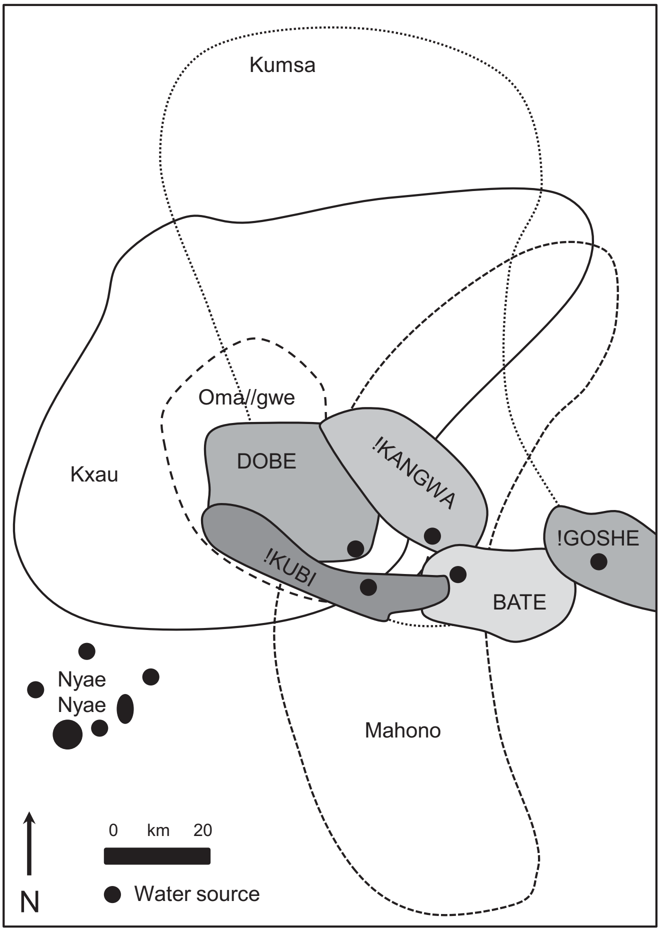


Figure 6-5. The ranges of four Dobe Ju/’hoan families (of Kumsa, Kxau, Oma//gwe, and Mahono) relative to those areas considered to be the Dobe and other band *n!ores*: movements of members of the Dobe band were by no means limited to the Dobe *n!ore*. Family ranges from Yellen and Harpending (1972) and *n!ores* from Yellen (1977), © Elsevier.

of scenery (Yellen 1977). The Ju/’hoansi find visiting other families to be both enjoyable and necessary (Marshall 1976: 180–81; Sugawara 1988), and Ju/’hoan men often acquire spouses from distant areas (Yellen and Harpending 1972). The annual movements of Dobe Ju/’hoan families, all of whom consider the land around the Dobe water hole to be their “territory” (or *n!ore*, which we return to later in this chapter), are by no means constrained to what is perceived by them as Dobe territory (Figure 6-5), nor do they avoid the *n!ores* of other groups.

The same sort of attitude toward land is found among the Canadian Naskapi – certain places are owned, but they are not out of reach to those who may need them:

> The Barren Ground people . . . were regarded as owners of the caribou crossing places on Indian House Lake, the White Whale River Indians had a special lake, Mē’hīkunnipī (Wolf Lake), west of the George River, which they claimed. The White Whale River people believed they owned this lake and if other Indians came there first, the White Whale River people became angry but never to the extent of fighting the intruders. Thus the vast northeastern part of the Labrador peninsula is very generally divided up between four tiny Indian bands, but it is really only certain locales rather than definite circumscribed areas that the Indians regard with any jealousy . . . no Indian questioned could give any real list of boundary markers . . . Fishing rights

> are somewhat more carefully guarded, but in time of famine all my informants agreed that Indians of several bands usually assembled at any place where food could be secured . . . When the crisis has passed they returned to their usual haunts. Thus, in good caribou years, the Davis Inlet people have often visited the Barren Ground band or Indian House Lake, once many people from Northwest River came that far north, and . . . the latter people have been driven by hunger to join the Davis Inlet people three times within recent years. (Strong, in Leacock and Rothschild 1994: 88–89)

Cultural ecologists argued that the relaxed territoriality of hunter-gatherers was "adaptive" since it permitted people to cope with resource fluctuations through movement. The social ties such movement encouraged formed security networks and encouraged a continuous flow of information about people and resources, which in turn permitted a continual adjustment of population to resources so as to prevent overexploitation (Lee 1976; Wiessner 1977, 1982b). Sentimental ties to land ensured that groups already spaced across the landscape would remain that way, but social mechanisms allowed movement of individuals to other territories in times of need (N. Peterson 1975, 1978; Peterson and Long 1986). Montagnais-Naskapi hunters could travel where they pleased as long as they had relatives there, but social conventions were such that they had relatives just about everywhere they might want to go (Mailhot 1986).

In the 1960s, however, evidence already existed of foragers who had distinct territories. Our definition of "territory" is paraphrased from that of E. O. Wilson: an area occupied more or less exclusively by a group through overt defense or signaling (in Dyson-Hudson and Smith 1978: 23). Many Northwest Coast villages had exclusive rights to the resources of specific stretches of beach (e.g., Drucker 1951). In California, Maidu village territories had boundaries marked with symbols and were "more or less regularly patrolled to guard against poaching. Even game that had been wounded outside but dies within the territory of a community belonged to the latter people and not to the hunter" (Kroeber 1925: 398).[17] Likewise, territorial boundaries among the Vedda of India were marked with a small archer carved into tree trunks. Those passing through a territory were met at the border and escorted across (Seligman and Seligman 1911).

On reconsideration of ethnographic evidence, we see that no society has a truly laissez-faire attitude toward spatial boundaries. Instead, all have ways, sometimes very subtle ways, of "assigning" individuals to specific tracts of land and of allowing them to gain access to others. Among the nonterritorial Great Basin Shoshone and Paiute, and even the Bushmen (Heinz 1972; Thomas 1981; Cashdan 1983; Barnard 1992b), boundaries exist. Many foragers do not live their lives on delineated tracts of land that they consider to be theirs and theirs alone, but individuals do have specific use rights or statuses as members of a group that connect them with a particular area. Foraging groups "are largely the outcome of individual decisions, and the actual composition can be explained only through understanding the processes of individual affiliation" (Myers 1982: 183). Understanding land tenure, therefore, requires considering the ways that people relate themselves to one another and thus to land.

The decision-making processes establishing interpersonal relations are complex and operate on many different levels simultaneously. Yet, although many of these ostensibly control only social affiliation, they also control physical access to land and resources. Among the Eskimo, trading partnerships and spouse exchanges established ties between unrelated individuals, usually men, but also women. For example, Netsilingmiut men's social ties were extended through meat-sharing partnerships established by a man's mother when he was young (Balikci 1970). The Nuuchahnulth's *potlatch* also sustained social ties between affinal relatives (Drucker 1951). Among the Northern Paiute, use rights to land were associated with named social groups, such as Toedökadö (cattail-eaters) and Aga'dökadö (trout-eaters). These names do not tell us where particular Paiute individuals lived but instead refer to areas whose resources they had the right to give others permission to use (Fowler 1982). The historic family hunting territories of the North American boreal forest also served to regulate land use by regulating access to the resident social group (Bishop 1970, 1986).

The Australian Pintupi and Dobe Ju/'hoansi provide detailed examples.[18] Throughout much of Australia, people identify very strongly with particular sites and with areas of land that they refer to in English as their "country." In the desert, these countries are frequently defined by dependable water sources. People do not live out their entire lives in their own country, but older Pintupi men often express a great deal of sentiment for their country, and they desire to die in it (Hamilton 1982a; Myers 1982; Peterson and Long 1986).[19] Pintupi tribal members in Australia's Western Desert are related to each other and to the land through the concept of *one countrymen* (Myers 1982, 1986, 1988a). This is an individual-centered concept; although two individuals may regard each other as one countrymen, they do not necessarily share all of the same countrymen. One's countrymen are people with whom one could potentially camp and share resources.

Being one countrymen with another man can be based on ties of kinship as well as on the location of one's birthplace. But countrymen relationships are also established by "ownership" of sacred areas, *estates* (see Chapter 1). Australian Aborigines have a rich mythological history referred to as the Dreaming or Dreamtime, a period during which mythological beings moved across the land, their paths or tracks memorialized for their Aboriginal descendants via the topographical features they created in their adventures, and by a rich body of mythology, ritual, and songs. Today, many of these places are considered sacred, and men are expected to learn the "story-lines" or "song-lines" that connect them.

The Dreamtime also forms the cultural logic through which Pintupi negotiate their identity with each other. A Pintupi man can potentially become one countrymen with another Pintupi man who is associated with site A: (1) if the first man was conceived there; (2) if he was born at a place made by or identified with the same Dreamtime beings as those who created A; (3) if the story line associated with the man's place of conception is associated with the story line of the Dreaming associated with A; (4) if the man is initiated at A; (5) if the man was born at A; (6) if conditions 1–5 hold true for his father; (7) if his mother was conceived at A or if conditions 2, 3, or 5 are true for her; (8) if the man's grandparents were conceived at A or conditions 2–5 are true for the grandparents; (9) if the man lives around A; and/or (10) if the man's close relatives die at or near A. These multiple and varied criteria mean that claims are always open to negotiation and counterclaim, but they do provide a man with a way to lay claim to a country or, conversely, to extend use rights in his country to another (Myers 1986; see also Blundell 1980).[20]

The Ju/'hoansi provide another case of how a foraging group maintains physical access to another territory by maintaining social access to the resident group. Here, individuals associate themselves conceptually and sentimentally with inherited tracts of land called *n!ore*. *N!ore* are centered on a water hole and vary in size from 300 to 600 km^2; *n!ore* can vary in size from year to year as well (Lee 1979: 334). They are associated with a core group of individuals who hold the right to be asked to use a *n!ore*'s resources. *N!ore* can be inherited equally through the father, mother, or someone else (Wiessner 1982b), so most Ju/'hoansi hold rights to at least two *n!ore*s. Permission to use resources located on another *n!ore* must be secured from one of the *n!ore*'s "owners."

Access to a *n!ore* other than one's own comes through social mechanisms, including trading partnerships and fictive kin relationships. *Fictive kin* are established partly through personal names. The Ju/'hoansi name a child after a relative other than his or her parents. A firstborn son, for example, is often named after his paternal grandfather, and a firstborn daughter after her paternal grandmother; subsequent children are named after the maternal grandparents and parents' siblings (Lee 1979). Since names are continually recycled, there are relatively few Ju/'hoan names for men or women (in 1964, there were only thirty-six male and thirty-two female names in use). Names affirm close kin ties even between distant relatives. For example, if an older man with a son named /Tishe encounters a young man also named /Tishe, the older man may call the younger man "son" (it is the older person's prerogative to decide whether there will be a kin relation and what form it will take). The use of kin terms implies social obligations, and the older male relative may now treat the younger man as if he were his son, including giving access to his *n!ore*.

Trade networks also establish social ties among the Ju/'hoansi and other Bushmen. From the time they are infants, Ju/'hoansi participate in a trade network called *hxaro* (Wiessner 1977, 1982a). *Hxaro* entails the giving of goods such as ostrich eggshell beads, blankets, pots, arrows, and clothing (but never food). An adult, especially one over the age of about forty, normally has a dozen or more *hxaro* partners; children and adolescents have fewer. One's direct *hxaro* partners are usually consanguineal relatives, but since spouses trade with each other, a person's *hxaro* network becomes linked with that of his or her spouse. Age and sex of partners matter less than the ability and willingness of a person to trade. Most *hxaro* partners live within about 40 km of each other, but some live as far as 75 or even 200 km apart (Wiessner 1982b).

Hxaro partners expect timely reciprocation of their gifts, and Ju/'hoansi will often drop substantial hints for specific items. Gifts are kept for two weeks to two years but eventually are passed on to yet another partner. In the long run, no one gains materially from the exchange. Arguments over the appropriateness of an item do occur, however, since all items carry symbolic value – giving an "unworthy" item can signal a desire to terminate a relationship.

People travel intentionally for *hxaro* and, in times of resource fluctuations, *hxaro* provides an ostensible motive for visiting others. For example, in 1974, high winds and rain destroyed the mongongo nut crop of the /Xai/xai area and made hunting and trapping difficult. Food became increasingly hard to come by and sharing eventually broke down. Within two weeks, half the population had gone to visit relatives because "they missed them and wanted to do *hxaro* with them" (Wiessner 1982b: 77), thus lessening the pressure on those who remained behind.[21]

In detailing the complexity of Pintupi and Ju/'hoan group affiliation, we are describing instances of a widespread (although not universal) pattern in hunter-gatherer land tenure: that connections to land are social and permeable rather than geographic and rigid. In the Pintupi and Ju/'hoan cases, access to land is controlled through consensual rules that are backed by the threat of social sanctions, normally the realization that violation of someone's right to be asked for permission would result minimally in the withholding of permission in the future (Williams 1982).

The basis for much of the behavior labeled "territoriality," then, is the product of individuals deciding whether and how to share the right of resource use with others. These decisions are embedded in a complex intellectual process whereby people come to share an identity. Through kinship, trade, mythology, and other cultural mechanisms, people construct ways to relate themselves to each other and thus to land. These social relations form the basis for the right to be asked – and the right to ask – to use resources. The focus of research into land tenure, then, should be on the elements that condition permission-giving behavior. The question is not whether hunter-gatherers are or are not territorial but rather in what ways and to what extent does a group regulate access to land directly versus regulating access to social affiliation and hence to resources?

In the remainder of this chapter, we look at two approaches to land tenure: the economic defensibility and the social-boundary defense models. Using insights from these models, we then return to the Winterhalder risk-reduction model, but we will apply it to group rather than individual interaction.

The Economic Defensibility Model

The economic defensibility model (EDM) focuses on the cost and benefit of defending resources. As was true for tolerated scrounging, Rada Dyson-Hudson and Eric Smith (1978) argued that territoriality occurs when the cost of defending a resource is less than the benefit that could be derived from it. If a resource is not very dense and its occurrence in time and space is unpredictable, then the cost of defending it could be so high as to offset any gains derived from

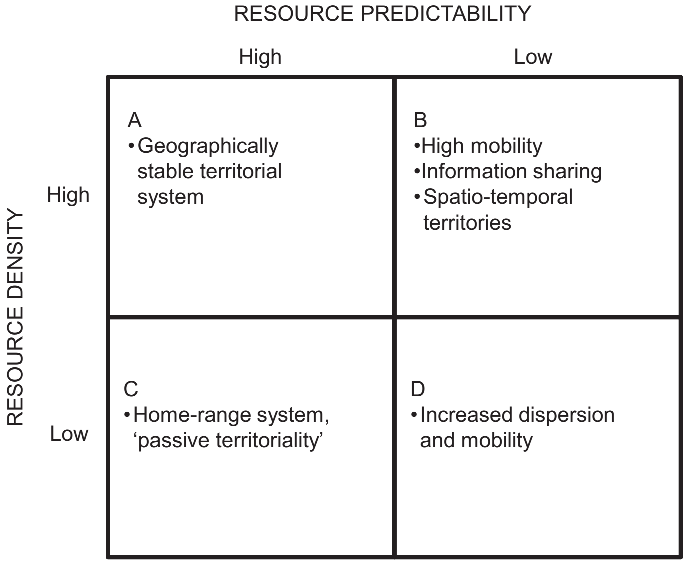


Figure 6-6. Four sets of relationships among foraging bands defined by resource predictability and density. Redrawn from Dyson-Hudson and Smith 1978. Reproduced by permission of the American Anthropological Association from *American Anthropologist*, 80(1), figure 1, p. 26, March 1978. Not for sale or further reproduction.

its exclusive use. Where resources are dense and predictable, resources may be worth the effort of defense and exclusive use.

The EDM allows us to predict variability in hunter-gatherer territorial behavior in terms of two basic dimensions of environmental variability: resource density and predictability (Figure 6-6). For the sake of simplicity, Dyson-Hudson and Smith divided each of the scales into high and low values, creating four land-tenure categories:

- *Case A*. Where food resources are dense and predictable, territoriality appears since the cost of defense is worth the benefit of the safeguarded resources.
- *Case B*. Where food resources are dense but not predictable, we expect high mobility, information sharing about the state of resources in different regions, and the shifting of territories.
- *Case C*. Where food resources are not dense but are predictable, we expect "home ranges" or passive territories to develop, probably at low population densities; here, groups tend to stay in one region of predictable resources and do not need to use other areas.
- *Case D*. Where food resources are neither dense nor predictable, groups are dispersed and mobility is high since the cost of trying to defend an area is low relative to its benefit.

David Thomas (1981) used this model to analyze three ethnographically known Great Basin societies (Figure 6-7). Following Dyson-Hudson and Smith's approach, Thomas did not classify these societies as either territorial or not; instead, he labeled them as more or less territorial at different seasons depending on the resource(s) exploited. Thomas suggested that the Reese River Shoshone are territorial with respect to winter piñon villages but not in regard to summer seed-gathering areas because piñon is a denser, more predictable resource, whereas grass seed is more scattered and less spatially predictable.[22] Living in a dry valley with almost no piñon, the Kawich Valley Shoshone had few territories at any time of the year. But food resources in the better-watered Owens Valley were denser, permitting some resources, such as fish, seeds, and acorns, to be gathered in bulk and stored, resulting in more distinct territories throughout the year than we find elsewhere in the Great Basin (Thomas 1981; see Steward 1933, Eerkens 2009). All three cases are anticipated by the EDM. Likewise, Elizabeth Andrews (1994) shows that where resources are concentrated and predictable, western Alaskan Eskimo societies are territorial. The Akulmiut, for example, defended river bottlenecks, where whitefish and pike could be predictably harvested in large numbers twice a year.

The EDM's predictions are based solely on characteristics of the resources themselves, and it predicts "exclusive use" where resources are dense and predictable. Dense resources can presumably be defended more easily, at a lower cost, because a smaller area must be defended. And exclusive use may not be costly under the appropriate social conventions and sanctions. But, at some point, those social conventions may develop into overt territorial behavior, what we will call *perimeter defense* (building walls, patrolling borders, attacking trespassers, and making retaliatory or preemptive raids). These behaviors arise when *demand* for a territory increases. The Owens Valley Paiute had denser and more predictable resources than the Reese River or Kawich Valley Shoshone, but they also had a higher population density. Dense and reliable resources are necessary for perimeter defense to be worth the effort, but its benefit "should tend to be in proportion to the intensity of competition" (J. Brown, in Cashdan 1983: 54), and competition is generally a product of population pressure. When a population bumps up against carrying capacity, the benefit of trying to take a resource from another becomes worth the potential cost; and, consequently, defending a resource becomes worth the cost of doing so. Dense, predictable resources may be a necessary but not a sufficient condition to result in perimeter defense. Perimeter defense implies competition because the time it entails (building stockaded villages, for example) entails an opportunity cost – time spent building stockades is time not spent on something else. What happens, though, when population nears carrying capacity where resources are neither dense nor predictable?

Perimeter defense is relatively rare in hunter-gatherer ethnographies (although it may be more common in archaeological cases). However, even where perimeter defense is absent, many ethnographies note that people must acquire *permission to use* land that "belongs" to another group, and that permission is virtually assured *if* asking for permission is culturally legitimate. Resources are not there for the taking, but they may be there for the asking.[23]

The giving of permission is the giving of a gift – and it puts the receiver in debt. As was true for sharing, land-tenure systems develop in response to the long-term condition of an ecological system and the evaluation of past actions and future possibilities of a petitioner. A strong tendency toward permission-granting gives human land tenure its own particular character. This observation is at the center of another model of land tenure.

Social-Boundary Defense

As we saw in the previous Australian example, Pintupi men can claim more than one country through their claims to one-countrymen status with other men. In so doing, they can legitimately expect to use the countries of others, provided they ask permission. One-countrymen status can be claimed but it is always open to negotiation. Permission is almost always granted but the potential to deny it is always present. People cannot simply go wherever they want. Even among those foragers who do not maintain defended boundaries, social mechanisms control whether one group will be allowed into the territory of another. Among western Cape York Aborigines, ritualized greeting ceremonies allowed a host group the opportunity to decide whether to permit a visiting group to stay with them:

> Three men, each carrying a bundle of spears, spear-thrower and fire sticks, appeared out of the scrub to the north of the camp. Although their approach was at once observed, causing an under-current of excitement in camp, no apparent notice whatever was taken of the men, who approached slowly to within about 40 feet of the northern fringe of the camp, where each squatted on the ground a few feet apart, placing his weapons in front of him . . . Not a word

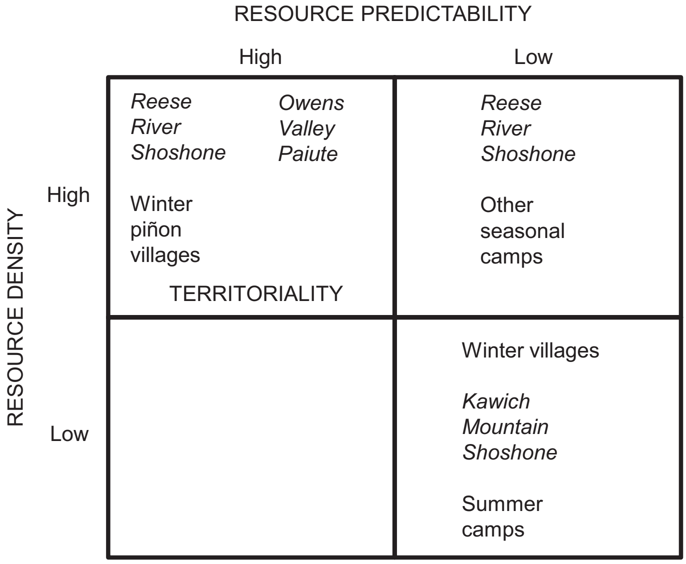


Figure 6-7. The economic-defensibility model applied to three Great Basin foraging societies. Redrawn from Thomas (1981). Courtesy of the Division of Anthropology, American Museum of Natural History.

> was spoken, and apparently no notice whatever was taken of their presence for about 10 or 15 minutes. Then a "big" man left the camp unarmed and strolled casually toward the man on the left, scraped a shallow depression in the ground close to him with his foot, as a native does before sitting down, and then squatted on the ground about a yard away from the visitor . . . Still not a word was spoken. They did not even look at one another, but kept their eyes downcast. After a few minutes had elapsed the old man of the camp spoke a few words in a low tone – inaudible to me where I stood a few yards away – and the other replied in the same casual way. Still neither looked up . . . At length the old man called the single word *Bat* (fire) and a boy brought out a small piece of smoldering wood which he handed to the old man from the camp. This fire the old man then placed on the ground between himself and the visitor to whom he had spoken . . . on this occasion a tobacco pipe was lighted and handed to the visitor. A second man now left the camp, strolled casually over and spoke to the man at the other end of the line, making a present, which was reciprocated. A little later all entered the camp, to be followed, in the evening, by a larger party. (Thomson 1932: 163–64; see also Batty, Allen, and Morton [2005: 55–56] for an account of a similar meeting among the Arrernte, as recorded by Baldwin Spencer in 1923.)

As with sharing, there are costs and benefits to sharing a land's resources with visitors. On the one hand, the visitors may reduce the host group's foraging efficiency; on the other, there is the potential for reciprocation in the future. The host group's alternative to accepting these costs is to patrol the territory's borders, pay the cost of physical retaliation, and find another way to respond to periodic resource failure within the bounds of their own territory (e.g., long-term storage).

Elizabeth Cashdan (1983) argues that the benefits of permitting visitors outweigh the costs when resources are scarce and (consequently) territories are large, making them difficult to patrol. Under these conditions, hunter-gatherers ensure reciprocal access to the resources of others by maintaining social access to the group through individual(s) holding the right to grant permission to use those resources. These hunter-gatherers defend their physical resources by controlling their social boundaries. Cashdan refers to this as *social-boundary defense*. The Pintupi's process of establishing one-countrymen status with another man are part of social-boundary defense. And these also mean that there are many ways for a man to deny the claim. Group affiliation among foragers is constantly negotiated.

One might ask why, if a region's perimeter cannot be physically defended, should permission even be sought? Why not just trespass? Two reasons make trespassing a poor decision. First, trespassing can be hazardous to the trespassers, since they may not have sufficient knowledge of the region to make use of it. Second, if a trespassing group intends to use something other than a quickly procured resource (e.g., an animal), they may be detected (e.g., through their tracks, smoke from fires), and risk retaliation (see Tindale [1974: 24] for a description).[24] (I am reminded of the time a Mikea man tracked my wife and me for 25 km through the Mikea forest; he knew by our shoeprints that we were foreigners, and he wanted to know who these strangers were.) But even if permission is sought, why should a host group allow visitors in? There are two answers that recall some parts of our discussion of sharing: first, the tables may be turned next year, and the current host group will need a favor from this year's visitors (similar to reciprocal altruism); and, second, the cost of excluding the visitors may be too high relative to the benefit of keeping the resources to themselves (similar to tolerated scrounging).

Cashdan sees perimeter defense occurring when competition is high and resources are defensible (see also Berkes 1986). Conversely, she expects social-boundary defense when competition is high but resource density (and hence defensibility) is low. When competition is low, Cashdan sees neither perimeter nor social-boundary defense but something more akin to Dyson-Hudson and Smith's home ranges.

To test this hypothesis, Cashdan analyzed the land tenure of four Bushmen groups using mean annual rainfall as a measure of resource abundance and the annual rainfall's coefficient of variability (standard deviation/mean) as a measure of resource predictability (these two variables are usually inversely related). Among these four groups, territory size increases as resource density decreases. The most scarce resources are found among the !Ko. According to the Dyson-Hudson and Smith model, the !Ko should exhibit the least perimeter defense; and, indeed, the !Ko do not guard physical boundaries and they did exhibit the greatest social-boundary defense of the four groups.

The benefits of perimeter defense decrease as resources become less dense. At some point, the benefits are less than the cost of social-boundary defense. For groups such as the Nharo, G/wi, and Ju/'hoansi, social boundaries are highly fluid, and individuals maintain a diversity of relations with members of other groups; little effort is put into controlling who has a social tie to any given group.

Among the !Ko, however, social access is tightly controlled since they face the greatest competition over their scarce resources; here, the cost of social-boundary defense is probably less than the benefit it provides.[25] And the potential threat of expulsion is high relative to the benefit of entry for potential trespassers (since trespassers would need the residential group's knowledge of the region).

There is no neat division of cases into those with social-boundary or perimeter defense. At any moment in time, an individual is affiliated with different kinds of social groupings. A person is simultaneously a member of a family, other kinship groupings, a residential group, perhaps an age grade or other sodality, a political group, and a linguistic group. If these different groups have geographic counterparts, then the negotiation of access to land and resources may take on a different character for one set of individuals than for another, depending in part on the nature of the resources encompassed by these different levels of society.

Among the !Ko, for example, bands are grouped into what Heinz (1972) calls *nexuses*. There is much intermarriage and visiting between bands that make up a nexus but not between bands of different nexuses. Social-boundary defense is low between the bands that make up a nexus, whereas it is high between each nexus. Cashdan (1983: 55) argues that the bands that make up a nexus are bands that can help one another in times of need, but when times are bad for one nexus, they are bad for others as well. The case of the !Ko suggests that social boundaries remain fluid between groups that can assist one another in times of need but are more rigid – or shift to perimeter defense – between those that cannot.

Recent changes in G//ana society also demonstrate the process that lies behind the social-boundary defense model (Cashdan 1984). The G//ana are a Bushmen group in central Botswana who, in recent decades, shifted from a foraging/horticultural base to one relying more heavily on horticulture and wage labor. The availability of metal storage drums allows them to store water, a scarce resource in the central Kalahari. As a result of these changes, the G//ana developed new means of buffering resource fluctuations through agriculture and the storage of food and water (and also goods that could be converted to cash to buy food). As resources became more concentrated and less variable from year to year, groups became more endogamous, and inheritance of *lefatshe* (a rough equivalent of the Ju/'hoan *n!ore*) became patrilineal rather than bilateral. Along with these social changes, the G//ana's social-boundary defense increased and it became more difficult for others to acquire permission to use G//ana resources.

In sum, we expect social-boundary defense instead of perimeter defense when (1) residents possess more information about resource location and abundance than visitors, (2) uncoordinated search produces inefficient foraging through overcrowding, (3) today's visitors are likely to be tomorrow's hosts, and (4) residents can impose effective sanctions against those who trespass (E. Smith 1988: 250). If reciprocity is a means of establishing social ties with people who could provide assistance in times of need, then choosing exchange partners is a decision based largely on the temporal and spatial parameters of resource fluctuations:

> If reciprocity is acting as insurance, it would be expected that an individual would find it beneficial to maintain reciprocity networks with individuals whose economic fortunes are independent of his own. If the economic well-being of everyone in the local area is tied to the same source, on the other hand, we might expect to see people closing off social ties to protect their limited resources. (Cashdan 1985: 471)

We can expect to see alliance-forming reciprocal exchanges of one kind or another between the members of groups living in a region of scarce, unpredictable resources that fluctuate on different temporal and spatial scales.

Finally, in our discussion so far, we have assumed that foragers do not acquire more resources than they need for survival, that acquiring more food than necessary does not confer sufficient benefits to make contests worthwhile. Thus, we said that perimeter defense appears only when population density had created competition over resources. This may be the case for many ethnographically known foragers, but it need not always be true. Where the cost of controlling additional increments of a resource beyond the minimal amount needed is less than the benefits those resources bestow upon a forager (e.g., greater infant survival rates, more offspring, or achievement of a culturally defined goal, such as prestige), then we could expect to see stronger social-boundary defense or, if resources are defensible, perimeter defense, even where population density is not high.

Cashdan suggests that foragers who routinely store large amounts of food for a lean season may live under these conditions (1983: 55). Competition over resources could occur here even at low population densities. As we will note in Chapter 9, food storage is often associated with social hierarchy. And, as we will discuss in Chapter 7, storage can increase a population's growth rate. Storage, hierarchy, population density, and territorial competition may be linked together in a long-term process. It may be left to archaeologists to address exactly how these factors interact with one another.

The Winterhalder Model Reconsidered

We can now return to Winterhalder's model of food sharing and modify it slightly so that it models intergroup rather than interindividual activity.

		INTERGROUP CORRELATION	
		High	Low
INTRAGROUP VARIANCE	High	A •Household storage •Restricted social access between groups •Perimeter defense •Warfare •Slavery	B •Social Boundary defense •Some storage •Intensive reciprocity and gift exchange
	Low	C •Home ranges •Passive territories •Long-distance migration •Rare hostilities	D •Relaxed social boundary defense •Differentiated exchange between groups

Figure 6-8. The Winterhalder model of sharing relations between individual foragers translated into relations between groups of foragers.

Recall that Winterhalder's model focuses on the nature of variance in individual resource returns and the degree of correlation between return rates of different individuals. Here, we substitute the group for the individual, so that we are looking at variance in the pooled efforts of group members over time and the degree of correlation between returns of different groups.

By saying that the *variance* in a group's return rate is high, we mean that a group could, in some years, have more than enough food and in other years, experience disaster. Low group variance means that the group always collects about the same amount of food. Assuming that population density is adjusted to some mean resource level, members of groups with a high variance will have to call on neighbors for assistance more frequently than will those living in areas with low variance in food abundance.

Likewise, high *correlation* of pooled return rates between groups means that when one group is doing well, the other is also doing well, and when one group is doing poorly, so is the other. As we noted previously, under such circumstances, there is no utility to maintaining mutual social access because, at any given time, one group either does not need or cannot help another.

With this perspective, we can modify Winterhalder's model (see Figure 6-8). Although we outline group responses here, it remains to be seen how these predictions play out in terms of individual decisions.

- *Case A.* When high intragroup variance occurs with high intergroup correlation, we expect social access to be restricted (perhaps to a few key individuals), perimeter defense, and household storage. This case could also describe circumstances under which warfare occurs (see Chapter 7); some fighting could be for conquest and food stores and some could be directed toward the acquisition of slaves to increase household production.
- *Case B.* This is the case of social-boundary defense and probably describes most ethnographically known hunter-gatherers. In this case, the frequency with which a group may need to call on neighbors may be high but, since intergroup correlation is low, social access will be permitted (for reasons given previously). Storage may occur during periods of abundant resources, but more energy may be invested in social storage through reciprocal exchanges. We could speculate that as the periodicity of resource failure increases (cases that would fall more

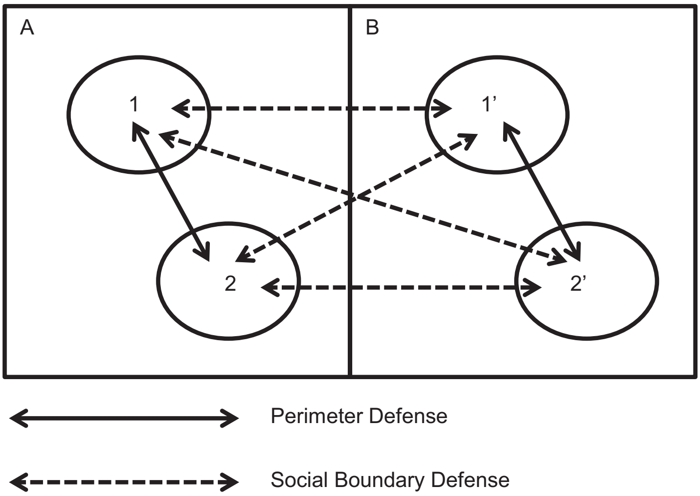


Figure 6-9. Different spatial scales of resource variability create territoriality between some groups, social-boundary defense between others.

to the right-hand side of the cell), the rigidity of the system of reciprocity (with concomitant specificity of the symbolic value of material goods) might also increase since individuals will call on one another with a greater frequency.

- *Case C*. This describes Dyson-Hudson and Smith's "home ranges." Since intragroup variance is low, the need to call on neighbors for assistance will be infrequent. Regardless of intergroup correlation, we could expect to see passive territories form; that is, groups remain in a given region not because they cannot move into another group's range but rather because there is no need to move out of their own territory. In addition, when resources do fail, we could expect to see long-distance migration, since neighbors with high intergroup correlation of net returns could not assist one another. Burch (1972), for example, describes a time for the Nuataqmiut when caribou densities were so low regionally that neighboring groups could not help each other. The Nuataqmiut moved 600 km to the coast – to a people not dependent on the caribou that the Nuataqmiut hunted. Some amount of hostility could occur during rare resource failures because the mechanisms (e.g., trading partnerships) to permit social and hence physical access to other regions may not exist.
- *Case D*. In this case, there will be infrequent need for a group to call on its neighbors, but we could still expect to see relaxed social-boundary defense maintained through reciprocity. At high population levels, ranges become more restricted, and we could expect to see differentiated exchanges (e.g., meat for carbohydrates) between less mobile populations, depending on the amount of habitat diversity (Spielmann 1986; Cashdan 1987). Additionally, differentiated exchange may be feasible only where tradable resources are predictable and abundant, and where "a decrease in search, procurement and/or production costs can be gained through a certain degree of specialization" (Spielmann 1986: 303).[26]

Deciding which case applies to a given ethnographic or archaeological situation depends on the spatial scale, since relations between groups depend to a large extent on the spatial scale of resource fluctuations. In Figure 6-9, we depict a situation similar to that described previously for the !Ko. Each pair of local groups lives in an area (A or B) within which resource fluctuations are correlated but between which resources fluctuate on different time scales. Therefore, intergroup correlation would be high for groups 1 and 2, on the one hand, and 1′ and 2′ on the other, but low between any group in area A and any group in area B. Depending on the density of resources (hence, the size and defensibility of the local groups' territories), we could expect to see perimeter or strong social-boundary defense between groups 1 and 2 as well as between groups 1′ and 2′; however, there should be more relaxed social-boundary defense between groups in areas A and B.

This hypothetical situation could become even more complex if one group falls within one category while its neighbors fall into another (e.g., within cases A and B in Figure 6-8). Some Kwakwak'awakw villages, for instance, were located on minor streams with small, variable salmon runs; others were located on large streams with large, consistent salmon runs. Those living on small streams may occasionally need the resources of those living on large streams but not vice versa. This creates a situation in which those with dense, defensible resources must weigh the cost of defense, and those with variable resources must weigh the cost of raiding or penetrating strong social-boundary defense. We return to this situation in Chapter 9. Our point here is that for any given case, we should be able to translate the interplay between environmental and population variables into their significance in terms of intragroup variance and intergroup correlation and, from these, predict the specific form of land tenure (see Nolan and Cook [2010] for an archaeological example).

Conclusion

On the surface, hunter-gatherers appear to share food, goods, and access to land quite readily. Yet a close reading of ethnographic data indicates that this is not simply primitive communism or a reflection of innately kind and generous dispositions (however kind and generous individual foragers may be). Sharing is not a product of an evolutionary stage or a subsistence mode but instead is the outcome of a decision-making process. There are costs and benefits to sharing resources, and it is clear that hunter-gatherers balance these when making decisions to share food or to admit outsiders into their territory.

It is also clear that the costs and benefits of sharing are analyzed over some period of time, taking into account past experiences and future expectations. These costs and benefits are probably analyzed in terms of the degree of correlation between foragers' efforts and the amount of day-to-day variance in those efforts. Individual foragers may share resources to reduce the risk of going without any food in the future or as an exchange for complementary resources, sexual favors, or support in old age.

If men and women procure different resources, the nature of those resources may affect the way that they share. If men hunt large game, then they will automatically come under demands to share since they can acquire more meat than they can use at one time. This also puts men in a position to acquire prestige and may direct their continued attention toward resources and activities that garner it (resulting in some men hunting more than is necessary for energetic needs). If women gather, they can control how much food is collected, perhaps bringing back only enough for their family – an amount of food that is not surplus and that cannot be acquired through demand-sharing. Women may use the results of their foraging efforts as a way to build social bonds with women, but they could also share by assisting others with childcare.

Land tenure can be analyzed using a similar framework, one that focuses on intragroup variance and intergroup correlation. Where peoples' fortunes are all tied to the same resource, or where resources are synchronized such that when one group does poorly their neighbors do the same, there is little utility to intergroup sharing of use rights. Territoriality may form under such conditions if resources are defensible (i.e., aggregated and predictable). Where the resources of different groups are not synchronized, but where there is variation in resource availability, land-tenure systems, whereby people are tied to the land through social processes of affiliation, may appear. Many hunter-gatherers today live under the latter situation, but many prehistoric foragers may have lived under conditions outside the range of those covered by ethnographic cases.

Land tenure is as variable as sharing. Evolutionary ecology predicts that territoriality results when resources are sufficiently dense and predictable and, especially, where competition is high.

But the land that foragers need to survive is often so large, and population density so low, that physical defense of a perimeter is impossible, yet the cost of allowing unregulated visitors in can be high. In these cases, foragers regulate physical access through social access, the strength of which is related to the cost of denying visitors the right to use resources versus the potential that visitors have to reciprocate in the future. This makes land tenure much like sharing, with variations predicted by resource density and reliability, intragroup variance, and intergroup correlation in returns. This adds a spatial as well as a temporal component to the environmental factors that affect sharing of food and access to land.

Chapter 7

Group Size and Demography

> A woman who gives birth like an animal to one offspring after another has a permanent backache.
>
> Ju/'hoan saying (Lee 1980: 325)

> A Dreamtime man died . . . no one knows why . . . and Wirlara the Moon-man, who was traveling with his large pack of dingoes, found the body and decided to try to save the man. He dragged him along by the hand but the body was rotting and pieces of it began dropping off, whereupon the Moon-man, being a clever magician, would stick them back on again. Some people saw him doing this and burst into laughter, ridiculing him for dragging a smelly corpse around. He was very angered by this, and embarrassed, so he scattered the pieces of the body far and wide, saying to the people, "From now on you will die and stay forever dead." Had these people not ridiculed the Moon-man in the Dreamtime, human beings would never have to die.
>
> Mardu myth (Tonkinson 1978: 61)

After *Man the Hunter*, conventional wisdom was that hunter-gatherer bands consist of about twenty-five persons and live at population densities that are only 20–30 percent of the environment's carrying capacity. Many argued that hunter-gatherers intentionally hold their populations in check through high rates of infanticide, especially female infanticide, and consequently experience low rates of population growth. We only have population-growth-rate measures for the Ju/'hoansi (0.5 percent; Lee 1979; Howell 1979), the Agta (1.1 percent; Early and Headland 1998); the Ache (2.5 percent; range: 1.6–3.5 percent; Hill and Hurtado 1996); the Hadza (1.4 percent; Blurton Jones, Smith, O'Connell, Hawkes, and Kamuzora 1992); and the New Guinean Asmat (1.5 percent; Van Arsdale 1978). From their analysis of foraging group sizes, Hamilton et al. (2007a) suggested a mean growth rate of 1.1 percent.

However, if the Ju/'hoansi's rate of just 0.5 percent characterized prehistoric hunter-gatherers, then the world's population should have reached one billion long before it actually did in the early nineteenth century. Prehistoric foragers must have had even lower growth rates. Based on genetic data, Pennington (2001) suggested an average annual growth rate prior to 10,000 years ago (i.e., before agriculture) of only 0.008 percent.

Our concern in this chapter is with identifying the factors that condition variability in those factors that go into the rate of population growth, notably fertility and mortality. Along the way, we examine forager group size, and we conclude with a discussion of the relationships among mobility, foraging, and population growth, with an eye toward the effects of sedentism on the rate of growth.

First, though, a word of caution about demographic data. We only have a few detailed ethnographic studies of forager demography (e.g., Burton Jones et al. 1992; Hill and Hurtado 1996; Howell 1979, 2010; Marlowe 2010; Howell's database on the Ju/'hoansi is housed on-line at the University of Toronto and Early and Headland's on the Agta at the Summer Institute of Linguistics). Although we can compile an impressive list of data (Table 7-1), its accuracy is debatable. It is hard to estimate the ages of people who do not know the year of their birth, who do not reckon time by the Western calendar, and who physically age at different rates than an anthropologist's home population.[1] Anthropologists are also the rear guard of colonialism, recording data after introduced diseases have taken their toll or, conversely, after the introduction of Western medicines and inoculations. Informants are understandably reluctant to answer questions about infanticide, paternity, sexual activity, and death. Accurate population enumeration is difficult when people hide their children for fear they will be taken, or when the mention of deceased individuals is culturally prohibited (Rose 1960; Hamilton 1981; Yengoyan 1981). Small groups undergo dramatic changes in demographic parameters from year to year as a consequence of chance events. Thus, a single census of a small population may not characterize that population's long-term demography (Weiss and Smouse 1976; Winterhalder, Baillageon, Cappelletto, Daniel, and Prescott 1988: 320). With this is mind, we should regard the ethnographic record of hunter-gatherer demographic data with healthy skepticism.

Group Size: The "Magic Numbers" 500 and 25

Two legacies of *Man the Hunter* were the "magic numbers" 500 and 25: respectively, the size of hunter-gatherer regional or tribal groups and the size of local residential foraging groups, groups that Steward (1968) once referred to as maximal and minimal bands. The use of the word "band" has a complicated history in anthropology, and its definition has shifted over time; it is not widely used today (see Steward 1970; Binford 2006).[2] For our purposes, we only need to know that the 500-person figure comes from Joseph Birdsell's (1953) effort to construct a gene-flow model for prehistoric populations from Australian Aboriginal data. To do so, Birdsell needed to hold the size of the breeding population constant. Examining relationships between Australian Aboriginal tribal area and density, he concluded that although tribal area varied considerably (as a response to resource abundance), tribal size remained constant at about 500 persons.

Unfortunately, there were several problems in Birdsell's analysis (K. Kelly 1994)[3] and although he (1953: 177, 172–73) attempted to test the constant, in actuality, Birdsell had to assume it. He noted that the 500-person figure was "not true when applied to a small series of tribes" and, at *Man the Hunter*, he was "inclined to think that the number is probably a little too high" (Lee and DeVore 1968: 246) and that variance in prehistoric breeding population sizes "will be considerable" (Birdsell 1968: 233).

Twenty years later, Martin Wobst (1974) used computer simulation to determine how small a human breeding population could be and still remain reproductively viable. He came up with a population that varied from 175 to 475 persons, due to variability in fertility and mortality rates, sex ratio, and cultural rules governing marriage. Still, Wobst lent some credence to Birdsell's constant by suggesting that the most realistic assumptions made 475 the likely minimum breeding population size.

Empirical data on minimal band sizes are more accurate, and they suggest an average of twenty-five or less in a variety of different environments (Table 7-2). In his compilation, Marlowe (2005a) found a median size of thirty. (Sedentary hunter-gatherers live in larger, sometimes much

Table 7-1. Hunter-Gatherer Demography

Group	Year	M/100F	m/100f	Ch/Ad	Reference
Arctic					
Bernard Harbor	20th century	109	116	–	Jenness, in Irwin 1989
Interior Padlimiut	1920	80	145	–	Birket-Smith 1929
Coast Padlimiut	1920	78	119	–	Birket-Smith 1929
Qaernermiut	1920	83	218	–	Birket-Smith 1929
Qaernermiut	1890	76	141	–	Boas 1907
Hauneqtormiut	1920	72	130	–	Birket-Smith 1929
Harvaqtôrmiut	1920	81	153	–	Birket-Smith 1929
Sauniktumiut	1890	79	123	–	Boas 1907
Sinamiut	1890	100	171	–	Boas 1907
Avilikmiut	1890	76	178	–	Boas 1907
Central Inuit	1890	93	105	–	Boas 1888
Cape Prince of Wales (Alaska)	1920	103	108	–	Weyer 1932
Cape Smith (Alaska)	1890	87	192	–	Smith, in Irwin 1989
Utknhikhalingmiut	1920	102	212	–	Rasmussen 1931
Netsilingmiut	1890	97	208	–	Boas 1907
Netsilingmiut	1920	98	212	–	Rasmussen 1931
Copper Inuit	1920	101	270	–	Rasmussen 1932
N. Greenland	1920	125	103	–	Birket-Smith, in Irwin 1989
E. Greenland	1920	90	100	–	Birket-Smith, in Irwin 1989
E. Greenland	1900	83	77	–	Hansen, in Irwin 1989
Nunamiut	1960	140	108	–	Campbell and Wood 1988
Subarctic					
Kutchin	1858	67	142	0.45	Osgood 1936
Kutchin	1858	111	159	0.73	Osgood 1936
Kutchin	1858	103	157	0.68	Osgood 1936
Kutchin	1858	158	–	–	Krech 1978
Tanana	1930	120	–	0.45	McKennan 1959
Tanana	1930	83	–	–	McKennan 1959
Tanana	1930	90	–	–	McKennan 1959
Tanana	1930	86	–	–	McKennan 1959
Tanana	1930	100	–	–	McKennan 1959
Central Northwest Coast (not including slaves)					Panowski 1985
Columbia River ($n = 15$)	1825	82	–	–	
Nass R. ($n = 4$)	1846	124	102	0.63	
Tako R. ($n = 1$)	1846	109	109	0.50	

Group	Year	M/100F	m/100f	Ch/Ad	Reference
Queen Charlotte Is. ($n = 3$)	1846	101	96	0.92	
Cape Fox ($n = 3$)	1846	97	90	0.81	
Chilkat ($n = 1$)	1846	230	108	0.36	
Cross Sound ($n = 1$)	1846	110	123	0.40	
Sebassas ($n = 5$)	1846	117	126	0.50	
Stekini R. ($n = 8$)	1846	137	125	0.45	
Milbank Sound ($n = 7$)	1846	105	80	0.42	
Skeena ($n = 2$)	1846	183	107	0.61	
Hood's Bay ($n = 3$)	1846	121	109	0.37	
Chatham's Sound ($n = 10$)	1846	95	104	0.61	
Sitka R. ($n = 2?$)	1846	109	109	0.57	
Prince of Wales ($n = 6$)	1846	95	95	0.96	
Temperate deserts					Fowler and Fowler 1971
Paiute/Shoshone					
Central Nevada ($n = 9$)	19th century	103	–	0.28	
S.E. Calif. ($n = 5$)	19th century	108	–	0.27	
Gosiutes ($n = 5$)	19th century	105	–	0.44	
Humboldt River ($n = 6$)	19th century	113	–	0.30	
S. Utah ($n = 8$)	19th century	147	–	0.26	
N. Arizona ($n = 3$)	19th century	117	–	0.35	
Utes ($n = 7$, res.)	19th century	104	–	0.63	
Battle Mt. ($n = 6$)	19th century	97	–	0.39	
Ruby V. Shoshone ($n = 3$)	19th century	172	–	0.33	
S. Nevada ($n = 15$)	19th century	115	–	0.30	
Reese River V. ($n = 7$)	19th century	98	–	0.42	
Pai	1881	113	–	0.88	J. Martin 1994
Tropical/subtropical deserts					
G/wi	1960	93	–	–	Silberbauer 1981a
≠Kade G/wi	1967	68	110	0.85	Tanaka 1980
G//ana	1970s	–	–	0.81	Cashdan 1984
Ju/'hoansi	1960s	81	–	–	Harpending and Wandsnider 1982
Dobe Ju/'hoansi	1964	91–93	78	0.43–0.5	Lee 1979; Howell 1979
Ghanzi Ju/'hoansi	1960s	91	–	–	Harpending and Wandsnider 1982

(continued)

Table 7-1 (*continued*)

Group	Year	M/100F	m/100f	Ch/Ad	Reference
Mardudjara	1960s	82	–	0.51	Tonkinson 1974
Pitjandjara	1933	116	–	0.75	Tindale 1972
Pitjandjara	1970s	101	94	0.57	Yengoyan 1981
Hadza	Late 20th century	75	102	0.68	Blurton Jones et al. 1992
Seri	1930	96	–	–	Neel and Weiss 1975
Anbarra	Late 20th century	100	106	–	White, Meehan, Hiatt, and Jones 1990
Anbarra	1958	–	124	–	Hamilton 1981
Pumé	2005	98	101	0.66	Kramer and Greaves 2007, pers. comm.
Tropical forests					
Onge (Andaman Islands)	1980	110	60	–	Pandya, in Hewlett 1991a
Casiguran Agta	1977	83	145	0.53	Headland 1988; Hewlett 1991a
Birhor	1960	121	167	0.75	B. Williams 1974
Asmat	1972	97	114	0.69	Van Arsdale 1978
Batak	1970	107	107	0.65	Eder 1987
Batek	Late 20th century	117	172	0.98	Endicott, in Hewlett 1991a
Mbuti (net hunters)	1960	94	120	0.66	Harako 1981
Mbuti (archers)	1960	119	67	0.29	Harako 1981
Western Pygmies	1965	197	122	0.45	Cavalli-Sforza 1986
Efe	1980	109	75	0.31	R. Bailey 1988
Aka	1976	139	–	1.02	Bahuchet 1979
Ache	1970	133	153	0.81	Hurtado and Hill 1987
Tiwi	1960	88	91	0.64	Jones 1963
Bathurst Island (Tiwi)	20th century	91	–	–	Peterson and Long 1986
Cape York	20th century	81	–	–	Peterson and Long 1986
Groote Eylandt	20th century	156	128	0.59	Rose 1960
Groote Eylandt	20th century	86	–	–	Peterson and Long 1986
Hiwi	1980	129	165	0.43	Hurtado and Hill 1987
Paliyan	1960	85	69	0.59	Hewlett 1991a
Hill Pandaram	1960	78	140	1.50	Morris 1982
Hill Pandaram	1960	64	120	0.61	Morris 1982
Hill Pandaram	1960	30	167	1.23	Morris 1982
Hill Pandaram	1960	100	500	0.50	Morris 1982

Group	Year	M/100F	m/100f	Ch/Ad	Reference
Hill Pandaram	1960	71	109	1.08	Morris 1982
Hill Pandaram	1960	62	40	0.33	Morris 1982
Hill Pandaram	1960	100	96	0.94	Morris 1982

M/F is number of adult males per 100 females, m/100f is number of child males per 100 females, Ch/Ad is the ratio of children to adults; TFR is total fertility rate. Dates of observation are specified as far as possible. Numbers in parentheses indicate that values given are the average of *n* separate groups.

Table 7-2. Hunter-Gatherer Group Size

Society	Group Size	Reference
Nomadic		
Ju/'hoansi	25 (mean)	Marshall, in Damas 1969c
Hadza (1990s)	30	Marlowe 2010
Hadza (1950s)	18	Marlowe 2010
Birhor	27 (mean)	Williams 1974
Semang	20–30	Gardner, in Damas 1969c
Andaman Islanders	30–50	Gardner, in Damas 1969c
Athapaskans	20–75	McKennan, in Damas 1969c
Cree	25–50	Rogers, in Damas 1969c
Iglulingmiut	35 (mean)	Damas, in Damas 1969c
Copper Inuit	15	Damas, in Damas 1969c
Cape York (Australia)	10–50	Chase and Sutton 1987
Pai	28	Martin 1973
Hill Pandaram	6–21	Morris 1982
Guayaki	16	Clastres 1972
Ngadadjara	20	Gould 1969a,b
Mistassini	15	Rogers 1972
Paliyan	24	Gardner, in Hayden 1981b
Tiwi	40–50	Hart and Pilling 1960
Pumé	61 (mean)	Gragson 1989; Greaves 2006
Sedentary		
Nootka	1,500	Jewitt, in Hayden 1981b
Wiyot	33	Schalk 1981
Yurok	46	Schalk 1981
Tolowa	43	Schalk 1981
Lower Chinook	50	Schalk 1981
Chehalis	110	Schalk 1981
Puyallup-Nisqually	35	Schalk 1981
Quinault	36	Schalk 1981
Makah	164	Schalk 1981
S. Kwakwak'awakw	420	Schalk 1981
Bella Coola	58	Schalk 1981
Haisla	650	Schalk 1981
Tsimshian	389	Schalk 1981
Haida	577	Schalk 1981
Tlingit	197	Schalk 1981

larger, settlements than nomadic hunter-gatherers.) From his compilation of 339 forager societies, Binford (2001) found even smaller residential groups, about ten to seventeen persons for nomadic, plant-dependent peoples; about eighteen for those dependent on aquatic resources; and fifteen for terrestrial hunters. Hill et al. (2011) found a weighted mean of twenty-eight persons from a tightly controlled dataset. Although nomadic foragers might periodically gather in large groups, they live most of their lives in small groups, often fewer than twenty-five persons.

Marcus Hamilton and his colleagues (2007a) lend some support to both "magic" numbers. They reanalyzed Binford's (2001) dataset of 339 hunter-gatherer cases, with data on 1,189 estimates of various group sizes, from families to regional populations. They found a remarkable cross-cultural regularity: starting with a single individual, groups seem to increase by a factor of about 4: families consist of 4–5 people, a residential group of about 14–17 people; social aggregations (e.g., at winter camps) of 50–60 people; periodic aggregations of 150–180 people, and an entire ethnic population of 730–950 people. This regularity holds true even for different environments. Why?

Hamilton and his colleagues (2007a: 2199–200) suggest that these groupings "reflect optimized networks of flows of essential commodities: food, other material resources, genes and culturally transmitted information. Individual foragers should maximize fitness by participating in social networks of exchanges that optimize the flow of resources." They also note that "in density-dependent populations, individuals face tradeoffs between resource availability and competition from conspecifics, leading to optimization principles acting to regulate interactions and therefore network organization." So, these groupings reflect a subliminal consensus about how to most efficiently move food, information, and mates among foragers without overt competition. Obviously, people did not get together and vote on these groupings. So, how does the process actually work?

The best level at which we can view the process is that of the residential group of about twenty-five persons. One factor that can limit group size is the process of making decisions: we all know that the larger a group, the harder it is to agree on a plan of action. Using a large ethnographic sample (not restricted to foragers), Gregory Johnson (1982) argued that when there are more than about six social units (in this case, families) acting corporately, then a new level of hierarchy appears to coordinate activities, including, and perhaps most important, foraging activities. A group of twenty-five people could contain about four or five families, and so increasing group size beyond twenty-five might require leaders to coordinate the families' separate foraging efforts. People accustomed to an egalitarian social order might respond to a leader by breaking away; thus, groups fragment as they grow beyond about 25 persons.

Wobst's (1974) computer simulation that we just mentioned argued that twenty-five persons is the minimum group size that can withstand short-term fluctuations in fertility, mortality, and sex ratio; in other words, groups smaller than twenty-five persons have a low probability of being reproductively viable (the empirical data suggest foraging groups can be smaller than twenty-five; reproductive viability is maintained through contacts with other groups). Wobst suggested that twenty-five is a compromise between reproductive and economic needs: large enough to keep the group demographically viable, yet small enough to prevent rapid exhaustion of local resources.

Both Johnson's and Wobst's explanations acknowledge the importance of foraging in conditioning group size, and so Winterhalder (1986a) examined this factor specifically. Recall our discussion in Chapter 6 of Winterhalder's sharing model. In it, Winterhalder focused on the relationship between the number of sharing foragers in a group and the mean postsharing variance in individual foragers' returns. That model also examined how variance responded to changes in the *number* of foragers and the *correlation* between each forager's presharing return rate. Having more than one active forager in a group increases the probability that someone will bring home food. That seems obvious. But it is also obvious that the more foragers there are in a group, the more mouths there are to feed, and the faster a foraging area is depleted of food. At some size,

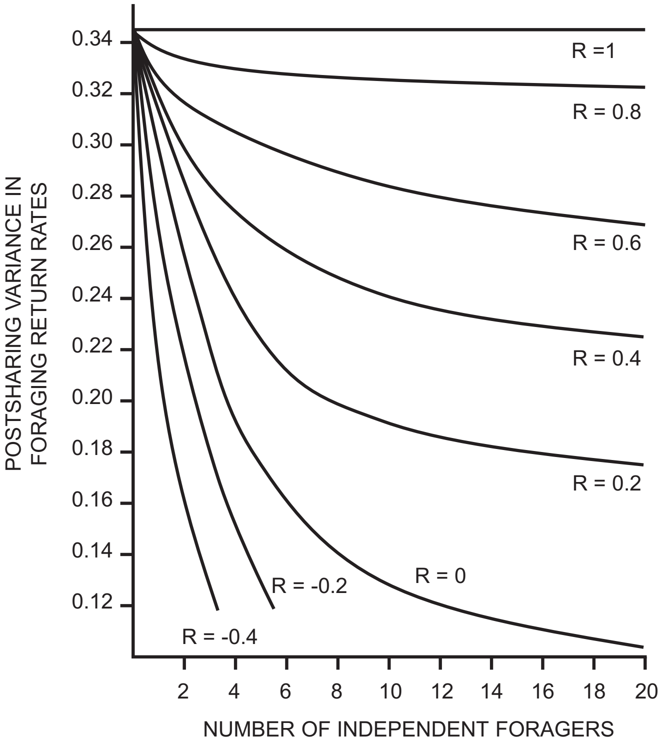


Figure 7-1. Relationship between postsharing variance in return rate and number of sharing foragers at different levels (*R*) of interforager correlation in daily return rates. Reasonable rates of *R* are probably >0. Note that the reduction in postsharing variance is not improved much beyond about seven sharing foragers. Redrawn from Winterhalder (1986a) with permission from Elsevier.

a group will fission due to interpersonal tension arising from stress on the local food base and constraints on sharing. I suspect that before reproductive viability and politics become important, group size must balance the risk of going hungry against the rate of resource depletion.

One of Winterhalder's conclusions is relevant to residential group size. Figure 7-1 graphs the simulated change in postsharing return rate variance (the coefficient of variance, or CV) along the y-axis against the number of independent foragers along the x-axis. The various curves indicate the relationship between these two variables at different degrees of correlation in the foragers' daily return rates (R). Where $R = 1$, there is a perfect correlation in return rates – every forager does just as well or just as poorly as each of the others. Where $R = 0$, there is no correlation between foragers' returns – when one does poorly, another does very well. Notice that for each R, there is a point at which an increase in the number of sharing foragers does not substantially reduce variance in postsharing return rates. In fact, there is not much advantage to having more than seven or eight foragers in a group.[4] Even where there is no correlation among foraging return rates ($R = 0$), eight foragers produce a postsharing return rate CV of ~0.12, whereas twenty foragers reduce it to ~0.08 – and yet the larger group will deplete the resources around camp much more rapidly than a smaller group, and camp will have to move more frequently (Winterhalder 1986a: 382).[5]

What does this have to do with a residential group of twenty-five? Not all members of a residential group are active foragers; from 30 to 50 percent, or eight to thirteen individuals, will probably be under the age of fifteen and contribute little to diet (Hewlett 1991a). Others will be old and infirm, and a few at any time may be ill and unable to forage. A group of twenty-five people, therefore, contains on average about seven to eight full-time foragers. Therefore, in most environments (as the Hamilton analysis suggests), a group containing no more than twenty-five people minimizes daily variance in return rates while also minimizing the rate of local resource depletion.[6] The realities of daily foraging probably govern the size of residential foraging groups. Similar processes, perhaps ones more related to information or breeding, probably affect the size of larger groupings. This needs further research.

Communal versus Individual Foraging

Although small foraging groups are common ethnographically, many foragers seasonally or periodically aggregate into larger groups. These aggregations are, in fact, a strong element in the lives of many hunter-gatherers. They play an important role in social organization and ceremonial life. The Great Basin Shoshone, for example, aggregated periodically into large groups and hunted antelope or jackrabbits in communal drives. At these gatherings, the Shoshone exchanged information, arranged marriages, traded, and caught up on gossip. Were these gatherings purely for social reasons, to see friends, swap stories, and arrange marriages (Steward 1941: 220–22, 272; Stewart 1941: 367; 1943: 359; Riches 1982: 51–52)? Or were they primarily to hunt communally, with people exploiting them to find mates, new friends, and to share information?

As we pointed out in Chapter 2, foraging models provide a way to predict behavior under a certain set of conditions, assuming a certain goal – foraging efficiency. How can we predict when foragers aggregate only for the purpose of maximizing foraging efficiency?[7] Or, more generally, how can we model variation in the size of foraging groups?

Years ago, Colin Turnbull set the stage for a long-running debate in anthropology when he observed that some BaMbuti of the Ituri Forest hunt individually with bows and arrows, whereas other groups hunt communally with nets (1961, 1965, 1968; Figure 7-2).[8] Among net hunters, women and children drive game through the forest undergrowth into an arc of nets, where men kill the entrapped animals (among the Aka, the roles are reversed). Archers often take arboreal prey but also hunt terrestrial animals such as duiker. Net hunters may also shoot arboreal prey (Harako 1981), and archers sometimes hunt communally. Nonetheless, there is a dichotomy in the frequency of the two different hunting methods among BaMbuti groups. Why?

Turnbull suggested that the Ituri Forest itself accounted for the different hunting methods. Because the Ituri is so lush and thick with resources, Turnbull argued, groups could simply pick and choose their hunting methods. The differences were "cultural" and nothing in particular determined whether BaMbuti foraged individually or communally.

But this conclusion did not sit well with later researchers, several of whom focused on the efficiency of net versus bow hunting. Reizo Harako (1976, 1981) argued that archery was the primary hunting method of the BaMbuti until the introduction of nets by Bantu horticulturalists; net technology then dominated because it provided higher rates of return. Accepting that net hunting was more efficient than archery, William Abruzzi (1979) argued that net hunting arose as a function of population pressure. Encroaching Bantu horticulturalists crowded the BaMbuti, requiring that some turn to more efficient net-hunting methods to increase yields in a food-depleted forest. Archers did not feel similar pressure, Abruzzi suggested, since they worked as laborers for the Bantu and received agricultural produce as payment. Katharine Milton (1985) turned this argument around, suggesting that the net hunters live in less productive environments and net hunt to increase yields in order to trade with horticulturalists. Like Abruzzi and Harako, Milton accepted that net hunting is more efficient than archery. But whereas Abruzzi saw little contact between net hunters and villagers, Milton and Harako saw the opposite. Finally, Paul Roscoe (1990) argued that the thick undergrowth of the net hunters' environment makes archery an impractical (low return rate) hunting technique there; thus, they use nets.

However, through field research and detailed environmental documentation, Robert Bailey and Robert Aunger (1989a) point out that there are, in fact, no significant differences between

Figure 7-2. Madjemb, a thirteen-year-old Aka boy, checks a net for rips prior to a communal hunt in 1984 near the Lobandji River in southeastern Central African Republic. Courtesy of Barry Hewlett.

the environments of net hunters and those of archers – neither in density of vegetation nor in the abundance of hunted resources. They also point out that net hunting does not necessarily produce a significantly higher per capita rate of return than bow hunting since net hunting requires more people (see also Ichikawa 1982; Terashima 1983; Wilke and Curran 1991; Hewlett 1996). Why, then, is net hunting used by some groups?

Bailey and Aunger (1989a: 273) make the important observation that "among net hunters, women participate in hunts; among archers, women rarely hunt." The question, perhaps, is not why some BaMbuti hunt communally and others hunt singly but instead how women decide whether or not to participate in hunts.

Many BaMbuti, especially those who hunt with nets, trade meat with Bantu villagers for horticultural produce – often receiving in exchange three or more times the caloric value of the meat (Bailey and Peacock 1988). Some women, however, work as laborers for Bantu, receiving produce in exchange. Bailey and Aunger argue that women decide to hunt or to labor in gardens depending on which activity gives them the highest caloric return rate. Bantu gardens in archers' areas tend to be large and laborers are needed; gardens in net hunters' areas tend to be small and do not require laborers. Where gardens are small, therefore, BaMbuti women cannot work for produce, so they choose to hunt. Presumably, as long as many people are going to hunt, net hunting is a better way to utilize this wealth of labor than bow hunting. Among the Mossapoula Aka, for example, net hunting only happens if women decide to do it (Noss and Hewlett [2001: 1030]; net hunters may also be responding to a greater demand for bushmeat from larger settlements [Wilke and Curran 1991]; but see Hewlett [1996], who suggests that enculturative processes explain the distribution of net and bow hunting).

One reason it has been difficult for us to understand the difference between communal and individual hunting is that the question has been framed as a simple dichotomy: communal versus individual hunting. The BaMbuti case, however, suggests that the question is not whether foragers should hunt individually or communally but rather how many people should forage together?

We can examine this issue from the perspective of a single forager looking for a group to join and, conversely, from the perspective of those who are already members and are being petitioned by this forager. E. Smith (1981, 1985, 1987, 1991) approached this problem using data on the size of foraging parties of the Inujjuamiut of Hudson's Bay's southeastern coast. Smith predicted that men will join a hunting party if they stand to achieve a higher return rate than if they hunted alone. Group size should maximize the average net return rate per forager for the duration of a foraging period:

$$R = \sum_{1}^{n} \frac{(E_a - E_e)}{tn}$$

where:

R = mean per capita return rate
n = total number of foragers for the foraging trip
E_a = total usable energy acquired on trip
E_e = total energy expended on trip
t = total time of trip

Smith analyzed a total of 558 hunting trips of sixteen different hunting types, such as caribou, ptarmigan, goose, and breathing-hole seal hunting. In about half of these hunt types, men sometimes hunted in groups.

It is reasonable to expect that the per capita return rate for a particular hunt type will change with increasing group size (assuming equal sharing of food among the party's members). Figure 7-3 shows a general form of this relationship, in which the per capita return rate increases as foraging group size increases until there are N members; after this point, additional group members do not add to hunting efficiency and, in fact, will *decrease* the per capita return rate. At a group size of n, the per capita return rate is equal to that of foraging alone and prospective joiners would do better to forage by themselves (or look to join another, smaller group).[9]

If R_x is the group's per capita return rate at size x, current members of the party should allow others to join as long as the per capita return rate will increase (i.e., as long as $R_{x+1} > R_x$); this is the *member's rule*. Prospective joiners, conversely, should try to join the group as long as R_{x+1} is greater than the return rate for foraging alone ($R_{x+1} > R_1$); this is the *joiner's rule*. Once group size equals N, where the per capita return rate is maximized, there will be a conflict of interest between group members and prospective joiners since the joiners stand to increase their individual return rate over that of foraging alone, whereas the per capita return rate of current foraging group members will decrease (where $R_x > R_{x+1} > R_1$).

Smith found that in half of the hunt types, foraging efficiency was highest when $N = 1$, and that this was the modal group size for these hunt types. Where communal foraging was favored ($N > 1$), the joiner's rule prevailed (63 percent of cases) because modal group size lay between N and n. Why? Although group members lose some foraging efficiency by allowing additional

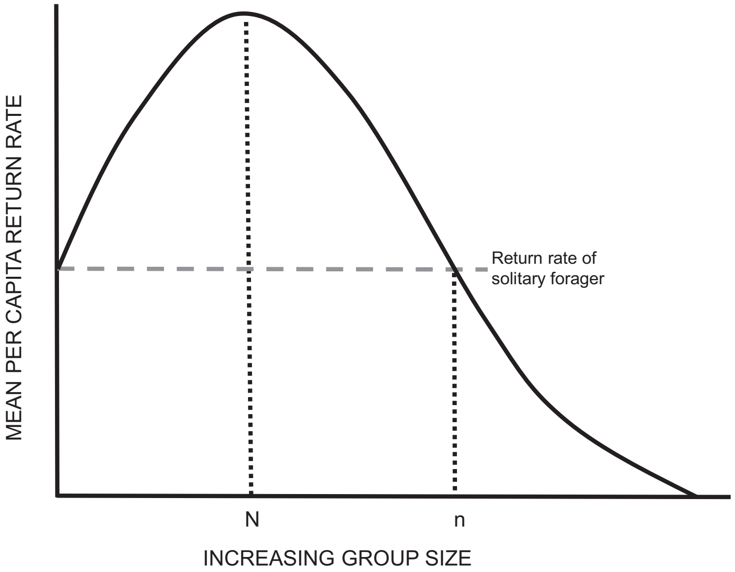


Figure 7-3. Relationship between foraging group size and per capita return rate. *N* is the optimal size, where per capita return rate is highest; *n* is the group size at which the group per capita return rate is equivalent to that of foraging alone. Redrawn and used with permission from E. A. Smith, *Inujjuamiut Foraging Strategies* (New York: Aldine de Gruyter) © 1991.

foragers to join, they build up social favors and minimize the chance that they themselves will be excluded from foraging parties in the future (they could be seen as minimizing future risk or as maximizing their long-term per capita return rate; the former is perhaps more likely). Likewise, foraging group size could also be larger than *N* if resources are pooled by all foraging parties of the residential group (Smith 1985), although this does not appear to be the case among the Inujjuamiut (with the possible exception of breathing-hole seal hunting; Smith 1991: 336). Smith also suggests that social factors affect group size; for example, the training of younger hunters, mutual aid, and recreation. Where communal foraging is favored, therefore, the foraging group may accomplish some nonforaging goals at a slight sacrifice in foraging efficiency.[10]

Smith's study suggests that the size of a communal foraging group is related to both foraging and social goals and that accomplishing social goals will increase the foraging group size at a slight expense in the per capita foraging return rate. This is interesting because Hamilton's study suggests that residential groups are frequently larger than that predicted by the 4× factor of increase (and that effect translates upward until some regional groups contain some 200 more than predicted). It is possible that the optimal co-residing foraging group size for nomadic foragers in many different environments is rather small – fifteen people or so (as Binford [2001] found) – but that long-term social needs often result in slightly larger residential groupings.

Carrying Capacity, Foraging, and Population Density

Although many anthropologists assume that foragers live at low population densities, Table 7-3 shows much diversity in those densities. Initial research into forager population density focused on predicting population density from food abundance as a way to ascertain a region's carrying capacity. That the population density of hunter-gatherers is related to the abundance of food in their environment makes sense theoretically and can be demonstrated empirically. Birdsell (1953, 1958), in fact, set the pace by showing that Australian Aboriginal population density increased exponentially with increases in rainfall (taking rainfall as a proxy for food abundance).

Table 7-3. Hunter-Gatherer Population Densities

Area	Group	Density (persons/100 km²)	Reference
Arctic			
Greenland	Polar Inuit	0.5	Gilberg 1984
Alaska	Nunivak	30	Kroeber 1939
N. Alaska Coast	Tağiuğmiut (Tareumiut)	4.0	Oswalt 1967
N. Canada	Mackenzie Delta Inuit	3.5	D. Smith 1984
Siberia	Yukaghir	0.5	Keeley 1988
St. Lawrence Is.	Sivokakhmeit	23	Hughes 1984
E. Greenland	Angmagsalik	8	R. Petersen 1984
Canada	Quebec Inuit	0.8	D'Anglure 1984
N. Canada	Copper Inuit	1.2	Damas 1984b
N. Canada	Iglulingmiut	0.5	Kroeber 1939
N. Canada	Netsilik	0.5	Boas 1888; Balikci 1984
N. Alaska	Nunamiut	2	Hall 1984
E. Canada	Labrador Inuit	1.7–4	Kroeber 1939
Canada	Caribou Inuit	0.2	Kroeber 1939
N.W. Alaska	Kotzebue Sound Inuit	4.2–19	Burch 1984
N.W. Alaska	(mean of 13 districts)	6.8	Burch 2006
Alaska	Bering Strait Eskimo	3.2	Ray 1984
S. Alaska	Chugach Eskimo	18	Birket-Smith 1953
Aleutians	Aleut	65	Kroeber 1939
Subarctic/cold forests			
W. Canada	Lillooet	23.5	Kroeber 1939
E. Canada	Naskapi (Innu)	0.1–0.4	Rogers and Leacock 1981; Leacock and Rothschild 1994
S. America	Yámana (Yahgan)	4.8	Steward and Faron 1959
Canada	Chipewyan	0.4	J. Smith 1981
Canada	Tutchone	0.6	McClellan and Denniston 1981
Alaska	Ahtna	0.8	de Laguna and McClellan 1981
Alaska	Kaska	1	Kroeber 1939
S.E. Alaska	Kuskowagamiut	3	E. Nelson 1899
Alaska	Tanaina (Dena'ina)	4–6	Townsend 1981
E. Siberia	Gilyak	19.2	L. Black 1973
Canada	Attawapiskat Cree	1.4	Kroeber 1939
Alaska	Kutchin (Gwich'in)	0.5–1.7	Krech 1978
Canada	Dogrib	0.4–0.8	Helm 1981
Canada	Hare	0.3	Savishinsky and Hara 1981

Area	Group	Density (persons/100 km²)	Reference
Alaska	Kolchan	0.5	Hosley 1981
Canada	Slave	1.4	Kroeber 1939
Canada	Round Lake Ojibwa	1.7	Rogers 1969a,b
Canada	Ojibwa	3–5	Kroeber 1939
Alaska	Ingalik	2.5–4	Snow 1981
Alaska	Han	1.6	Crow and Obley 1981
Alaska	Nabesna	0.6	McKennan 1981
Canada	Sekani	1	Kroeber 1939; Denniston 1981
Canada	Yellowknife	0.2	Kroeber 1939
Canada	Pikangikum (Ojibwa)	3.2	Rogers 1969a,b
Canada	Berens River Ojibwa	4.8	Rogers 1969a,b
Canada	Grand L. Victoria Cree	0.7	Rogers 1969a,b
Canada	Tahltan	1.1	MacLachlan 1981
Canada	Carrier	7.6	Tobey 1981
W. Canada	Chilcotin	13	Kroeber 1939
Canada	Beaver	0.5	Ridington 1981
Canada	Waswanipi Cree	0.4	Rogers 1969a,b
Canada	Saulteaux	0.6	Grant 1890
Tasmania	Tasmanians, N.W.	14.5	Jones 1974
Tasmania	Tasmanians, S.W.	9.3	Jones 1974
Tasmania	Tasmanians, Big River	4.3	Jones 1974
Tasmania	Tasmanians, Oyster Bay	8	Jones 1974
E. Canada	Micmac	2.3	Kroeber 1939
North American Northwest Coast			
	Tlingit	10–40	Schalk 1981; Keeley 1988
	Haisla	16	Schalk 1981
	Bella Coola	10	Schalk 1981
	Haida	62–96	Schalk 1981; Keeley 1988
	Tsimshian	32–83	Mitchell and Donald 1988; Keeley 1988
	Makah	86	Schalk 1981
	Quileute	64.5	Schalk 1981
	Quinault	33–59	Schalk 1981; Keeley 1988
	S. Kwakwak'awakw (Ft. Rupert)	57	Mitchell and Donald 1988
	Chinook	148.6	Schalk 1981
	Twana	17–33	Elmendorf 1960

(*continued*)

Table 7-3 (*continued*)

Area	Group	Density (persons/100 km²)	Reference
	Puyallup-Nisqually	18–195	Schalk 1981; Keeley 1988
	Cowichan	34	Keeley 1988; Kroeber 1939
	Nootka (Nuuchahnulth)	66–77	Mitchell and Donald 1988
	Puyallup	195	Jorgensen 1980
	Alsea	73	Kroeber 1939
California			
	Chumash	843–900	Keeley 1988; Arnold 2001a
	Serrano	39	Bean and Smith 1978
	Cupeno	39	Kroeber 1953
	Foothill Yokuts	237	Baumhoff 1963
	Kiliwa	33.4	Meigs 1939
	Monachi	190	Spier 1978
	Klamath	25	Keeley 1988
	Washo	28	Downs 1966
	Mattole	210	Elsasser 1978
	Sinkyone	270	Elsasser 1978
	N. Pomo	232	Baumhoff 1981
	C. Pomo	196	Baumhoff 1981
	Coast Yuki	166	Baumhoff 1981
	Tubatulabal	30	C. Smith 1978
	Wiyot	103–430	Schalk 1981; Keeley 1988
	S.W. Pomo	213	Baumhoff 1981
	Achumawi	17.5	Kroeber 1939
	Yurok	180	Schalk 1981
	Tolowa	138	Cook 1976
	W. Mono	40.9	Bean and Theodoratus 1978
	Yana	35	J. Johnson 1978
	Whilkut	214	Wallace 1978a
	Chimariko	34.1	Kroeber 1939
	Atsugewi	45	Garth 1978
	Maidu	103	Cook 1976
	Hupa	197	Cook 1976
	Karok	98.5	Schalk 1981
	Shasta	74	Cook 1976
	Wailaki	255	Baumhoff 1981
	Lassik	140	Elsasser 1978
	Yuki	232	Baumhoff 1981
	Diegueno (Tipai-Ipai)	18.1	Kroeber 1939
	Wintu	281	LaPena 1978

Area	Group	Density (persons/100 km^2)	Reference
	Lake Yokuts	38.1	Baumhoff 1981
	S. Yokuts	90	Baumhoff 1963
	Lake Miwok	180	Baumhoff 1981
	S.E. Pomo	431	Baumhoff 1981
	E. Pomo	196–633	Baumhoff 1981; Keeley 1988
	Wappo	176–350	Keeley 1988; Baumhoff 1981
	Sierra Miwok	55	Baumhoff 1963
	Patwin	62.5	Kroeber 1939; P. Johnson 1978
	Nomlaki	71	Cook 1976
	Kawaiisu	11.9	Kroeber 1939
	Cahuilla	39–97	Kroeber 1953; Keeley 1988
	Wappo	163	Cook 1976
	Luiseño	39–257	Kroeber 1953
Temperate deserts			
Great Basin	Sampits Ute	2.7–9	Callaway, Janetski, and Stewart 1986
	Wind River Shoshone	1	Leland 1986
	Wadadika (Ruby Valley)	13.4	Steward 1938
	Agaiduka (Lemhi)	1.5–4	Steward 1938
	Gosiute	1.5	Steward 1938
	Timpanogots (Utah L.)	5.7–15	Leland 1986; Callaway, Janetski, and Stewart 1986
	Reese R. Shoshone	10	Steward 1938
	Tosawihi (White Knife)	15	Steward 1938
	Kawich Shoshone	1.9	Steward 1938; Thomas 1981
	Kuyuidökadö (Pyramid L.)	18	Stewart 1941
	Pahvant Ute (Sevier L.)	6.7–14	Callaway, Janetski, and Stewart 1986
	Kaibab (Paiute)	3–4	Leland 1986
	Owens V. Paiute	19	Steward 1938; Thomas 1981
	S. Paiute (Las Vegas)	1.3	Steward 1938
	Panamint	2.1	Steward 1938
	Kidütökadö	1.1	Stewart 1941
Temperate forests			
Oregon	Modoc	4.8	Kroeber 1939

(continued)

Table 7-3 (*continued*)

Area	Group	Density (persons/100 km²)	Reference
Plateau	Shoshone-Bannock	1.31	Leland 1986
	Tenino	18	Murdock 1958
	Thompson	33.2	Kroeber 1939
	Shuswap	4.5–15	Keeley 1988
	Kutenai	2	Kroeber 1939
	Coeur d'Alene	1.5	Kroeber 1939
	Sanpoil	38	Ray 1932
	Nez Perce	8.9	Haines 1955
	Umatilla	4.5	Kroeber 1939
S. Texas	Karankawa	19–42	Keeley 1988
S.E. Australia	Clarence R. tablelands	1.8	Bellshaw 1978
	Clarence R. slopes	5.5	Bellshaw 1978
	Clarence R. coast	13.4	Bellshaw 1978
Plains			
	Blackfoot (Piegan, Blood)	4.3	Kroeber 1939; Ewers 1955
	Plains Cree	1.9	Kroeber 1939
	Assiniboin	5.8	Kroeber 1939
	Crow	2.6	Kroeber 1939
	Arapaho	3	Kroeber 1939
	Cheyenne	3	Kroeber 1939
	Kiowa-Apache	1.4	Kroeber 1939
	Comanche	5	Kroeber 1939
	Kiowa	1.4	Kroeber 1939
Tropical/subtropical deserts			
Australia	Mamu	55	Harris 1978 (c. AD 1800)
	Madjandji-Wanjuru	49	Harris 1978 (c. AD 1800)
	Keramai	29	Harris 1978 (c. AD 1800)
	Idindji	38	Harris 1978 (c. AD 1800)
	Tjapukai-Buluwai	19	Harris 1978 (c. AD 1800)
	Gulngai	60	Harris 1978 (c. AD 1800)
	Kongkandji	200	Harris 1978 (c. AD 1800)
	Djirubal	26	Harris 1978 (c. AD 1800)
	Ngatjan	149	Harris 1978 (c. AD 1800)

Area	Group	Density (persons/100 km^2)	Reference
	Djiru	125	Harris 1978 (c. AD 1800)
	Wongaibon	19	Yengoyan 1968
	Dieri	1.9	Yengoyan 1968
	Aranda	3	Yengoyan 1968
	Pintupi	0.5	Myers 1986; N. Peterson 1979
	Kariera	7.6	Radcliffe-Brown 1930
	Worora	2	Peterson and Long 1986
	Walpiri (Walbiri)	1	Meggitt 1962
	Alyawara	2.5	O'Connell, Latz, and Barnett 1983
	Mardudjara	0.6	Cane 1987; Tonkinson 1978
	Anbarra	2	White et al. 1990
	Yolngu	0.3-.06	White et al. 1990
	Kukadju	0.57	Cane 1990
Mexico	Seri	5	Keeley 1988
Mexico	Borjeno (Baja Calif.)	37.3	Aschmann 1959
Africa	Hadza	15–24	Woodburn 1968; Marlowe 2010; Blurton Jones et al. 1992
Africa	Dobe Ju/'hoansi	10–16	Hitchcock 1987a,b
Africa	G/wi	8	Silberbauer 1981a
Africa	Kua (E. Kalahari)	2.1–3	Hitchcock 1982
Africa	≠Kade	5	Tanaka 1980
U.S.	Walapai	4	Kroeber 1935
U.S.	N.E. Yavapai	1.4–4	Kroeber 1939
Seasonal and wet tropical forests			
Philippines	Batak	54	Eder 1987
Australia	Groote Eylandt	11.5	Peterson and Long 1986
Australia	Wikmunkan	18.7	Keeley 1988
Australia	Murinbata	8	Yengoyan 1968
Australia	Nesbitt R. (Cape York)	40	Chase and Sutton 1987
Australia	Yir Yoront	16	Peterson and Long 1986; Yengoyan 1968
Australia	Anbarra	43	Meehan 1982
Australia	Gidjingali	77	Hiatt 1965
Australia	Murngin	5	Warner 1937
S. America	Botocudo (Kaingang)	11	Steward and Faron 1959

(*continued*)

Table 7-3 (*continued*)

Area	Group	Density (persons/100 km^2)	Reference
S. America	Aweikoma	3.8	Keeley 1988
S. America	Ache (Guayaki)	23.4	Hill and Hurtado 1996
Africa	Mbuti	17	Turnbull 1965
Africa	Aka	28	Bahuchet 1988
Malaysia	Semang	5–19	Rambo 1985
Malaysia	Batek	13	Endicott and Endicott 2008
Andaman Islands	Andamanese	86	Keeley 1988
India	Hill Pandaram	69.6	Morris 1982
India	Birhor	22	Williams 1974
India	Paliyan	77	Gardner 1972
Venezuela	Pumé	49	Kramer and Greaves, pers. comm.
New Guinea	Nomadic groups	20–240	Roscoe 2006
New Guinea	Sedentary groups	100–2580	Roscoe 2006

Following Birdsell's lead, others (e.g., Baumhoff 1958, 1963; Thompson 1966; Rogers 1969b; Thomas 1981; Martin and Read 1981) found that hunter-gatherer population size could be predicted by a few measures of food density. Martin Baumhoff, for example, determined the abundance of three gross resource categories in California – fish, acorns, and game – by measuring the number of fish stream miles and the area of different forest types encompassed within the ranges of various ethnographic groups, and multiplying these estimates by coefficients to produce resource indices. These were used in a series of regression analyses to see which combination of variables provided the most accurate predictor of population. In the lower Klamath region of northern California, Baumhoff found that the fish index alone was the most accurate predictor of population.

These studies implicitly use the concept of carrying capacity, a concept that anthropologists have used in two major ways: (1) to refer to the number of people that theoretically can be supported by a given unit of land under a given subsistence technology, and (2) as a density-dependent limit on a population's growth rate (Dewar 1984). Most studies of hunter-gatherer populations use the first of these (e.g., Casteel 1972, 1979; Hayden 1975; Hassan 1981). To do so, they must measure edible resource abundance and extractive efficiency (see Dewar 1984), and these can become quite detailed. Take, for example, Fekri Hassan's (1981) model:

$$D = \frac{\sum_{i=1}^{1-n} F_i N_{ij}}{L_j}$$

where:

F_i = the optimum yield to humans for the ith food item/km^2 multiplied by a constant, K, which is a product of four variables: M, the percentage of the yield regularly extracted to allow for a safety margin; E, the edible percentage of live-weight meat; W, the percentage of yield that escapes spoilage; and S, the percentage of animal game selected from the range of game available in their territory

N_{ij} = the nutritional content in calories or some other unit of the jth nutritional element (e.g., protein, mineral) per kilogram of edible portion of the ith food item
L_j = the average consumption requirement per capita of the jth nutritional element
D = density (persons/km^2)

Although Hassan tested the model with some success using data from the Hadza and Caribou Inuit, we must handle carrying-capacity models with care. Like culture area studies and cultural ecology, carrying-capacity models assume that societies are at equilibrium at the time they are studied: the population may have grown in the past, but they (quickly) reached a plateau below or at carrying capacity. And, if we assume further that, in fact, foragers keep their population in equilibrium at only 20–50 percent of carrying capacity (Hayden 1972), then we also assume that they consciously or unconsciously recognize their environment's carrying capacity and implement cultural mechanisms (postpartum sex taboos, infanticide, abortion, senilicide, and lactation-induced amenorrhea) to maintain population below that level.

The flaw in this reasoning is the same as that of cultural ecology: *if* maintaining equilibrium is a "goal" of hunter-gatherers, and *if* hunter-gatherers maintain their population below carrying capacity, then why did some prehistoric foraging populations grow to the point at which they needed to augment their environment's productivity through agriculture and labor-intensive extractive technologies (e.g., irrigation, double-cropping, terracing, and so on)?

Carrying-capacity models failed to think about the actual act of foraging and its impact on population. How much food can people actually acquire in a day? How hard do they have to work for that food? What's the effect of their foraging on the density of food?

Winterhalder approached these questions by using the diet-breadth model to predict population growth rates from the interaction among foraging behavior, resource density, rates of resource recovery, and human reproduction (Winterhalder et al. 1988; Winterhalder and Goland 1993; Winterhalder 1993). His model assumed that as humans reduce the abundance of high-ranked resources, diet expands. This, in turn, affects foraging return rates, the foraging population's reproduction and, ultimately, population growth rates.[11]

Winterhalder began with a human group of known size and with food resources of given densities, return rates, and rates of increase using some reasonable assumptions about human energy needs, culling rates, and resource-density-dependent growth rates. The model's importance lies in recognizing that although prey affects hunter-gatherer demography, hunter-gatherers affect prey population dynamics as well.

Generally speaking, the model predicts the classic growth curve: human populations rise from their initial level and eventually plateau, reaching a level at which the human and prey populations are at equilibrium.[12] The human population growth rate increases with the net acquisition rate (NAR, see Chapter 3) and decreases when it falls.

The simulation produced large changes in overall population size and in the nature of population fluctuations over time with relatively minor changes in model parameters such as basal caloric needs, the amount of time spent foraging, or the response of prey to predation. For example, Winterhalder varied the length of the foraging day, finding that as the work day got longer, the human population at first increased but then crashed, oscillating before eventually reaching equilibrium at a level below that of short work days. Put simply, the harder foragers worked, the less their population grew. The magnitude of oscillations, growth rates, and the eventual equilibrium level are sensitive to the density of prey, the NAR, and the rate at which prey recover from predation. Where resources are dense and their rate of recovery is high, the human population grew rapidly.[13]

Such modeling offers a useful approach to the study of foraging population dynamics. Tests of such models will ultimately have to come from archaeological data, where population dynamics are recorded over long spans of time. In addition, a better understanding of the relationships among behavior, diet, physiology, and reproduction will enhance such models. We now turn to those subjects.

Reproduction and Cultural Controls

The literature on hunter-gatherer demography is replete with references to conscious controls on fertility. Primary among these are contraception and abortion, postpartum taboos on intercourse, and infanticide. Some ethnographies contain references to herbal potions that prevent pregnancy or induce abortion, but there is no evidence that these potions actually work (Marlowe 2010: 140; Howell 2010: 23). Foragers simply do not have effective means of contraception or abortion (Handwerker 1983; Wood 1990; Ellison 2001).

Foragers can try to control fertility through postpartum taboos on sexual intercourse. Such taboos appear frequently in the ethnographic literature. Nyae Nyae Ju/'hoansi parents, for example, avoided intercourse after birth for at least three months because they believed sex would dry up the mother's milk and harm the newborn (Marshall 1999: 121). But such postpartum taboos probably have little effect since they cover the natural period of postpartum amenorrhea, made longer in some cases by breastfeeding and the effects of maternal nutrition and labor (see Maternal Nutritional Condition later in this chapter; one study found postpartum taboos more commonly among horticulturalists than hunter-gatherers; see Cohen 1980: 287–88). Thus, even if postpartum taboos exist, they likely have little effect on fertility (Hamilton 1981: 123).

This leaves infanticide as the primary conscious control on reproduction and population. Birdsell (1968) postulated that infanticide occurred at rates of 15–50 percent during the Pleistocene (like many others, Birdsell assumed that most of this was directed at female offspring). Hassan (1981) suggested rates of 15–25 percent, with a maximum female infanticide rate at the low end of this range. But where the incidence of infanticide has been tabulated from informant interviews, it is often substantially lower: 1.2 percent for the Dobe Ju/'hoansi (Howell 1979) and 5–11 percent for the Anbarra (Hamilton 1981: 123). In one sample of thirty-four foraging groups, fewer than half practiced infanticide (Morales 1987; see also Daly and Wilson 1988; Marlowe 2010: 152).[14] Conversely, some populations see high rates of infanticide and child murders. Fourteen percent of male Ache and 23 percent of female Ache children are killed before the age of ten years (Hill and Hurtado 1996), and 40 percent of Hiwi female infants and 14 percent of male infants die from infanticide/homicide (Hill, Hurtado, and Walker 2007).

Many ethnographies mention cultural rules requiring that deformed infants and one or both twins be killed at birth, but these make up a small proportion of births. More important to hunter-gatherer demography are *preferential female infanticide* and *nonpreferential infanticide*. In the former, female children are killed either at birth or through neglect soon after birth. In the latter, an infant (<1 year old) or juvenile (between 1 and 14 years old) is killed regardless of sex. The latter is sometimes called "birth-spacing infanticide," although it is not clear if the desire to space births widely is always its cause.

Preferential Female Infanticide

The idea of female infanticide as a significant population control method can be traced through the anthropological literature to data collected on several Arctic groups, especially the early twentieth-century Netsilingmiut, whom Danish explorer Knud Rasmussen (1931) visited in the 1920s.

Rasmussen's data came from interviews with eighteen women and a population census. From the interviews, it appeared that 67 percent of female offspring were killed at birth (Rasmussen reported 80 percent, but he either added incorrectly or the published table contains typographic errors; Schrire and Steiger 1974a; Remie 1985). In his census, Rasmussen found far more juvenile males than females and, from this, he concluded that the Netsilingmiut were on their way to extinction. Was he right?

Evidence of female infanticide in the Arctic and elsewhere comes largely from sex ratio data (e.g., Weyer 1932; Helm 1980; Irwin 1989); some censuses show more and some less skewed populations than that of the Netsilingmiut. Informant interviews are a secondary source of information about female infanticide. But just how accurate are informant interviews and census data as a record of female infanticide?

Interview Data

Rasmussen interviewed women, but accounts of infanticide from many other foraging groups are based on statements made by male informants to male ethnographers. How accurate are male accounts of infanticide or accounts given by women to male ethnographers?

In some cases, men are responsible for deciding whether a newborn lives or dies. Among some Inuit, life-and-death decisions were not always left to the mother; the husbands often decided (Balikci 1967: 619–20; 1970) and sometimes the grandparents (Irwin 1989). Sometimes there may be many witnesses to a birth. An Australian Tiwi woman about to give birth, for example, is surrounded by a "big mob of people, [her] father, mother, in-laws, brother, sister," although not the baby's father because "maybe he get too frightened" (Goodale 1971: 146).[15] Several people in that group may influence the decision to keep a newborn.

However, women frequently give birth alone, or with only older female relatives, and since infanticide may occur even before the infant has taken its first breath, how does a husband find out about the child's death? Obviously, a man will not miss the fact that his wife has given birth. Yet, if birth occurs away from the husband, then the mother could kill a newborn male but tell her husband it was stillborn or female so as not to anger him; she may tell the same to a male ethnographer (or may not be interviewed by him because it is culturally inappropriate). Working with the Bolivian horticultural Ayoreo, Paul Bugos and Lorraine McCarthy (1984) found that men knew very little about infanticide except for general rules (in the case of twins, deformities, or if the woman felt she could not care for the child); and they knew little about specific women's reproductive histories. Ayoreo women, however, when interviewed by a female ethnographer, gave very accurate reproductive histories of themselves and of their neighbors, including accounts of infanticide.[16] Thus, some interview data on infanticide could be significantly biased (see also Hamilton 1981: 119).

Sex Ratios

Sex ratios are the other evidence of infanticide. In small populations, sex-ratio data can be affected by a number of factors, such as differential male and female death rates, emigration, immigration, and catastrophes (such as the death of an all-male hunting party). Rasmussen's data, for example, may be affected by the fact that up to one-third of the local population had emigrated before his arrival (Balikci 1984). Some populations may hide children when census takers arrive out of the fear that they will be stolen – and girls may be hidden more than boys (Yengoyan 1981). Unbalanced at-birth sex ratios can also be a source of variation. The Ache's at-birth ratio is 125:100 (125 males for every 100 females born; Hill and Hurtado 1996: 440), whereas the Hiwi's is 117:100 (based on a small sample; Hurtado and Hill 1987). The Ju/'hoansi, on the other hand, have an at-birth ratio of 105:100 (Howell 1979: 214).[17]

These factors can dramatically alter the demography of small populations over time; note the diversity in adult sex ratios among local groups of Tanana, Northwest Coast societies, Shoshone/Paiute, and Hill Pandaram in Table 7-1.[18] Nonetheless, where multiple censuses show child sex ratios that are consistently biased against females (as in the Arctic), there is probably some level of female infanticide behind them. The rate, however, cannot be simplistically extrapolated from census data; the Netsilingmiut case shows us why.

Put simply, Rasmussen and other early Arctic ethnographers miscounted adult women (Schrire and Steiger 1974a). In the Arctic (and other places as well), grooms were older than their brides.[19] Women married at about age twelve, whereas men married later, at about twenty years. Like other Arctic explorers (e.g., Mathiassen 1928), Rasmussen used marriage to separate adults from juveniles and, in so doing, he undercounted juvenile females relative to juvenile males – and thus biased the juvenile sex ratio in favor of males.

Still, studies of Rasmussen's and other Arctic data find evidence of female infanticide, although at much lower rates. Schrire and Steiger (1974a) arrived at a figure of only 8 percent and suggested that anything above this level would drive a population to extinction (see Acker and Townsend 1975). A model by Michael Chapman (1980), however, concluded that a population could suffer female infanticide rates of about 33 percent before evidence of population decline and extinction occurred. Chapman argued that once errors in population enumeration are accounted for, the child sex-ratio data from several Inuit populations suggest a female infanticide rate of about 37 percent. He concluded that many Inuit populations practiced female infanticide at the maximum possible rate (although at half the rate predicted by Rasmussen).

Making insightful use of life-table models, Eric Smith and Abigail Smith (1994) also analyzed sex-ratio data, this time from ten Inuit societies. They found that the best fit came from life tables that took into account the differential age of marriage and female infanticide. The requisite level of infanticide to produce the observed sex ratios varied among the groups from 0 to 40 percent, averaging about 21 percent. Marriage age alone cannot account for the Arctic sex-ratio data but neither can high rates of female infanticide. Schrire and Steiger's dismissal of female infanticide and Rasmussen's fear of the Netsilingmiut's self-inflicted extinction were *both* unfounded.

Two major explanations for female infanticide in the Arctic are population control and adult sex-ratio balancing. Following a cultural ecological perspective, Milton Freeman (1971) suggested that infanticide in the Arctic ensured ecosystem stability by keeping population low and in balance with the food supply. *Female* infanticide, Freeman suggested, was a product of male dominance in Arctic cultures.

Alternatively, Asen Balikci (1967, 1970) argued that female infanticide was a way to maintain adult sex ratios and thus prevent adult male competition over females. The idea is that in precontact times, adult Inuit males died at a younger age than adult females due to the danger of hunting in the Arctic (Weyer 1932; Damas 1975b). By suppressing females at birth, the adult sex ratio allegedly was kept in balance. If correct, we would expect an inverse correlation between the Inuit juvenile male-to-female ratio and a measure of the danger of hunting. Using mean annual temperature as such a measure (the lower the temperature, the more dangerous the conditions), Colin Irwin (1989) showed that when temperature is low, there are more boys than girls in the population. Irwin argued that adult male mortality also correlates inversely with temperature – the lower the temperature, the higher the adult male mortality. Thus, female infanticide may help even out the adult sex ratio.

Smith and Smith (1994) evaluated these two arguments and found no evidence to support female infanticide as a population-control mechanism. Indeed, devastating periods of starvation probably reduced population so much and so frequently that Inuit populations were nearly always in a recovery phase. And female infanticide is woefully inadequate as a short-term population-control mechanism that catastrophes in the Arctic (or anywhere) demand. As to female infanticide's role in balancing sex ratios, Smith and Smith argued that, if true, female infanticide should be higher not only where adult male mortality is high but where it is *higher* than adult female mortality – but they found no evidence to support this prediction. Indeed, they found no evidence that female infanticide balanced adult sex ratios at all (which might explain why Inuit men apparently were sometimes forced to raid other camps for wives). Neither population control nor adult sex-ratio balancing appears to account for female infanticide in the Arctic.

A third explanation arises from evolutionary theory, one that concerns the fitness benefits of raising males versus females. Fisher's theory of parental investment (see Smith and Smith 1994; Smith 1995) predicts that parents should invest in the offspring that maximize the parents' reproductive fitness. This could mean (a) invest in the offspring who "cost" the least to raise to adulthood, or (b) invest in those who will contribute to the household economy sooner (and help ensure the survival of younger siblings). Many Inuit explained to ethnographers that women were not as important as men since women do not hunt (e.g., Balikci 1967: 622). In the Arctic, a son is crucial to provisioning his parents and his younger siblings years later, when his father's hunting ability has declined. Of course, although women may not have directly procured food in the Arctic, they certainly played roles essential to life – making clothing, processing food, and caring for children (Schrire and Steiger 1974a; Halperin 1980: 394; Waguespack 2005) – and if parents wanted a hunter, it was not inconceivable to raise a daughter as such. But, since most Inuit societies are patrilocal, women move away to live with their husband's family just as they reach their full productive capacity; so, even if women are productive, they are not productive for their siblings or parents (Riches 1974). (It was not just Netsilingmiut men who thought this important: at least one woman urged her daughter to "strangle" a female infant rather than "waste several years" nursing it [Rasmussen 1931: 140].)

Ensuring that a couple has a son, then, assures the couple that they will have someone to hunt for them in their old age and to help with younger siblings. Smith and Smith conclude that the most plausible hypothesis to account for female infanticide in the Arctic is that sons were favored early in the birth sequence because they could contribute more to the fitness of their parents and siblings than could daughters.[20] One modern study of an Inuit community supports this claim (Collings 2009).

Using cross-cultural data, Barry Hewlett (1991a) also showed that juvenile male-biased ratios exist where men directly contribute more to subsistence than do women. He suggests that infanticide in these societies may occur more from neglect than outright homicide at birth, meaning that the effects of female infanticide could occur without the existence of a cultural notion of female infanticide.[21] Hewlett also suggests that where males suffer a higher rate of mortality than females due to warfare, raiding, or dangerous foraging activities (as in the Arctic), female offspring will suffer from neglect.[22]

After years of debate plagued by theoretical and evidentiary difficulties, we might conclude that female infanticide is limited to those populations in which men contribute more food directly to the family hearth than do women and in which male foraging or other activities (e.g., warfare) are dangerous. It is probably not very prevalent outside of these conditions; it certainly was not as common as some early published accounts and models suggest. And since a female infant is suppressed so that the mother might become pregnant again, female infanticide might suppress population growth rates by only a negligible amount. In any case, female infanticide is not an *intentional* population control mechanism.

Birth-Spacing Infanticide

An alternative explanation of infanticide is that infants are killed in order to space births a few years apart, so that a mother does not have too many infants to breastfeed or carry at one time. We refer to this as birth-spacing infanticide and, if there is an even chance that a birth will be male or female, it should not result in a bias against one sex or the other. In Tom Morales' (1987) sample, of those foraging societies that admitted to infanticide, 63 percent claimed it was to space births. A mother's ability to care for a child is primarily affected by whether she still has a child breastfeeding or otherwise requiring her attention. Since mortality rates due to disease among infants in foraging populations are higher than those among juveniles, if a mother produces a child when another is still breastfeeding, she may elect to suppress the newborn rather than risk losing the older child, which has a better chance of survival.[23]

The key variable in birth-spacing infanticide is whether a mother thinks she can care for her offspring. Two factors that affect a mother's thinking are the extent to which children forage on their own and how much support a woman can expect from others in childcare.

Juvenile Foraging

Some children in foraging societies work hard; others, not so much (Hayden 1981b). Hadza children, for example, forage on their own at four or five years of age, gathering baobab fruit, tubers, and berries to provide up to 50 percent of their needs (Figure 7-4). Conversely, Ju/'hoan children do not forage until into their early teens (Draper 1976; Blurton Jones, Hawkes, and O'Connell 1989, 1996; Marlowe 2005b). One reason for this difference is that Hadza children do not have to walk very far from camp to forage but Ju/'hoan children do, placing them at greater risk from predators and heat exhaustion. Additionally, Ju/'hoan children forage in an expanse of featureless dunes, where there is a good chance of their becoming lost. Hadza children forage among more easily memorized broken hills and gullies (Blurton Jones, Hawkes, and Draper, 1994a,b). Likewise, pygmy children do not forage independently due to lack of strength, skill, and the dangers of the forest (Henry, Morelli, and Tronick 2005).

This difference in juvenile foraging can affect a mother's fecundity in two ways. First, children can decrease a woman's foraging efficiency. On the north coast of Australia, small children "drastically inhibited the mother's ability to procure food. Gidgingali women were very much aware of the problem, frequently complaining about having 'too many kid'" (Meehan 1982: 137). When Hadza women have children in tow, they tend to focus on those (generally lower return rate) foods such as berries, which children can more easily acquire, rather than tubers, which require digging and moving rocks. Meriam women sometimes switched to lower-return-rate fishing activities when children tagged along (Bliege Bird 2007). Second, carrying children gives a woman more work, affecting her physiological state and thus her ability to become pregnant (see later discussion). Hadza women do not have to carry children as much as Ju/'hoan mothers do. According to the backload model (see Chapter 2), Hadza mothers can "afford" to have more offspring, and do (Blurton Jones et al. 1989, 1992). It is not clear whether this is due to a shortened birth interval or a longer reproductive period, but the former is more likely.[24] The important point is that juvenile foraging affects fertility by influencing a mother's energetic state, foraging efficiency, and her perception of the "cost" of children.

For the most part, research into children's foraging (e.g., Bock and Johnson 2004; Bird and Bliege Bird 2005; Bock 2005; Marlowe 2005b; Tucker and Young 2005) is wrapped up in life-history theory, which seeks to understand the long period of human juvenility compared to other primates (e.g., Kaplan, Hill, Lancaster, and Hurtado 2000). Our concern, however, is with what determines how much foraging children do.

And how much foraging children do depends on the level of danger, skill, and physical strength involved. The importance of each of these is still a matter of debate. The level of danger largely results from the presence of poisonous animals (mostly snakes) and predators such as large cats, hyenas, wolves, or dingoes; it also includes how difficult it is to negotiate an environment (as we discussed previously).

Some food resources require years to learn how to acquire (Blurton Jones and Marlowe 2002). Hiwi women are not proficient at tuber collecting until they are in their late thirties, and Ache men master archery at around forty years of age (Kaplan et al. 2000; Walker, Hill, Kaplan, and McMillan 2002; Gurven, Kaplan, and Gutierrez 2006; Gurven and Kaplan 2006). In fact, across all foraging societies, large game seems to be the only food resource that children do not regularly procure. Their ability to fully participate in hunts may be limited by strength and endurance but also by skills – patience, the ability to keep quiet, to stay "on task," to ignore hunger and thirst, and to read tracks and spoor.

Some other foraging tasks may be limited by strength, such as prying shellfish loose from rocks in tidal pools or digging tubers in rocky terrain. Australia's Meriam and Mardu children's foraging efforts seem to be limited primarily by their *size* rather than either their age or skill. Being smaller, children move less quickly than adults, and so they encounter the rarer, high-return-rate resources less frequently. According to the diet-breadth model, a forager who encounters high-return-rate resources less frequently should take a wider diet breadth. And this is exactly what Mardu and

Figure 7-4. Hadza girls, aged 8–12, foraging for tubers in the area of Tli'ika, southeast of Lake Eyasi. Courtesy of James O'Connell.

Meriam children do (Bird and Bliege Bird 2000, 2002, 2005; Bliege Bird and Bird 2002): they take the more abundant but lower-return-rate foods.

Likewise, Mikea children are capable of foraging for the same tubers that adults collect (Tucker and Young 2005). Their return rates improve with age, but this does not appear to be a product of skill as much as of size and also need. The large tubers they collect are found up to 75 cm below the ground – conveniently about the length of an adult arm. The substrate is sandy and fairly easy to dig (with a metal paddle on the end of a digging stick and a wooden digging bowl). But a young child's arms are short and to reach the large tubers that grow deep, they must dig a larger hole (I have seen small children burrow down to procure large tubers). As a result, children often target the younger, smaller tubers that grow closer to the surface and that provide lower returns. And they do not work hard or efficiently, taking time out for games of tag and playful fights (often with the tubers that they just collected). Indeed, they reach maximum efficiency in late adolescence, not because they have mastered the skill but rather because they are larger and have higher opportunity costs since they are providing for their own families or demonstrating their ability to potential spouses.

So, children are sometimes able to contribute to their own subsistence needs, if not those of their families, by a very early age. Constraints may be imposed by strength, size, and skill, and these may be most important in the Arctic, where large game is the primary food and the environment is quite unforgiving. Where children can forage, it appears that they do so in ways that are efficient for their size, strength, and/or skill levels, but they are also not under great pressure to forage efficiently. Although even low-level foraging can be helpful to mom, perhaps a greater aid is childcare.

Help for Mother

Across all foraging societies, mothers are the primary caretakers of their offspring (Konner 2005; Kramer 2005). And yet, children are a double strain on mothers: they increase a woman's energy needs *and* decrease her ability to meet those needs. Mothers need help, and the two sources are female relatives or friends and her children's father(s).

Among the few foragers for whom we have data, from 20 to 50 percent of the time that an infant is in someone's arms, someone other than the mother is holding it (Hewlett 1991a). Among the Efe and Onge, women other than the mother may breastfeed a child. Children can have multiple caregivers when there are few children in camp and where there is a trusted female cohort freed from other duties (e.g., grandmothers, older sisters; Blurton Jones, Hawkes, and O'Connell 2005a). Multiple caretaking is more common among foragers than among horticulturalists and pastoralists (Hewlett 1991a). Where settlements are small and socially "open," multiple caregiving is possible because all members of the band will be familiar with an infant and its parents. But there is variability in how readily women leave their children in camp. Australian Aboriginal women, for example, leave children in the care of another more frequently than do Ju/'hoan women (McCarthy and McArthur 1960; Rose 1960; Denham 1974a,b). If a woman lives away from female relatives (e.g., in the case of patrilocal postmarital residence), she may not have a trusted female cohort. Or, flux in band membership may not leave a sufficient number of known baby-sitters (Draper and Cashdan 1988). These could contribute to cultural childrearing ideals that emphasize constant maternal care and attention.

Paternal care is also crucial for a child's well-being. Ayoreo women excuse infanticide by arguing that the father had left or was unwilling to take responsibility (Bugos and McCarthy 1984); this is, in fact, a strong cross-cultural pattern (Daly and Wilson 1988). Conversely, Ayoreo men say that women kill a newborn if she cannot care for it. Clearly, men and women perceive the costs of raising children differently.[25]

The absence of a child's socially recognized father can also have an unfortunate effect on children. Pennington and Harpending (1988) found that among nomadic Ju/'hoansi, children whose mothers were married more than once were twice as likely to die as those children of women married only once. Among the sedentary Ghanzi Ju/'hoansi, children of mothers married more than once were almost three times as likely to die during infancy (and evidence suggests that the predominant reason for multiple marriages is the husband's death). Hill and Kaplan (1988a) and Hawkes (1990) record a similar pattern for the Ache, where children whose fathers die stand a 9 percent chance of dying before age fifteen, whereas those whose fathers live have a less than 1 percent chance of death (see also Hill and Hurtado 1996: 438). Likewise, Hadza stepfathers pay less attention to their stepchildren than to their own biological offspring (Marlowe 1999a, 2005b).

Hill and Kaplan argue that because men provide 90 percent of total calories in the form of meat (when the Ache are in the bush), and because all meat is shared, group members feel pressured to appease the good hunters by watching over and providing for their children. After a man's death, however, those members may pay less attention to his surviving offspring. In fact, if the hunter's wife remarries, her new husband may even kill her previous children, so as to allow her to care for his own (current or anticipated; Hill and Kaplan 1988a,b).[26]

In general, evolutionary theory predicts two basic reproductive "tactics": invest in raising offspring or invest in mating opportunities. Because women invest nine months in creating a child, women maximize fitness by parenting and raising offspring. Without such an up-front investment, men are predicted to invest time in mating as opposed to parenting (the so-called "cad" and "dad" tactics), where additional increments in paternal investment in offspring (food, protection, education) does not increase the probability of offspring survivorship (yes, it's crass, but we're talking evolution here, not morality).

Cross-cultural data show that men's hunting strongly influences completed family size: the more men contribute in general, the higher the average fertility rate of the society (Marlowe 2001). However, this does not appear to be a result of decreased mortality but rather of an increase in fecundity. It may be that a man's contribution to diet – meat – provides his wife with high-quality nutrition that affects her overall nutritional state and, consequently, her fecundity (see Maternal Nutritional Condition later in this chapter).[27] Hewlett (1991b, 1992a) adds to this that the more time husband and wife are together, the more the father will participate directly in childcare; this is likely to improve child survival.

In sum, female infanticide may only be a significant factor in those societies where men contribute significantly more to subsistence than women, and that may be restricted to the Arctic (patrilocal postmarital residence and high adult male mortality may exacerbate this). Birth-spacing infanticide may be more common cross-culturally but still may not affect an appreciable number of births. It probably worked to maximize reproductive success rather than control population size, although its impact on population growth rates is not known. The frequency of birth-spacing infanticide can be affected by how hard women must work, which is linked to how much children can forage and by the support, in terms of food and childcare, that a child's mother can expect from the father.

The "need" for infanticide, however, is obviously linked to the rate at which children are produced in a noncontracepting population. So, perhaps we have put the cart before the horse: before considering what happens to infants after they are born, we need to consider how many infants are born. That requires considering the ecology of reproduction, the variables and processes that, in a foraging environment, control *fecundity*, the potential a woman has to conceive (for reviews, see Voland 1998; Wood 1994; Ellison 2001; Vitzthum 1994, 2008).

The Ecology of Reproduction

Many claim that hunter-gatherers have lower fertility than other kinds of societies, even without invoking intentional cultural controls. Fertility here is measured by a population's *total fertility rate* (TFR). The TFR of a population is the mean number of children that women bear over the course of their reproductive years. This information is acquired by interviewing postmenopausal women (normally defined as women who are at least forty-five years old) for their reproductive histories. In general, TFR tends to be low in foraging societies, about five to six children (Campbell and Wood 1988; Hewlett 1991a; Bentley, Jasienska, and Goldberg 1993). Although Campbell and Wood (1988) found no difference between the TFR of hunter-gatherers and other noncontracepting societies (see also Hewlett 1991a), Bentley et al. (1993) found a significantly higher TFR for agriculturalists (mean, 6.6 ± 0.3). Although foragers may have lower fertility than agriculturalists, Table 7-1 suggests variability in the fertility rates of foragers. What conditions this variability?

To start, let's consider the Ju/'hoansi's much-ballyhooed four-year birth spacing. Nicholas Blurton Jones argued (see Chapter 2) that rather than resulting from intentional controls on population to keep the growth rate low, this wide birth spacing may actually *maximize* reproductive success for the Ju/'hoansi (Blurton Jones and Sibly 1978; Blurton Jones 1986, 1987; see also Anderies 1996). Why?[28]

Hunter-gatherer children are often in close physical contact with their mothers for at least the first twelve months of life (Konner 2005). Ju/'hoan women walk long distances when foraging – up to 20–25 km – carrying their children, equipment, and, on the return trip, the gathered food. Because children ride on their mothers until they are four years old, carrying more than one child puts an unbearable strain on the mother in the hot Kalahari and, consequently, on her children.

Through a computer simulation of a "backload model," Blurton Jones showed that the total average weight a Ju/'hoan woman carries on foraging trips decreases dramatically as birth spacing increases until a birth interval of four years is reached. At birth intervals longer than four years, there is not much reduction in total weight carried because the mother only carries one child at a time at such a long birth interval. Thus, spacing births at four years maximizes the number of children a woman can produce (four to five) by preventing maternal exhaustion. Having children at less than a four-year interval, conversely, could affect a child's survival chances by decreasing

Table 7-4. Mean Age at First Marriage

Group	Males	Females	Reference
Nyae Nyae Ju/'hoansi	22–25	14–15	Lee 1982
Dobe Ju/'hoansi	23–30	16–17	Lee 1982
Dobe Ju/'hoansi	26.7	16.9	Howell 2010
≠Kade	25	17–18	Tanaka 1980
Aka	18–21	16–17	Hewlett 1991b
Tlingit	16	12–14	Emmons 1991
Hadza	20	17	Marlowe 2005b, 2010
Pumé	–	15	Kramer 2008
Agta	–	18.7	Early and Headland 1998

the mother's ability to provide for him or her by literally working the mother to death (thus, the Ju/'hoan proverb that heads this chapter).

For this pattern to be adaptive, Blurton Jones must demonstrate that women who gave birth at less than a four-year interval raise fewer children to adulthood than women who do. And, using Nancy Howell's data, Blurton Jones shows exactly that. For the Dobe Ju/'hoansi, a four-year birth interval appears to maximize reproductive success.

However, Renee Pennington and Henry Harpending (Pennington 2001; Pennington and Harpending 1988) analyzed data from a broad survey of Ju/'hoansi (including some of Howell's sample) and argued that child survival does not decrease with a birth spacing of less than four years. Contrary to the Blurton Jones model, Pennington and Harpending found that the more children a woman bore, the more children she had who lived to reproductive age. Instead, Pennington (2001) argues that fecundity in Africa (and elsewhere) is most heavily impacted by venereal disease and the resulting sterility (but see Howell 1979: 135).

Blurton Jones predicted (and measured) the optimal birth intervals, not the number of offspring produced. Pennington and Harpending estimated these intervals from reproductive histories, but the higher fertility could also be a function of a longer period of reproductive viability for the women in their sample and not necessarily a shorter birth interval. If so, this would not necessarily contradict Blurton Jones's conclusion (Borgerhoff Mulder 1992: 349). At the same time, Blurton Jones's measurement of child mortality relative to the birth interval may have overestimated the levels of mortality for short birth intervals (Pennington 2001). Pennington (2001: 188) concludes that it "is likely that the length of the IBI [interbirth interval] is related to child survival, especially for short intervals, but the optimal length is undetermined" (see also Ellison 2001: 94–97).

Regardless of how this debate is resolved, it does not mean that all foragers do or do not have a four-year birth interval. Cross-culturally, in fact, birth spacing averages 3.3 years for foragers (Marlowe 2005a, 2010). And, given this discussion, it is clear that factors other than cultural controls lower fecundity, producing long interbirth intervals. What are those other factors?

Kenneth Campbell and James Wood divide the factors affecting fertility into exposure and susceptibility factors (1988). *Exposure* refers to the frequency of intercourse and susceptibility to the likelihood that intercourse will result in a pregnancy. Campbell and Wood did find that "age at marriage" had some effect on TFR globally. If sexual relations do not occur until after marriage, and if marriage occurs sometime after menarche, then age at marriage can affect the overall TFR of the population. Our data are limited, but foraging women are often married at or before menarche (see Tables 7-4 and 7-5). Ju/'hoan women, for example, reach menarche at age sixteen or seventeen, which is about the age when they marry. Many ethnographies allude to premarital

Table 7-5. Birth Interval, Mean Age of Menarche, First Birth, Last Birth, and Total Fertility Rate

Group	BI	MAM	MAFB	MALB	TFR	Reference
Mbuti Pygmies ($n = 16$)	4.2	–	–	–	5.0	Cavalli-Sforza 1986
Dobe Ju/'hoansi	3.7	16.6	18.8	34.4	4.1–4.7	Lee 1979; Howell 1979
Dobe Ju/'hoansi	2.9	17.1	20.9	37.0	–	Campbell and Wood 1988
Dobe Ju/'hoansi	–	16.6	21.4	34.3	4.6	Howell 2010
≠Kade	–	12	–	–	–	Tanaka 1980; Harpending and Wandsnider 1982
Agta	2.8	17.1	19	39	7.0	Early and Headland 1998
Agta	–	–	–	–	6.5	Goodman, Griffin, Estioko-Griffin, and Grove 1985
Batak	2.3	15.1	18	26.3	3.9	Eder 1987
Aka	3.5–3.7	–	–	–	6.2	Hewlett 1988, 1991b
Efe	–	–	–	–	2.6	Bailey and Aunger 1995
Kutchin (pre-1900)	3.3	–	22.8	35.0	4.4	Roth 1981
Kutchin (post-1900)	3.2	–	19.8	39.0	6.4	Roth 1981
James Bay Cree	2.7	–	21.9	39.0	–	Romaniuk 1974
Arnhem Land, monogamous	3.3	–	19.3	34.1	–	Chisholm and Burbank 1991
Arnhem Land, polygynous	5.4	–	19.2	34.3	–	Chisholm and Burbank 1991
Pitjandjara	–	–	–	35.0	4.1	Yengoyan 1972
Anbarra	–	–	15.9	35.0	6.4	Hamilton 1981
Savanna Pumé	3.1	12.9	15.3	–	7.4	Kramer 2008, Kramer and Greaves 2007
River Pumé	2.9	12.9	15.3	–	7.8	Kramer 2008, Kramer and Greaves 2007
Hadza	3.3	–	16.5	–	6.2–6.4	Blurton Jones et al. 1992, 2002
Birhor	–	–	–	–	5.5	Williams 1974
Chenchu	–	–	–	–	5.8	Sirajuddin 1984
Asmat	–	–	–	–	6.9	Van Arsdale 1978
Tiwi	–	–	–	–	4.6	Jones 1963
Nunamiut	–	–	–	–	6.4	Binford and Chasko 1976
Ache (forest)	37.6	–	20	42	8.0	Hill and Hurtado 1996
Hiwi	–	–	–	–	5.1	Hurtado and Hill 1987

(continued)

Table 7-5 (*continued*)

Group	BI	MAM	MAFB	MALB	TFR	Reference
Pumé	–	–	–	–	7.4[a]	Kramer and Greaves 2007
Nunamiut (1960)	–	–	–	–	6.9	Campbell and Wood 1988
Kuskowagamiut	–	–	–	–	6.2	Driver 1961
Konyags	–	–	–	–	8.4	K. Taylor 1966
Polar Inuit	–	–	–	–	4.6	Malaurie 1956
Copper Inuit (20th century)	–	–	–	–	4–5	Jenness 1922
Greenland Inuit (1950)	–	–	–	–	3.5	Campbell and Wood 1988
Western Alaskan Eskimo (20th cent.)	–	–	–	–	6.0	Brainard and Overfield 1986
Mbuti (net hunters)	–	–	–	–	5.5	Harako 1981
Efe	–	–	–	–	2.6	R. Bailey 1988
Aka	–	–	–	–	6.2	Bahuchet 1979
Ache	–	–	–	–	7.8	Hurtado and Hill 1987
Tiwi	–	–	–	–	5.7	Jones 1963
Arnhem Land, monogamous	–	–	–	–	6.0	Chisholm and Burbank 1991
Arnhem Land, polygynous	–	–	–	–	4.6	Chisholm and Burbank 1991
Pahira	1960	–	–	–	6.3	Basu 1969
Semang	1978	–	–	–	4.5	Gomes 1990
Semang	1988	–	–	–	5.2	Gomes 1990
Ghanzi Ju	–	–	–	–	4.0	Harpending and Wandsnider 1982
Seri	–	–	–	–	6.8	Neel and Weiss 1975
Onge	–	–	–	–	2.6	Pandya, in Hewlett 1991a
Casiguran Agta	–	–	–	–	6.3	Headland 1988
Palanan Agta	–	–	–	–	5.9	Headland 1988
Asmat	–	–	–	–	6.9	Van Arsdale 1978
Batak	–	–	–	–	3.7	Eder 1987
Netsilingmiut	–	–	–	–	6.4	Schrire and Steiger 1974a
Kutchin (1858)	–	–	–	–	5.4	Osgood 1936
Batek	–	–	–	–	5.2	Endicott, in Hewlett 1991a
Semai	–	–	–	–	5.7	Williams 1974
Yámana	–	–	–	–	7–10	Stuart 1980

BI is the birth interval in months, MAM is mean age of menarche, MAFB is mean age at first birth, MALB is mean age at last birth. James Bay Cree BI is the mean of trend toward a reduction in BI.
[a] Surviving TFR, 4.25.

or premenarcheal sexual activity of boys and girls, but this may not be significant because a high number of menstrual cycles are anovulatory (cycles that do not release an egg) for two to three years after menarche, especially if a girl's diet is marginal. In any case, in noncontracepting societies, marriage is frequently adjusted to pregnancy; that is, by definition, pregnant women are married women (Wilmsen 1986: 62; Howell 1979: 232). Therefore, age at marriage may not be an important variable for hunter-gatherers.

This leaves us with susceptibility factors, and there appear to be two linked ones that affect how quickly a foraging woman becomes pregnant after giving birth: breastfeeding and maternal nutritional condition.

Breastfeeding

In the first edition of this book, I concluded that "breastfeeding is probably the single most important control on hunter-gatherer fertility and population growth." We cannot draw such a conclusion today.

I supposed that breastfeeding was important for two reasons. First, many foragers breastfeed children for long periods of time – two, three, or more years is not uncommon (Table 7-6). Ju/'hoan children may even breastfeed until six years of age, long after they begin to eat weaning foods (Shostak 1981; after three years, male children are more likely to breastfeed than females; Konner and Shostak [1987]). Field studies document "on-demand" breastfeeding among some foragers – frequent, short, but intense breastfeeding bouts. Ju/'hoan children, for example, can breastfeed for two minutes four times an hour (Konner and Worthman 1980; Shostak 1981). And, by sleeping with their mothers, a Ju/'hoan child can breastfeed through the night. It was this frequent, "on-demand" breastfeeding that we thought increased the production of prolactin, which decreased estrogen and progesterone production by the ovaries, resulting in a higher percentage of anovulatory cycles and decreased luteal-phase length (the time during which the uterus is prepared to receive and implant a fertilized egg). In sum, on-demand breastfeeding was thought to decrease the probability of both ovulation and, should ovulation occur, viable conception.

A number of empirical studies showed a strong correlation between the duration of lactation and TFR (e.g., Bongaarts and Potter 1983; Campbell and Wood 1988; or case studies such as Romaniuk [1974]). However, new clinical studies show that the physiological links between breastfeeding and ovulation are unclear and challenge the effectiveness of breastfeeding *alone* as a "natural contraceptive" (e.g., Hill and Hurtado 1996: 311; see review in Ellison 2001; Vitzthum 1994); instead, breastfeeding works in concert with a woman's nutrition and activity to affect fecundity.

Maternal Nutritional Condition

In the 1970s, biologists observed that female athletes in endurance sports, such as marathon running, ovulated irregularly, if at all. Rose Frisch (1978) hypothesized that this was related to body fat. Briefly, Frisch argued that after menarche, about 22 percent of female body weight must be fat for the maintenance of normal reproductive function; she referred to this ratio of fat to lean tissue as "critical fatness." Although the specific value has been refuted (Scott and Johnston 1982), Frisch's work did point to the importance of energy stores and expenditure, and researchers suggested that the fecundity of foraging women could be reduced by the hard day-to-day, fat-depleting work of foraging combined with the poor quality of a foraged diet (Figure 7-5). This idea is supported by evidence that in human populations manifesting seasonal weight changes as a function of seasonal changes in nutrition, births tend to be clustered nine months after the season of highest food availability, when maternal nutrition is presumably at its

Table 7-6. Weaning Age

Group	Weaning Age (months)	Reference
Washo	12–24	Barry and Paxson 1971
Mbuti (net hunters)	12–36	Harako 1981
Montagnais	12–60	Barry and Paxson 1971
Pomo	15?	Barry and Paxson 1971
Micmac	24–36	Barry and Paxson 1971
Slave	24–36	Barry and Paxson 1971
Bella Coola	24–36	Barry and Paxson 1971
Kaska	24–36	Barry and Paxson 1971
Klamath	24–36	Barry and Paxson 1971
Semang	24–36	Barry and Paxson 1971
Eyak	24–36	Barry and Paxson 1971
Yurok	24–36	Barry and Paxson 1971
Yokuts	36+	Barry and Paxson 1971
Andamanese	36–48	N. Peterson 1976; Jones 1963
Tiwi	36–48	Barry and Paxson 1971
Siriono	36–48	Barry and Paxson 1971
Dobe Ju/’hoansi	36–72	Campbell and Wood 1988
Ainu	48–60	Barry and Paxson 1971
Hadza	30	Marlowe 2010
Aleut	12	Barry and Paxson 1971
Yámana	24	Stuart 1980
Gilyak	24	Barry and Paxson 1971
Haida	24	Barry and Paxson 1971
Gros Ventre	24	Barry and Paxson 1971
Kutenai	24	Barry and Paxson 1971
Vedda	24	Barry and Paxson 1971
Paiute	24	Fowler and Fowler 1971
Aranda	36	Barry and Paxson 1971
Yukaghir	48	Barry and Paxson 1971
Murngin	48	Barry and Paxson 1971
Pumé	30–36	Kramer and Greaves 2007
Ache (village)	24	Barry and Paxson 1971

best. This is true for Ju/’hoansi, Ache, and Hiwi hunter-gatherers; Turkana pastoralists; and Lese horticulturalists.[29]

Empirical studies suggest that nutrition, activity levels, and breastfeeding all work synergistically to affect a woman’s energy storage, balance, and flux, which, in turn, affect fecundity. *Energy storage* refers to how much energy a woman has stored on her body, as fat, at any given moment. *Energy balance* refers to whether a woman is expending more or less energy than she is consuming. Negative energy balance means she is using more and positive energy balance means she is using less energy than she is consuming. *Energy flux* refers to the *rate* at which energy is coming in and going out. Through these three dimensions, and a complex hormonal chain, we might say that a woman’s body “knows” when it can or cannot afford to become pregnant (see Van der Walt, Wilmsen, and Jenkins 1978; Hausman and Wilmsen 1985; Ellison 2001).

If a woman does not have enough energy stored on her body, then she does not have the reserves to keep herself alive and create a fetus. If a woman does have a minimal amount of stored

Figure 7-5. Ahtna women carrying camp equipment with tumplines. Women's workload can affect their fecundity as well as determine how much support they will need in childcare. Photo by the Miles Bros., probably 1902. Courtesy of the National Anthropological Archives, Smithsonian Institution, No. 03459000.

energy but is losing weight – that is, she has a negative energy balance – then her body "knows" not to ovulate. Among the Lese, for example, seasonal changes in ovulatory frequency correlate with seasonal changes in body weight and low progesterone levels (Ellison, Peacock, and Lager 1989; Ellison 1990). Negative energy balance could be produced simply by a lean season, a heavy workload, and/or the presence of a breastfeeding child. A woman eating a diet low in calories, who is foraging daily in a challenging environment, *and* who is lactating – in other words, a normal Ju/'hoan woman – will not ovulate frequently. Her body knows it cannot provide for three (the mother, the fetus, and the breastfeeding child).

Women with lots of calories coming in but lots of calories going out quickly because of physical labor also experience reduced fecundity. Even female athletes, who have sufficient energy stores and eat a nutritional diet, may experience reduced ovulation due to their high energy flux (Ellison 2001). The body knows that high energy flux does not leave much room for error. It takes only a slight decline in nutrition or a slight increase in workload to slip into negative energy balance, and so the body prepares for this eventuality by shutting down the reproductive system.

It is difficult to separate the effects of these different variables. For example, the season of highest food availability for the Ju/'hoansi is also the season of least demanding female labor (Bentley 1985). Is it energy stores, balance, or flux at work here? Work probably lowers fecundity the most when it is combined with weight loss, a negative energy balance (Ellison 1990, 1994). And we do not necessarily mean enormous weight losses. Among the Lese, weight losses of 2 kg (5.5 lbs.) were sufficient to lower progesterone levels and the frequency of ovulation (Ellison

2001: 189). Hurtado and Hill (1990) found that seasonal fertility did not correlate with Hiwi women's weight, work effort, or caloric consumption. Neither did it correlate with differences in weight or work effort between one season and the previous season. Instead, Hurtado and Hill found that the difference in *net* caloric intake – a product of gross caloric intake and work effort – between one season and the previous season predicted fertility. So energy stores, balance, and flux working in concert – and not breastfeeding, nutrition, or activity alone – determine how quickly a woman can conceive a child after giving birth.

Mortality

Fertility is only one side of the population coin. We cannot understand forager demography without also understanding their patterns of death. The rate of population growth may, in fact, be more a product of changes in mortality than in fertility (Handwerker 1983).

Infant and Juvenile Mortality

We should be especially concerned with the death of pre-reproductive age individuals; that is, infant and juvenile mortality (most demographic studies classify individuals older than fourteen or fifteen years of age as reproductive). Juvenile mortality is high in hunter-gatherer populations, although Hewlett found no difference between the rate of hunter-gatherers and horticulturalists/pastoralists (Hewlett 1991a). Only 50–60 percent of children survive to age fifteen (of those, 60–70 percent reach age forty-five; Gurven and Kaplan 2007; Table 7-7). The low life expectancies at birth in Table 7-7 are largely a product of high infant/early juvenile (<5 years) mortality.

We have already discussed infanticide as one agent of childhood death. Two others are accidents and disease. It is possible that accidental death may contribute more to mortality as one moves farther away from the equator. In colder environments, seasonality may be a harsher selective force than in more equatorial climates, because it can make accidents potentially more dangerous in cold seasons. We do not have much ethnographic data on accidental deaths. Accidents are responsible for only 2 percent of Ache infant (0–3 years) deaths but 23 percent of deaths of 0 to 14-year-olds (Hill and Hurtado 1996: table 5.1, forest period; most of that occurring from 3 to 14 years of age). Among the Hiwi, accidents account for 6 percent of infant deaths and from 5–14 percent of child (1–9 years old) deaths (Hill et al. 2007: table 4, precontact period). The increased rate for children is due to their greater mobility and (as every parent knows) their ability to get themselves into trouble quickly.

An important cause of childhood death in many forager societies are infectious and parasitic diseases, including respiratory tuberculosis (TB), influenza, pneumonia, bronchitis, and diarrheal diseases resulting in dehydration. These are harder to preempt. Among the Dobe Ju/'hoansi, disease, especially TB and malaria, account for 85 percent of childhood deaths; degenerative diseases (e.g., cardiovascular disease) accounted for only 4 percent and violence for 8 percent (with no differences between male and female children; Howell 1979). Infectious disease (with most deaths occurring among infants and juveniles) accounts for 85–95 percent of Agta deaths (Headland 1989; Early and Headland 1998); only 2 percent of deaths are due to accidents and 3 percent to homicide.[30] Among the Aka Pygmies, the primary causes of death are measles, then diarrhea, and convulsions; the last two factors account for 26 percent of childhood deaths (Hewlett et al. 1986). When they lived as nomadic foragers, San Ildefonso Agta infant deaths were probably caused by parasites, especially intestinal worms (Early and Headland 1998: 114). Among the precontact Hiwi, infectious disease accounted for 27 percent of infant deaths and about 66 percent of child (0–9 years) deaths (a higher rate for girls than for boys; Hill et al. 2007). Disease accounts for 27 percent of Ache child deaths (0–3 years; 15 percent for 4–14 years).

Table 7-7. Child Mortality

	Mortality (%)			
Group	<1 yr.	<15 yrs.	e_0	Reference
Ju/'hoansi (nomadic)	8	12	42	Harpending and Wandsnider 1982
Ju/'hoansi (sedentary)	–	6	17	Harpending and Wandsnider 1982
Dobe Ju/'hoansi	20	44	30	Lee 1979; Howell 1979
≠Kade	–	28[a]	40	Tanaka 1980
G/wi	–	7	–	Silberbauer 1981a
Efe	14	22	–	Bailey 1988
Asmat	30	25	25	Van Arsdale 1978
Yámana	–	29	–	Stuart 1980
Ngamiland Ju/'hoansi	–	34	–	Harpending and Wandsnider 1982
Ache (forest)	12	34	37	Hill and Hurtado 1996
E. Cagayan Agta	–	35	–	Headland 1988; Goodman et al. 1985
Palanan Agta	–	43	–	Headland 1988
Casiguran Agta	34	49	21	Headland 1988; Hewlett 1991a
San Ildefonso Agta	37[c]	50[a]	24	Early and Headland 1998
Greenland Inuit	20	45	–	Hewlett 1991a
Kutchin (pre-1900)	17	35	–	Roth 1981
Kutchin (post-1900)	9	17	–	Roth 1981
Aka	20	45	–	Bahuchet 1979
Hiwi	–	–	48	Hurtado and Hill 1987, 1990
Mbuti (net hunters)	33	56	–	Harako 1981
Seri	–	61	–	Neel and Weiss 1975
Batak	29	52	22	Eder 1987
Chenchu	–	49	–	Hewlett 1991a
Pitjandjara	19	–	–	Hewlett 1991a
Tiwi	10	–	–	Jones 1963; Hewlett 1991a
Anbarra	–	38[b]	–	Hamilton 1981
Savanna Pumé	–	34	–	Kramer and Greaves 2007
River Pumé	–	13	–	Kramer and Greaves 2007
Hadza	21	46	33	Blurton Jones et al. 1992; Marlowe 2010
Hiwi	–	43	27[d]	Hill et al. 2007

For the Ju/'hoansi, male children have a lower survivorship than female children; 44 percent die before age fifteen, compared to 30 percent for female offspring. The pattern is the opposite among the Ache, where 47 percent of female offspring die as opposed to 37 percent of male offspring; the same holds true for the Hiwi, where 55 percent of female and 49 percent of male offspring die before age fifteen.

[a] By age ten.

[b] By age five (39 percent of all male offspring and 37 percent of all female offspring).

[c] Forager phase; there is some potential for measurement error here because it is based on memory and some of these offspring may have died in the second or third year of life (Early and Headland 1998: 113).

[d] Precontact phase; most deaths are in the 0–5 age group.

Diarrhea-inducing diseases may be more prevalent among tropical hunter-gatherers than among those living in drier or colder environments that are less conducive to the growth of bacteria and parasites. Based on a sample of five populations, Dunn (1968) showed that there are two to seven times more parasitic helminths and protozoa among tropical-forest cases than among tropical-desert cases. Contagious disease is probably not an important factor among small, mobile peoples because their populations are too small to support the responsible organisms (F. Black 1975). For this reason, some authors suggest that mobility can ensure a population's health (Cohen 1989). However, mobility may contribute to other kinds of disease.

Although infant mortality appears to be higher among some sedentary as opposed to nomadic Bushmen (Hitchcock 1982), the infant-mortality rate among the mobile Ju/'hoansi is twice as high as among the sedentary Ghanzi Ju/'hoansi (12 percent as opposed to 6 percent; Harpending and Wandsnider 1982). The more readily available medical care and supply of cow's milk in the sedentary settlement may be responsible for the difference. However, the difference may also be due to "traveler's diarrhea" among the mobile Ju/'hoansi. Because different parasites are found in different regions, mobility continually brings highly susceptible infants into contact with new strains of parasites, resulting in repeated bouts of diarrhea and dehydration that produce a chronic state of poor health that takes its toll (analogous to the less dangerous day-care syndrome in industrialized nations).

Children of sedentary groups build up resistance to local parasites and are thus less susceptible to diarrhea and dehydration.[31] Still, the availability of weaning foods in sedentary settlements may reduce child mortality (Pennington 2001). However, we should be cautious. Waguespack (2002) found no relationship between residential moves and childhood mortality (in a sample of only nine cases), whereas Morabia (2008) found an *inverse* (but not significant) relationship when environment was controlled. Clearly, the factors that affect child mortality need further study.

Pennington suggests that without sexually transmitted diseases, hunter-gatherers would experience a TFR of 6–8. To achieve the extremely low rates of population growth evidenced by archaeology, she (2001: 197) suggests that mortality "must have been much worse than anything we have observed among modern hunter-gatherers." Hill and his colleagues (2007) suggest that the cause of that mortality was homicide, including infanticide, warfare, and internal disputes.

Lethal Violence

You will recall from Chapter 1 that prior to *Man the Hunter*, foragers were generally considered to live Hobbesian lives, a war of all against all. But after *Man the Hunter*, anthropologists, and the public, envisioned foragers living lives of blissful peace, as presciently revealed by the title of Elizabeth Marshall Thomas's 1959 book about the Bushmen, *The Harmless People*.

You can guess my position: life in foraging societies is not all sweetness and light but neither is it a Hobbesian hell. There are a few foraging societies who know virtually no violence (e.g., the Malaysian Batek and the Indian Paliyan; see Gardner 2000; Endicott and Endicott 2008) but most, unfortunately, do (Table 7-8). Although foraging societies vocalize an ethos of nonviolence and have mechanisms to resolve disputes (see Fry 2006, 2011), ethnographic (and archaeological) data show that many foragers lived with high levels of homicide and warfare (Ember 1978; Keeley 1996; Wrangham, Wilson, and Muller 2006; Gurven and Kaplan 2007). Wrangham et al. (2006), for example, calculated a median forager homicide rate of 164/100,000; compare this to the U.S. homicide rate in the late 1990s of 5.5/100,000.[32]

But let's first consider the nature of homicide statistics. Note that the actual number of murders is low – the San Ildefonso Agta rate of 129/100,000 is based on eleven murders (including at least two by outsiders) over a forty-three-year period, or about one murder every four years (Early and Headland 1998). Visit the Agta or the Ju/'hoansi or the Hadza most years and you too would label them a "harmless people."

Table 7-8. Hunter-Gatherer Homicide Rates

Group	NAGP[a]	Ratio[b]	Population Density (persons/ 100 km²)	Population Pressure (ln)[c]	Homicide Rate[d]	Reference
Hadza	1,246	3.8	24	5.28	6.6	Marlowe 2010: 141
Andamanese	4,400	0.5	86	3.24	20	Keeley 1996: table 6.1
Ju/’hoansi[e]	570	3.8	6.6	5.79	42	Lee 1979
San Ildefonso Agta	3,856	0.4	38	3.70	129	Early and Headland 1998: 103
Gidjingali	1,904	0.4	72.7	2.35	148	Hiatt 1965
Tiwi[f]	2,273	0.4	37.5	3.19	160	Keeley 1996: table 6.1
Yahgan	484	0.2	4.8	3.00	169	Cooper 1917, in Wrangham et al. 2005
Yurok	685	0.8	131	1.43	240	Keeley 1996: table 6.1
Casiguran Agta	4,512	0.4	87	3.03	326	Headland 1989
Murngin	1,969	0.4	11.7	4.21	330	Keeley 1996: table 6.1
Modoc	195	0.8	22.9	1.92	450	Keeley 1996: table 6.1
Ache	2,480	0.4	14	4.26	500	Hill et al. 2007
Hiwi	2,895	0.3	4.3	5.31	1,018	Hill et al. 2007
Piegan	348	0.2	4.3	2.78	1,000	Keeley 1996: table 6.1
Batek[g]	3,315	0.4	13	4.62	1	Endicott and Endicott 2008

[a] From Binford (2001).

[b] Following Keeley’s (1988) lead, NAGP is multiplied by a fraction (from Kelly 1983, table 3, column 5) to reflect the portion of NAGP that is edible by humans and large fauna. The value used for the Hiwi accounts for the fact that large portions of Hiwi territory are not productive (Kim Hill, personal communication, 2011).

[c] Population pressure is (NAGP∗ratio)/population density.

[d] Many are warfare deaths alone (especially from Keeley 1996; Piegan is only warfare deaths); for those, taking intrasocietal deaths into account would increase the rate. However, some rates (e.g., Hiwi, Ache) include suicide, infanticide, and murders by external forces; see text for comments on Hiwi and Ache data.

[e] Lee (1979: 398) gives the Ju/’hoansi homicide rate as 29/100,000, based on twenty-two murders over a fifty-year period, 1920–1970. However, he notes that murders ceased about 1955 due to the presence of an outside police force; for a thirty-five-year period, this results in a rate of 42/100,000.

[f] For the years 1893–1903; this is perhaps too short a time period to establish a “normal” homicide rate.

[g] Endicott and Endicott (2008) do not specifically state that the homicide rate is 0/100,000, but they did seek out instances of violence, recording only a few, and only one possible homicide (which would be counted as infanticide). I gave them a minimal rate of 1/100,000 so that the log could be taken and made comparable to other data in the table.

Ratio data can fluctuate widely in small populations. By convention, homicide rates are given as the number of murders per 100,000 person-years, but the relevant group size for foragers is far smaller. The "peaceful" Semai, for example, saw only two murders over a twenty-two-year period (Dentan 1968). But in such a small population, this translates into a homicide rate of 30/100,000 (Knauft 1987: 458). But what is the relevant population? Robert Dentan (1988) replied that the base population is larger than Knauft assumed and that the rate is consequently closer to 1/100,000.[33] In small groups, it takes only a few deaths to alter the rate significantly. The Hadza rate increases from 6.6 to 40/100,000 if three murders by neighboring Datoga are included (Blurton Jones, Hawkes, and O'Connell 2002; Marlowe 2010: 141). And how do we account for "extenuating circumstances?" In five of the eleven San Ildefonso murders, for example, alcohol was a significant contributing factor (as it is everywhere; see, e.g., Marlowe 2002). Would the rate have been lower without the booze? One solution to these problems is to collect data over long spans of time. But because ethnographers cannot be present for decades, they have to rely on informants' memories (e.g., Lee 1979: table 13.2), which are not always accurate.

The Ache and Hiwi rates stand out in this table: 500 and 1,018/100,000, respectively. However, these numbers are not directly comparable to the other figures. The Hiwi (precontact) rate includes all violent deaths, including murders by Hiwi, murders by Venezuelans, suicide, and infanticide. Breaking the data down (Hill et al. 2007, table 4), murders by Hiwi themselves account for only 7 percent of all deaths (8.5 percent if we assume that those killed by Venezuelans lived; 22 percent of all deaths are a result of homicide if we add the Venezuelan murders). Among the Ache, 39 percent of all infant (0–3 years) deaths result from infanticide or child homicide (e.g., burial with a deceased parent), as well as 17 percent of all juvenile deaths (4–14 years). About 9 percent of adult deaths are a result of homicide or club fights (Hill and Hurtado 1996: table 5.1). These lower rates are similar to that of the Agta, Ju/'hoansi, and Hadza, where violence, not including infanticide, suicide, or external murders, accounts for 3–7 percent of deaths.

Still, there is variability in violent death among foragers, whether we are talking about intra-group murder, warfare or raiding, infanticide, or other child murders. Hill et al. (2007) suggest that low homicide rates are a product of colonial intervention and that prehistoric foragers may have witnessed higher rates. An overarching authority to which individuals could petition for redress can restrict violence (Knauft 1987: 476), and such authority did apparently stem violence among the Ju/'hoansi (Lee 1979), Ache (Hill and Hurtado 1996: 155), Inuit (Burch 2007b), and Agta (Early and Headland 1998: 115), although we do not know by how much. Conversely, Blurton Jones et al. (2002) discount the role of outsiders in stemming the Hadza's murder rate. And whether the past was more violent than the ethnographic present is an issue for archaeology to decide (see Kelly 2013).

Foragers tend to have low rates of nonlethal aggression (e.g., fist fights; Wrangham et al. 2006), but this comes from the cultural denial of aggression in small egalitarian communities rather than the lack of squabbles. Turnbull (1965), for example, recorded a noteworthy dispute every three to four days among the Mbuti (see also Ness, Helfrecht, Hagen, Sell, and Hewlett 2010). These disputes were motivated by jealousy (often over women) or some slight, real or perceived. When Jean Briggs (1970) entitled her book on an Inuit family *Never in Anger*, she did not mean that the Inuit are never angry, only that it is inappropriate to show it. The violence that can erupt in foraging communities often has no particular objective other than expressing anger; and that anger can become lethal, a form of rage or "blood drunkenness."[34]

Violence can take many forms, and because these forms can have different proximate causes, it is important to sort them out. Keeley (1996), for example, classifies Australia Aboriginal society as warlike egalitarian foragers, but Fry (2006) demonstrates that most of this fighting was rare and usually fell under the category of feuding or revenge killings rather than specifically warfare (we will define warfare in a moment). Previous cross-cultural studies of war or "intergroup aggression" (e.g., Ember 1978; Keeley 1996) do not separate deaths from interpersonal homicide from those resulting from war or raiding.[35] In the standard cross-cultural sample (SCCS) (Murdock and White 1969), the reasons given for homicide among nomadic foragers are revenge, disputes over women (including adultery; see, e.g., Lee 1979; Marlowe 2010), crimes, and execution (see Fry 2011).

These have in common that someone gets hurt (and that it is usually men who do the hurting; Ness et al. 2010), but something is lost by collapsing these different behaviors into a single measure. In fact, some of the homicide rates we cited previously (e.g., Hiwi, Piegan) include deaths from war and raiding. Unfortunately, although it would be useful to separate the different forms of violence, it is difficult to do so with the current data. In the next section, we look at the prevalence of one form of violence: internal warfare among foragers; that will lead us to look at the general homicide statistics in a new light.

Warfare

Put most simply, war is "relatively impersonal lethal aggression between communities" (Fry 2006: 91). "Impersonal" does not mean that warriors are not passionate. In fact, leaders must inspire passion if they want their followers to put their lives on the line and to kill someone who has done them no wrong. They accomplish this in part by what R. C. Kelly (2000) calls "social substitutability" – the idea that a wrong can be righted by killing anyone in another group containing the offending member. War is often fought for revenge or to retaliate for some slight, but I suspect that for a *group* to be compelled to retaliate, rather than just the offended party, the goal must also be to secure some advantage: to acquire slaves, women, food, or territory, or to acquire security through a preemptive strike.

It is important to separate war from other forms of violence because fighting to secure an advantage and fighting out of passion are two different things. There is rarely a direct calculation of risk when a man sets off in a rage to kill his wife's lover or to revenge his brother's death, but there is a calculation in warfare, at least by those calling for a raid: is the risk of losing (perhaps one's life) worth the possible benefit of securing an advantage? Such a weighing of costs and benefits means that warfare and, perhaps violence in general, can be understood from an evolutionary perspective. It becomes complicated, however, because the reason that communities fight is not the reason that the rank-and-file go to war. War requires understanding the relations between the communities involved but also between the leaders and followers within those communities (see Chapter 9).

Table 7-9 compiles cross-cultural data on warfare and its occurrence among egalitarian and nonegalitarian foragers (Fry 2006: 106). Warfare is more common among nonegalitarian hunter-gatherers. In egalitarian societies, people can level an ambitious and potentially violent man through teasing and ridicule before things get out of hand; or they can "vote with their feet" and move away from troublesome people. Just as there is no overarching mechanism to adjudicate disputes or punish wrongdoers – and, hence, stop interpersonal violence – there is also no mechanism for building a fighting force. Where others have glossed foragers as "violent" (Ember 1978; Keeley 1996), it is instructive to point out that nomadic, egalitarian foragers do not go to war as much as sedentary, nonegalitarian foragers; these two social forms should not be combined. War, as defined here, is relatively uncommon among egalitarian foragers (Knauft 1991; R. C. Kelly 2000).[36] Among nonegalitarian foragers, however, violence is culturally sanctioned (see Chapter 9's epigram) and often raises a man's status (Knauft 1987). And nonegalitarian foraging societies are universally sedentary peoples. As we argued in Chapter 4, sedentary foragers arise not from food abundance but rather because population density is so high relative to habitable places on the landscape that residential movement is not possible without displacing another group. War appears when mobility is not an option.

Warfare also appears among nonegalitarian societies in part because they are what R. C. Kelly (2000) calls "segmentary societies." These are societies in which the concept of "the group"

Table 7-9. Hunter-Gatherer Social Type and Warfare

Foraging Social Type	Warfare Absent	Warfare Present
Egalitarian	Ju/'hoansi, Hadza, Aranda, Copper Inuit, Mbuti, Andamanese, Semang, Saulteaux, Vedda, Paiute, Tiwi, Yámana, Slave	Montagnais, Gilyak, Ingalik, Micmac, Botocudo, Kaska, Aweikoma, Yukaghir
Nonegalitarian	–	Bella Coola, Haida, Gros Ventre,* Yurok, Comanche,* Yokuts, Chiricahua,* Kootenai,* Tehuelche,* Twana, Klamath, Eyak, Eastern Pomo, Aleut

* = Equestrian foragers.
Source: Fry 2006: table 8.3.

is well developed and, consequently, in which there is a concept of "group liability" (see also Roscoe [2009] on modular organization). The segments can be organized into a hierarchy – families, villages, and territorial groups. In segmented societies, specific families make up a lineage, particular lineages make up a clan, and so on (R. C. Kelly 2000: 45). These kinship units are well defined and less susceptible to negotiation. Unsegmented societies are fluid; families and individuals can move among coresiding groups, and the ties that link people together are negotiable (recall the Pintupi notion of one-countrymen). The numbers of people who are mobilized in segmentary organizations reduce the perceived cost of war and could lead to more frequent fighting (in Chapter 9, we ask what leads to such segmentary societies), but this still begs the question of what initially leads to war.

The proximate causes of war can be varied, and they can include mere insults or accusations of witchcraft. Although such causes may seem silly, at heart, they are not. For example, Ames and Maschner (1999: 195) recount how the Yakutat Tlingit attacked the Sitka Tlingit because the Sitka had out-sung the Yakutat two years in a row. It seems a silly thing to come to blows over, but the songs are a mere idiom for a far more significant fact. To retaliate after the first embarrassment, the Yakutat had learned songs from a neighboring group, but the Sitka had also increased their repertoire with songs from the Aleut. It was not the songs themselves that mattered but that the songs were evidence of friendly connections with others: with their more extensive playlist, the Sitka proclaimed themselves more powerful than the Yakutat. The Yakutat had to strike preemptively or risk being perceived as weak and attackable. The Yakutat's goal was to maintain a balance of power.

War, like any choice, has costs and benefits. The most devastating cost of war from the point of view of the participants is obvious: the warriors might die. The benefits are equally obvious: they might win resources – territory, supplies, women, and more. When does the benefit outweigh the potential cost? It is logical that one set of circumstances would be when the cost of not going to war is starvation. In that case, the *potential* cost of fighting, death, is the same as the *definite* cost of not fighting. So it is also logical that the ultimate cause of warfare would be related to a population's demand on resources (Durham 1976).

Table 7-10. Hunter-Gatherer Warfare and Population Pressure

Group	NAGP	Ratio	Population Density (persons/100 km²)	Population Pressure (ln)	v768
Ju/'hoansi	570	3.8	6.6	8.28	4
Mbuti	2,242	0.4	17	6.45	4
Semang	3,315	0.4	17.57	6.81	4
Andamanese	4,400	0.5	86	3.24	2
Tiwi	2,273	0.4	37.5	3.19	2
Gilyak	417	0.2	19.31	3.07	2
Ingalik	416	0.7	2.71	5.78	3
Copper Eskimo	42	0.7	0.43	4.22	2
Saulteaux	411	0.2	1.2	5.84	3
Slave	172	0.2	1	4.64	2
Eyak	573	0.2	5.86	4.36	3
Bellacoola	769	0.2	13	4.08	2
Yurok	685	0.8	131	1.43	2
Yokuts (Lake)	115	0.5	38.1	2.90	3
Klamath	286	0.8	25	3.82	1
Gros Ventre	391	0.35	3.37	5.31	4
Comanche	696	4.3	2.33	9.46	3
Chiricahua	485	0.7	1.16	7.98	4
Yámana (Yahgan)	484	0.2	4.8	3.00	3

See Table 7-8 for variable definitions.

Demand might be measured by population density: as population density increases, so too does the likelihood of war. However, in an analysis of the SCCS, including foraging and nonforaging societies, Keeley (1996: table 8.3) found no evidence for such a relationship. He argued that as societies become larger, the potential for warfare and serious, widely lethal violence becomes greater (think mutually assured destruction). Under such conditions, societies find ways to short-circuit aggression, through feasting or other "appeasement" rituals, and hence warfare declines.

However, population density is not an adequate measure of pressure on the food base (see Keeley 1996). High population density may simply reflect that there is a lot of food on the landscape, which can be converted into more people. Instead, the critical variable is *population pressure*. Population pressure is roughly a measure of how much food is available per person. Following Keeley's (1988) approach, we obtain a rough measure of population pressure by dividing the net above ground productivity (NAGP) of the group's environment by the population density. In this case, I followed Keeley's (1988) lead by first multiplying the NAGP by a fraction (from Kelly 1983, table 3, column 5) to reflect the portion of NAGP that is edible by humans and large fauna; the *higher* the value, the *greater* the food availability per person and the *lower* the population pressure. Does population pressure correlate with warfare?

Table 7-10 shows a sample of nineteen SCCS societies for which there are appropriate data. The warfare measure is variable 768 in the SCCS: "conflict between communities of the same society."[37] Conflict was measured along a 4-point scale: 1 = once a year, 2 = once every five years, 3 = once every generation, 4 = rare or never. There is *no* significant relationship between the incidence of internal warfare and population density ($r_s = -0.28$, $n = 19$, $t = -1.20$, $p = 0.35$).

However, there is a correlation between this measure of warfare and population pressure ($r_s = 0.59$, $t = 3.0$, $n = 19$, $p = 0.009$; Figure 7-6A; see also R. C. Kelly 2000). As population pressure increases, communities fight more often. It may seem odd that the Comanche appear more "peaceful" (conflict once every generation) than some other foragers in Figure 7-6A, given their reputation as fierce, even vicious warriors. However, they do rank high in the SCCS for *external* warfare (variable 774, once a year). The population pressure measure used here does not account for the pressure placed on the Comanche by advancing Euroamerican society. If it could, it would almost certainly push this case further to the left on the graph.

The Klamath are the most warlike of societies in this sample – and they also score as violent in terms of external warfare (same as the Comanche). The Klamath raided each other and their neighbors for slaves, who were sold for horses and guns; they also tried to control the trade of more northern peoples with those to the south (Murdock 1980). Whether this thirst for horses and guns was a product of Euroamerican encroachment or increasing pressure on the food base is not clear. It is clear, however, that their high level of conflict is not unexpected given their level of population pressure. Other societies living under high population pressure may have "solved" the problem of warfare, as we suggested previously, using other social mechanisms, such as the Yokuts mourning ceremony (Wallace 1978b).

This simple analysis agrees with Ember and Ember's (1992) broader cross-cultural one. There, they found that war was associated with societies that were impacted by periodic natural disasters, and, to a lesser extent, that were characterized by a mistrust of nature and of other peoples. However, they did not argue that war happened as a result of natural disasters – which would make sense in light of the previous discussion – but as a hedge against them. Given how the data were collected (see Ember and Ember 1992: 256), I suspect it likely that people who feel threatened by natural disasters are actually impacted by such disasters frequently enough that it would be hard to separate war generated by fear of disaster from war generated by actual disaster without analyzing each instance of violence. In fact, the Embers' variable that measures the "threat of disaster" predicts war as well as a variable that measures the actual occurrence of disasters.

Homicide

We can take the same approach to general homicide rates as we did to warfare since we can expect the tensions that erupt in interpersonal violence to be linked to overall societal stress, which could, in turn, be linked to population pressure (recall from Chapter 4 how the /Xai/xai Bushmen moved to visit relatives after days of bickering over food during a famine). Recall, though, that some of these estimates include those who died from warfare (so this is not an entirely separate test from that discussed previously).

Figure 7-6B shows the relationship between homicide rates (from Table 7-8) and population pressure. This relationship is not significant ($n = 15$, $p = 0.17$, $r = 0.37$). However, the Hiwi and Ache rates are probably too high (see previous discussion), and if we remove the major outlier, the Hiwi, the relationship is significant ($n = 14$, $p = 0.04$, $r = 0.54$): homicide rates increase with population pressure. Looking at Figure 7-6B, the trend seems to level out at a rate of 1,000/100,000. This may be the upper end of homicide/warfare death rates. Such high rates of death in warfare are rare events (Pinker 2011); neither the Piegan nor the Hiwi could probably sustain a homicide/warfare death rate of 1,000/100,000 for several generations. Under such a high rate, virtually everyone in the population would be affected by a death and that could lead people to pressure leaders to negotiate a solution that did not involve further bloodshed.

In sum, hunter-gatherers will always have some minimal level of violence that results from the rage that builds up among people in small groups who cannot avoid stepping on each other's toes. Homicide above this level, and more serious violence such as warfare, increases with increasing population pressure. At some level of pressure, people will weigh the benefits of violence higher than the potential cost. It is perhaps under such circumstances that groups form that are segmental,

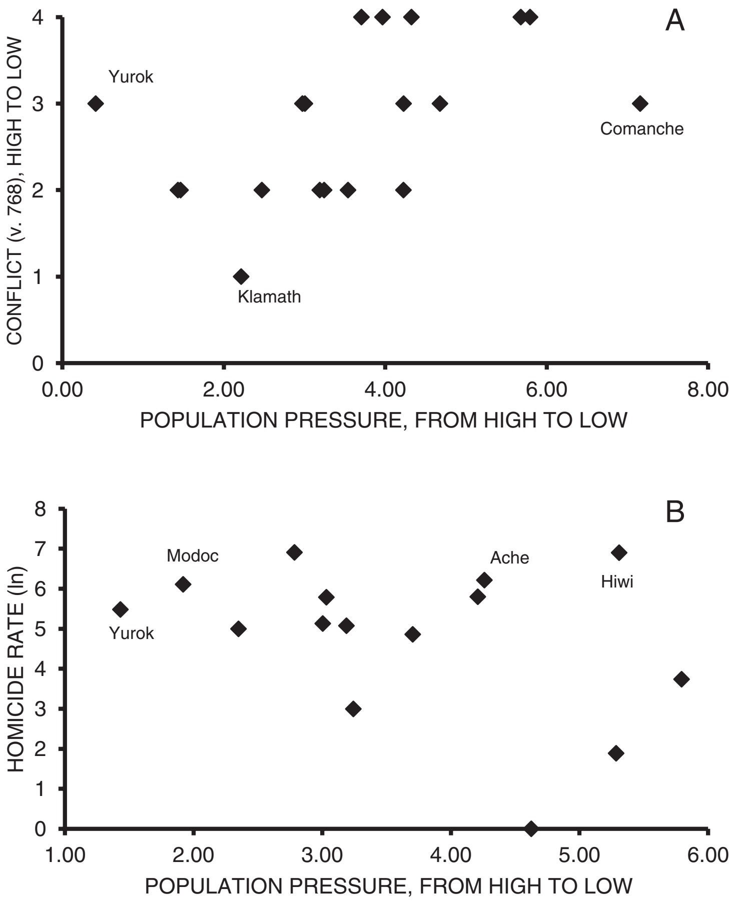


Figure 7-6. A: The relationship between population pressure and warfare (SCCS variable 768, conflict between communities of the same society. 1, yearly; 2, once every five years; 3, once every generation; 4, rare or never). B: The relationship between population pressure and homicide rates in a sample of foraging societies.

that permit social substitutability, and hence are primed for war. However, I suspect that Keeley (1996) is correct in that as the potential for warfare and a society's bellicosity increase, so too will the practice of peace-keeping behaviors such as the *potlatch* – fighting wars of property, as the Kwakwak'awakw say, rather than wars of blood.

Mobility and Population Growth

I have suggested that warfare is more common among nonegalitarian foragers and that nonegalitarian foragers are sedentary and live under high population densities. Warfare, then, is linked to the changing demography of sedentary foragers. What is the link between mobility and population growth?

As some mobile people become sedentary, the TFR increases (e.g., Binford and Chasko 1976; Hitchcock 1982; Roth and Ray 1985; Gomes 1982, 1990; Ellanna 1990). Since the sedentization process today is often associated with the availability of Western medicine, this association between population growth and sedentism could be a postindustrial phenomenon (although death rates similar to those of a nomadic context can also result from sedentism in a postindustrial context; see Early and Headland 1998: 116–17). Pennington (2001), in fact, suggests that among nomadic peoples, the major factor is the reduction in sexually transmitted disease sterility brought about by the availability of antibiotics. Populations affected by sexually transmitted diseases have primary sterility rates of 40 percent or more. Among foragers, they vary from 8 percent (Ngamiland Ju/'hoansi; Harpending and Wandsnider 1982) to 28 percent (Efe, Bailey, and Aunger 1995). The low TFR of the Ju/'hoansi, in fact, could be a result of unchecked sexually transmitted diseases reducing the mean age of last birth to thirty-four years (Pennington 2001).

The availability of modern medicine makes the archaeological study of mobility and demography all the more important. Although population increase does occur before the appearance of prehistoric sedentary villages in many parts of the world, dramatic population growth may also occur *after* the appearance of such villages. Although there is still much we do not understand about the relationship among behavior, biology, fertility, and mortality, it is possible for us to sketch out a model relating the factors we have discussed in this chapter to mobility (Figure 7-7).

We argued in Chapter 4 that sedentism is a trade-off between residential mobility and the use of resources that entail higher harvesting and processing costs. From this, we might deduce that both men and women must work harder in sedentary than in nomadic camps. A change in women's work may be especially important and could affect fertility in two ways. First, an increase in women's workload might encourage a reduction in or an early cessation of breastfeeding, perhaps through the use of weaning foods (Nerlove 1974). Either might reduce the energetic demand on a woman's body and help return her to regular ovulation. One cross-cultural study found that when a child's diet is supplemented *before* it is one month old (decreasing the need for breastfeeding), women perform more subsistence activities than women in societies in which children's diets are supplemented *after* the child is one month old (Nerlove 1974). Draper and Cashdan (1988: 343) also note that the adults of sedentary Ju/'hoan camps are more busy while they are at home than are adults in camps of mobile groups (although we do not know if this is related to sedentism itself or the particular circumstances of sedentization among the Ju/'hoansi). Finally, the sedentary Nata River Bushmen nursed less often and weaned children at an earlier age than the more mobile Kua – and the Nata River group appears to have higher fertility than the mobile Kua (Hitchcock 1982).

We know that breastfeeding works alongside diet and activity to affect fecundity through energy stores, balance, and flux. For women, reduced residential mobility may also result in a reduction in the aerobic quality of their work because they spend less time walking while foraging or moving camp and more time processing resources (Surovell 2000). My impression is that this is the case for recently settled foraging groups, but we have no direct evidence as to the difference in the aerobic quality of women's work in nomadic versus sedentary contexts.

We also noted in Chapter 4 that as mobility decreases, stored resources become the way to tide people over a lean period. Several researchers argue that the diet of recently sedentary hunter-gatherers is poorer than that of mobile groups (Hitchcock 1982), but this generally means that sedentary groups eat a less diverse diet containing less meat and more carbohydrates and sugar. Even if the diet of sedentary groups is chronically poorer or less diverse than that of a mobile population in the same region, reducing fluctuations in the diet through food storage could reduce fluctuations in the long-term energy balance and remove seasonal fluctuations in fecundity. Along with a decrease in breastfeeding and a decrease in aerobic activity, a constant long-term energy balance could increase fecundity. For example, Ju/'hoan women who live in sedentary settlements have diets that are higher in calories and that are more constant throughout the year; and they have both higher fertility and births spread more evenly throughout the year than do nomadic Ju/'hoansi (Hausman and Wilmsen 1985). Likewise, River Pumé have a more constant diet and less year-to-year and seasonal fluctuations in their food supply than do the Savanna Pumé, and they have both lower mortality and higher fertility than the Savanna Pumé (Kramer and Greaves 2007).

As we noted previously, children may be less susceptible to debilitating gastrointestinal disorders in sedentary villages, and a greater percentage of the increased number of offspring might survive.

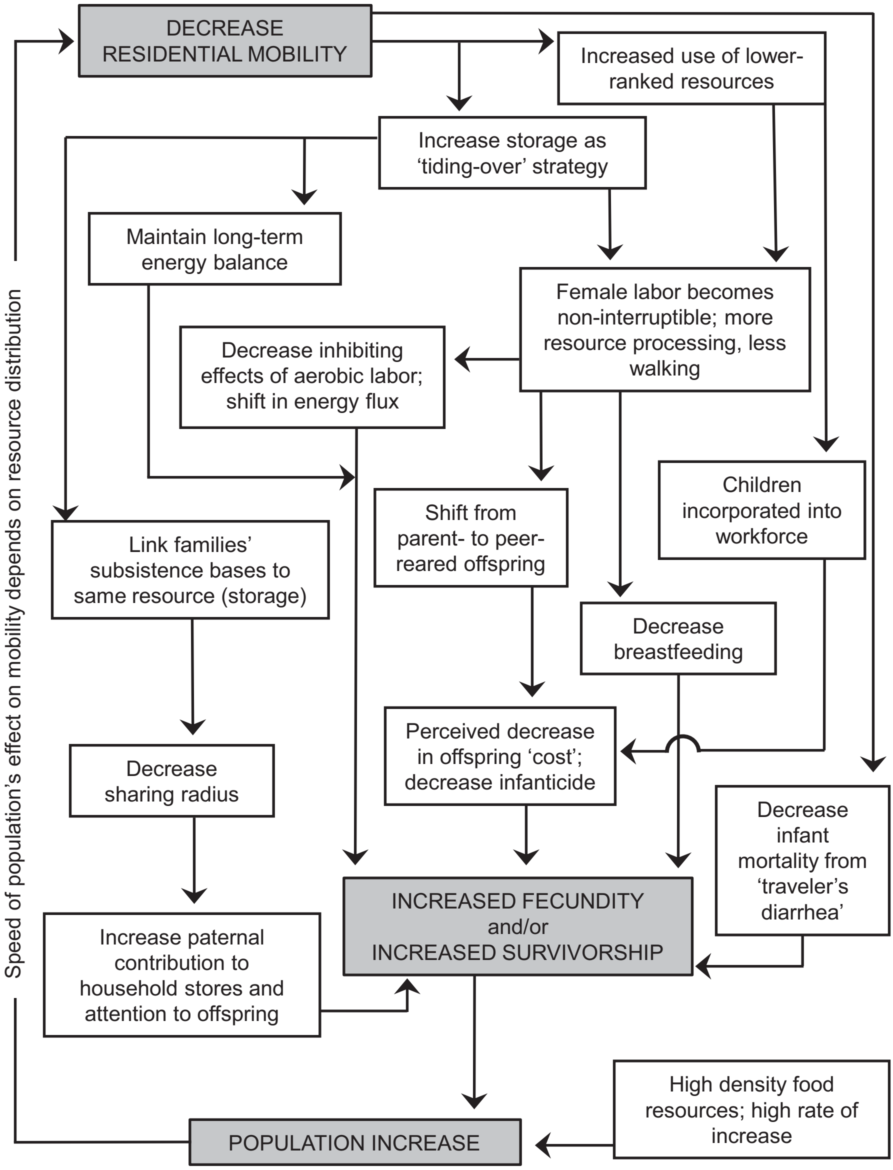


Figure 7-7. Potential relationships among factors that could lead sedentism to produce an increase in the rate of population growth.

However, more empirical studies are needed to determine how child mortality relates to changes in mobility.

Two other processes may reduce infant mortality due to infanticide as a group becomes sedentary. As women's work efforts increase with the use of lower ranked resources, children may be incorporated into the workforce. Draper and Cashdan (1988; Draper 1975) demonstrate a difference in child activities between nomadic and sedentary Bushmen. By helping care for domesticated animals, harvesting and processing agricultural produce, caring for other children, and doing tasks such as fetching water, children in sedentary Bushmen villages do substantially more work than children in nomadic camps. Additionally, as we described in Chapter 4, when women's labor increases, older children may care for infants and toddlers. When children are peer-reared and do adult labor, the perceived cost of raising children is lowered, and women may be inclined to raise more (Draper and Harpending 1987), since they would not have, as the Ju/'hoansi say, a "permanent backache" even if they gave birth frequently. Reducing the perceived cost of children, therefore, could also reduce the incidence of infanticide.

In addition, as we pointed out in Chapter 4, as a group of hunter-gatherers become sedentary, their subsistence may become tied to the same local resources (especially those to be stored since there is usually only one or two in an environment available in sufficient bulk to make them suitable for storage). Following the discussion in Chapter 5, hunter-gatherers who are linked to the same resource would do better to increase family or household stores rather than share. In this case, fathers may contribute more to household stores and, in so doing, contribute more to their offspring. As paternal input increases, child mortality due to infanticide or neglect may decrease.

In sum, sedentism can set into motion a number of interrelated biological, behavioral, and psychological changes that can result in increased fertility and decreased child mortality, and an increase in the population growth rate, even if such growth increases work efforts in the long term. The scenario we have outlined here, however, is speculative and requires testing against archaeological data.

Conclusion

We began this chapter with a review of hunter-gatherer group size – maximal and minimal bands – and foraging group size. We found that there was some evidence to support a residential foraging group of about twenty-five persons; group sizes above this may increase by a factor of four, up to a maximum regional interacting population of around 800. It appears to be foraging considerations that structure the residential group size, allowing for some additional members who would be difficult to remove.

We next saw that the argument over communal versus individual hunting is not an either/or question but rather an issue of optimal foraging group size. Smith provided a model that predicts foraging group size that assumes individuals attempt to maximize their own return rates regardless of the consequences for the group. Tests of the model suggest that just as with residential group sizes, social needs and realities built on a base of foraging efficiency condition foraging group size.

We then considered hunter-gatherer population dynamics, pointing out that simple carrying-capacity approaches do not model the dynamic relationship between predators and their prey. Theoretical models suggest that hunter-gatherer population dynamics are more complex than is suggested by the standard growth curve found in many carrying-capacity models. The amount of harvestable primary production, the length of the working day, resource return rates, and rates of resource response to exploitation all affect the rate of human population growth in computer simulations.

We examined evidence for cultural controls on fertility, finding that none of them was truly significant. Preferential female infanticide was probably relatively uncommon for many past hunter-gatherers. It may have been present in the Arctic, but the importance of this case for other foragers has been overstated. Nonpreferential infanticide may primarily be a birth-spacing mechanism and a reflection of how much assistance a mother thinks she will have with a child.[38] The perception of assistance is affected by how much foraging children can do, whether children can be left in camp while the mother forages, and how much assistance the mother expects from the child's father.

More important in fertility and population growth are biological mechanisms, specifically the intensity of breastfeeding, diet and seasonal variance in diet, and female activity. Frequent, intense breastfeeding; high seasonal variability in diet; a diet that is nutritionally marginal; and intense, frequent aerobic foraging by women act together to reduce fecundity. Modeling how women's activities and diet are affected under different circumstances will allow us to predict how different environments could produce different rates of foraging population growth. Infant and child mortality is very high in most foraging societies and is related to the harshness of an environment (which increases the potential for accidents) and the amount of disease present, which will be highest in wet/warm environments and lowest in cool/dry ones. By bringing children into continual contact with new parasites that result in diarrhea and dehydration, mobility may contribute to child mortality. I suspect that the low long-term rates of population growth in foraging populations evidenced by archaeology was a result of the impact of foraging on the physiology of reproduction, an impact that would have tracked climate-induced change in the environment. Homicide, and especially warfare, could be expected to appear under conditions of population pressure.

Finally, we outlined a scenario in which mobility and population growth are interrelated through complex social, psychological, and biological mechanisms. These may act together to produce a positive feedback loop: once a system begins moving toward storage and sedentism, the long-term rate of population growth may increase, raising the population density and increasing the cost of residential mobility (see Chapter 4); this further reduces residential mobility, thus increasing storage and the population growth rate. This model needs archaeological testing but, if correct, it suggests that hunter-gatherers may become caught in an upward spiral of increasing population density once they become sedentary.

Chapter 8

Men, Women, and Foraging

> Women dug roots and men ate them . . . men hunted rabbits and sat around.
>
> Paiute woman (I. Kelly 1964: 132)

> Dreams about men are good dreams . . . I dream like that all the time. God really tortures me with dreams [laughs]! But when I dream that someone is making love to me, it makes me happy. It means that I have lovers and I like that . . . One time, Bo found out about us [Nisa and her lover]. Debe and I had gone with some other people to live in the mongongo groves for a few days. When we returned to the village, people saw us and said, "Oh, you're all already dead! Nisa, you and your friend are finished. Your husbands are going to kill you." Because my friend was also there with her lover. My heart became miserable. I said, "If that's what's going to happen, then I'll sit here and when my husband comes, let him just kill me."
>
> Nisa, a Ju/'hoan woman (Shostak 1981: 329, 331–32)

You will be happy to know that Nisa's husband did not kill her. But it was from conversations such as those that the late Marjorie Shostak had with Nisa that anthropologists in the 1970s created a new model of hunter-gatherer social organization. This included bilateral (or sometimes patrilineal) kinship, bilocal postmarital residence, a sexual division of labor, egalitarian political organization, and male-female equality. As we discussed in Chapter 1, foraging society was early on defined in social terms, those of descent and residence. Although the stereotype shifted from patrilineal to bilateral descent, patrilocal to bilocal residence, male dominance to male-female equality, variability was ignored. In this chapter, we consider that variability, in the division of labor, postmarital residence, descent, and marriage. Our focus is on social organization as it entails relationships between men and women.

Division of Labor

One of the most important revelations of *Man the Hunter* was that foragers eat a lot of plant food – berries, seeds, tubers, and nuts. And since these foods are gathered primarily by women, the conference also emphasized the contribution of women's work to the foraging diet. And so, the two critical elements of the *man* the *hunter* model were overthrown. Hunter-gatherer societies were cast as sexually egalitarian ones, where men and women were equal.[1] Male hunting fell in importance, and women's contribution to subsistence could no longer be ignored (Brown 1970; B. Hiatt 1978; Barry and Schlegel 1982). But is it true that women and men in hunter-gatherer societies contribute equally to diet? Do they both do the same amount of work? Do men always hunt and women always gather? If so, what are the implications of a division of labor?

To answer the first question, Carol Ember (1975) used cross-cultural data from the ethnographic atlas (Murdock 1967) to conclude that yes, men do provide most of the food in most foraging societies. However, Ember's data are biased in favor of Arctic and high-latitude cases, where most of the food comes from large game and marine-mammal hunting (Hunn 1981), which is, as we'll see, men's work. In addition, based on ethnographic accounts for the Columbian Plateau in the northwestern United States, Eugene Hunn (1981) found that the atlas data outside the Arctic overemphasize men's contribution, reflecting an unwitting pre-*Man the Hunter* bias in favor of hunting.

Betty Meehan (B. Hiatt 1978) took a different approach. She used measures of dependence on hunted, gathered, and fished food along with estimates of how much of each category was provided by men or women to determine men's and women's overall contribution to diet (Table 8-1). Plotting those data against effective temperature (ET), they show that male subsistence contribution is inversely related to ET (Figure 8-1A; $r = 0.605$, $n = 70$, $p < 0.01$): the colder the environment, the more food is directly procured by men.

Figure 8-1A suggests that although there are cases in which men are almost the sole procurers of food (in the Arctic), the converse is not true. Given that women have childbearing and breastfeeding responsibilities, there is undoubtedly a limit to how little work men can do – perhaps a lower limit of around 25 percent of direct food procurement. In some tropical societies, there can be relatively little division of labor (see Marlowe 2007). In the dry season in southwestern Madagascar, for example, Mikea men and women both collect tubers (Figure 8-2). But as Figure 8-1A shows, there are tropical groups (Semang, Murngin, Andamanese, Mbuti, and Tiwi) in which men contribute more to subsistence than might be expected, and one cold-environment group, the Yámana (Yahgan), in which men contribute less than anticipated. With only 35 percent dependence on meat, I suspect that the Semang "male contribution" estimate is incorrect. The other tropical cases are ones in which men hunt to obtain bushmeat for trade or in which men do marine fishing. Conversely, the comparatively low input by men into direct food procurement among the Yámana may reflect the importance of shellfish gathering by women.[2]

These data pertain only to the labor of direct food procurement and are only proxy measures of the amount of calories each gender contributes to the family larder. They also are not measures of the overall amount of work that men and women in foraging societies do. Men in Arctic societies may bring in 90–100 percent of the food but, as we mentioned in the previous chapter, Arctic foraging women do plenty of other work:

> When seal hunting has been good, women are extremely busy and may feel somewhat pressed, because seal skins spoil if the blubber is not removed from them within a day or two. They may also work long hours sometimes if a man is in need of a new pair of boots or a new fur parka. In this sense, the rhythm of their work is dependent on that of the men. But the men are also dependent on the pace of the women's work. A man cannot hunt until his parka is finished, nor can he move his family to spring camp until his wife has finished making the tent. (Jean Briggs, in Halperin 1980: 394)

Nicole Waguespack (2005) demonstrates this point, showing that as the importance of meat in the diet increases, women devote less time to food procurement. However, she also shows that as the amount of meat in the diet increases, the percentage of tasks other than food procurement performed by women increases (Figure 8-1B), from 40 to nearly 100 percent. As women do less food procurement, they do more weaving, basketry, pottery and cordage manufacture, house building, firewood collection, water hauling, leather working, and camp moving. (Clothing,

Table 8-1. Effective Temperature (ET) and Division of Labor

Location	Group	ET	Male Food Procurement (%)	Activities Performed Predominantly by Women (%)
Siberia	Yukaghir	8.9	90	75
E. Greenland	Angmagsalik	9	100	–
S. America	Ona (Selk'nam)	9	75	–
N. Canada	Copper Inuit	9.1	90	–
N. Alaska	Nunamiut	9.8	85	–
S. America	Yámana	9.9	50	–
N.W. Coast	N. Tlingit	10	90	–
Canada	Chipewyan	10.3	100	–
E. Siberia	Gilyak	10.4	70	33
N.W. Coast	Haida	–	–	67
Alaska	Kaska	10.4	65	67
California	Klamath	–	–	67
S. Alaska	Chugach Eskimo	10.5	85	–
Canada	Caribou Eskimo	–	–	50
N.W. Coast	Bella Coola	10.5	80	33
Alaska	Eyak	10.5	80	–
Alaska	Ingalik	10.8	80	60
Canada	Pikangikum (Ojibwa)	11	90	–
Canada	Sekani	11.1	95	–
N.W. Coast	Tsimshian	11.1	70	–
W. Canada	Chilcotin	11.2	65	–
N.W. Coast	Quileute	11.3	70	–
Canada	Beaver	11.3	68	–
Aleutians	Aleut	11.6	90	–
E. Canada	Montagnais	11.6	70	–
Canada	Saulteaux	11.7	70	67
Japan	Ainu	12	50	–
Plateau	Flathead	12.1	60	–
N.W. Coast	Klallam	12.3	75	–
California	Washo	12.3	55	–
Plateau	Gros Ventre	12.4	80	80
N.W. Coast	Squamish	12.6	90	–
N.W. Coast	Nootka (Nuuchahnulth)	12.6	65	–
N.W. Coast	Cowichan	12.6	60	–
E. Canada	Micmac	12.7	85	86
Plateau	Coeur d'Alene	12.7	70	–
Plateau	Kutenai	12.7	70	67
Plateau	Sanpoil	12.7	58	–
S. America	Tehuelche	12.8	85	57
California	Tubatulabal	12.9	58	–
Plains	Crow	13	80	–

Location	Group	ET	Male Food Procurement (%)	Activities Performed Predominantly by Women (%)
Great Basin	Tosawihi (White Knife)	13	50	–
Plains	Arapaho	13.2	80	–
Plateau	Umatilla	13.3	70	–
California	Achumawi	13.3	60	–
California	Yurok	13.3	58	33
Plateau	Tenino	13.3	50	–
California	Chimariko	13.5	80	–
California	Maidu	13.5	58	–
Great Basin	Kaibab (S. Paiute)	14	48	–
Plains	Comanche	14.4	63	100
Southwest	Chiricahua	–	–	86
S. America	Botocudo (Kaingang)	14.4	50	50
California	Wintu	14.6	78	–
California	Diegueno (Tipai-Ipai)	14.6	50	–
California	S. Yokuts	14.7	73	–
California	E. Pomo	14.7	63	40
California	Wappo	14.7	63	–
Great Basin	Panamint	15	40	–
Great Basin	Shivwits (S. Paiute)	15.1	48	–
Australia	Aranda	15.9	30	67
Australia	Dieri	15.9	30	–
Southwest	N.E. Yavapai	16	55	–
S. America	Aweikoma	16.5	70	67
Africa	Hadza	17.7	20	–
Australia	Walpiri (Walbiri)	18.4	30	–
Africa	Ju/'hoansi (Dobe)	18.8	40	50
Africa	G/wi	19.3	30	–
Australia	Wikmunkan	19.6	35	–
Australia	Tiwi	22.6	38	67
South America	Yámana	–	–	80
Australia	Murngin	23.5	53	–
Malaysia	Semang	23.7	80	67
Africa	Mbuti	23.7	40	–
Andaman Is.	Andamanese	24.4	50	–
Venezuela	Pumé	24.5	25	–

Sources: B. Hiatt (1978); ethnographic or author estimates; Pumé data courtesy of K. Kramer and R. Greaves; percent activities performed predominantly by women from Waguespack (2005).

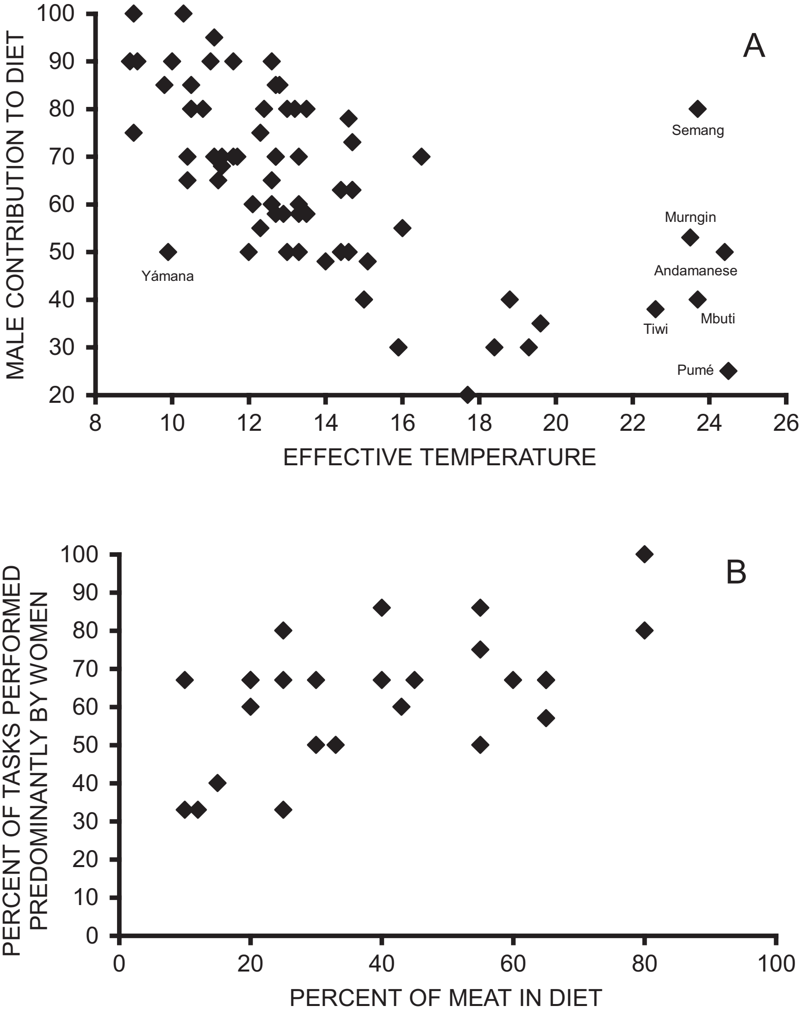


Figure 8-1. A: Relationship between effective temperature and men's contribution to subsistence (100 = men directly procure all food). B: The relationship between the amount of meat in diet and the percent of nonhunting tasks accomplished by women (from Waguespack 2005). Reproduced by permission of the American Anthropological Association from *American Anthropologist*, 107(4), figure 3, p. 672, December 2005. Not for sale or further reproduction.

by the way, seems to be especially time-consuming to make and is obviously crucial in colder environments.) So, why don't women do some of the hunting?

Why Do Men Hunt (and Women Not So Much)?

In fact, women in foraging societies do hunt small game regularly and, occasionally, large game. Sometimes women set out intentionally to hunt small game. Martu women in western Australia, for example, frequently hunt goannas and skinks (Bliege Bird and Bird 2008).[3] In many other foraging societies, women hunt small game opportunistically, setting out to gather plant food and changing plans if they encounter small game. The hunting of *large game* is usually men's work – and that is our focus here.

Figure 8-2. Rabemainty, a Mikea man, digging for roots in July 1993. Among the Mikea, both men and women gather roots in the dry season. Most hunting, done almost exclusively by men, occurs in the wet season. Photo by the author.

There are, in fact, quite a few individual cases of women hunters, even in the Arctic (Landes 1938: 137; Watanabe 1968: 74; Romanoff 1983). Women also participate in communal game drives (Turnbull 1965; Bailey and Aunger 1989b) and can have extensive "bush knowledge" as well, which they use to assist their husbands in hunting (see Biesele and Barclay 2001). Individual or small group hunting, in fact, requires patience and skill more than strength; and plant collecting, especially digging for tubers, can be a physically demanding task (and frustrating if done with children in tow). So, strength, endurance, or patience does not explain why women do not regularly hunt large game.

One case of women hunters who appear to be a striking exception is that of the Philippine Agta (Figure 8-3; Estioko-Griffin and Griffin 1981, 1985; Goodman, Griffin, Estioko-Griffin, and Grove 1985). Agta women are good hunters, coming home with a kill 31 percent of the time, whereas men average 17 percent; mixed groups of male and female hunters are even more successful, coming home with kills 41 percent of the time (note, however, that these data are based on only six women). The higher success rate of the women is not because they are better than men at hunting but rather because the men tend to target the larger, more difficult to acquire prey (and, as a result, bring in twice as much meat as do women). Both men and women hunt wild pigs and deer, but Agta women usually hunt as part of game drives, and they use dogs.

Few Agta women hunt (although all Agta men do), and there is more variation in how good they are at hunting than among men (Estioko-Griffin and Griffin 1985). Although we might suppose that Agta women have different physical capacities than nonhunting women, Agta women hunters are no taller, larger, or older than nonhunting women. There is also no difference between the two groups in terms of age at menarche, age at first pregnancy, or total number of living children. Women hunt while menstruating,[4] and if a child is still breastfeeding, the mother may take him or her along in a shoulder sling; older weaned children are left behind in the care of a female relative.

However, the Agta may be the proverbial exception that proves the rule. Very few Agta women actually hunt (fewer than 100 from a population of 9,000; Gurven and Hill 2009), and they rarely hunted when lactating or pregnant; women with infants hunted less than women without infants. Women also hunted within a twenty- or thirty-minute walk (5 km) of camp, so that they could return quickly to care for children. (Similarly, Batek women in Malaysia tend to hunt small birds and squirrels and hunt in short bouts close to camp, but they are not as successful as Agta women; see Endicott and Endicott 2008: 76.) Agta women hunt because they can leave their children with others and can hunt fairly close to camp; "a harsher environment or a more retentive or individualistic mode of childcare and -rearing might have discouraged women's hunting" (Goodman et al. 1985: 1208).

One explanation of the division of labor is that pregnancy, breastfeeding, and childcare are incompatible with hunting large game (Brown 1970; Burton, Brudner, and White 1977: 250). Since an infant's primary food is breast milk and since, as we saw in Chapter 7, children may breastfeed until they are several years old, women of childbearing age are frequently accompanied by children while foraging. Hunting is not necessarily more physically demanding than gathering for adults, but it is so for children. Additionally, since the prey more or less controls the hunt, the hunter cannot interrupt pursuit to tend to a child's needs. Gathering is an interruptible activity but hunting is much less so. Gathering plant foods allows a person to return to camp when necessary, but hunting may require an overnight stay so as to continue tracking the animal in the morning.[5] Mikea men did not want to take me hunting, claiming that I would get tired, be hungry, complain, make noise, and ask to return to camp; in other words, they were afraid I would act like a small child (likewise, the Batek prefer not to have children along on a hunt for the same reasons; Endicott and Endicott 2008: 107). Gathering is more compatible with breastfeeding and childcare than is large game hunting.

Tending to a child means not digging tubers or picking berries, so it is not surprising that Ache, Hiwi, and Hadza women with children are less efficient foragers than women without children (especially if breastfeeding; Hurtado, Hawkes, Hill, and Kaplan 1985, 1992; Marlowe 2010: 214). It is likely that if a woman were to hunt with a child on her back or following behind her, she would quickly realize that the return rate of large game hunting for her was lower than other foraging choices. According to the diet-breadth model, she would forgo large game hunting for those other choices.

This is why the most serious female Agta hunters are those who have reached the end of their childbearing years, those with children old enough to look after themselves in camp, or those who are sterile. Although women with nursing infants or a number of young children will occasionally hunt if the opportunity arises, it is older women who set out intentionally to hunt (P. Bion Griffin, personal communication, 1990). Aka women, conversely, can net hunt (often in single-sex hunts) because the group provides assistance with children (and also protection from rape and accusations of liaisons; see Noss and Hewlett 2001). These net hunts happen fairly quickly, often several times a day. This means that a woman could participate in one or two and then return to camp to care for a child. Children may be cared for by others in camp (e.g., among the Hadza, about a third of the time that a child is held, it is held by someone other than

Figure 8-3. Out hunting with bow and arrow near the Malibu River in the Cagayan Province in the northern Philippines in 1982, an Agta woman signals to a female companion that she has spotted game – wild pigs feeding on fruit fallen from a tree. Courtesy of P. Bion Griffin.

the mother), but this does not seem to reduce the amount of time that mothers spend with their own children (Marlowe 2005b; Meehan 2005; Crittenden and Marlowe 2008). In other words, even with help, foraging women are never completely free of childcare obligations. Women hunt when it is compatible with children, and this usually means communal net hunts and/or hunting small, not very mobile game. Women undertake child-compatible hunting when that activity provides higher returns than other foraging opportunities (see Bliege Bird 2007).

If childcare prevents a woman from hunting when young, then she cannot acquire the experience to be an effective hunter later in life. It takes a long time to learn to hunt well – some ten to twenty years (Gurven, Kaplan, and Gutierrez 2006; Gurven and Kaplan 2006; Marlowe 2010). It is simply not worth the investment for a woman to start learning to hunt after her childbearing years – especially since her gathering productivity may dramatically increase later in life, when she can work without a child (e.g., Howell 2010: 114). Instead, she will work for her daughters by foraging for them, as happens among the Hadza, or by watching after their children, as is the case among the Ju/'hoansi (Hawkes, O'Connell, and Blurton Jones 1989; Marlowe 2010).[6]

This difference between men's and women's foraging is important. It means that women target reliable but low-return-rate foods, whereas men target less reliable but high-return-rate foods. Large game hunting is a highly valued activity in foraging societies, even when it has appallingly low success rates. The reason is that meat from large game is always shared – because it is highly desired for its fat and because it cannot help but enter camp in large packages. Everyone benefits and the hunter acquires the prestige that comes with gift giving. This means that *even the most egalitarian of foraging societies are not truly egalitarian because men, without the need to bear and breastfeed* *children, are in a better position than women to give away highly desired food and hence acquire prestige.*[7] The potential for status inequalities between men and women in foraging societies (see Chapter 9) is rooted in the division of labor (Collier and Rosaldo 1981: 282; Bliege Bird, Codding, and Bird 2009).

This is not a matter of the volume of food collected – indeed, on many days, a family would go to bed hungry were it not for the mother's foraging – but of the potential one's resources have to be shared outside the family.[8] Men target high-return/high-variance resources that are widely shared for prestige, whereas women target lower return/low-variance resources that largely remain within the household. This fact could also establish "cultural" rules about particular foraging activities and the control of the necessary technology, such as nets, that effectively prohibit women from participating in "male" foraging (Noss and Hewlett 2001; see also Brightman 1996). Stated simply, the incompatibility of hunting large game with childcare creates foraging choices that could make husbands and wives less of a cooperative unit and more like competitors (Bliege Bird and Bird 2008; Bliege Bird et al. 2009; Codding, Bliege Bird, and Bird 2011). Does it?

Costly Signaling or Provisioning?

How do we account for men's apparent devotion to an activity with a lower probability of success than the alternatives? The possible answers concern the evolutionary strategies we discussed in the previous chapter: investing in mating opportunities versus investing in parenting offspring (Bliege Bird 1999; Bliege Bird, Smith, and Bird 2001). We argued that women are expected to invest in parenting offspring whereas men may seek more mating opportunities and leave the parenting to the mothers. Large-game hunting could be a way to provision a family (by keeping most of the meat there), to reduce variance in meat intake (through sharing), to gain extramarital liaisons (through trade, as among the Ache), to build political alliances (by sharing meat and helping other men provision their families), or all four.

Costly signaling, which we described in Chapter 7, describes the process whereby men signal their quality and gain mating opportunities and/or build political alliances. Hunting accomplishes this since it is an honest signal (you cannot fake killing a bison) and widely advertised (everyone gets something to eat). The assumption is that men are advertising their qualities. These might be genetic – strength, stamina, eyesight and hand-eye coordination, tenacity, and so forth, but they might also be developmental or cultural – skill and generosity, for example. And these are qualities that a woman might want in a husband. In looking for a husband, Hadza women look for a man who is a "good hunter" and, if possible, one who is of "good character" (meaning he won't have affairs) and "attractive" (Marlowe 2004b, 2010; the same is true of Ju/'hoan women [Howell 2010: 114]).

Data from the Ache, Hadza, Ju/'hoansi, Lamalera, Meriam, and Tsimane show that good hunters have greater reproductive success (Smith 2004; Gurven, Winking, Kaplan, von Rueden, and McAllister 2009) than poorer hunters.[9] Do these men have greater reproductive success because they gain more mating opportunities or because they invest in their families? The data are not clear, but I suspect it is the latter for four reasons. First, in the preceding cases, only the Ache data must include children from extramarital affairs for good hunters to achieve higher reproductive success than poor hunters. In the other cases, good hunters achieve higher reproductive fitness through their legitimate offspring. Men stand to lose if they have affairs; the gain in illegitimate offspring may be offset by divorce and the loss of further children with their mother (and, as we saw from the previous chapter, divorce can leave a man's offspring in danger from his former wife's future husband). Instead of extramarital affairs, good hunters may get a head start on poor hunters by marrying earlier, as appears to be true for Lamalera whale hunters (Alvard and Gillespie 2004).

Second, it now seems clear that the family of a good hunter receives more meat from the husband's efforts than do other families (Gurven 2004a). Hadza men, for example, keep the lion's share of their kills for their families, especially when those men have young children (Marlowe 2010).[10] The children of better hunters are perhaps a little better fed and hence more likely to survive. Cross-cultural data also suggest that where men provide more food, largely in the form of meat, women have higher fertility (Marlowe 2001). Presumably, this is because wives are being provisioned with high-quality food, improving their fecundity (Hadza women have a higher body-fat percentage when meat as opposed to tubers are the staple; Marlowe and Berbesque 2009). Interview data also suggest that Hadza men prefer to be in groups with good hunters who will provide meat rather than groups with more mating opportunities (single young women; B. Wood 2006).

Third, I suspect that many foragers take the expression "good hunter" to be a euphemism for "good forager" or even "good all-around man." Marlowe (2010) shows that Hadza men who are good hunters are also good general foragers. Even if large-game hunting has a low success rate and benefits others, men who are good hunters will probably not come home empty-handed. Ju/'hoan men, for example, who fail to make a kill "often bring back some vegetable foods or at least get a load of firewood before they return to the village" (Howell 2010: 115).

Fourth, unmarried men are most likely competing for wives who are good foragers (and vice versa). Hadza men and women both want spouses who are hard-working (Marlowe 2004b, 2010); the same is true of the Ju/'hoansi (Howell 2010: 210) and the Tsimane, where work efforts between spouses are correlated: hard-working women marry hard-working men (Gurven et al. 2009). The higher reproductive success of good hunters might be attributable to their wives' efforts; in fact, this appears to be true for the Meriam (Smith, Bliege Bird, and Bird 2003).

So, men aim largely to provision their families. And yet, men also undertake risky foraging activities. These may be dangerous activities, but "risky" here really means "a low probability of success." Hunter-gatherer men do this frequently enough that it demands an explanation. Costly signaling may provide exactly that. Where food resources are both high return rate and *not* risky, we might expect both men and women to devote most of their foraging effort to provisioning families. But where high-return-rate resources are also risky – and that is usually the case – and when a wife's foraging can sustain a family's needs, men can devote some portion of their time to acquiring those resources that are shared and that build up a hunter's (and his family's) political capital (Codding et al. 2011).

Meriam men, for example, would do better to forgo some of the fishing activities they undertake for the ones that women do (Bliege Bird 2007). Bliege Bird (2007) argues that Meriam women's choices are not constrained by compatibility with childcare (although children do lower women's returns on three of the five fishing activities for which there are relevant data). Men focus on hard-to-acquire species that permit a man to demonstrate his skill. Neither men nor women spend much time on the most high return rate activity – near-shore netting of sardines (although men spend twice as much time as women). Bliege Bird suggests that this might be because it acquires a sufficient amount of household food in very short order (and the take from net fishing is consumed predominantly by the household). In other words, this particular fishing is a lot like gathering plant food: work hard at it and you simply end up benefitting others who demand-share the return. Meriam men also undertake sea-turtle hunting to provide feast food – something that women never do (Smith and Bliege Bird 2000; Bliege Bird, Bird, Smith, and Kushnick 2002; Smith et al. 2003). This activity demonstrates skill at several levels and is risky in that failure produces a public embarrassment. Meriam women tend to focus on lower variance foods whose volume is an honest signal of how hard a woman works. Meriam men spend time on high-variance fishing activities to acquire resources that are highly desired (such as deep-sea fish) and shared or that demonstrate skill (e.g., spearfishing small reef fish). Still, Meriam men provide 60 percent of their households' food (Bliege Bird 2007).

Likewise, Bliege Bird and Bird (2008; Bliege Bird et al. 2009; Codding et al. 2011) also show that Martu men in Australia's Western Desert would do better over the long term to ignore kangaroo and bustard hunting (Australia's large game) and let women bring in the smaller but more reliably acquired goannas (Figure 8-4). Men hunt, in this case, to provision old men with large-game meat so that they can acquire religious knowledge (of the Dreamtime), to show respect for "the Law," and thus to acquire wives. By targeting the more difficult to acquire large game of their environment, men are signaling their qualities, albeit not directly to potential mates but rather to the elders who will arrange their marriages. Women, in the meantime, share goannas with one another to build and maintain cooperative bonds. (On those occasions when Meriam women take fish that men normally share, they too share them [Bliege Bird 2007].) It is the resource, not the gender, that drives sharing. But men tend to go after the risky, "sharable" targets more than do women.

Marlowe (2007) suggests that if women procure reliable foods as the daily fare, they might very well *want* their husbands to focus on more "risky" but highly desirable and widely shared foods for both reciprocity-in-kind as well as the political benefits that accrue to generous families. Both are necessary for a family to survive and thrive. This suggests that if women can forage for what men forage, even when burdened with children, or where women can provide much of a family's daily needs, men may seek high-variance foods that allow them to share and build political capital. Put another way, costly signaling is a likely explanation of men's foraging choices where both the opportunity to undertake high-variance (and perhaps even dangerous) hunts is present and where men's contribution to the daily diet is not so essential or is easily met. These behaviors are not necessarily intended to signal men's genetic attributes or to acquire more mating opportunities. Instead, they communicate to potential allies and competitors one's skills, abilities, generosity, and propensity for hard work. In this, generosity helps acquire allies and ward off competitors.

In sum, I think the evidence suggests that the division of labor is rooted in the fact that large-game hunting is not compatible with children and that children, by virtue of their need for breast milk, must remain with their foraging mothers. Hence, women do little hunting. But this fact can both allow and encourage men to pursue large "risky" game that they can use for political purposes; the results of such actions can assist their wives as well – so women might encourage men in their "risky" pursuits. In this sense, husbands and wives cooperate, although one can imagine that men could spend too much time (in their wives' opinions) chasing prestige.

This discussion raises the issue of childrearing and how women might resolve conflicting demands on their time – to forage (and collect firewood and so on) and to care for children. One way is to seek assistance, and this fact might affect and be affected by the practice that anthropologists label "postmarital residence." To consider this possibility, we have to tour the anthropological research on postmarital residence among foragers.

Postmarital Residence

As we discussed in Chapter 1, Julian Steward argued that band societies, most commonly represented by hunter-gatherer societies, predominantly display patrilineal descent and patrilocal postmarital residence. Elman Service argued that the key feature was patrilocal residence because he saw patrilineal descent as following from it (see also Murdock 1949). Both Service and Steward agreed that patrilocal residence derived from the presumably natural dominance of men and also from "the importance of the solidarity of the males in hunting, sharing game, and particularly in offense-defense" (Service 1962: 67).[11] Service argued that the prevalence of patrilocal residence in foraging societies in so many different environments indicated that the local habitat had no bearing on postmarital residence and, by extension, social organization. Service attributed deviations from the patrilocal model (e.g., composite bands, with bilocal or neolocal residence) to population decline brought about by European-introduced disease.[12]

Man the Hunter changed much of this. Participants noted that many ethnographic cases did not fit the patrilineal/patrilocal model, yet these societies did not appear to be affected by radical demographic change. June Helm (1965), for example, showed that composite bands of Canadian

Figure 8-4. Martu women and children, returning from hunting lizards. At left, Cecilia, holding her daughter Shaylene, returns from hunting sand monitor and other small prey in a recently burned area in March 2004 with daughters Roshaun and Brianna and her mother Nola. Roshaun holds a blue-tongued skink in one hand and a sand goanna in the other. Their hunting tools are long metal crowbars fashioned from abandoned windmill shafts. Courtesy of Rebecca Bliege Bird.

Athapaskans were not made up of unrelated families. A new model developed after the conference that emphasized bilateral descent and bilocal (or multilocal) residence, in which the couple lives with the bride's and then the groom's family and possibly on their own (actually, Murdock [1949: 204] suggested that bilocality should be prevalent among hunter-gatherers in unstable bands long before *Man the Hunter*). After *Man the Hunter*, anthropologists saw hunter-gatherer social organization as more fluid and variable than the patrilocal/patrilineal model allowed. By permitting group sizes to adjust to changes in resource abundance and demographic imbalances (in sex ratios, for example), and by allowing group fissioning as a way to settle disputes, bilateral descent was considered to be more adaptive (in the cultural ecologists' sense) than unilocal descent. The fluid, bilateral, bilocal hunter-gatherer model of band society soon replaced the patrilineal/patrilocal model.

Ten years later, however, Ember (1978) tested the assumption that most known hunter-gatherers have bilocal residence. Her survey of 179 cases showed *patrilocal* residence to be the most common form of postmarital residence (62 percent; omitting equestrians, 64 percent; omitting equestrians and intensive fishing groups, 56 percent). A survey by Kay Martin and Barbara Voorhies of ninety foraging societies reached a similar conclusion (58 percent patrilocal [1975: 185]), and the same result derives from Table 8-2 of 193 cases (in 99, or 65 percent, of those cases where there were no contradictory accounts). In terms of descent, Martin and Voorhies found that 62 percent of their sample was made up of groups with bilateral descent; only 37 percent of Table 8-2 have bilateral descent (excluding nine cases with contradictory accounts).

From Table 8-2, it would appear that the most common pattern is bilateral descent with patrilocal residence (47 percent of this compilation). However, cross-cultural samples are tricky

Table 8-2. Hunter-Gatherer Postmarital Descent and Residence

Descent	Patrilocal	Matrilocal	Residence Bilocal	Avunculocal	Contradictory	Total
Patrilineal	24	0	0	0	2	26
Matrilineal	3	9	0	6	4	22
Bilateral	69	19	18	0	30	136
Contradictory	3	0	0	0	6	9
Total	99	28	18	6	42	193

Notes: Viri/patrilocality are combined, as are uxori/matrilocality and neo/bilocality; bilateral descent may include some cases of double descent; the contradictory category contains groups with contradictory assignations.

This table is not a random sample but rather a summary of all cases that I have checked. It is biased toward North American groups. All three of these cross-cultural surveys are affected by a latitudinal bias, for we have few temperate cases outside of specific culture areas such as the Plains and California. Thus, there is the potential for bias toward particular latitudes and, especially, culture areas in these samples.

Sources: Most data from Driver (1961); Driver and Coffin (1975); Murdock (1967).

because it's possible to bias the sample toward groups that are culturally related. For example, we have no foraging societies from the eastern United States, Europe, and much of Asia; instead, the sample is biased toward western North America, the Arctic, and tropical regions (especially of Africa). The standard cross-cultural sample (SCCS) (Murdock and White 1969) was intended to minimize this problem by including societies that were not culturally related. Of its sample of thirty-six foraging societies, 75 percent have bilateral, ambilineal, or double descent; 11 percent have matrilineal descent; and 13 percent have patrilineal descent. In the same sample, 49 percent of the societies have multilocal postmarital residence, 34 percent patrilocal, and 17 percent matrilocal (see also Knauft 1991; Marlowe 2004a; Fry 2006). The dominant (44 percent) pattern in this sample is bilateral descent with multilocal residence; strict patrilocal residence is infrequent. This is a significantly different pattern from that of agriculturalists, which do tend to be patrilineal and patrilocal (Marlowe 2004a).

These surveys only point to patterns in descent and residence. As Ember (1975: 199) reminds us, "assuming that different residential patterns are the result of different causal conditions, that which is normal as of recent times may only be a statistical artifact of the recent prevalence of certain of those causal conditions." In other words, cross-cultural studies are useful beginning points, but we now need to ask: what factors condition postmarital residence?

Anthropologists have tried to explain the different forms of postmarital residence among hunter-gatherers (Table 8-3). Here, we consider only the three most common patterns: matrilocal, bilocal, and, to begin, patrilocal residence.

Steward and Service argued that hunters should live patrilocally, in part because men need to be familiar with a territory in order to hunt successfully in it. As we noted in Chapter 1, both Steward and Service thought hunting was of prime importance to hunter-gatherer societies, and so they associated the hunter-gatherer lifeway with patrilocal residence. A derivative of this hypothesis is that if hunting is *not* important, then women's familiarity with an area should be of primary importance and residence should be matrilocal. Assuming that men do most of the hunting and fishing and that women do most of the gathering, societies dependent on hunting or fishing should have patrilocal residence, whereas societies dependent on gathering should have matrilocal residence. Ember (1975) tested this hypothesis by looking for correlations between residence practices and the division of labor in a sample of fifty societies.

Ember found a significant tendency toward matrilocality among societies heavily dependent on gathering and a significant tendency toward patrilocality among societies heavily dependent

Table 8-3. Explanations of Postmarital Residence Rules

Residence Pattern	Author	Explanation
Patrilocal	Stewart, Service	Permits men to be familiar with area to ensure success in hunting; provides strength in offense and defense; result of "natural" dominance of men
Matrilocal	Ember, Perry	Associated with long-distance warfare or hunting, coupled with women as primary food and childcare providers
Bilocal	Ember, Service, and others	Response to fluctuating environments; evens out skewed sex ratios of small groups; results from colonization and breakdown of previous patrilocal rule

on fishing. In contrast to the patrilineal/patrilocal model, however, she found no correlation between heavy dependence on hunting and patrilocality (Ember and Ember 1971; Ember 1975). Some North American boreal-forest groups, for example, have matrilocal residence and yet are heavily dependent on large game, such as caribou and moose. In fact, Marlowe (2004a) found that the *more* heavily a group relied on hunting, the *less* likely they were to have patrilocal residence. It does not appear to be true that male relatives must remain together in order for men to be successful hunters. Among the patrilocal Efe Pygmies, Bailey and Aunger (1989b) found that neither hunting efficiency nor hunting success were correlated with the degree of relatedness of the hunters nor the proportion of relatives on a hunt. (Conversely, Hewlett [1988] found that an Aka male with brothers is more likely than a male with no brothers to live in a reliable economic unit.)

Ember (1975: 212) suggested that in areas where game is not predictable, there is no advantage to men remaining where they grew up, an explanation that has some merit. Hunter-gatherers use varying mixes of two basic food-getting strategies. In one, the forager learns an area, exploiting the geography of that area to procure food resources. An example is the Gwich'in (Kutchin), who live in Alaska's interior forests. The Gwich'in know the geography of their land extremely well – where springs, game trails, recent burns, and other good hunting places are as well as sheltered places, firewood, and raw materials. One of their most important foraging tools is a mental map of resource geography.

In the other strategy, the forager learns the various characteristics of the desired food resources, for example, where food is likely to be at certain times of the year or under different weather conditions (R. Nelson 1986: 275–76; N. Peterson 1975). The Inuit of Alaska's northern coast provide an example of this strategy. When living on the frozen surface of the sea during the winter, the Inuit face a landscape that changes from day to day as the ice shifts. Here, the Inuit learn animal behavior intimately and use it to predict where seals or fish will be found given the day's configuration of ice, water, and weather.

Foragers use both strategies, but one may be emphasized depending on the nature of the food resources and geography; the fewer resources used, or the more monotonous an environment, the more likely that one or the other strategy will dominate. There could also be seasonal and long-term shifts in the importance of these strategies. For example, a person could learn the resource geography of as large an area as possible to be able to call on that knowledge in times of need, whereas the short term rely more on knowledge of animal behavior.

Differences in the short- and long-term predictability of large game could account for some of the variability in postmarital residence among societies heavily dependent on hunting (see also Marlowe 2004a). The more that hunter-gatherers depend on hunting, the larger both their yearly foraging ranges and long-term ranges must be (see Chapter 4). And the more unpredictable their resource base, the more important it is for them to learn as large an area as possible. Both these factors could encourage matrilocal postmarital residence (at least as the initial practice of a marriage) as a way to learn the area of the wife's country, since the hunter already knows the area in which he grew up. In this case, postmarital residence could reflect hunters educating themselves about a region to decrease long-term variance in returns and reduce risk.

Ember also considered the effects of warfare on postmarital residence. In her sample, matrilocality is associated with external warfare, long-distance fighting between different social groups (see also D. Jones 2011). Ember argued that external warfare is associated with matrilocality only if warfare places more emphasis on women as the primary procurers of food (Ember and Ember 1971).

Ember also tested several hypotheses of bilocal residence (i.e., living first with one set of parents and then the other). One hypothesis is that bilocality is a response to fluctuating environments. Where environments are uncertain, the argument goes, camp membership needs to be fluid to allow populations to disperse themselves rapidly in response to changes in the resource base. Bilocality allows families to move back and forth between the locations of the couple's parents. Ember tested this by examining the relationship between bilocal residence and the degree of environmental fluctuation as measured by the coefficient of variation in annual rainfall. She found that bilocal groups occur most frequently in environments of variable rainfall; unilocal (patri- and matrilineal) groups are associated with climatically stable environments.

Another hypothesis suggests that bilocality allows small groups to even out discrepancies in group sex ratio. As discussed in Chapter 7, small groups can undergo random and often dramatic fluctuations in sex ratio. Small groups, therefore, may allow for more variability in residence in order to permit movement of couples to even out sexual imbalances that could affect food procurement. Ember found a significant correlation between group size and residence, with bilocal residence occurring among hunter-gatherers of small local group size (see also Marlowe 2004a). However, Ember also found that group size and precipitation variability are correlated – high variability is associated with small group size. Thus, Ember could not separate environmental from demographic factors in her study.

Ember's analysis also supported Service's hypothesis that bilocal residence is the result of the fragmenting effects of contact between hunter-gatherers and European populations: in her sample, bilocal groups are associated with evidence of recent depopulation. Evidence of depopulation was not associated with precipitation variability or group size. However, the same process may be at work in all three cases. In areas of high precipitation variability, or where groups are small, or in regions that have undergone depopulation, foragers may seek to maximize the number of social groups and families to which they have social access, to reduce long-term variance in their food supply. As we saw in Chapter 6, they can do this through a variety of means, and bilocal residence could be one since it helps a person solidify relations with his or her affinal relatives.

Part of the difficulty in understanding postmarital residence arises from confusing social rules with behavior. In my survey of ethnographic data, instead of rejecting cases for which there were contradictory accounts, I included these under a "contradictory" category. As Table 8-2 indicates, only 5 percent of the sample had contradictory descent assignations but 22 percent had contradictory residence rules.

Some contradictions undoubtedly stem from ethnographers' errors and some from the fact that where one ethnographer records rules of behavior, another records actual behavior. Some differences also arise from changes over time. Both Leacock (1955, 1982) and Dunning (1959) noted a shift from matrilocality to patrilocality in postcontact times among many Canadian Algonquians. Dunning also showed that residence would be recorded differently depending on whether data were collected in the summer or winter. And, at any given moment, few people may adhere to the normative residence rule. Marlowe's (2010: 49) survey of the Hadza found 32 percent of couples living in a camp with the wife's mother, 18 percent with the husband's mother, 6 percent with the mothers of both the husband and the wife, and 44 percent in a camp where neither the husband's nor the wife's mother lives. Based on these data, in which postmarital residence pigeonhole should we place the Hadza?

I suspect the "violations" of residence rules is more apparent than real. Rules, of course, do exist. They are what people say should be done, but they are by no means what people always do. To understand residence, "the empirical patterns of post-nuptial co-residence, stable or shifting, demand as much attention as do formal rules of kin alliance and residence assignment" (Helm 1968: 125).

Rules versus Actual Postmarital Residence

Nicholas Peterson's (1978) description of the subtle relations between the rules and actuality of residence in Australia provides an example. Among many Australian Aborigines, young men desire to live patrilocally in the estate of their father, from whom they inherit various ceremonial and stewardship duties (see Chapter 6). This is the ideal situation. However, men tend to be much older than their wives (Peterson and Long 1986: 154; Chisholm and Burbank 1991); consequently, a man's parents are often deceased by the time he marries. The wife's parents, conversely, are alive, in need of the couple's assistance, and capable of providing the couple with various sorts of aid (e.g., childcare, social access to different tracts of land, and knowledge). Some couples might therefore be encouraged to reside matrilocally early in their marriage. As the husband ages, he will eventually return to his estate with his family and fulfill his culturally created desire (which anthropologists express as the residence "rule" of patrilocality). Note that at any given point in time, however, local groups will be made up of elderly men living patrilocally and younger men residing matrilocally. Neither the ideology nor actuality of residence describes the Aborigines' (or any other culture's) system in its entirety.

The Ju/'hoansi present a similar pattern, although for a different reason. Like many hunter-gatherers in the bilocal/multilocal residence pigeonhole, a newly married Ju/'hoan couple lives initially with the bride's parents (the Hadza also consider this to be the ideal; Marlowe 2010: 49; Wood and Marlowe 2011). This is usually not because the groom's parents are deceased, as with the Australian Aborigines. Instead, the Ju/'hoansi say that this is because the bride is too young to leave her parents and, additionally, that it allows the bride's parents to see whether the new son-in-law is a good hunter and husband. Ju/'hoan women also prefer to be near their mothers so that they can assist with the bride's first birth (Howell 2010: 23). To these reasons, Wilmsen (1989b) adds that since children acquire their birthplace as their primary *n!ore* (see Chapter 6) but also acquire rights in the *n!ore* of their parents, remaining with the bride's family until a child is born links together land-based kin networks. The bride's family continues to have responsibilities to their children born at their *n!ore*, as well as to grandchildren born there. Later in life, as the couple and their children age (and the wife's parents die), they may live near the husband's brothers or move to someplace new to each of them.

In the 1960s and 1970s, anthropologists discovered that the patrilocal band was not always the fundamental unit of membership among foragers. For some, such as the Chipewyan, it is the hunting unit; the Chipewyan band is a temporary, noncorporate group that is physically present only for advantageous occasions (Sharp 1977: 378). More to the point, no matter what the fundamental corporate group above the family was, anthropologists found that it was not constituted in a simple or straightforward fashion. There were rules that dictated group membership and postmarital residence, but they were layered and often violated without informants considering the violations to be wrong. We can now return to how residence rules reflect and condition how women affiliate with kin for the purpose of childrearing.

Postmarital Residence as Social Strategy

The reason that postmarital residence rules seem to be "violated" frequently is that they are not rules but rather the outcome of men and women aligning themselves with different people under different conditions. In the days of the "patrilocal-patrilineal" band, anthropologists saw foragers' residential groups as rather tightly knit (around a male line) and somewhat xenophobic. But this is not the case; in fact, the "mean" foraging group, across many different kinds of environments, consists largely of unrelated individuals linked through marriages, brothers and sisters, and bilateral kin associations (Hill et al. 2011). Such residential groups are the collective result of individuals' decisions to join (or to allow others to join) a group. These decisions may be rooted in the foraging rate maximization process described in Chapter 7 (see discussion of Smith's member and joiner rules) but are written in a kinship idiom. Henry Sharp, for example, attributes fluctuation in the size and composition of Chipewyan hunting units to "an organized search for maximum individual benefit within a highly structured set of possibilities" (1977: 385). Chipewyan men are inclined to reside patrilocally because they know the other members of their hunting unit and its traditional terrain well; they are also more likely to gain positions of prestige in their natal hunting unit. Conversely, there are reasons why a man may wish to reside matrilocally. Because of the nature of kin relations in these societies, younger brothers work for their fathers and older brothers and are obliged to obey them. Relations between brothers-in-law, however, are more circumspect and shy. A man residing matrilocally can have greater control over his labor and achieve higher returns for his effort. A Dogrib man explained this to June Helm:

> With your dad, you kill yourself to do all the work. Going with your older brother is just like going with your dad. He won't work hard. He expects you [as the younger brother] to do most of the work. So you don't take your own brother very often [as a work partner]. You take your brother-in-law most of the time. Brothers-in-law do the work just the same [that is, they share the labor equally]. (Helm 1972: 73; see also Sharp 1977: 383)

A younger brother may therefore find it more advantageous to reside matrilocally even though his desire may be to reside patrilocally.[13] Although men may have the same goals, kin and age-structured relations can result in their choosing different postmarital residences.

Men and women, conversely, may have different objectives in negotiating group membership (e.g., maximize hunting returns versus assistance in childcare). Among the Chipewyan, women prefer to remain with their natal hunting unit (Sharp 1977: 383), perhaps because of the support they could expect in childrearing from their sisters or mothers. Such a desire could be especially significant when men are away on long-distance hunting trips (or long-distance raiding, as noted previously). Among foragers, matrilocal residence is often associated with groups that rely heavily on hunting and, in fact, long-distance hunting as, for example, among the foragers of subarctic Canada (e.g., Dogrib, Han, Sarsi, Sekani). Long-distance hunting could have the same effect as long-distance warfare: it removes men from the residence, puts them in dangerous situations, and reduces the reliability of their contribution to childcare (Perry 1989). This could lead related women to bond together to form support networks among themselves. Given the important effect of the expectation of paternal care on infant survivorship (see Chapter 7), subsistence strategies that remove men from their families for long periods of time and place them at risk could result in matrilocal postmarital residence as part of a woman's reproductive strategy.[14]

Humans are often labeled "cooperative breeders" because we use *alloparents*, individuals who act as parents, to help raise children. This is, in fact, one reason that humans have been so successful as a species. Among many agricultural peoples, first-born children are important as childcare providers, but among nomadic foragers, it may be that adults are more important (Hames and Draper 2004) simply because older children may not be sufficiently common. Aka women, for example, reside matrilocally when their husbands are away to avoid demands on their time by their parents-in-law (C. Meehan 2005) and to obtain help with childcare from their mothers and sisters. Likewise, even though the Martu have patrilineal inheritance and patrilocal residence, women have more same-sex kin in their residential group than do men; in particular, women associate with their mothers and daughters (Scelza and Bliege Bird 2008). The matrilocal Pumé reside *natalocally*, a very rare practice in which a husband and wife each live where they were raised, separately, with children living with the mother. This achieves a similar result as multilocality or bilocality and builds up bilateral kinship bonds (Kramer and Greaves 2010), but it also leaves a woman where she has sisters for assistance. Where neither the husband's nor wife's family are more capable of providing assistance in the long term, a couple may reside bilocally so as to keep all options open. Hadza may also maximize their reproductive fitness by seeking assistance from mother's kin with their first child, moving later when the husband acquires greater reproductive fitness by shifting his attention from other kin to his own offspring as family size increases (Wood and Marlowe 2011). A woman's mother or sisters may be the primary alloparents in a foraging camp, but other individuals act as such also – perhaps to learn parenting or in expectation of reciprocity (Blurton Jones et al. 2005a,b; Crittenden and Marlowe 2008).

Residence patterns, then, are shorthand for one tactic that men and women in foraging societies use to balance the costs and benefits of joining or allowing others to join a residential group. The decisions they come to will be affected by men's and women's activities. Sometimes these rules reflect what I think are women's need for alloparents; at other times, they reflect a need to maintain wide social networks. But even where the "rules" favor men's foraging, they can be subverted by practices (e.g., lengthy visits) that permit women to continue to associate with their mothers and/or sisters (e.g., Scelza 2011).

Descent

Many anthropologists assume that descent and postmarital residence are linked (Murdock 1949; Martin and Voorhies 1975: 184): patrilineal with patrilocal, matrilineal with matrilocal, and bilateral with neo- or bilocal residence, but these associations are not perfect. Sixty percent of foragers in the SCCS with bilateral kinship (including ambilineal and double descent) have multilocal residence; another 28 percent have patrilocal; and the remaining 12 percent have matrilocal residence. Groups with matrilineal descent are split between multilocal and matrilocal residence; and patrilineal groups are nearly evenly split among multilocal, patrilocal, and matrilocal residence (note that the sample of matrilineal and patrilineal societies is small).

Following Service, Martin and Voorhies suggest that bilateral descent is more prevalent today than unilineal descent because of the effects of European intrusion, including adoption of a European kinship model. This may be true in many instances. However, there are some cases where contact produced the opposite result, a shift from bilateral to unilineal descent. The G//ana of the central Kalahari, for example, shifted from bilateral toward patrilineal inheritance (Cashdan 1984), as did the Paliyans of India (Gardner 1988). Moreover, some groups, such as the Batek of Malaysia, still maintain bilateral kinship despite the fact that they are encapsulated by societies of unilineal descent (Endicott 1981; Endicott and Endicott 1986). As we pointed out in our discussion of postmarital residence, the argument that contact results in bilateral kinship only specifies one set of proximate conditions rather than the actual cause. The received wisdom of *Man the Hunter*, in fact, was that bilateral kinship was an adaptation to uncertain environments and that, like bilocal residence, it increased the number of relatives one had and their geographic distribution to reduce the risk that comes with living in environments of spatially and temporally variable resources.[15]

But we must take care not to use the concepts of descent and kinship too simplistically. Consider, for example, the Ju/'hoansi, who are frequently cited as an example of bilateral kinship. The Ju/'hoansi's bilateral system is quite flexible. One's name and age can be used by another (older) individual to categorize a nonrelative into the status of relative (as described in Chapter 6), and affines can become recognized, through kin-term alteration, as consanguineals (Lee 1979). Wilmsen (1989a,b) argues that Ju/'hoan kinship, marriage, and postmarital residence are linked to existing social networks that are made up of positions of responsibility and prerogative with regard to the use of land. In what sense is one bilateral group, such as the Ju/'hoansi, like other peoples in the bilateral kinship category?

A more detailed example comes from Australia, where many groups are classified as patrilineal in cross-cultural surveys. Do these groups have the same social organization? Does labeling them patrilineal sufficiently capture their descent system and its function?

Take, for example, the Pitjandjara, among whom persons, especially men, are united into groups who share an estate containing sites of spiritual significance where they hold rituals (Hamilton 1982a). It is identification with this land, or rather with specific locations in it, that is most crucial, rather than identification with a descent group.[16] A Pitjandjara boy usually, but not always, shares his father's totemic cult (this may be the mother's cult as well, since the preferred marriage is one in which husband and wife have the same totemic affiliation). Although men prefer that their children be born in their country, near the water source associated with their totemic figure, this is not always possible, given the exigencies of life in the Western Desert. We mentioned in Chapter 6 that, in Aboriginal thought, geographic locations can be linked together into a Dreamtime track. If a Pitjandjara boy is born away from his father's totemic country but near a locality on a track that traverses his father's country, then he will have rights in his father's totemic complex. But if he is born away from his father's country and off the Dreamtime track that includes the father's country, then he takes the cult totem of the country where he was born. His participation in the cult totem of his father is then restricted (but not entirely cut off; as we noted in Chapter 6, association can be based on many criteria).

Thus, Annette Hamilton (1982a: 101) asks: in what sense are the Pitjandjara patrilineal, for "rights do not accrue primarily by being born to a particular father, but by being born at a particular place."[17] Additionally, the Pitjandjara's taboo on using the names of deceased persons, and their tendency to forget the long-dead, operates against the formation of patrilineal descent groups. Hamilton contrasts this situation with that of the peoples of Arnhem Land, where the dead are remembered through elaborate mortuary ceremonies, and where members of a patrilineal descent group act corporately. To categorize both these societies as patrilineal tells us little about their social organizations in particular or about the principles of hunter-gatherer social-group formation in general.

The Martu of Australia's Western Desert provide another example, one that introduces the concept of section systems (Tonkinson 1978, 1991). In addition to kinship categories, many Australian Aboriginal societies are divided into two, four, six, or eight additional social groupings. Where there are two, these are *moieties*; where there are four, they are called *sections*; and where there are more than four, they are called *subsections*. Moieties may not be named categories but sections and subsections are (Berndt and Berndt 1964; Tonkinson 1978, 1991). Although kinship rules dictate most day-to-day behavior between people, there are also patterned relationships between (sub)sections.

The Mardudjara have a four-section system; people are Garimara, Banaga, Burungu, or Milangga. Membership in one of the four sections is ascribed at birth and cannot be changed. Referring to Figure 8-5, Robert Tonkinson describes how the Mardudjara's section system works:

> taking, for example, a Garimara female as Ego, or starting point, she will marry a man of Banaga section whom she calls by the term for "spouse." She cannot marry just any Banaga man because his section contains her real and classificatory mother's fathers, son's sons, and certain cross-cousins who are classed as "brothers," all of whom are nonmarriageable relatives . . . The sons and daughters of this Garimara woman will be in the Milangga section and will eventually marry Burungu spouses. Her daughter's children will belong to Garimara, her own section,

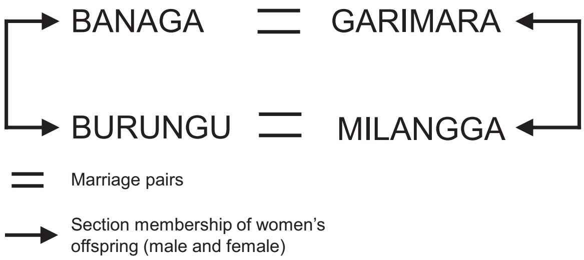


Figure 8-5. The Mardudjara section system. Redrawn from R. Tonkinson, *The Mardu Aborigines*, 2nd ed. © 1991, Wadsworth, a part of Cengage Learning, Inc. Reproduced by permission. www.cengage.com/permissions.www.cengage.com/permissions.

> but her son's children will be born into Banaga section, eventually to take their spouses from among the Garimara. (Tonkinson 1978: 55–56)

Thus, sections are exogamous and play a role in marriage, although they are not straightforward marriage classes since marriage partners are specified through the kinship system (Meggitt 1968; Yengoyan 1968; Tonkinson 1978: 54). Additionally, since a child's section depends on but is not the same as that of his or her mother, section systems do not parallel descent systems. Instead, as an independent grouping, (sub)sections cut across other groupings based on kinship or estate ownership.

Implicit in section systems are three possibilities for dual groupings. Garimara and Milangga sections could be combined on the one hand (since women of the former bear daughters who belong to the latter and vice versa), and similarly Banaga and Burungu, on the other hand, to form matrimoieties. Likewise, members of the Banaga and Milangga sections, and members of the Garimara and Burungu sections, can be combined into patrimoieties (these are identified egocentrically, not as socially named divisions among the Martu). Finally, Banaga-Garimara and Burungu-Milangga are combined among the Martu into what are called *merged alternate generation pairs*. By drawing a simple kin diagram of the sectional relationships between marriage and descent, as outlined here (or see Tonkinson 1978: figure 3-2), we could see that Ego's generation (siblings and cousins) are members of one of the intermarrying pairs of sections. Everyone in the +1 (parental) or −1 (offspring/niece/nephew) generation belongs to the other intermarrying pair, whereas everyone in the +2 (grandparental) or −2 (grandchildren) generation belongs to the same pair as Ego's generation. Patrimoieties and merged alternate generations are found among the Martu; matrimoieties are not (they do occur among other Aboriginal societies, although not in the Western Desert). Martu social divisions, especially merged alternate generations, play a role in some ritual obligations and gift giving.

Yes, it's confusing. But the important point is that as far as a Martu person is concerned, certain relatives always fall into certain sections (see Tonkinson 1978: 57). This means two things. First, by lumping together sets of kin terms, sections provide people with a guide for behavior. If one knows a person's gender, age, and section, one has a good idea of how to act toward him or her – even in the case of a stranger – by reducing the possible kin connections (although interaction does not normally occur until the specific kin connection is established). Among the Martu, in fact, section terms are often used to refer to people in place of personal names, which are never used casually (Tonkinson 1978: 55). Second, these merged alternate generations contain a majority of kin with whom Ego has much less restrained interaction. Ego can joke with those on his or her "side," but he or she must act with respect and deference to those on the "other side." Finally, yet another division consists of Ego's generational grouping on one side and some close consanguineal kin – brothers, sisters, and some cross-cousins – on the other. This division figures in male initiation and mortuary rites.

In discussing the similar Walbiri section system, Mervin Meggitt (1987: 132) sums up our point: “Kinship studies alone are simply not enough, not even for comprehending the kinship systems themselves.” We have already seen that postmarital residence “rules” reflect tactics for surviving. Kinship is the same because it is a way of organizing people by placing them into categories that are accompanied by certain rights and responsibilities. Western society thinks of kinship as a way to categorize biological facts, but every anthropologist knows that this is just the beginning and may, in fact, lead us astray. Anthropology not only imposes the categories of patrilineal, matrilineal, bilateral kinship on people, we also impose the very concept of kinship on them (Schneider 1984).

Kinship as Social Strategy

We could use our categories of descent and residence as an initial avenue into understanding the organization of interpersonal relationships in a society. The correlations between particular forms of descent and residence suggest that descent, too, relates to decisions about group formation. We suggested that such decisions may be rooted in considerations of foraging costs/benefits and parental investment and are affected at any given time by existing ideas about how different kinds of kin are created.

Sharp (1977: 385) notes, for example, that Chipewyan hunting units try to become as large as possible, for large hunting units are politically powerful. There is a trade-off, however, since the larger a hunting unit, the more rapidly it depletes resources in its hunting territory and the longer members have to travel to reach trapping lines (travel time to hunting areas is the critical variable in a hunter’s decision to remain in a group). This means that there are limitations on the size of hunting units. These units, as named groups, also rarely last more than three generations. This is due to a number of factors, but Sharp gives priority to the lack of concern with genealogies (partly generated by a taboo on using the names of the deceased) and to the limited control that elder brothers have over their younger brothers (since the latter can leave). If the resource configuration (or younger brothers’ options) were to change such that larger units were possible, we could see a change toward corporate groups with a unilineal bias (and perhaps more consistent postmarital residence patterns) as individuals try to negotiate entry into a group. The point here is that there is room for research on hunter-gatherer kinship from an evolutionary perspective. To the best of my knowledge, this is a wide-open field.

Marriage

Our discussion of Australian Aboriginal section systems leads us to a more general discussion of marriage among hunter-gatherers. From the ethnographic atlas, we obtain some idea of the variability in marriage arrangements among hunter-gatherers (Murdock 1967). As Table 8-4 indicates, marriages without significant gift exchanges make up the largest category, although this accounts only for one-third of the 113 cases. Marriages involving significant bridewealth are the second most common category but still make up only 20 percent of the sample. Gift exchange between parents of the prospective couple and brideservice are the third and fourth most common. In the SCCS, 36 percent of foragers have brideservice; 33 percent have no specific practice of labor or gift exchange; 14 percent have bridewealth; and the remainder is divided among female kin exchange, minor gift exchange, token bridewealth, and dowry.

Service argued that among patrilocal bands, the most common form of marriage is cross-cousin marriage, marriage to a parent’s (or other lineal’s) opposite-sex sibling’s offspring. In the *Man the Hunter* survey, 59 percent of eighty-one hunter-gatherer societies permitted cross-cousin marriage: 33 percent matrilateral and 26 percent patrilateral (Lee and DeVore 1968: 338). Assuming patrilocality, as Service did, cross-cousin marriage forces band exogamy and results in alliances between bands because all potential mates – father’s sister’s or mother’s brother’s

Table 8-4. Hunter-Gatherer Marriage Arrangements

Marriage Arrangement	Number (%)
Bridewealth	23 (20.4)
Dowry	2 (1.8)
Gift exchange (between parents of bride and groom)	20 (17.6)
Absence of any significant exchanges	38 (33.6)
Brideservice	18 (15.9)
Token bridewealth	7 (6.2)
Exchange of sisters or female relative	5 (4.5)
Total	113 (100.0)

Source: Murdock (1967)

offspring – live away from Ego's band. And, assuming that warfare was endemic to hunter-gatherers, Service saw these alliances primarily as peacemaking gestures and ways to acquire allies (Service 1962: 75). But, even as Service himself pointed out, it is always possible to find someone who is a cross-cousin of some kind in a patrilocal band (assuming that a parent is from that band). To say that hunter-gatherers have cross-cousin marriage, therefore, overlooks diversity in the form of these marriages. Varieties of cross-cousin marriage among hunter-gatherers are summarized in Table 8-5. The largest category is that of nonlateral marriage, in which marriage is forbidden with any first or second cousin, but this category only accounts for half of the sample.

As with descent and residence, it is difficult to judge what marriage rules actually mean. Service (1962: 67) recognized this when he noted that "it is doubtful that this [cross-cousin] form of marriage should be considered truly a rule, however, for it is in large measure a construct of anthropologists rather than something conceptualized by the members of the society." True enough. Although Meggitt found that 92 percent of Walbiri marriages fit the Walbiri's stated norm (1987; see also Tonkinson 1991 on the Martu), L. Hiatt (1968) found that only 17 percent of marriages in the Anbarra community of the Gidjingali of northern Australia fit the Gidjingali's norm. In cases where there was no proper marriage partner for a woman (and Hiatt shows that

Table 8-5. Hunter-Gatherer Cousin Marriage

Form	Number (%)
Duolateral cross-cousin (MBD or FZS, with parallel cousins forbidden)	15 (14.0)
Duolateral with maternal cousins only	1 (1.0)
Matrilateral cross-cousins	5 (4.6)
Nonlateral (first and second cousins forbidden)	51 (47.6)
Nonlateral (but information available for first cousins only)	14 (13.0)
Patrilateral cross-cousin	2 (2.0)
Quadrilateral (marriage with any first cousin)	7 (6.5)
Nonlateral (all first and some second cousins forbidden)	3 (2.8)
Nonlateral (first cousins forbidden but permitted with some second cousins who are not lineage members)	8 (7.4)
Trilateral (marriage with first cousins except lineage members)	1 (1.0)
Total	107 (99.9)

Source: Murdock 1967

demographic factors make this likely in small communities), her mother and/or her mother's brother would select a husband for her (she need only be a potential husband's classificatory mother's mother's brother's daughter's daughter; or, he should be her actual or classificatory cross-cousin – that is, there are rules to get around the rules). Similarly, among the Pitjandjara, a marriage that is considered less than ideal may be made ideal by recategorizing a person's genealogical status (Yengoyan 1979: 404).

Analysis of "rules to get around rules" will give a better understanding of social organization than a study of either the rules or behavior alone. Among the G/wi, for example, the stated rule is that a person should marry his or her cross-cousin. However, Silberbauer found that of seventy-three marriages, only 11 percent were between biological cross-cousins (1981a: 149–50). Cross-cousinship among the G/wi, however, is used only as an idiom to express the ideal prerequisites of marriage: the potential spouses should be joking partners (as biological cross-cousins are among the G/wi), their parents should be on friendly terms, and the parents of the bride or groom should know that the parents of their child's potential spouse are reliable, trustworthy, and of even temperament. Siblings would know this information about one another but so would close friends. Unrelated G/wi who grow up together and know one another well may call one another by sibling terms (brother and sister) and thus their children would address one another as cousins (and for all intents and purposes, they would be cousins). The G/wi's cross-cousin marriage rule is shorthand for the ideal marital relationship. It shows that the relationships between the parents are as important, if not more so, than the feelings between the future spouses. (This is also demonstrated by the many societies, especially some Australian Aborigines and Inuit, in which children are promised as marriage partners before they are born or even conceived.)

Today, a common explanation of marriage practices builds on observations made many years ago by Lévi-Strauss: marriages are exchanges that construct alliances between groups of people (and, in fact, Lévi-Strauss [1949] argued, constructed those kin groupings). Service emphasized alliance for the purposes of offense and defense in warfare. This is undoubtedly a possible proximate cause of exogamous marriage rules but, given the lack of warfare among many foragers, it is perhaps more important that affines could provide one another with physical access to resources in times of need via social access to their respective groups. It is not odd that marriage systems among many foragers operate in such a way that husband and wife often come from different areas (e.g., Lee 1979). Among the Pitjandjara, for example, it was preferred that a man's wife have the same totemic affiliations as he did but that she come from an area away from what he considers his country, although not too far away (Hamilton 1982a).

Yengoyan (1968) argued that the Australian Aboriginal section system served as a way to force people to find marriage partners from distant areas, providing links to resources in times of need. Accordingly, Yengoyan hypothesized that as tribal areas became larger and population density decreased (as a product of decreasing food abundance), section systems should become more elaborate. Four-section systems, he suggested, should be found in areas of higher population density, smaller tribal areas, and high food density, whereas eight-section systems should be found in areas of lower population density, larger tribal areas, and lesser food density. However, the data do not support these predictions (McKnight 1981); rather, section systems are found among the rich coastal groups and moieties among some groups of the central desert. In fact, the section system also does not necessarily force people to find partners from distant areas since it does not discriminate on geographic grounds (Robert Tonkinson, personal communication, 1992; see also Berndt and Berndt 1964: 59).

Marriages do establish social ties and provide close affines who can be called on in times of resource failure. However, specific marriage practices cannot be explained solely by reference to the need for alliances and resource safeguards. People do not intentionally devise marriage systems so they can construct alliances adapted to the local resource configuration. Understanding marriage, like understanding kinship, means understanding how interpersonal relations and group affiliation are constructed, negotiated, and manipulated over time. Some northern Australian aboriginal societies, such as the Yolngu, for example, could encourage polygyny through kin terminologies that increase the number of potential wives with the culturally appropriate age difference (Keen 1988, 2006; Yolngu men are not expected to be generous with wives; hence, older brothers take more wives than do their younger brothers). These facts produce and maintain large and powerful patrilineal clans among the Yolngu, as well as powerful individual (polygynous) men. Men and women can have different goals for marriage and thus ascribe different costs and benefits to marriage choices. This establishes the potential for competition between men and women, and among men, as well as the potential for marriage to play a key role in the evolution of social inequality.

Gender, Marriage, and Social Inequality

Jane Collier provides valuable insight into the relationships among gender, marriage, and social inequality through an intriguing analysis of three systems of marriage in classless societies: brideservice, equal bridewealth, and unequal bridewealth (1988; Collier and Rosaldo 1981). These are typified by three Plains hunter-gatherer societies: the Comanche, Cheyenne, and Kiowa, respectively. Collier argues that the different potentials for marital instability in these three types of societies – instability that is related to the groom working for the bride's family or for his own elders – organizes marriage in classless societies.

Collier begins by examining the functionalist perspective on inequality, the argument that those individuals who perform the most critical services for society garner the most prestige. On the nineteenth-century North American Plains, for example, a man's avenue to rank and prestige was through warfare and raiding for horses. Horses were crucial to a man's ability to hunt and to more raiding, ostensibly for defense – both important activities. But Collier points out that it was *only men who already had high rank* who had the time to go raiding and participate in activities that would bestow prestige on them. Apparently, inequality in power *preceded* the formation of prestige value systems. Raiding and horse stealing were prestigious not simply because of the need for protection and horses but also because prestigious men did them. How then do men become prestigious?

As Jeanne Arnold (1993, 2001b) has pointed out, it has to do with the control of labor. High-ranking men on the Plains received their status because they had wives, sons-in-law, and brothers-in-law to work for them and to provide them with the free time for raiding and other activities. Collier's analysis builds on this observation to link social inequality with the nature of relations between affines. The three different marriage systems described by Collier, however, result in different kinds and intensities of inequality.

Brideservice

In brideservice societies (which form the largest group in the SCCS of foragers), men work for their bride's parents after marrying. In these societies, according to Collier, men seek their own wives and acquire them through their own actions. The wife's family can neither give nor take back a wife (although the wife can leave – and may even have her parents' assistance in this) because the parents do not have the right to control the daughter's behavior. In Comanche society, men sought horses on their own to acquire a wife. (In other hunter-gatherer societies, a man may hunt for his bride's family for a year or more but eventually move with his wife to his parents' location or set up a new residence.) The groom is not assisted by his elders in acquiring a wife. If a wife should take a lover, her husband has no recourse except to provide her with greater attention, take action against the lover himself, ignore him, or leave his wife.

Equal Bridewealth

In equal-bridewealth societies, men acquire a wife or wives through the giving of more or less standardized gifts, gifts that are frequently held or acquired by the groom's seniors, his father, uncles, or older brothers (which they may have acquired from giving away the groom's sisters as brides). In bridewealth societies, the groom's seniors often arrange the marriage with the bride's seniors. Thus, the groom is beholden to his seniors, and a kind of gerontocratic society can form (such as is frequently seen in Australia) in which young men must do the bidding of older men in exchange for marriage arrangements. However, the more labor extracted from men, the greater the marital instability because the groom must devote time and energy to his elders and, consequently, not to his wife. She may then seek attention from lovers or return to her family, setting up a dispute between the groom (or his seniors) and the bride's family. Potential for marital instability gives power to the bride's family and requires that the groom seek assistance from his seniors should his wife leave, further indebting himself to them.

Unequal Bridewealth

In unequal-bridewealth societies, gifts are not standardized and can vary from marriage to marriage; and they may be requested from the groom throughout the marriage. Wife-givers can extort labor from the husband (and his family) by constantly threatening to take back a wife. This marriage system is associated with social ranking, although it is hard to say how the process begins (see Chapter 9). Given a differential in prestige, a high-ranking male can refuse to give a daughter in marriage until a large bridewealth is secured or until he locates for his daughter a husband who will be unable to refuse to continue to give bridewealth. Giving a wife to such a lucky (or unlucky) man, the bride's father can continually demand gifts and labor from the husband "on the grounds that they are not exercising their right to take their kinswomen back" (Collier 1988: 233). A high-ranking male can easily keep his wives since her brothers will not wish to break their affinal tie with a high-ranking male (who can provide them with the opportunity to partake in prestigious activities). Low-ranking males, conversely, may keep their wives only as long as they comply with the wishes of her male relatives. Since a low-ranking male will spend time working for his wife's relatives, he may provide her with little support in the household, making her unhappy.

Does the wife have much to say in this? Not likely, if she wishes to have supportive male relatives in the future. Just as ranking males can extort labor from lower ranking sons-in-law, men extort cooperation from their sisters (or daughters) by forcing them to remain with a husband who is providing her brothers (or father) with labor. As women lose their autonomy through marriage, so do their husbands also lose theirs. As others have observed, social inequality goes hand in hand with gender inequality (Bern 1979; Collier and Rosaldo 1981; Strathern 1987; see Chapter 9).

Polygyny

Collier does not discuss polygyny, but we note it here because of its bearing on marriage, gender, and inequality. Polygyny is uncommon among ethnographically known foragers and, even in societies where it exists, relatively few men are polygynous. In some cases, an older wife will request that her husband marry another woman so that she has assistance with domestic duties and childcare (see Rose 1968). In bridewealth systems, a man may take additional wives because they can contribute to household production. Among the Tolowa in California, wives were used to increase household stores of food. Likewise, among many Plains tribes, women processed hides for the fur trade, which allowed men to acquire horses, guns, and other goods that helped them move up in rank. Polygyny, therefore, allows men to increase their wealth and compete with other men (for an example, see Keen 2006).[18] What do women get out of polygyny?

Where men control all resources, Monique Borgerhoff Mulder (1992) suggests that women may choose men on the basis of how many resources they can offer an incoming wife, regardless of whether or not the man is already married. Where men control access to hunting and fishing sites, for example, polygyny tends to be higher (Sellen and Hruschka 2004). It is not clear, however, if this is always women's choice at work or the choice of her male kin, who may seek a spouse for their daughter/sister who can offer *them* access to the resources controlled by a potential husband. The cost of not choosing the right spouse could, as Collier's analysis suggests, result in the loss of consanguineal support and, perhaps as a result, an even lower fitness (see Borgerhoff Mulder [1992] for a discussion of the conditions favoring polygyny).

This discussion of polygyny and marriage systems speaks to a link between marriage and inequality. In fact, the ideologies of Collier's three marriage systems differ from one another and play a role in the development and maintenance of social inequality. "In brideservice societies, people credit men (and women) with forging their own destinies. In equal bridewealth societies, people perceive themselves as being dependent on the beneficent help of seniors and supernatural beings. In unequal bridewealth societies, people consider hereditary rank the most important determinant of a person's fate" (Collier 1988: 232). Consequently, in unequal-bridewealth societies, people are culturally prepared to accept differential rank and access to power as natural. This creates an ideology that establishes rank as the primary organizing factor of social relations and that conceals and permits exploitation (Collier 1988: 242). Specifically, Collier's analysis points out that wife-givers rather than wife-takers acquire power in the marital relationship in bridewealth societies, and it is especially power over the labor of affines. In nonegalitarian societies, as we see in the following chapter, marriage is about establishing alliances, but it is also about acquiring power through labor.

Conclusion

This chapter examined the division of labor, postmarital residence, descent, and marriage among hunter-gatherers. These topics are interrelated because the division of labor under different environmental conditions affects the costs and benefits of associating with one corporate group versus another; since men and women do different things, they could easily have different membership preferences. Membership in one or another group is negotiated through kinship and the structured relations it entails among individuals, residence, and marriage.

The division of labor is not so much between hunting and gathering as it is between high- and low-variance foraging activities – or risky and not risky foraging. It just so happens that the hunting of large game is generally the highest return rate but also the highest variance foraging choice in most (if not all) environments. Where hunting is compatible with childcare (e.g., communal hunting; hunting very close to camp; or hunting small, not very mobile prey), we expect women to participate in it to the extent that it provides higher returns (even with the added cost of childcare) than competing foraging choices. Women do not hunt large game as much as men do because the return rate from large-game hunting with a child in tow would probably fall below other foraging choices, especially those, such as gathering, that can be interrupted without a large decrease in the foraging return rate. Once freed of children later in life, the lack of experience and cultural prohibitions might prevent women from participating in large-game hunting.

Since meat from large game is the most highly shared food, the division of labor means that men garner more prestige than women (even where male-female status is otherwise nearly equal). Women are rarely in this position, and the division of labor may lay a foundation of inequality between men and women in perceived status.

Discussions of postmarital residence and descent point not only to the amount of variability present among foragers but also to the fact that the terms we use – rules of residence and forms of kinship – do not even describe the full range of variation. Rules of residence are related to a number of variables, but all revolve around individuals finding ways to join one group or another. For men, the primary factors may be foraging and warfare (internal versus long-distance), whereas for women, it may be assistance in childrearing. Since we suggested that residence is part of a process of negotiating group membership, it could be analyzed in terms of a modified version of E. Smith's group-size model, discussed in Chapter 7.

Research into descent systems now focuses on figuring out which kinship categories are used and how people go about placing themselves and others into those categories. Societies that are classed as having one form of descent may be substantially different from other similarly classed societies in how people are assigned to different kin or other categories. As with postmarital residence, we can also see descent and rules of kin relations as resulting from and controlling the kinds of corporate groups that exist, the potential they have for change, and the directions they take. Insofar as rules of descent reflect the negotiation of group membership that affects foraging returns, kinship, especially its rigidity, should be amenable to an evolutionary analysis.

Finally, we considered variability in marriage relations, finding that, again, anthropologists' rules of marriage often mask the process of association and group formation. We concluded with Collier's analysis of marriage in three types of systems. From this, we saw that marriage is part of the process of group affiliation; much of this process is masked by looking at marriage only as a way to build alliances. In bridewealth societies, wife-givers enter into a marriage for different reasons than wife-takers: wife-givers get labor, whereas wife-takers gain prestige. These different agendas result in inequality among men and between men and women by limiting their autonomy. Although Collier's analysis probes the nature of marriage within nonegaliatarian systems, it is not intended to account for the conditions under which these systems might arise. We turn to this question in Chapter 9.

Chapter 9

Nonegalitarian Hunter-Gatherers

> When a young man kills much meat, he comes to think of himself as a chief or a big man, and he thinks of the rest of us as his servants or inferiors. We can't accept this. We refuse one who boasts, for someday his pride will make him kill somebody. So we always speak of his meat as worthless. In this way we cool his heart and make him gentle.
>
> Ju/'hoan man (Lee 1979: 246)

> You know that every time when the tribes come to our village, we always have four or five more to give blankets away than they have. Therefore, take care, young chiefs! else you will lose your high and lofty name; for our grandfathers were never beaten in war of blood nor in war of wealth, and therefore all the tribes are below us Kwakiutl in rank.
>
> Kwakwak'awakw man (Codere 1950: 120)

If I asked the average anthropology student to imagine a group of hunter-gatherers, it is most likely that the Ju/'hoansi would come to mind: small, peaceful, nomadic bands composed of men and women with few possessions and who are equal in wealth, opportunity, and status. Yet, given the prominence of the *potlatch* in introductory courses, the average student is also aware of cases that easily overturn that image: large, sedentary, warring, possession-laden Northwest Coast societies, where men boasted of their exploits, status, and power.

Anthropologists have used the terms *simple* and *complex* or *nonaffluent* and *affluent* to distinguish these two types of foraging societies (Table 9-1; Price and Brown 1985b; Grier, Kim, and Uchiyama 2006). Simple, nonaffluent hunter-gatherers include band or family-level groups such as the Australian Pintupi or Martu, whereas complex, affluent hunter-gatherers include tribal groups such as the Northwest Coast's Kwakwak'awakw or Tlingit (Figure 9-1). Complex hunter-gatherers are nonegalitarian societies, whose elites possess slaves, fight wars, and overtly seek prestige. Although anthropologists have long considered complex hunter-gatherers to be exceptions, products of resource-rich environments, archaeologists continue to discover evidence of nonegalitarian foraging societies in many environments; this has created a new interest (especially among archaeologists) in complex foragers.[1]

Table 9-1. Simple Versus Complex Hunter-Gatherers

	Simple	Complex
Environment	Unpredictable and/or variable	Highly predictable, less variable
Diet	Terrestrial game, or game/plant food mix	Marine or plant foods
Settlement size	Small	Large
Residential mobility	Medium to high	Low to sedentary
Demography	Low population density relative to food supply	High population density relative to food supply
Food storage	Little to no dependence	Medium to high dependence
Social organization	No corporate groups	Corporate descent groups (e.g., lineages)
Political organization	Egalitarian	Hierarchical; classes based on wealth and/or descent
Occupational specialization	Only for elderly	Common
Land tenure	Social boundary defense	Perimeter defense
Warfare	Rare	Common
Slavery	Absent	Frequent
Ethic of competition	Not tolerated	Encouraged
Resource ownership	Diffuse	Tightly controlled
Exchange	Generalized reciprocity	Wealth objects, competitive feasts

Source: Based in part on Keeley 1988

These terms, however, are unfortunate. Even a cursory treatment of Australian aboriginal social organization (as in the previous chapter) will leave any student's head swimming. No anthropologist thinks that the egalitarian Bushmen, Pintupi, or Shoshone are easier to understand than "complex" hunter-gatherers. Still, the term "complex" leads us to think that societies classed as simple are passive ones, that egalitarianism is simply the lack of hierarchy (Flanagan 1989; Wiessner 2002b; Kim and Grier 2006). The word "complex" focuses attention on specialization of tasks and functions, an important characteristic of these societies, whereas the term "affluent" focuses on issues of resource abundance and elaborate cultural trappings. In doing so, these terms direct our attention away from social inequality, a trait whose origin is more enigmatic and, in my opinion, more important. Thus, we will eschew the simple–complex or nonaffluent–affluent dichotomies in favor of an approach that focuses on the origin and evolution of social inequality.

We have less ethnographic information on nonegalitarian than on egalitarian foraging societies; these include Florida's Calusa (Widmer 1988; Marquardt 2001; although the Calusa probably cultivated some plants such as gourds and chili peppers); various California foragers, with the Chumash of southern California the most heavily studied (e.g., Bean 1978; Arnold 2001a,b; 2004; Kennett 2005; Gamble 2008); the Northwest Coast (Ames 1995; Ames and Maschner 1999; Grier 2006); the Plateau region of the northwestern United States (Hayden 1992; Prentiss and Kuijt 2004); some New Guinean peoples (Roscoe 2006); and Japan's Ainu (Watanabe 1968, 1972a,b). Rather than attributing nonegalitarian foragers simply to "resource abundance," as many have done in the past, we will see that sedentism, the resource base, geographic circumscription, storage, population pressure, group formation, and enculturative processes all play a role. Therefore, this chapter calls on previous discussions of foraging, mobility, land tenure, exchange, demography, social organization, and marriage.

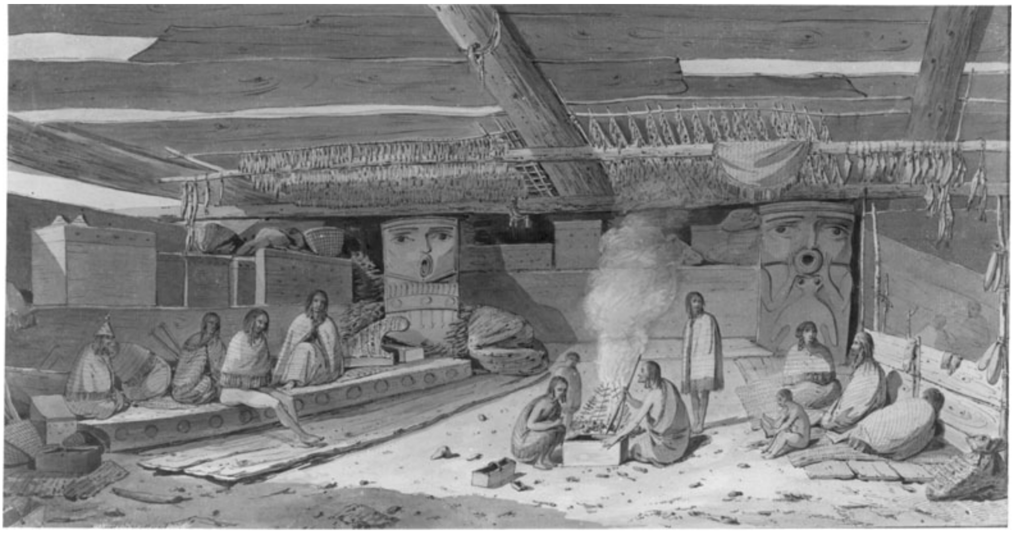


Figure 9-1. Interior of Nootka (Nuuchahnulth) house, Vancouver Island. Note stored, dried fish hanging from ceiling; the cedar boxes for ceremonial paraphernalia on shelves; the decorated whale dorsal fin on the bench to the left. To the right, low plank walls separate family units in the house. The women in the center are roasting fish and heating water with stones from the fire. Pen-and-ink drawing by John Webber, April 1778, photographed by Hillel Burger. Courtesy of the Peabody Museum of Archaeology and Ethnology, Harvard University, ID # 2004.24.26744.

Egalitarianism

Let's first consider egalitarianism. James Woodburn described egalitarian societies as "immediate-return" societies, those in which there is a short time between the acquisition and consumption of food. They are also ones in which individuals supposedly have equal access to resources and technology, and people use mobility as a method of dispute resolution (Figure 9-2):

> [Egalitarian] societies are nomadic and positively value movement. They do not accumulate property but consume it, give it away, gamble it away or throw it away. Most of them have knowledge of techniques for storing food but use them only occasionally to prevent food from going rotten rather than to save it for some future occasion. They tend to use portable, utilitarian, easily acquired, replaceable artefacts – made with real skill but without hours of labour – and avoid those which are fixed in one place, heavy, elaborately decorated, require prolonged manufacture, regular maintenance, joint work by several people or any combination of these. The system is one in which people travel light, unencumbered, as they see it, by possessions and by commitments. (Woodburn 1980: 99)

The term "egalitarian" does not mean that all members have the same of everything – goods, food, prestige, or authority. Not everyone is equal in egalitarian societies, but everyone has (or is alleged to have) equal *access* to food, to the technology needed to acquire resources, and to the paths leading to status and prestige (Woodburn 1979, 1980, 1982). Even in this regard, the inheritance of material wealth (especially productive land) and relational wealth (political connections) give some individuals a head start in life (Smith et al. 2011). For these reasons, the key property of egalitarianism is not material equality (although that may result) but rather an ethos and practice of *individual autonomy* (Gardner 1991).

Many hunter-gatherers emphasize autonomy in their everyday lives (e.g., Myers 1986; Fortier 2009a). They describe their societies as those in which each person "is headman over himself"

(Lee 1979: 348; Bird and Bliege Bird 2009: 26). Egalitarian societies are those in which each person has the potential to achieve prestige and where the enforcement of cultural norms prevent a person from using that prestige to gain power over another.

But egalitarianism is not simply the absence of hierarchy. Egalitarianism is not human nature but is itself an adaptation. Indeed, Christopher Boehm (1999) argues that human egalitarianism arose in the distant past from some kind of social hierarchy that characterizes many nonhuman primates today. Hunter-gatherers are sometimes described as being "fiercely egalitarian" (Lee 1979: 24), not because they routinely take up arms to protect their way of life (although some might be willing to do so) but instead because the maintenance of an egalitarian society requires effort. Egalitarian relations do not come easily; they are not "natural" in that they are not what is left in the absence of stratification.

There are people in every society who will try to lord it over others, but egalitarian cultures contain ways to level individuals, to "cool their hearts" as the Ju/'hoansi say. Humor is used to belittle the successful but boastful Ju/'hoan hunter; if that fails, he will be shamed with the label *!xka ≠xan*, "far-hearted," meaning mean or stingy (Lee 1988: 267). The Martu berate such people with warnings that they are "like rocks," with no compassion (Bird and Bliege Bird 2009: 44). Wives use sexual humor to keep a husband in line; and gambling, accusations of stinginess, or demand-sharing maintain a constant circulation of goods and prevent hoarding.[2] Many foraging societies contain ritualized means of defusing tensions and ending feuds (e.g., the Australian Aborigine penis-holding ritual [Berndt and Berndt 1945: 263], Inuit song duels [Balicki 1970], or the Selk'nam's wrestling matches [Gusinde 1934]). And, in nomadic societies, a family can simply pack up and move away from belligerent individuals (Marlowe 2010: 44). Mobility, in fact, is often what allows foragers to maintain an egalitarian ethos and practice because it permits autonomy.

As we noted in Chapter 6, sharing helps even out the variability inherent in foraging returns (especially the hunting of large game). One might think that would be a good thing, and it is. But sharing can also create tension because it establishes debts and proclaims differences in ability, and so self-effacing behavior makes sharing easier (Cashdan 1980; see review in Fry [2011]). A hunter who acknowledges his worthlessness as his wife distributes meat from a fat antelope he has just killed relieves the tension of sharing. He is saying, "I know I'm a good hunter. I know you owe me. But I'm not going to use that against you." And that behavior creates and is created by a culture that is assertively egalitarian, one in which the open hoarding of goods or the imposition of one's will on another is at odds with cultural norms.

And yet, there are differences in ability, and those are rewarded. Egalitarianism can mask hierarchy. Australian Aboriginal men acquire authority and power in religious affairs by disengaging from property, by giving away meat, for example. But one can only disengage from property if, at some level, one claims a right to it (see Bird and Bliege Bird 2009). Appeals to autonomy and equality by informants in egalitarian societies often contradict an ethnographic reality in which some members have higher status and greater access to resources than others. We have already seen that people are well aware of, give greater prestige to, and may lose some of their autonomy to men who are good hunters. Differences in autonomy are perhaps especially pronounced between men and women. As we pointed out in the previous chapter, social inequality is inseparable from gender inequality. Therefore, before we consider nonegalitarian sociopolitical organization, we need to consider gender equality.

Male-Female Egalitarianism

Prior to *Man the Hunter*, women in foraging societies were often seen as chattel and slaves, dominated by male authority in the realms of subsistence, marriage, religion, and sex. After *Man the Hunter*, however, anthropologists portrayed hunter-gatherers as useful role models for a Western society striving for gender equality (Martin and Voorhies 1975). The argument was that

Figure 9-2. A Penan family in 1986 set up camp, fitting the image of egalitarian foragers. The woman in the foreground, Lisim, with her son Barney (named after a helicopter pilot) on her back is making a roof for the shelter from palm fronds. This group lives in a central settlement for five to seven months of the year, where they grow rice and cassava. While on a trek in the forest, they stopped here for one night after the men had killed a wild pig. Courtesy of Peter Brosius.

female foragers provide as much (if not more) food as men do and therefore have a status equal to that of men (Barnard 1980; Endicott 1981). However, our discussion of the division of labor in the previous chapter shows us why this is almost never actually true. Even in those societies in which women are not directly involved in food procurement (e.g., the extreme Arctic), anthropologists argued, female labor is still integral to the processing of resources (Halperin 1980) and maintains their status (see Chapter 8).

Claims of gender equality in the decades following *Man the Hunter*, however, were more asserted than demonstrated. At least one cross-cultural survey shows no clear association between women's status and women's economic contribution (Hayden, Deal, Cannon, and Casey 1986). Instead, Peggy Sanday (1981) found that where men and women spend time separated from one another, men come to think of women as subservient to them. Sanday argues that this may make it easier for men to justify the control of their wives, sisters, and daughters. But Sanday also found that domination of women by men occurs not only where men spend time away from their spouses but also where people perceive the environment as hostile (e.g., where men hunt large game and are away from their spouses for long periods of time). It is in these cases, Sanday points out, that there is a greater male perception of menstrual blood and intercourse as dangerous. Thus, the nature of foraging activities might be added to the amount of food acquired as a significant variable.

As we described in Chapter 8, Collier (1988) found nonegalitarian relationships between men and women as well as among men in societies that some would quite readily class as egalitarian. Even in that classic egalitarian society, the Ju/'hoansi women appear to have autonomy and control if they demand it. As a young girl, Nisa had little say in the choice of her first husband and had her way only by putting her foot down repeatedly (Shostak 1981). Ju/'hoan men do about two-thirds of the talking at public meetings and act as group spokespersons more frequently than do women (Lee 1982). In domestic conflicts, Ju/'hoan women are more often the victims than are men; the same holds true for Australian Aboriginal women (homicide in both of these cases, however, is largely a male activity directed at other males). And yet, even where women have less public authority than men, they can still exert power, often using a culture's own precepts. Among the Gros Ventre, for example, "If a woman did not wish a man for her lover, she might send him to do a certain act of bravery. If he returned successfully from war, having accomplished the deed, he was then accepted. This custom is said to have led to the death of many young men" (Kroeber 1908: 180). And although Aka men are more likely to use physical violence (although not frequently), Aka women use indirect aggression to express anger (Hess, Helfrecht, Hagen, Sell, and Hewlett 2010).

Still, differences in power can result in real impacts in well-being. Some studies suggest that foraging women eat less meat than do men (see Chapter 6; Spielmann 1989; Speth 1990, 2010). Walker and Hewlett (1990) found that Aka women have significantly more caries than Aka men, suggesting that they eat more carbohydrate and less meat than do men.[3] And, in a number of societies, women are forbidden to eat fat during pregnancy and lactation, just when they could use the extra calories, fat-soluble vitamins, and fatty acids (Spielmann 1989).

It is not easy to interpret the significance of gender inequalities reported in ethnographies. Since equality is a subjective category, interpretation is subject to bias. Observations by explorers and untrained observers are replete with instances of such misinterpretation. Even trained male ethnographers misinterpreted relations between the sexes by applying the standards of their own culture (Leacock 1978, 1980). In addition, colonial governments actively sought to alter existing relations by imposing European sexual ideology on native peoples. French Jesuits, for example, imposed a European, patriarchal ideology on the Montagnais-Naskapi in the seventeenth century (Leacock 1978, 1983). As Europeans imposed their standards of conduct on Australian Aborigines, tension between men and women increased as men turned their frustration and anger on women while women sought to conform to European marital concepts that emphasized love and permanence (Bell 1980; see also Kent 1995). Sanday (1981) also found that colonialism increased male dominance in indigenous societies, although she saw this as a function of changes in resource availability and men's versus women's tasks (e.g., warfare and rebellion) rather than a straightforward imposition of European customs.

Additionally, the concept of status itself is ambiguous and difficult to measure cross-culturally. If men and women do different things, does that mean they are unequal? Do we use Western standards of equality or the sentiments of informants? If the latter, do informants see the reality or the ideology of their society? In response to these questions, Elsie Begler (1978) suggests that we avoid the concept of status in favor of *authority*. Authority entails identifying who controls the activities of whom and thus measures autonomy. It might be a more straightforward concept than status, but extracting information on authority from the ethnographic record is still difficult, as demonstrated by the Australian Aboriginal case.

Woodburn (1980) argues that inequality existed within Aboriginal society because older men arranged marriages between young, uninitiated men and girls or unborn females. This sets up inequality between older and younger men but, more to the point, it means that women are always under the authority of their husbands, brothers, fathers, father's brothers, or mother's brothers. Woodburn, Cowlishaw (1981), and Begler (1978) see this as the precontact situation in Australia. Men assist men in retrieving a missing wife, for example, but women are unable to rally support to protect themselves from violent husbands. Violence by men toward women is condoned, Begler argues, because men have culturally defined authority over women. John Bern (1979) sees this inequality between men and women as situated within Aboriginal religion. It is true that Aboriginal religion gives greater importance to men's increase ceremonies (those intended to increase the land's productivity), but others argue that this does not translate into daily oppression of women in secular life (see Hamilton 1980; Merlan 1988; Tonkinson 1988). Isobel White (1978) argued that men were jealous of women's productive and reproductive abilities, and so they took the lead in religious affairs; women, she claims, accepted secondary status in religious affairs because of the psychological satisfaction they received from giving birth.[4]

Tonkinson (1988) finds that although kinship sets up asymmetrical power relations between male and female categories of kin, these eventually balance out, and no person is in a completely unequal position relative to others. White (1978), Catherine Berndt (1978, 1981), and Diane Bell (1980) go further, arguing that women were far more equal to men, especially in the domestic realm, in precontact Australia than just after contact (when ethnographic data were collected). White also argued that women were seen as junior partners because the age difference at first marriage could often be quite extreme. A woman's first husband could be fifteen to twenty years her senior; this age differential decreased as a woman aged and she married men (after her husband's death) closer to her own age. Bell suggested that women controlled many of their second and third marriages; a woman's mother also played a role in the selection of her first husband. It is also possible to find instances in which women were physically aggressive toward men, even beating those over whom kinship relations gave them authority; men were also obliged to come to the aid of women to whom they had particular kinship obligations (e.g., Tindale 1974: 124–25).

The Yaraldi provide a further example (Berndt and Berndt 1993). In everyday life, Yaraldi women had considerable control over their activities and decisions, and contributed significant amounts of food to the family hearth. There was equality between men and women in religious affairs, and there were no secret-sacred male ritual activities (as are found in many other Aboriginal societies). Both men and women underwent formal initiation ceremonies. The Yaraldi's *kuruwolin* or "sweetheart expedition" gave girls a more active role in selecting a marriage partner. Girls sought their mother's permission to marry, but their fathers did not give them away.

In other ways, however, Yaraldi women were under the authority of men. They acquired their status from their husband. Girls who sought sexual liaisons with boys who were undergoing initiation were punished, but boys who sought out girls in the process of being initiated were not. Men could have more than one wife and carry on affairs, but women were punished for promiscuity. Men initiated together had sexual access to each others' wives, but the reverse was not true.

It is not that previous interpretations are in error (although mistakes have undoubtedly been made) but rather that there is a fundamental paradox in Aboriginal society between, on the one hand, a strongly egalitarian ethos coupled with high levels of female autonomy in daily life and, on the other, structural inequalities that favor males, especially in domestic quarrels, marriage, and ritual matters (Tonkinson 1988, 1991).

Thus, we should replace the question of whether men have higher status than women and the search for generalizations about gender equality among hunter-gatherers with more open-ended questions about who has authority, who has power, and under what conditions is it exercised. In so doing, we must inevitably consider links between institutional structures such as economy and marriage practices and their influence on relationships between men and women (Merlan 1988).

Brian Hayden and his colleagues (1986) attempted to analyze such links with a cross-cultural survey of female status in thirty-three hunter-gatherer ethnographies, collecting data on female status in domestic, ritual, and political affairs as well as on warfare, degree of dependence on hunting, and environmental characteristics. They found that female status is lowest in all areas of life when the level of resource stress is highest. (Resource stress was measured subjectively and reflected both periodicity and severity of food shortages.) To explain this association, Hayden argued that in societies undergoing resource stress, population–resource balances are controlled by restraining population size. "By placing women of child-bearing age in positions where they can be easily overworked, they can be pressured by the community to control reproductive activities and infant survival" (Hayden et al. 1986: 460). Thus, by seeing women as inferior to men and even potentially dangerous and polluting, males ideologically justify their control of female reproduction and production for the good of the group.

This position is similar to arguments we reviewed, and rejected, to account for female infanticide in the Arctic. The logical question is: if controlling the birth rate benefits the group as a whole, then why do men need to aggressively control women? The assumption appears to be that women are unable to constrain their reproductive abilities and unwilling to harness their productive abilities, requiring men to control both for them. This seems unlikely. And, empirically, it does not seem to work. Many New Guinea native populations, for example, have dramatic differences in men's and women's power and autonomy, as well as high precontact population densities; and yet the male concept of women as polluting does not seem to have had any effect on regulating population density on that island (Gelber 1986).

Nonetheless, there might be something to the relationship Hayden found, for Sanday (1981) also found a significantly higher number of sexual-pollution beliefs associated with societies that have unreliable food supplies. An alternative interpretation of this pattern is that in situations of high year-to-year resource variability, men control women's productive activity in a way that is in the men's but not necessarily in the women's best interest. Collier has already shown how marriage practices may operate to create and maintain nonegalitarian relations between men and women, just as they create and maintain nonegalitarian relations among men (see Chapter 8). As we turn to the nature of nonegalitarian hunter-gatherer society, we must bear in mind that social inequality is tied to gender inequality.

Nonegalitarian Hunter-Gatherers

Ethnographically, nonegalitarian hunter-gatherer societies are characterized by high population densities, sedentism or substantially restricted residential mobility, occupational specialization, perimeter defense and resource ownership, focal exploitation of a particular resource (commonly fish), large resident-group sizes, inherited status, competitive feasting, standardized valuables, prestige goods or currencies, food storage, and warfare (Testart 1982; Watanabe 1983; Keeley 1988; Fry 2006; Eerkens 2009). Woodburn (1980, 1982) refers to nonegalitarian societies as "delayed-return" and thus emphasizes resource storage – a delay between the procurement and consumption of food.[5] However, delayed-return societies also are characterized by an expected delay in the return of gifts and brides.

On the strength of archaeological data, it is reasonable to assume that nonegalitarian society developmentally followed egalitarian society. On the northwest coast, for example, slavery appears about 1500 BC, warfare by AD 1000, and nonegalitarian societies by at least AD 200 (Donald 1997; Ames and Maschner 1999; Ames, 2001, 2008; Grier 2006; see also reviews of global prehistory by R. C. Kelly [2000] and Keeley [1996], and Kennett [2005] on California's Channel Islands). Egalitarian behaviors and an egalitarian ethos were adaptive for quite a long time in human history before the selective balance tipped in favor of nonegalitarian behaviors and a nonegalitarian ethos (Cohen 1985).

If nonegalitarian societies arise from egalitarian ones, then how do "fiercely egalitarian" hunter-gatherers relinquish some of their autonomy? Why do demand-sharing, belittling, and berating cease to be effective leveling mechanisms? What transforms a group whose members have had their "hearts cooled" to one whose leaders openly boast of their accomplishments and rank? How could the Tsimshian social categories of *smkikét* and *li'qakikét*, or "real people" and "other people," or the Chumash's *paqwot* (big chief) and *'alaqlapch* (shaman-priest) develop from egalitarian society?

One explanation, that we can call the *resource-abundance argument*, runs like this: in favored areas of the world, there is an abundance of food whose long-term productivity is not harmed by intensification of its use.[6] This abundance allegedly permits people to be sedentary and, with the aid of mass-harvesting technologies (e.g., fish nets), to store additional food. Hayden (1994: 226–27) argues that under these circumstances, "competition will occur if there exists a way to transform these abundant resources into highly desired, scarcer goods or services." Doing so allows some individuals to participate in competitive feasting, what Richard Gould and Brian Hayden refer to as "aggrandizing behavior" (Hayden 1981a, 1994, 1995, 2001; Gould 1982). In so doing, some individuals acquire not only prestige but also advantages in acquiring the critical resources of life. This argument assumes that food surplus carries the inherent potential for manipulation (Testart 1982, 1988; Woodburn 1982: 431) and that hierarchy is the inevitable result of the intensification of production.[7]

In Hayden's model, neither storage nor population pressure on the resources is necessary for competition to result. Inequality between groups results from the activities of key individuals, "accumulators" or "aggrandizers," who manipulate competitive feasts and who skim off some resources for themselves and their households. Others patronize an accumulator by contributing to his feasts because they stand to acquire some of the prestigious goods that the accumulator will eventually receive in return, when he is the guest rather than host.

In this argument, sedentism lifts the constraints of a nomadic lifestyle and thus releases human nature. Hayden explains that this process is inevitable because it permits aggrandizers, those with domineering personalities, to accumulate the goods and food necessary for prestige and economic competition (Hayden 1981a: 527).[8]

A second argument is the *information-processing argument*. This one argues that hierarchies emerge because they resolve disputes, maintain efficient information flow about the changing availability of resources, and thus help redistribute resources, especially under conditions of stress (Ames 1985; but see Ames 1994, 1995). In this argument, hierarchy arises from stress on the subsistence base created by high population density, temporally and spatially incongruent resources, and reduced residential mobility. Recall from Chapter 7 that as the number of "organizational units" increases (individuals or family units), there is an exponential increase in the number of disputes (Johnson 1982; Kent 1989a; see also Hamilton et al. 2007a) and a similar decrease in the efficiency of decision making. This is termed *scalar stress*, and there are three possible responses to it:

1. Groups can fission – the standard response among nomadic foragers.
2. Where this is not possible, "sequential hierarchies" merge smaller, independent groups (e.g., nuclear families) into larger units (based perhaps on kinship and held together by ritual or religious obligations), decreasing the number of organizational units and reducing scalar stress.
3. If these groups last long enough, "vertical hierarchies" appear, in which groups have leaders and groups of groups have leaders who process information.[9]

Each of these arguments has its difficulties. The resource-abundance argument does not explain how devoting some resources to prestige competition increases an aggrandizer's fitness; in fact, giving away food and goods should decrease fitness. Nor does it explain how the aggrandizer's supporters decide to participate; the benefits might be clear – a big party every once in a while – but what are the costs? It is crucial to remember that *people do not take prestige, they are given it by others* (Riches 1984).[10] And those who give prestige usually do so at a cost. How do they decide that it is better to elevate some members of the group than to implement another option (e.g., leaving)?

The information-processing argument assumes that there is a group-level benefit to hierarchies but skirts the issue of inequality. Good hunters accrue some benefits by providing a service to the group, but in egalitarian society, the right to lord it over others is not one of them. Why should "information processing" produce such a result? (Also, it is not clear to me that high-status individuals in places such as the Northwest Coast were responsible for processing information. Given that people could apparently move from household to household, they must have done so based on information about the productive or defensive capabilities of other households in other villages. This information would have come through some channel other than one's current leader.)

Finally, those explanations that point to intensification and storage as leading to competition and inequality where food is abundant do not explain (a) why competition exists where resources are abundant; (b) why intensification exists where it does and not in other equally productive areas or earlier in the archaeological sequence; or (c) why community members should not continue to implement mechanisms that level self-aggrandizing individuals, especially those who seek to intensify production by using the labor of others. Intensification and food storage are linked to inequality, but they do not inherently cause inequality (Ingold 1983).

Part of the problem here is that the places where nonegalitarian hunter-gatherers live *seem* to be places where food is abundant. Why is this? First, we often take the limited material culture of nomadic hunter-gatherers as a sign of impoverishment and hard living, and the elaborate material culture of sedentary hunter-gatherers as a sign of affluence (see Chapter 1), of food abundance. But this is a Western interpretation of material goods; a lack of material goods does not necessarily signify impoverishment. Likewise, an abundance of material goods does not necessarily signify an abundance of easily harvested food. It takes time to carve mortuary poles, paint houses, build ocean-going canoes, and weave ceremonial hats and cloaks for feasts – time that people could devote to foraging. Is elaborate material culture a sign of affluence or a sign that time devoted to the social relationships signified by this material culture has become more important than time devoted to foraging?

Second, the term "abundance" can be used with little thought to the costs of finding and processing food – which, as we saw in Chapter 3, are crucial. The Northwest Coast, for example, is frequently cited as a place where food is abundant. However, abundance here is of a very particular kind. Millions of salmon once traveled up the region's rivers each year, in a number of runs over a period of months. But each run only lasted two to three weeks, and people could only take fish in large quantities at particular locations along a stream – at bottlenecks, riffles, and falls where they could erect spearing platforms or fish weirs. Additionally, the number of salmon in a run fluctuates from year to year in relation to changes in river level, temperature, and sediment load (Romanoff 1985; Kew 1992; Grier 2006). Thus, the resource is characterized by both temporal and spatial bottlenecks as well as by annual fluctuations (see review in Ames 1994).

Moreover, if not enough fish are stored, the spring will not be a time of food abundance – and it often was not on the Northwest Coast. The unfortunates who could not access good salmon streams sought to acquire food from others (see subsequent discussion of Northwest Coast). Thus, there was not only an added cost to getting food on the Northwest Coast but also an added cost to keeping it as well (see our discussion of tolerated scrounging in Chapter 6). In sum, although it is not wrong to say that food was abundant on the Northwest Coast, that simple phrase must be amended with the recognition that this "abundance" was available only at certain times, in certain places, at a certain cost, and with a certain probability of failure (Suttles 1968; see also Schnirelman 1994).[11]

In fact, it appears that food is actually in short supply for nonegalitarian foragers. Through analysis of thirty-three foraging societies, Keeley (1988) found that sedentism (defined as a stay of longer than five months in one village), food storage, and *population pressure* were all correlated with nonegaliatarian organization. In fact, Keeley concluded that population pressure "fits very well the expectations for a necessary and sufficient condition for and the efficient cause of complexity among hunter-gatherers" (1988: 404). Foragers who are sedentary, store food, and

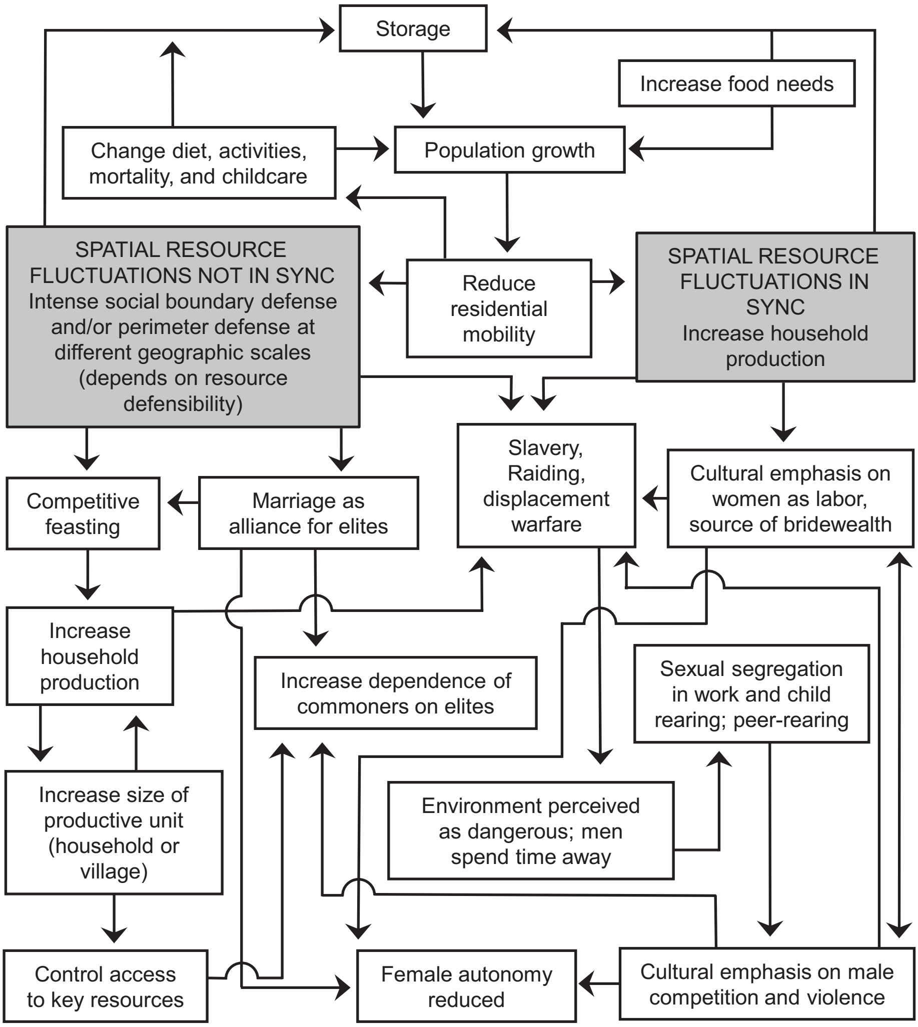


Figure 9-3. A speculative model describing the development of inequality under conditions where resource fluctuations are spatially out of sync and where they are spatially in sync.

have a nonegalitarian sociopolitical organization live under high population pressure. How does population pressure produce nonegalitarian organizations?

Although previous explanations have their shortcomings, they have identified the factors needed to answer this question: (1) the costs and benefits of foraging, (2) the process of group formation, (3) sedentism, (4) population growth, (5) the control of labor, and (6) the defensibility of key resource locations. The effects of men's and women's foraging, the enculturative process, the inheritance of wealth, and the control of expensive technologies also play a role. The following outlines a model of the origins of inequality (Figure 9-3), one that was anticipated by Robert Carneiro's (1970) circumscription theory of state formation and that we can label the *patron-client model* (Smith and Choi 2007). The point is that sedentary hunter-gatherers with their "abundant" resources have not had the constraints of a nomadic lifestyle lifted from them but have traded one set of constraints for another. If sedentary hunter-gatherers accumulate wealth in the form of food or culturally defined prestige goods through trade, feasting, or warfare, it is not simply because their resource base is abundant enough to allow for such accumulation but rather because the long-term consequences of sedentism require it (Bishop 1987: 81). Selection in some contexts works against egalitarianism in favor of nonegalitarian behaviors.

The Patron-Client Model of Inequality

Sedentism and Population Growth

From my perspective, a reduction in residential mobility due to increasing population density, which eventually results in sedentism, is the "kick" that sets sociopolitical changes in motion. As described in Chapter 4, sedentism results from the interplay between the distribution of food across a landscape and population density. The process will happen more or less quickly depending on the "patchiness" of the environment and on the cost of residential movement compared to the foraging return rate. Where resources are localized and defensible and travel is difficult, residential mobility will decrease quickly as population density increases.

Where foragers can store food in quantity and/or rely on a food base – such as marine resources – that rebounds more quickly than terrestrial ones, we can expect a forager population to grow and to reach carrying capacity fairly quickly in archaeological time (Winterhalder and Goland 1993). Although standard ecological theory suggests that the growth rate should slow as foragers reach carrying capacity, as they close in on it, the diet-breadth model leads us to conclude that foragers would still have to use lower ranked resources with high processing costs; they would probably do so with technological innovations (e.g., acorn leaching, fish nets, boats). The result is that foragers would have to work longer hours to achieve the same foraging return rate they experienced under a lower population density (see Chapter 3); this work will probably fall heavily on women since they are generally the ones who harvest more reliable, lower-ranked foods. Working more will reduce on-demand breastfeeding (e.g., Hirasawa 2005), but it probably also reduces aerobic work by exchanging time spent foraging for time spent processing food. At the same time, the use of stored foods may increase long-term energy balance. All of these may conspire to reduce women's energy flux and increase fecundity.

On the other side of the demography coin, sedentism and storage may reduce child mortality, and the increased need for labor and the potential for peer-rearing in sedentary communities may decrease the perceived cost of children (e.g., Hirasawa 2005) and lower the frequency of birth-spacing infanticide. Population size, food storage, and decreasing residential mobility are linked in a self-reinforcing cycle.

Where would sedentary foragers live? We could expect that the best places on the landscape would be occupied first – those that provide the highest rates of return, the most reliable food sources, the most defensible resource-extraction locales, and/or the most habitable physical space. As population grows, the quality of the initially occupied habitat will lessen, and some individuals will move to lower quality habitats – ones with lower return rates, less reliable food sources, less defensible locales, and/or more precarious habitable space. This process is described by the *ideal-free distribution* (see Boone 1992; Kennett 2005). In Figure 9-4, we show three habitats (A, B, and C) that differ in their initial overall per capita return rate. In each, the per capita return rate declines as the population density increases. When the return rate of the better habitat, A, declines to the maximum of habitat B (point *a*), we expect some people to abandon A and move to B, where they will do better than if they remained in A (in a sense, this is the reverse process of the group-size argument we pursued in Chapter 7). The same process is repeated, with habitat C occupied once enough people have moved to habitat B and the overall per capita return rate has fallen to the best rate of habitat C (point *b*). Like a game of musical chairs, as some people become sedentary and remove a place from possible occupation, the environment, in effect, becomes patchier and thus encourages sedentism among the remaining mobile groups (Rosenberg 1998). In this game, though, some chairs are better than others. This particular settling-in process appears to hold true in at least one archaeological case (Kennett at el. 2009).

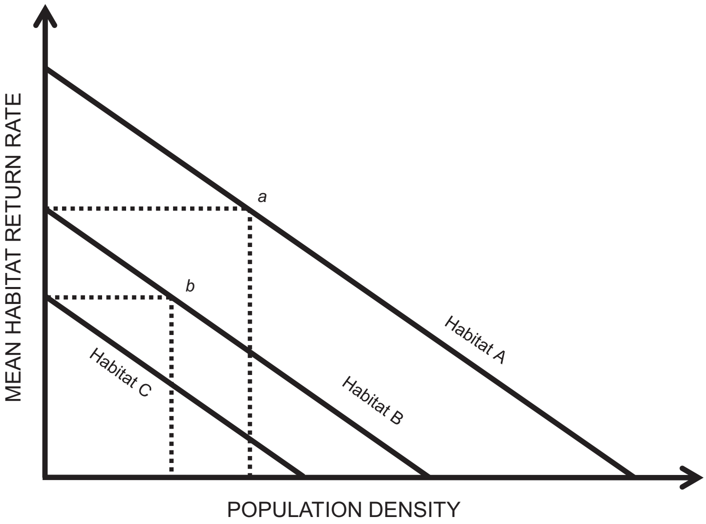


Figure 9-4. Ideal-free distribution. Three habitats (A, B, and C) here differ in their initial per capita return rates; each rate declines as the number of inhabitants increases due to depletion and expansion of diet breadth (see Chapter 3). When the return rate of the best habitat, A, declines to the maximum of habitat B (point *a*), we expect some people to abandon A and move to the unoccupied B. Likewise, as habitat B fills with people, at a per capita return rate equal to *b*, some will move to habitat C.

Food Storage

A reduction in mobility and an increase in food storage have additional effects. For a storage economy to operate, a high-return-rate resource must be consistently available in bulk at the appropriate time of year. But no locality is perfectly stable: there are always droughts, insect plagues, spring floods, early frosts, or vicious winters. One response to resource fluctuations is to move to another area. But if hunter-gatherers become sedentary because of population packing, then pushing someone off their "chair" – annihilating them – becomes a potentially expensive element of the mobility option (for those being pushed, obviously, but also for those doing the pushing: they might lose). Therefore, once population reaches the point at which all habitable patches are occupied, hunter-gatherers are circumscribed, their home ranges will overlap at high population densities (Hamilton, Milne, Walker, and Brown 2007b), and devoting time to warfare or perimeter defense becomes a viable possibility – because the potential benefit (keeping what one has) is worth the potential cost (loss of time devoted to foraging or other activities).[12]

This relationship between sedentism and resource failure takes on special importance when we look at storing economies on a regional scale. In Chapter 6, we saw that a hoarding strategy is predicted to take the place of a sharing strategy unless there is uncorrelated variance in the return rates of foragers and unless retaliation against hoarders is possible. If a group of foragers is situated on a productive resource that fluctuates little from year to year compared to other resource locations in the region, then there is no advantage in their sharing with others – because they do not anticipate needing assistance. These fortunate foragers have every reason to try to keep as much of their food as possible – and those in less fortunate circumstances may occasionally (during bad years) have every reason to try to get it. Looked at in a regional context, but not simply as the practice of accumulation itself, storage carries with it the seeds of conflict. Where stored resources are highly defensible (concentrated in particular locales, such as choice fishing areas along a river), we could expect to see warfare early (in archaeological time) in the developmental sequence of nonegalitarian societies.

Storage creates a second problem if the resource can only be gathered in large quantities for a short period of time. This appears to be the case with many stored foods (e.g., anadromous fish or migratory herd animals). The problem is that gathering the resource in bulk may require considerable labor. Fish weirs, for example, can require the coordinated effort of many workers, as can the rapid spearing/netting and processing of fish. The hunting of sea mammals, especially whales, requires the effort of a dozen hunters in a large boat (and someone has to make the boat); the hunting of a herd of bison also may require the efforts of many people. Making a storage economy work, then, may require that someone coordinate and/or control the efforts of some number of foragers. Hayden, for example, argues that the limiting factor on the Northwest Coast "was not the salmon, but the labor required to procure and above all process, dry, and store the salmon" (1994: 234). Here is where the cost of slavery – raiding other villages and risking your own life – becomes worth the benefit (I do not mean to ignore the morality of slavery, but our perspective here is evolutionary and thus focuses on the costs and benefits of any particular behavior). This is also where men might seek to control the labor of their sons- or brothers-in-law.

Last, we need to reconsider the value of additional increments of food beyond that which is immediately necessary in a storing economy. Foragers store food for an upcoming lean season, but it is not always possible to predict how lean that season will be. An especially vicious winter, for example, can make hunting difficult or increase the rate at which stored food is eaten, either of which could deplete food supplies before spring. It is to the foragers' advantage, therefore, to gather more food than is needed; increments beyond the necessary amount can be diverted into competitive feasts, as Hayden suggests, but additional increments are also a hedge against any contingency (this may be why Ember and Ember [1992] found a correlation between warfare and the perception of natural disasters). Where storage is necessary, additional increments of food beyond what is minimally necessary will confer a selective advantage. Unlike a forager who brings in a large elk for the evening's meal, there is no tolerated-scrounging decline in the utility of stored food (as long as it will remain edible).

The Formation of Groups and Leaders

This discussion suggests that the course to inequality is charted by a leader's ability to organize labor. Jeanne Arnold sees the "sustained or on-demand control over nonkin labor" (1996a: 78) as an essential element of nonegalitarian societies (see also Arnold 1993, 1995a, 1996b, 2001a,b, 2009). How might this happen?

One way is through the benefit foragers gain if they relinquish some of their autonomy to a leader. One of the problems of cooperative groups is free-riders, people who gain from a group's efforts without contributing their share. Everyone has experienced the frustration of working in such groups. Hooper et al. (2010) and Smith and Choi (2007) show that group leaders can arise where an economy of scale means that the per capita return rate increases with a larger group size (see also Henrich and Boyd [2008] on the benefits of specialization). An example might be whale-boat crews among the Inuit or on the Northwest Coast. It is easy to imagine that a single forager might have a rough time (to put it mildly) taking down a whale from his personal kayak, and he would quickly see that having a crew of eight to twelve men in a large *umiak* or ocean-going canoe would increase his own return rate (see Alvard and Nolin 2002). Why would a leader be needed in such cases?

For a share of the return, a leader ensures that each whaler contributes his share of labor and coordinates efforts to avoid duplication and inefficiency. (They could also provide incentives for members to monitor each others' behavior to reduce their own cost of taking on the role of "enforcer."[13]) Thus, leaders become more important the larger the cooperating group since (a) they take on the cost of ejecting the free-riders who can invade large groups if no one is watching, and (b) they reduce the potential for inefficiency that increases with larger groups (and this becomes especially important with warfare). The importance of such leaders increases with the size of the difference between foraging alone and as part of a group and as the optimal group size becomes larger (Hamilton 2000). This process may account for leaders whose positions afford them some but not large amounts of power over other areas of life (e.g., village headmen among the Owens Valley Paiute; see Eerkens 2009).

Leaders will also arise where a resource-extraction locale is defensible, where one or a limited group of foragers can control access to, say, a prime stretch of storm-protected beach or an excellent fish-weir location on a salmon stream. In these instances, leaders can take a cut of the foraging returns – a portion of the whale or share of the salmon – ostensibly in return for enforcing group membership by removing free-riders and coordinating labor, but actually because they can control access to the resource. Hard-working group members benefit because their efforts are not supporting goldbrickers, and yet they do not have to pay the social cost of "being stingy" (Smith and Choi 2007; Hooper et al. 2010). In economies of scale, then, foragers benefit by turning over some of their autonomy to a leader.

This might explain why leaders appear, but it does not explain inequality – why leaders might receive larger shares of the whale or salmon. Group leaders are common in egalitarian societies – Shoshone "rabbit bosses" for example – but they are temporary and have their position only because they have demonstrated skill at a particular task. Their leadership does not carry over into other realms of life, nor is it permanent. The process of group formation, however, suggests how the process of leader creation might result in inequality.

In Chapter 7, we pointed out that additional members can be expected to try to join a group of size N as long as the return rate from foraging in a group of size $N + 1$ is higher than the return rate from foraging alone (see Figure 7-3). Likewise, those who are already members of a group are willing to include others as long as the per capita return rate does not decrease. In fact, they would encourage others to join since it is to everyone's advantage. This is what we might call the "many hands make light work" stage.

At some point, however, the group reaches its maximum size, and additional members will only drag the per capita return down. When this happens, we would expect current members to exclude others. This is the "too many cooks spoil the broth" phase. But what happens when population pressure is high, and there is no foraging space open for an individual or group, and their only option is to join a group that is already at its optimum size?

In such cases, a conflict of interest arises between group members and newcomers. And, if newcomers have no other options, then the cost of group membership can be high and still be worthwhile, as long as their per capita return is better than going it alone. Group members likewise have to choose between the cost of admitting another member (and lowering per capita returns) and the cost of not admitting the petitioner, which could include physical retaliation.

James Boone models what might occur under these circumstances (Boone 1992, 2000). This model assumes that there is a single leader in a group, perhaps through the resolution of scalar stress or the development of coordinating leaders[14]; that the leader's only option is to redistribute benefits within the group to his or her benefit (i.e., the leader can skim); and that the only options other group members have is to accept the unequal distribution or leave. Boone shows that the shape of the average per capita utility curve and the utility curve of the group leader are similar to that of Figure 7-3 but that the utility curve of the leader predicts a slightly larger group size than that of the average per capita utility curve: optimal group size for a leader is slightly larger than for nonleaders, assuming that key resources are economically defensible by a group's leader. *It is to a group leader's advantage to keep members in the group, even when it is not necessarily to the other members' maximum benefit.* Note that the Kwakwak'awakw orator whose speech heads this chapter is proud to have "four or five" more people to give blankets away. Also recall the discussion of Chipewyan hunting-unit size in the previous chapter; a leader of a hunting unit will try to make the unit as large as possible, even if it eventually leads to increased travel time and declining returns for the existing members.

A leader has to justify this action to current group members. He can do so by permitting someone to join a group but by giving them second-class status or by forcing them to give up some of their autonomy, such as the choice of where and with whom to forage and how much of a resource they can keep. *When this happens, nonegalitarian society has formed*. And it happens under high population pressure and where access to resources can be controlled by a limited number of people (e.g., Andrews 1994; Keen 2006).

Sharing

Recall from Chapter 6 that nomadic hunter-gatherers acquire physical access to another region primarily by acquiring social access to the group who holds the right to grant permission to use a region's resources. This social access is more or less defended depending on the costs and benefits of allowing another group in: the incoming group will take some resources, but the host group knows the visitors will reciprocate in the future. The extent to which a host group can allow another group entry depends on whether its members think they will need the visiting group's resources in the future, on the possibility of violence if they deny access, and on the amount of resources they can afford to share.

More than nomadic groups, sedentary groups who store food may seek to maintain rights to other's resources while trying to limit the rights of others to their own. Well-placed groups with abundant and reliable resources may seek ways to assuage those who are less well placed to reduce the potential for warfare. Alternatively, less well-placed groups will seek the least costly ways of acquiring the food of well-placed groups; here, the cost of tendering prestige, and accepting lower returns by doing so, may be worth the benefit of receiving needed resources.

If sedentism and storage occur where resources are highly localized (either physically, through their distribution, or effectively, through population packing) and population pressure is high, it would not be advantageous to open one's social door to everyone who knocked. Under these conditions, groups could benefit by maintaining access to another group's resources but could be harmed by letting another group into their own pantry.

This sets up a paradox that may result in social-boundary defense taking on a different character as residential mobility decreases. Among nomadic hunter-gatherers, individuals maintain relations with others through trade, sharing, kinship, marriage, and so on (see Chapter 6), forming individual and interlocking social networks. It is my impression that in sedentary societies, one or a few people maintain links with other groups, whereas other group members are linked only indirectly through these few individuals. Some individuals become gatekeepers and within that fact lies the potential for manipulation and skimming.

Warfare

We noted previously that storage carries with it the potential for warfare and raiding – because if your stores run out and your neighbors cannot support you, taking their stores by force may be the only option. But warfare sets up an additional dilemma in terms of group membership. If an insufficient number of people participate in raiding or defense, the entire group suffers. Thus, there is a strong impetus for current members to encourage others to join the group. Where warfare is prevalent, we expect residential groups or clusters of cooperating communities to be larger than expected based on food abundance alone (Alexander 1987; Roscoe 2009). Conversely, warfare can exact a severe toll, as lost opportunities, but more significantly as injury or death. In large groups, a smaller percentage of people are needed for warfare, and more people can avoid defense's direct cost, free-riding on the efforts of others. This could lead to more individuals wanting to join a group since they could share or avoid the cost of warfare and yet reap the benefits of a defended resource.

Costly Displays

If new members join a group that is already at optimal size, they lower per capita returns for everyone. An answer to this problem is to enlist their participation in activities that deliver prestige to the ranking individual or family (Roscoe 2009). These activities are costly signals and usually come in the form of what Paul Roscoe (2009: 95) calls *conspicuous distribution, conspicuous performance*, and *conspicuous construction* – feasts, artistry, and public works. These are designed to communicate the numerical strength of a population and, importantly, the capacity of its leaders to mobilize that strength. Trade goods figure into this process as well. *Hxaro* goods among the Bushmen are visible evidence of social connections beyond the immediate group. But in the context of nonegalitarian societies, elaborate, nonfunctional goods or esoteric knowledge and immaterial goods (e.g., dances, songs) communicate elite's connections to other elites and the power they can draw on should their position be challenged.

These activities communicate at an informational level but, as artistic endeavors, at an emotional level as well; they are social "shock-and-awe" tactics – and are aimed at both a group's members and at potential competitors (Roscoe 2009). They communicate an individual's social power, and that information can be very useful to the rank and file, especially if warfare is prevalent (Boone 2000). When a Northwest Coast chief held a potlatch, he was communicating to both his guests and his constituency "this is how powerful I am; this is how many people stand behind me; this is how much labor I command; crossing me would be foolish." Likewise, if a guest refuses to attend a feast, the host sees it as an insult that must be avenged if he is to communicate his power to his own people (see, e.g., Gamble [2008: 258] for an instance of such an event among the Chumash). These feasts and public works help resolve the inevitable conflict of interest that arises when additional group members are not accorded the same rights as existing group members (Roscoe 2009) because they remind lower-status group members what they acquire in exchange for the prestige (and resources) they grant a group's leadership.

This is also where a Marxist perspective provides some insight. The leadership in nonegalitarian societies must provide an explanation for why some members receive more than others, why some live in larger houses, have more stored food, or can command labor – and why others cannot adopt the tactics of the elite. And that explanation is invariably an *ideology* (e.g., my forefathers founded this village, so you are permitted here by the good graces of my family). Costly displays, such as feasts, are visual demonstrations of the "honesty" of this claim. And warfare is perhaps the most definitive and most costly of all possible displays.

The Patron-Client Relationship

We have pointed out that leaders in nonegalitarian societies control access to resources either by controlling physical access to key resource-extraction localities or by controlling the necessary technology (e.g., the Chumash *tomol*, or large plank canoe; Arnold 2007, 2009). In so doing, they can exchange access for the labor of others – and hence control that labor. As Collier pointed out in Chapter 8, some of this labor can be devoted to the pursuit of prestigious activities that allow the elite to demonstrate why they have power and hence perpetuate an ideology.

This is made possible by a process similar to that of tolerated scrounging: additional increments of wealth have less value with increasing amounts of overall wealth (see Boone 1992: 321). Figure 9-5 shows one likely relationship between a resource's utility and increasing amounts of that resource. For those who hold small amounts (less than A on the x-axis), utility increases proportionately with increasing units of the resource. For those with more wealth (between A and B on the x-axis), utility increases more quickly with increasing amounts of a resource, and these individuals can be expected to fight harder for those additional increments (perhaps taking from those with less, for whom additional increments are not worth as much). For those individuals who possess a great deal of wealth and/or control resource-extraction localities (more than B on the x-axis), each additional unit is worth relatively little in terms of utility, and they can be expected to give this up more readily, perhaps through competitive feasting or other costly displays. At high levels of wealth, the social benefits of generosity are worth more than the resource itself.[15]

Those individuals in the middle of the curve would fight the hardest for resources because they have the potential for upward movement, and those at the bottom would fight the least. Those at the very top are in danger of being toppled by those immediately below them. Leaders could, however, avoid this by enlisting the support of those at the bottom of the curve by distributing resources to them. Those at the very bottom have little potential for social movement; they survive by serving leaders and accepting their largesse, since their primary alternative is to move to another group – which may not be possible and could leave them no better off.[16] If leaders cannot control resources or if resources are not abundant enough (relative to the current group size) to keep disgruntled members, and if another group is available to join, group members may leave. Recall from Chapter 6 the case of Chipewyan hunting units, where leaders could not completely control access to resources, where a forager always had the option of foraging alone or joining another group, and where increasing group size decreased each individual's foraging return rate. Here, the hunting group dissolved after reaching a critical size because the individual's option to move was still possible.

So far, we have mostly considered the relationships between leaders and other group members. To understand relations between groups, we need to consider how the spatial parameters of resource fluctuations could affect social relations. Following Winterhalder's sharing model (see Chapter 6), we will look at two hypothetical situations that affect the patron-client relationship: one where food resources are not in sync over time and one where they are (see Figure 9-3).

Resources That Are Not in Sync across a Landscape

Nonegalitarian societies form under conditions of high population pressure, in places where groups can each defend resource-extraction localities. Such regional population packing can create severe bottlenecks during times of famine. Where resources are not in sync – where one habitat does poorly while another does better – those in the poor habitats will periodically seek access to the good ones. It is during such demographic bottlenecks that fitness-depressing costly displays could promote greater fitness *over the long term* if such activities permit one to control access to the best resource-extraction localities (Boone 2000). The utility of such displays will become greater with increasing frequency and severity of periods of famine – and the severity and frequency of such events will effectively increase with increasing population.

We pointed out in Chapter 6 that one way to reduce risk was to construct social alliances based on trade and to call on those relationships in bad times. This works only (a) if the subsistence bases of those participating in the network are not tied to the same source, so that when one group is doing poorly, a neighbor is doing well; (b) if one group can accommodate a neighbor; and (c) if the tables might be turned in a future year. Where resource variations are not in sync, social relationships are useful as risk-reducing insurance strategies, and we could expect to see the trade of goods or food as a symbolic indicator of social-boundary maintenance and negotiation.

But as population increases, so does the cost of letting in visitors.[17] A host group under high population pressure cannot absorb many people, and so the cost of membership (through marriage or some other social practice) increases. Referring to Figure 9-5, established leaders could use resources to establish ties with other groups (e.g., through feasting or the production of elaborate trade items such as beads, copper axes, elaborate weaving, or pottery). Other group members could "ride on the coattails" of leaders, receiving some of the goods from their social connection, and could therefore be willing to serve their leaders' interests in prestige competition. In sum,

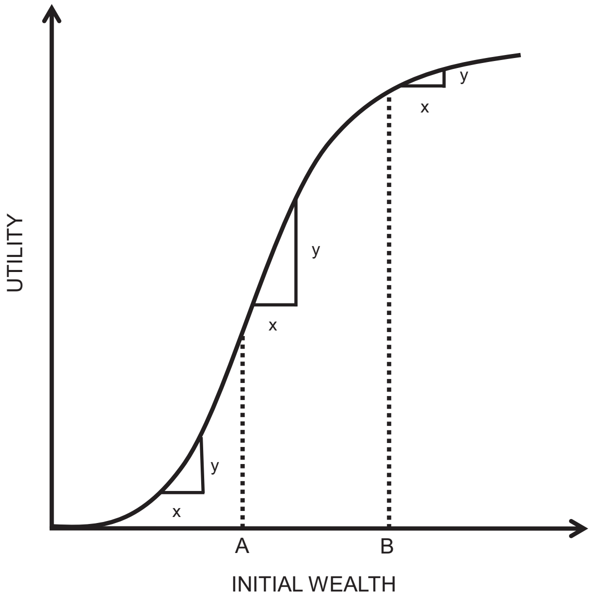


Figure 9-5. One potential utility function describing the relationship between the utility of resources and amounts of that resource. Individuals below point A are "poor" whereas those above point B are "wealthy." An additional amount (x) of a resource has different utilities (y) for individuals of different levels of initial wealth. Redrawn from Boone 1992. Used with permission from E. Smith and B. Winterhalder, eds., *Evolutionary Ecology and Human Behavior* (New York: Aldine de Gruyter) © 1992.

inequality and costly signaling should increase with increasing variation in resource abundance over time:

> [P]atrons compete with each other for clients who demand the least, for example, in terms of food security, and clients scramble for patrons who will offer the most food security or who have the most power to protect them from the depredations of competing groups. Since how much each would have to offer in the long term may not be directly or immediately observable, it is in this context that we would expect to see honest signaling of these underlying capacities. (Boone 2000: 99)

Those who gain social access to another group become the funnel through which some or all members of one group have access to the resources of the other. These individuals become middlemen who control critical intersections in the social web (Rodman and Counts 1983). These individuals always walk a fine line, since they must manage an image of generosity and selflessness while maintaining authority and power. On the one hand, they must appear to their own group to be able to gain access to another group's resources; on the other hand, they must appear to that other group as in control of their own constituents and able to guarantee access to their own group's resources. The leaders must act generously to their constituents while encouraging them to assist in elaborate feasts that demonstrate the leader's power to others. This is why leaders in nonegalitarian societies boast of their generosity, an unthinkable act among, say, the Ju/'hoansi (see Ingold 1983).

Patrons in the patron-client relationship must communicate their power. For this reason, social hierarchies take on a life of their own as ever greater effort must be directed toward prestige activities such as feasting (Hayden 1990). Leaders ostensibly do this to acquire prestige, but the result is that they keep lower-ranking individuals in their group and control their labor.

Once one or several members of a group recognize and accept that maintaining an actual position of authority while fostering an image of egalitarianism is essential to their well-being, they pursue objectives that are different from those of most group members. Consequently, decisions cannot be made on the consensual basis that characterizes egalitarian hunter-gatherer societies. Consensus-based politics "can only operate as a mode of decision-making where there is general agreement about 'the rules of the game'" (Silberbauer 1982: 32). As soon as one individual controls access to another group or to resources, he or she develops objectives different from the rest of the group; the leader aims to remain the only point of access and must therefore control the social and productive activities of fellow group members. This is inequality, since it limits individual autonomy (Leacock 1978; Gardner 1991).

The patron-client strategy is viable only where each group tries to restrict social access and where members of an outside group want access to the resources of another.[18] Surplus is necessary to prestige competition, but it alone is not the cause of inequality. The critical issue is what someone controls (Josephides 1985: 219; see also Arnold 1993; Hayden 1994), and what patrons control is access. Since prestige is given, not taken, the question is at what point is the giving of prestige, which may encompass working for another individual or giving goods and food for feasts, worth what one might get in return?

Woodburn notes that certain Hadza sought to acquire control over other Hadza by virtue of *what they were able to acquire through their contacts with outsiders*, which gave them access to valuable goods and associated them with intimidating Europeans: "in every instance . . . in which a particular Hadza has been said to be any sort of figure of authority . . . he was someone with contacts with outsiders who was attempting to use these contacts to acquire power over other Hadza" (Woodburn 1979: 262).

But these individuals were not accorded prestige. Instead, they were treated by other Hadza as nothing more than "rather predatory entrepreneurs" (1979: 263). Why don't similar attitudes and behavior prevent the formation of nonegalitarian communities?

Individuals are granted prestige when the benefit outweighs the cost of doing so. This describes the process that occurred when European traders contacted Northwest Coast peoples. Archaeological data show that at the time of contact, peoples of the Northwest Coast had lived in large, sedentary villages with well-developed elites who participated in long-distance trade, fought one another, and had taken slaves for some time. There was a well-developed elite hierarchy in some places.[19]

After contact with Europeans, warfare on the coast increased as villages fought to control access to trade goods (Ferguson 1983, 1984). These goods included many things that could have been used in competitive feasts but also many weapons that could be used in fighting and tools that improved foraging efficiency. Through armed conflict, some groups dominated the market; coastal groups were especially able to control the trading activities with interior groups such as the Tutchone and Carrier. Those Tutchone and Carrier who were considered rich (by other Tutchone and Carrier) were those who controlled access not only to the best fishing spots but also access to the best coastal trading partners (Legros 1985; Bishop 1983, 1987). Anyone who wanted access to European goods had to go through, give prestige to, and lose autonomy to those who controlled the trade market.[20] We would hypothesize that at the time of contact, the cost of acquiring Western goods (which may have meant being subservient to a village that successfully channeled trading activities through itself) was lower than the benefit.

A similar kind of social access between groups is probably achieved through marriages between kin groups. Recalling Collier's analysis of marriage in Chapter 8, marriage is one strategy for constructing alliances; but, in the kind of marriages we are discussing here, the stakes are too high for divorce or for the partners (male or female) to disagree. Wife-givers acquire prestige as they capitalize on the labor of wife-takers. Wife-takers, conversely, acquire prestige in their respective communities because the marriage provides a portal through the social boundary of another group. If a woman wishes to have any support from her male relatives, she will accept her husband. Women, therefore, become candidates for nuptial politics. The status and authority of prestigious women may be high in these circumstances, but their autonomy and power could be equally low.

Resources That Are in Sync across a Landscape

This is perhaps a simpler situation than where food-resource fluctuations are not in sync. Where resource fluctuations are in sync across a landscape, social relationships as risk-reducing measures are less useful – the cost of admitting visitors is high relative to the benefit because, in times of need, the host is always doing as poorly as the visitor. As we noted in Chapter 6, one strategy in such a situation is for each family to restrict its sharing radius and build up personal stores of food. In these cases, individual resource ownership may appear (perimeter defense at the level of households), as well as ways to increase household productivity. As in the earlier circumstances, leaders may find ways to keep people in their household, or otherwise under their control, and accept a lower rate of return. This happens where the leader can control access to resources, especially stored food, and where potential joiners have no alternatives; that is, where population pressure is high.

I suspect that in these societies, women will more often be valuable (to men) for their labor and for their bridewealth rather than for their potential as players in marriage-based social alliances. Under such circumstances, polygyny as well as slavery may become more common as households try to increase their productivity.[21] Therefore, women's status will decrease as household storage increases (see Sacks 1974).

An Example: The Northwest Coast

We can elucidate these propositions by examining cultural variability along the Northwest Coast of North America, where foragers lived in large, sedentary villages; owned slaves; participated in warfare for booty, food stores, slaves, and land; and where, in some societies, individuals, kinship units, and villages were ranked.[22] There was also a lively trade in a variety of foodstuffs and material goods such as flint, copper, eulachon oil, canoes, furs, moose and caribou hides, tobacco, baskets, hats, and mats, as well as slaves (see review in Mitchell and Donald 1988).

As a gross characterization, we could say that resource fluctuations shift from being spatially in sync to spatially out of sync from the southern to the northern coast (i.e., from northern California up through the Alaskan panhandle). From south to north on the coast, there is an increase in the use of fish, especially salmon (Schalk 1981). Since these are taken from rivers, this means that from south to north, food resources are increasingly localized (Richardson 1982), and there is a greater probability that one village's resource base is not linked to that of another.[23] Thus, as we move from south to north, we should see an increase in the size of the social group that owns resource areas, an increase in the role of women as alliance builders as opposed to producers, an increase in hierarchy, and an increase in social alliances that are more firmly constructed and more tightly controlled through "conspicuous" activities and controls on group membership.

As resources become more localized from south to north along the coast, they also became more defensible. Access to a good fishing locale was critical for central and northern Northwest Coast societies. At the same time, habitable space is also more limited on the central and northern coasts than on the southern coast. For example, of Vancouver Island's Pacific coast, Drucker states:

> Between the sounds there are areas of low headlands fringed in many places by long, straight beaches on which the surf pounds endlessly. It is said that anciently there were a few groups of people who lived all the year on these "outside" coasts. They suffered many hardships during

> winter storms when the surf was too heavy for them to launch their canoes. Eventually they made alliances with people of the sounds and abandoned the outer coasts except for spring and summer camp sites. (1951: 7)

In addition, the steep terrain of the mountains bordering the central and northern coast, as well as the dense temperate rainforest vegetation, makes travel difficult and, as discussed in Chapter 4, would have discouraged residential mobility. Everywhere along the coast, some of the critical resources – acorns to the south, salmon to the north – were labor intensive, especially when prepared for storage (Donald 1985; Basgall 1987). Where fishing weirs and platforms were constructed, or where large boats had to be manned to acquire whales or sea mammals, labor had to be acquired and coordinated. As mobility became less of a viable option to resource shortfalls, the growing population along the coast became increasingly circumscribed, decreasing the cost of warfare relative to its alternatives. Labor was therefore needed for defense of villages and raids against others, in addition to that for food harvesting and processing.

Southern Coast

Groups on the southern coast, such as the Tolowa and Yurok of northwestern California, lacked elaborate positions of prestige (Kroeber 1925: 8) and larger social units such as clans; instead, families focused on household production, which involved the control of labor and wealth objects. Marriage played a key role in both of these pursuits.

Marriage required wealth objects (e.g., red-headed woodpecker scalps, dentalium, and obsidian bifaces) as bridewealth payments. Marriages were arranged by a (usually wealthy) intermediary and were accompanied by little ritual; the most important element was the schedule of bridewealth payments. Taking a California pattern to an extreme, wealthy Yurok men married their children into other wealthy families, and a women's value, and the status of her children, was judged in terms of her bridewealth (Kroeber 1925: 29; Bean 1978: 677).

To choose a wife, Tolowa men looked at a woman's hands to see whether they were scratched and worn – evidence of a hardworking disposition (DuBois 1932). Polygyny was allowed if a man could afford the bridewealth payments. The bridewealth objects were acquired by men through the betrothal of their daughters, trade, direct acquisition, or as payment for some transgression (in fact, "every injury and offense, [could] be exactly valued in terms of property" Kroeber 1925: 20).[24] Although crucial to marriage, wealth objects also increased household production since they could be traded for food in times of need (Gould 1978: 132; this was especially important for men with no wealthy relatives). There were still other ways to increase production. One was half-marriage, in which a poor man paid part of the bridewealth and then gradually paid the rest. In the meantime, he and his wife remained with her natal family. The bride's parents therefore retained both her labor and that of her husband for a while – sometimes a long while; they also retained the bridewealth of any daughters she produced while still living with them. Likewise, debt slavery allowed men to work off a debt produced by homicide or some other transgression (including uttering the name of a deceased person). Household production was also increased through the taking of slaves. Divorce was possible but only with the repayment of the bridewealth.

Although wealthy individuals could hold sway over small villages, there were no permanent tribal or intervillage leaders, and "property and rights pertain[ed] to the realm of the individual" (Kroeber 1925: 3). Inland resources, such as oak trees and salmon-fishing riffles, were owned by individuals or families (Gould 1978, 1982; Pilling 1978: table 2). Kroeber (1925: 34) stated that "it was forbidden to establish a new fishing place or to fish below a recognized one," meaning that individuals and families controlled access to all potential fishing places on rivers.

The Tolowa and Yurok did not engage in as much organized warfare as did groups to the north. For the most part, the violence consisted of revenge killings between villages (but see

Kroeber's [1925: 126] account of a Tolowa-Yurok feud initiated by accusations of witchcraft that stopped a salmon run). These were sometimes settled by intermediaries with payments of wealth objects (Gould 1978).

Central Coast

Farther north, in the Wakashan and Salishan linguistic regions, residential groups were more sedentary, spending more time in their winter villages than people to the south. Unlike the Tolowa and Yurok, all individuals and family lines were ranked. Chiefs presided over villages and their households owned the majority of property or the best resource patches; lower ranking people who used their resource areas had to give some of the food to the chief, who might use it in a feast. Whales that washed up on the beach belonged not to the hunter or finder but rather to the chief with rights to that stretch of beach.

There is also an increase in the importance of the inheritance of wealth and status and more tightly defined ownership units (Drucker 1939, 1951). Among the Kwakwak'awakw, the ownership unit was a patrilineally biased bilaterally extended household called a *numaym*. Kwakwak'awakw villages were made up of one to seven *numayms*, consisting (prior to extensive population reduction in the mid-nineteenth century) of some seventy-five to a hundred people. The *numaym* could lay claim to particular house and resource sites as well as titles, crests, and potlatching positions (seating places at the competitive feast). Among the Kwakwak'awakw and Nuuchahnulth, the *numaym* owned berry fields and hunting grounds, although there was some individual ownership of resources as well (Drucker 1939, 1951: 247, 251–52; Boas 1966: 35–36). Nuuchahnulth chiefs had to maintain their positions of authority and power or they risked the loss of their villagers' support because villagers could use kinship ties to move to another village; they could even overthrow a chief (Arima and Dewhurst 1990).

Wars among the Nuuchahnulth were fought primarily for economic reasons. In precontact times, if a group wanted "the territories and fishing stations of its neighbors, and if they could share in the rights no other way [they] would send out war parties for the express purpose of exterminating the intended victims and seizing their property" (Drucker 1951: 333). Some Nuuchahnulth recalled the time that the Clayoquot, a Nuuchahnulth tribe, drove their neighbors away, taking over their territory; others recalled stories of fighting those who lived on inner channels and salmon streams to control fishing areas (Drucker 1951: 37; Ferguson 1984: 291). The southernmost Kwakwak'awakw eventually drove some Coast Salish from their villages, taking over their lands and salmon streams; the Salish did the same to their neighbors (Ferguson 1984: 297–98). Although the Kwakwak'awakw ostensibly fought for reasons of revenge, grief, shame, or prestige (e.g., Codere 1950), Ferguson (1984) argues that most precontact and early postcontact warfare was motivated by economic reasons, conflicts over hunting or fishing grounds, or, in times of famine, raids to acquire food stores. Of course, both factors are at work: wars of possession are usually couched in terms of honor, prestige, and glory to inspire passion in warriors; undoubtedly, such passions can take on meaning and causality of their own.

Marriage ceremonies of Kwakwak'awakw high-ranking individuals here were more elaborate than in northern California. *Numayms* were exogamous and although there appears to have been equal amounts of village endogamy and exogamy (Rosman and Rubel 1971), those of the highest social rank were expected to marry a woman of comparable rank in another village (Ruyle 1973: 611–12). Among the Coast Salish, rank was associated with intervillage connections, normally established through marriage (Suttles 1960; Elmendorf 1971). Intervillage marriage ceremonies were sources of tension and apprehension and were accompanied by elaborate rituals, including tests by fire and ritual battles between the two families – demonstrations of each family's power and influence (Boas 1966: 57–68). Among the Nuuchahnulth, grooms proved their worth by climbing greased ropes, running a gauntlet of torches, or breaching a line of strong men – after waiting outside the bride's house for up to four days, repeatedly offering the bridewealth payment.

Bridewealth was important, but the focus of attention was not on wealth objects, as it was in northwestern California, but rather on "the transfer of names and privileges" from father-in-law to son-in-law (Boas 1966: 55).

Alliances were constructed between close clusters of tribes, and most warfare or violence was directed outward, toward tribes belonging to other clusters (although close neighbors were still subject to occasional violence [Codere 1990]). The Nuuchahnulth men took wives from less militarily powerful tribes, perhaps to establish alliances for warfare but also to control trade with Europeans (Ferguson 1984: 288). Through marriage and trade, the Nuuchahnulth expanded their territory to improve their salmon resources, reducing variance in the harvest by forced pooling of the returns from different streams. As evolutionary theory would predict, local Nuuchahnulth groups that joined larger federations of villages had poorer salmon streams than those in the federation's territory (Donald and Mitchell 1994).

Kwakwak'awakw villages were ranked; their ranks correlated with the size of their river's salmon run and, to a lesser extent, with the annual variance in the run (for those villages that had access to sizable runs [Donald and Mitchell 1975, 1994]; some 10 percent of Wakashan villages, for example, did not have access to any streams or to streams with minor runs [Mitchell and Donald 1988]). As expected, villages of smaller salmon runs granted prestige to a village situated on a river with a consistently large run, since the benefit of an alliance with them would outweigh its cost (which was undoubtedly less than the cost of raiding or displacement).

Conversely, villages situated on streams with large, secure runs could afford to hoard resources, partly because the localized fishing places on streams and food stores were defensible and partly because, with low variance in runs, they received no variance-reducing benefit from sharing with other villages. They did not need goodwill; rather, they had to alleviate the cost of demand-sharing, which, in this case, could take the form of raiding by people desperate for a prosperous village's resources. Streamless tribes seem to have frequently been the aggressors in efforts to displace a more fortunate tribe; upriver tribes, whose salmon supply was reduced by those living downstream, directed aggression at them (Ferguson 1984: 310, 312). The competitive feasts of potlatching offered a way to give some people social access to a host village while relieving the host villagers of the cost of defending themselves or retaliating for attacks.

Northern Coast

Still farther north, among the Tlingit, Tsimshian, and Haida, we find the "highest development of formal village organization with permanent discrete social units" (Suttles 1968: 64; Rubel and Rosman 1983). Tsimshian villages consisted of extended or three-generation matrilineal family households of twenty-five to forty people living in houses up to 2,500 m^2 in size (Coupland 1994); we also find here the largest village sizes along the coast (Schalk 1981: table 2). There is a "south-to-north gradient of increasing tightness of structure and size of social unit" (Suttles 1968: 64; Richardson 1982: 97) on the coast, evidenced on the northern coast by the presence of moieties, with "houses" (sometimes three to five physical households) as the primary resource-controlling groups headed by a "keeper of the house," who held all property in trust (Donald 1985; Coupland 1994). Some Tsimshian chiefs may have held resource-collecting areas individually, in addition to those they controlled for the household. Chiefs among the Tlingit and Tsimshian were men who did not work, and a chief's status could be endangered if he undertook menial tasks (Oberg 1973: 87; de Laguna 1983). Gitksan chiefs strove to increase their household size, suggesting that the optimal household size for them was slightly larger than for those encouraged to join it – as predicted earlier (Adams [1973]; see also Hayden [1992] on the Lillooet).

Slavery may have played an important role here because it was a source of labor that chiefs could reliably control. Slavery existed all along the Northwest Coast, and slaves were a major objective of raiding and warfare. Although it is difficult to judge the reliability of estimates of the number of slaves, the proportion may have been up to 25 percent in some communities, but 7–15 percent was probably more common. For the northernmost Northwest Coast, slaves contributed to household production by processing hides, gathering firewood and water, collecting plant foods, and manufacturing hunting gear (Mitchell 1984; Mitchell and Donald 1985; Ames 2008).

Since the optimal size of a group is predicted to be larger for chiefs than for group members, a chief might have coerced individuals occasionally to join, with slavery being the ultimate form of coercion. However, slaves could also be traded for wealth objects if production fell short of needs (or killed if stores were inadequate to support them). Mitchell (1984) lists what slaves were worth among various northern coastal societies (e.g., 1 slave = 15 elk skins among the Tlingit, or 100–200 blankets among the Haida). However, slavery may even have been more common in the southern reaches of the coast, where the need to increase household production was perhaps felt more keenly (Donald 1985). Around the mouth of the Columbia River, slaves may have comprised 20 percent of the population – a considerably higher number than in more northern communities (Donald 1984, 1997).

On the northern coast, wars were directed toward the acquisition of land and food, as well as slaves, before Europeans arrived on the scene. The Tlingit and Tsimshian fought over the Skeena and Nass River estuaries, and the Haida sought to displace the Tlingit on part of the Prince of Wales Archipelago (Ferguson 1984: 274). The Tsimshian expanded their territory through war, and both they and the Haida raided neighbors for food supplies. Bella Coola downstream villages were stockaded, and the Kwakwak'awakw and Tsimshian regularly raided them for slaves. Warfare is always expensive, and it appears that as soon as European traders arrived on the scene, warfare for territory ceased and conflict shifted to fights over access to trade routes and to the traders – the new patrons.[25]

Societies on the northern coast displayed a more hierarchical sociopolitical structure, a structure that was overtly reinforced and maintained through the potlatch (from the Chinook jargon word, *patshatl*, meaning "to give away"). Although it was originally a variety of feasting rituals, it became elaborated after contact (especially among the Kwakwak'awakw) perhaps as a function of disease-induced population decline and an increase in material wealth from the traders. Previous ecological explanations of the potlatch focused on its redistributive role (Piddocke 1965). However, critics have demonstrated that this was not the function of the potlatch and, although it did result in the movement of goods, its material role in this regard was limited (Drucker and Heizer 1967; Adams 1973; Coupland 1985; Kan 1986). Instead, the potlatch was a symbolic way of establishing a man's power and prestige. He did this by holding a large feast at which he would give away or destroy large amounts of food and goods, occasionally including slaves and prestige goods, such as coppers (hammered, sometimes embossed, plates of native copper), to a rival from another village. In so doing, the guests recognized the titles, status, and prerogatives of the host. The goods given away at such a feast were acquired from members of his own village through smaller debt-producing feasts, suggesting that everyone in the village held a stake in a high-ranking man's potlatch and was willing to pay the cost of his receiving prestige.

This form of gift giving on the coast often was met by remorse on the part of the recipient since the gifts entailed a debt that, until repaid by a larger gift, reduced the recipient's prestige. Among the Kwakwak'awakw, potlatches were held at many different levels. The largest potlatches, those called "doing a great thing," were held between villages. These could be held for many reasons, including the giving of gifts by a man to his new father-in-law, gifts that would eventually be given back to "repurchase" the bride (Codere 1950). (Note the ritualized mechanism for terminating a marriage by the bride's family as anticipated by Collier's analysis of unequal-bridewealth marriages.) Everywhere, potlatching allowed a group to evaluate a ranking individual's authority relative to that of another village or kin group. They might then alter their allegiance, by moving if necessary (Adams 1973). The potlatch existed only on the central and northern coast, where we would expect to see more tightly controlled social boundaries between larger social units (which could muster the labor for a great display of wealth) than on the south coast. Potlatches established patron-client relationships, something that was of less value on the southern coast.

Although it created a series of escalating debts, we should note that we have no evidence that the debts established by giving gifts in a potlatch could be repaid by helping the creditor during a time of resource stress (Hayden and Gargett 1990).[26] Ferguson (1984: 30) notes, however, that the Bella Bella Heiltsuk, a Northern Kwakwak'awakw tribe, annihilated a Rivers Inlet Kwakwak'awakw tribe who failed to repay a potlatch debt.

An evolutionary model suggests that high-ranking individuals stood to enhance their fitness by participating in prestige competition, acquiring greater utility from the social relationships and prestige they gained than from the resources they gave away (as Boone's [2000] model suggests), whereas commoners stood to gain more by assisting than by not assisting high-ranking individuals. One of the ways that commoners may have gained is by the reduced possibility of warfare between themselves and their guests. Some Gitksan moved to join other households after potlatches when they felt that their leader was not as powerful as others (Adams 1973: 99–106; population decrease may have played a role in this as well). Thus, northwest coast chiefs had to walk a fine line to maintain their support while at the same time managing to build and eventually exploit a labor base. And, once such relationships are established, they are propagated through the generations by the inheritance of wealth, rights, and political connections (Smith et al. 2011).

Enculturation and Inequality

A shift toward nonegalitarian relationships entails dramatic changes in social norms; from an emphasis on generosity and humility to an emphasis on hoarding and boastfulness; from values that do not sanction violence to those that do. How do value systems change? Although this question goes beyond this book, we can speculate based on the effects that the circumstances of sedentism and population growth might have on enculturation (see Chapter 4).

We know that nonegalitarian hunter-gatherers are sedentary. We noted in Chapter 4 that a shift toward sedentism may precipitate changes in the structure of foraging activities, which can alter childrearing methods from parent-reared to peer-reared and change the modal personality. Some of this shift entails changes in how people perceive individual autonomy and gender relations. Peer-reared children tend to display greater gender differentiation and to manipulate the world through social relations rather than through technology. Sanday's (1981) cross-cultural study pointed to an association of large-game hunting, a perception that the environment is hostile, and segregation of the sexes in work and childrearing with a predisposition for competition to be culturally endorsed, and for men to see women as potentially dangerous. As we have seen, sedentism establishes structural conditions that encourage men's absence from a village (long-distance hunting or fishing). Eventually, as population grows, some men devote time to prestige-seeking (or -giving) activities (including trade of wealth objects and warfare) and thus remove themselves further from their wives and children.

Therefore, by changing the nature of the enculturative process, the advent of sedentism may, after several generations, alter a population's modal personality toward one that sees social manipulation – the control of another's labor – and competition as the primary way of achieving goals. Peggy Sanday's (1981) study suggests that this may be especially true for men, and thus it sets the stage for the manipulation of women by men.

Variability in enculturation within a community could also promote inequality. Children of high-ranking families will learn a different set of values and expectations than the children of low-ranking families. If high-ranking men invest time in prestige-seeking activities and have additional wives or slaves to care for children, then they may spend little time with their children. As a result, children in high-ranking families may be more heavily impacted by the general enculturative process we have associated with sedentism, and sons would see competition and social manipulation as the keys to success. And, through inheritance, they would have the capacity to do so. Low-ranking men, being limited in their resource-acquiring potential, may devote more time to childcare and raise children who are less inclined to competition. This leaves children of low-ranking families open to exploitation by the competitive attitudes and greater resources of children of high-ranking men. If true, this would help account for Collier's observation that in unequal-bridewealth societies, people see their fortunes in life as being controlled primarily by birth.

Conclusion

The study of hunter-gatherer societies offers the opportunity to study a range of human sociopolitical organizations: from egalitarian to nonegalitarian, from societies where men and women are relatively equal, to those where they clearly are not. There is much we still do not understand, but it is clear that neither egalitarianism nor hierarchy is the "natural" condition of humanity. An evolutionary perspective sees inequality and egalitarianism as arising from the same process of humans trying to maximize fitness rather than the blossoming of innate attributes. Inequality appears under circumstances of competition and circumscription, where access to key resource locales can be and, from the perspective of the participants, must be controlled and not simply where intensification, storage, or wealth accumulation is possible.

We began with a discussion of egalitarianism, pointing to individual autonomy and a group's ability to operate on a consensual basis as its important characteristics. Individuals who attempt to rule others are quickly put in their place through ridicule or ostracism in egalitarian societies. Yet, even in these societies, there are inequalities, especially between men and women. The amount of food that a woman contributes directly to the family hearth only partially accounts for her level of autonomy, status, or authority. Instead, inequality is affected by marriage and the relationships it creates between men as wife-takers and wife-givers, and the nature of men's versus women's activities, perhaps especially as they affect the amount of time men spend with their wives and children. Since marriages form alliances between families and since alliances become more or less important depending on the intensity, frequency, and spatial extent of resource fluctuations, it is logical that the nature of marriage and, consequently, the nature of male-female relations can fruitfully be examined within an evolutionary framework that focuses on the reduction of risk and the formation of social groups in different kinds of environments.

We pointed to the association of sedentism, high population density, resource defensibility, and storage with social hierarchies. From our discussion, it should be clear that the existing variability within the category of nonegalitarian hunter-gatherers is related to different resource configurations. This variability must be recognized and analyzed if we are to understand the evolutionary pathways of inequality.[27]

We then presented a perspective on the development of nonegalitarian societies that focused not on the functionalist benefits of hierarchy but rather on how hierarchy and inequality result from individual efforts to maximize fitness. Critical here is the nature of group membership. Leaders arise as a product of the need to coordinate communal labor and alleviate the stress on group members of punishing free-riders. And, as more individuals join a group that has achieved its optimum group size, the per capita return rate decreases for all members, so there will always be tension between members and potential joiners, between patrons and clients. Where resources are defensible, the cost of joining the group may be that the joiner allows some of the results of his or her labor to be skimmed by a patron, lowering his or her returns below that obtained if returns were simply averaged over the entire group. Also important is that the optimal group size is larger for the leader than for the other group members, creating competition and tension between the leader and group members.

The geographic scale of resource fluctuations and the defensibility of resources could exert a strong influence over the form of nonegalitarian relationships by encouraging middlemen in some cases and increased household production in others. Both of these factors are at work in nonegalitarian societies, but one or the other may be more prevalent depending on the particular resource configuration, or they may operate at different social levels. We noted that in either case, women's status could decrease as a function of men's use of marriage as a way to establish social alliances and reduce risk or as a way to use female labor to increase household production. Archaeologists should bear in mind that climatically induced environmental change could alter resource configurations and, in so doing, accelerate the game of musical chairs described by the ideal-free distribution and, consequently, the formation of nonegalitarian societies (see the case of the Chumash; e.g., Kennett 2005; Arnold 2009).

Although initially rooted in resource structure and population density, prestige seeking and the resulting hierarchies could result from and be part of an evolutionary runaway process (Boyd and Richerson 1985), as other individuals (perhaps those in the middle of Figure 9-5's utility curve) mimic the activities of prestigious individuals and shift cultural values to create a greater frequency of those who emphasize overt prestige seeking. Structured by men's and women's labor, the enculturative process plays a key role in developing values that promote competition and that permit exploitation and inequality.

Thus, a change from a mobile to a sedentary existence puts a complex chain of events into motion involving behavioral, psychological, and cultural variables. The scenario is speculative but based on the recognition that social-level phenomena are produced by individual decision making with a complex of regional resource configurations, population distribution, and enculturative processes. Understanding the evolutionary development of hierarchy and inequality is one of the greatest challenges facing students of foraging societies.[28]

Chapter 10

Hunter-Gatherers and Prehistory

> I want to talk only about proper things, old time.
>
> Annie Ned, Athapaskan (Cruikshank 1990: 323)

One of the final questions posed at *Man the Hunter* was "Are the hunter-gatherers a cultural type?" (Lee and DeVore 1968: 335). A half-century later, we are still asking that question.[1] Harvey Feit suggests the answer is no: "a universal concept of socially distinctive hunter-gatherer societies may not be a credible anthropological category" (1994: 422; see also Burch 1994a: 452). Indeed, why should we expect any category imposed on the continuous diversity of humanity to have neat and tidy boundaries?

And yet, the category of hunter-gatherer continues to be one that anthropologists give special significance. The reason is that like our intellectual forebears, we seem overwhelmed by "the fact that hunter-gatherers *appear* to be the most ancient of so-called primitive societies – [by] the *impression* that they preserve the most archaic way of life known to humanity, that characteristic of the whole of the Palaeolithic" (Testart 1988: 1; emphasis added). This impression leads many anthropologists, even those familiar with the diversity of foraging societies, to seek a glimpse of the past in the present. Leacock and Lee (1982b: 1) suggested that we study foragers to know "What was human social life like when people lived directly from the fruits of the earth?" (1982b: 1). Alain Testart claimed that "structures and social forms analogous to those observed in Australia were probably present in Palaeolithic societies." He recommends that

> if we seek to know about the past, a field of study that has never seemed dishonourable to any discipline other than social anthropology, the point of departure should be hunter-gatherers in favourable regions, hunter-gatherers who might not have been such and probably remain such only by reason of restrictive social forms that for them are quite possibly a distant and glorious heritage. (Testart 1988: 12–13)

David Riches (1982: 208) considered the possibility that his study of northern hunter-gatherer societies offers "indications as to the basis of certain fundamental institutions in an original human society." Tanaka was more explicit, finding it a "miracle" that the ≠Kade were "still living in the same fashion as human societies of almost 10,000 years ago" (1980: xii). Allen Johnson and

Timothy Earle (1987: 55) used the Ju/'hoansi and Great Basin Shoshone as analogues for hominin life of the Lower and Middle Paleolithic. Marlowe (2010: 259) is upfront with readers of his Hadza ethnography: "I am concerned with extrapolation to the more distant past (at least to the origin of modern humans in East Africa)." Many others have sought to understand "the evolutionary and ecological bases of human social organization" through the study of living foragers (Kaplan, Hooper, and Gurven 2009: 3289).

None of these authors would argue that living hunter-gatherers are relic populations untouched by the passage of time; Marlowe (2010: 281), for example, is quite clear that the Hadza are *not* an analogue of early hominins. Instead, they make a subtle but important distinction by arguing that the living conditions of modern hunter-gatherers (those living in small, nomadic groups exclusively by foraging) replicate conditions of the past and that the lifeway of modern foragers is largely structured by these conditions (Marlowe 2005a). Therefore, if the nature of modern foraging lifeways is a product of living conditions, and if those conditions replicate those of the past, then modern foragers should more or less resemble prehistoric ones.

I am sympathetic to this approach. Ethnography, especially if informed by evolutionary theory, is a logical place from which to draw hypotheses about early human behavior and selective pressures. But let's also be clear that ideas about ancient societies and evolutionary change drawn from ethnography must be tested against the most direct record we have of ancient societies and evolutionary change: the archaeological and paleoanthropological record – the stone tools and bones that are all that remain of our ancient ancestors (Kelly 2005). We can start with the Hadza or the Ju/'hoansi or the Martu to learn about the past, but we cannot stop with them.

Archaeology and paleoanthropology are difficult routes to knowledge of the past. As an archaeologist, I know just how depauperate the records of these fields can be. No area of human behavior has a direct reflection in archaeological remains. Interpretation is made even more difficult by the fact that centuries, even millennia of behavior (both human and nonhuman) and natural processes go into the formation of even the most meager of archaeological sites. As I often tell my students, archaeology is not rocket science; in fact, it's a lot harder. So, perhaps we should forgive those who bypass archaeology altogether and turn to the ethnographic record? Maybe, but given the importance that several intellectual fields today place on evolutionary analyses and reconstructions of our foraging past, it is more important than ever that we acknowledge the difficulty of knowing the past and the importance of a theoretical understanding of foraging behavior.

I am thinking most particularly of the field of *evolutionary psychology*. Evolutionary psychology (EP) assumes that "the evolved structure of the human mind is adapted to the way of life of Pleistocene hunter-gatherers" (Cosmides, Tooby, and Barkow 1992: 5; Tooby and Cosmides 1992). Thus, EP is concerned with how natural selection produced the psychological mechanisms that underlie behavior today, selection that took place when all humans lived as foragers. Evolutionary psychology argues that there are multiple, perhaps hundreds of psychological "modules" that govern behavior. Rather than the mind being a generalized decision-making device (as human behavioral ecology sees it), EP sees the mind as a Swiss army knife, with multiple tools – labeled "modules" – designed to do specific psychological tasks. It supposes that these modules were created through selection during the so-called environment of evolutionary adaptedness. In the words of John Tooby and Leda Cosmides, two of the field's founders, our modern skulls house a stone-age mind.

The importance of this observation is that it strives to explain the psychological disorders of modernity, such as depression. Our minds, evolutionary psychology argues, were selected to cope with small groups, not megacities with millions of inhabitants. Industrial society arose so quickly – in the last few hundred years – that humans could not evolve sufficiently fast in tandem to produce a mind capable of coping with life in large cities.[2] Others use EP's approach to account for impulse-buying, perceptions of beauty, homicide, why older men divorce and seek younger wives, why men don't ask for directions, promiscuity, and how we detect cheating.[3]

Knowing if EP or any similar approach is correct requires testing ideas against archaeological and paleontological data. This is not easy, and so EP generally looks to living hunter-gatherers as representatives of our ancient ancestors. Can they do this? First, let us be clear about the time frame. Evolutionary psychology argues that selection produced our minds during the environment of evolutionary adaptedness. You might ask, as many have, which environment, for our ancestors lived in many different kinds. But practitioners of EP claim this question is irrelevant; the environment of evolutionary adaptedness is not a time or place but rather a set of reproductive problems that would have faced hominins everywhere all of the time. For EP, the "environment" is a very generic concept. It simply refers to all those places that hominins have lived since the beginning of the *Homo* lineage some 2–2.5 million years ago. So, the question is whether knowledge gained from living foragers is relevant to this time period. Humans have existed as an evolutionary line separate from the other primates for some seven million years.[4] Leaving aside the first 5 million years or so, which apparently are not important to EP, were the hominins who lived in Africa during the late Pliocene and early Pleistocene like modern foragers?

Using archaeological and paleontological data, Robert Foley (1988) demonstrated substantial differences between pre-*Homo sapiens* hominins and modern humans in biological and behavioral attributes. Among early hominins, child growth and maturation were more rapid, home ranges were smaller, and meat was perhaps acquired primarily through scavenging rather than hunting. There is no good evidence for home bases or, thus, for sharing. And a few million years of remarkable uniformity in first Olduwan and then Acheulean stone-tool technology across three continents (Europe, Asia, Africa) speaks to substantially different mental capacities and behavioral attributes of pre-*sapiens* hominins (Kuhn and Stiner 2001). Foley (1988: 215, 220) concluded that early hominins were "neither human nor hunter-gatherers" and that "modern hunter-gatherers do not necessarily represent the basal hominid [hominin] way of life, as was suggested in the 'Man the Hunter' conference." There is little doubt that the Australopithecines and early members of the genus *Homo* were not "cultural" in the sense that we understand the term. When did we become human foragers?

Although it is debated, most evidence suggests that biologically modern humans arose in Africa about 200,000 years ago. But the appearance of biologically modern humans may not signal the appearance of behaviorally modern humans. It is difficult to pinpoint one archaeological signature – elaborate burials, for example, or art or complex tools – as the fingerprint of behaviorally modern humans (see review in Kusimba 2005). However, when I say "behaviorally modern," I am referring to hominins with the capacity to use symbols. And given that definition, behaviorally modern humans seem to appear only in the last 100,000 years (certainly by 40,000 years ago). After they arose in Africa, behaviorally modern humans migrated out, eventually populating much of Europe and Asia,[5] replacing the hominin populations that had previously migrated out of African about 1.8 million years ago. So, it is perhaps for no more than the last 100,000 years that humans behaved as hunter-gatherers; that is, in a way that would make sense to us from ethnographic data.

Foley also explored evolutionary changes that occurred after the appearance of modern humans. Upper Paleolithic (40,000–10,000 years ago) humans, for example, were larger and more sexually dimorphic than later, post-Pleistocene humans. Relating this biological difference to male reproductive strategies and the division of labor, he concluded that "What we think of as modern hunting-gathering is a largely post-Pleistocene phenomenon. Rather than being an adaptation ancestral to food production, it is a parallel development" (1988: 219). It appears that *analogies* from living foragers cannot be extended back any time at all. Each chapter of this book has demonstrated variation among ethnographically known hunter-gatherers, variation that can be related, in large part, to environment and demography and that is intelligible within an evolutionary framework. If humans lived in various environments in the past, then we can expect them to have lived in various kinds of foraging societies.

What this means is that if EP, or any evolutionary approach, wishes to study the process of selection on hominins in the Pleistocene, they cannot do so by looking to modern foragers because modern foragers did not exist until only about 100,000 years ago, and they changed significantly over the next 90,000 years, adapting to different environments with different selective pressures. Adam Kuper (1988: 7) sums up our point:

> Even if some very ancient social order could be reconstituted, one could not generalize it. If it is useful to apply evolutionary theory to social history, then it must direct attention to variation in adaptation to all sorts of local circumstances, and so to diversification. Surviving hunter-gatherers certainly do not conform to a single organizational type. Since ecological variations constrain social organization, especially where technology is simple, there must have been considerable differences in social structure between the earliest human societies.

I have singled out evolutionary psychology but my point is more general. Like the Enlightenment thinkers before them, anthropologists seek human nature, to discover the traits that lay the foundation for all humankind. This is a worthy enterprise; indeed, it lies at the heart of anthropology. But despite our rejection of nineteenth-century cultural evolutionism, many anthropologists have still been "led to live and work among the hunters because of a feeling that the human condition was likely to be more clearly drawn here than among other kinds of societies" (Lee and DeVore 1968: ix). No social scientist or evolutionary psychologist today would say that members of industrial society are more evolved than modern foragers. But we still seem to be haunted by the ghosts of Hobbes and Rousseau: we still think of hunter-gatherers as displaying human nature unfettered by the additions of evolution. By implication, they have witnessed no evolution, no history. Clearly, we can agree that this is not true.

Foragers, past and present, live and lived under specific environmental and social conditions and within particular historical trajectories, as do all peoples. The variability present among living and ancient foragers demonstrates that as a group, foragers are no more representative of human nature than any other kind of people. They can be used to support whatever image you wish: generosity or greed, violence or peace, monogamy or polygamy, attentive or aloof to children, and so on. This does not mean that the study of foragers has nothing to say about human nature but rather that we cannot discover what is common among humans without understanding what is variable. To do otherwise will lead us to assume, as the early evolutionists did, what we are trying to discover.

Archaeologists are perhaps even more susceptible than sociocultural anthropologists to give in to the urge to create a hunter-gatherer stereotype – since job number one for archaeology is to reconstruct the past. And given the usually impoverished nature of the archaeological remains of hunter-gatherer societies, especially those of the Pleistocene, archaeologists, like evolutionary psychologists, understandably are tempted to look elsewhere for ways to reconstruct the past. We commonly justify a reconstruction of a prehistoric hunter-gatherer society not by inferring the existence of a trait through analysis of archaeological data but rather by reference to ethnographic analogy or by appealing to how common the trait is ethnographically.[6] Worse, appeals to the frequency of a trait usually mean only that it is found among the Ju/'hoansi, or the current group-du-jour (the Ache, Meriam, Martu, or Hadza) that closely approximates what the archaeologist already supposes the prehistoric case to have been like. We have drawn remarkably detailed pictures of early human society, complete with family bands of twenty-five people who share food, trace kin relations bilaterally, reside bilocally, eat a generalized diet with women gathering plant food and men hunting, build alliances through monogamous marriage, and regulate their population to avoid environmental degradation.

But this detailed picture comes not from archaeological evidence but instead from ethnographic analogy. And such misuse of modern hunter-gatherer research provides spurious support for the idea of a single primitive human society, a uniform hunter-gatherer stage.

Does this mean that archaeologists should reject the use of ethnographic data? Well, obviously, I do not think so. But the translation of information from ethnography to archaeology is not simple. Some thirty-odd years ago, Martin Wobst (1978) warned archaeologists of how ethnographic data, with its wealth of details unrecoverable through archaeology, could "tyrannize" archaeologists by lulling us into envisioning the past before we excavate it. Ethnographic data can, if we let them, limit our ability to recognize unknown prehistoric forms of organization associated with hunting and gathering. Modern hunter-gatherers differ from prehistoric ones not only because they interact with multinational corporations and colonial governments but also because they may and probably have changed for a variety of reasons (e.g., environmental change or internal social dynamics). Even if a pristine, isolated, uncontacted group of hunter-gatherers were found (and there is none), it could not be used as an analogy to reconstruct prehistory. And, in fact, even if we could take a time machine to Europe or East Africa of 15,000 BC – when hunters did indeed, to use Sahlins's phrase, live in a world of hunters – the resulting ethnography could not necessarily be projected backward to Australia of 25,000 BC or forward to North America of 8,000 BC.

What, then, is the relationship between the behavioral data of ethnography and the material data of archaeological research? There are two answers to this question. Before getting to them, however, we must first consider the phenomena that archaeology can study. For the most part, archaeology is concerned with explaining cultural behaviors as they are manifested over long spans of time and vast reaches of space. No other social science has as much time and space at its disposal. Prehistoric archaeology covers the time from before we were human until the present, from Greenland to Tierra del Fuego. This is archaeology's strength. Its weakness is that the archaeological record is too coarse-grained, for the most part, to record individual events. We see the past in 1,000- to 10,000-year slices; at best (and only for the most recent time periods), we see what happened in 25- to 100-year bits. This time scale is completely different from that of ethnography. Ethnographies can record the behavior of individuals, a capacity that is beyond the techniques of archaeology today (and in the foreseeable future). As Michael Jochim (1991: 315) put it, "ethnographies give us brief, individual snapshots, whereas the archaeological record represents fragments of the entire family album." A fundamental difference in time scales precludes the easy transfer of models from ethnography to archaeology.

However, although archaeology may not be able to see the material effects or cultural musings of a lone forager, to understand large-scale changes in foraging strategies – changes from dependence on meat to dependence on plants or from foraging to farming – we must understand how that lone forager makes decisions. Coarse as it may be, the archaeological record was nevertheless produced by the behavior of individuals. Human cultural evolution is the outcome of millions of decisions involving food, mates, kin, non-kin, land, prestige, reputations, spirits, and the cosmos. Ethnographic research provides archaeology with an understanding of the daily, on-the-ground, decision-making behavior that is the ultimate source of the archaeological record. Our task is to ask what role do ecological, social, biological, and cultural variables play in decisions. How do foragers decide to rank foods in terms of calories, protein, or something else? How do they decide to share with someone, to let someone into their territory, to move, or to raise a newborn? How do they decide whether to participate in a feast that will garner prestige for someone else?[7]

And this is where ethnographic data become useful to archaeology. If interaction with the environment exerts any kind of influence over foragers' lives, then how living people make decisions relative to their environment should bear some resemblance to how people in the past made decisions as well. This is nothing more than geology's principle of uniformitarianism: *living foragers are not identical to those of the past, but living foragers do operate under the same principles as did prehistoric hunter-gatherers*, albeit under different conditions and constraints generated by their technology, historical circumstances, and cultural environments.

There is no doubt that all living and recent hunter-gatherer societies today are structured in part, perhaps in large part, by interaction with non-hunter-gatherer societies. It would be foolish to apply a model drawn from these societies in a wholesale fashion to prehistory. But it would be equally foolish for archaeologists to ignore these societies because contact allegedly casts a shadow over them. Despite living in the midst of agrarian and industrial societies, sometimes for hundreds of years, modern hunter-gatherers still make decisions about where to move; when to move; whether or not to work for wages; whether or not to store food; whether to give something away or hoard it; to arrange a marriage or not; to eat this, that, or something else; to buy food or forage for it; to stay near a village or move away from it; to have children or not; or to compete for prestige. Whenever they make these decisions, they provide archaeology with food for thought. Ethnology should help archaeologists construct more accurate models of the past, models whose success or failure will not depend on ambiguous or inappropriate assumptions, and which therefore will be more accurate tests of hypotheses about prehistory. To borrow Lévi-Strauss's phrase, ethnological data are "good to think."

But they are even more than that, and this brings us to the first use of ethnographic data. There are some very good, sophisticated analyses of ethnographic data that aim to model what might be some fundamental aspects of a human foraging adaptation (e.g., Binford 2001; Hamilton, Milne, Walker, Burger, and Brown 2007a; Hill et al. 2011; Marlowe 2010). All models require assumptions; they cannot be avoided. But we must ensure that those assumptions are not simply wishful thinking based merely on empirical patterns. Instead, we want to justify those assumptions theoretically. This is different from analogy or, at least, it is a more powerful analogy.

For example, after the first edition of this book was published, a colleague asked me if there was anything from the ethnographic data that I thought could be projected into prehistory, something that we could assume in a model of the past. Then and now, I think there are only two things: nomadic foragers live in residential groups of somewhere between eighteen and thirty people, and men hunt while women gather. And I feel comfortable making those assumptions not because they are empirically common, which they are, but because we can provide a theoretical justification for each, as we have done in this book. A standard group size across environments results from the balancing of the desire to reduce daily variance in food intake while minimizing the rate of depletion of the foraging radius, and the division of labor is rooted in fundamental biological differences between men and women and the incompatibility of children with hunting. If we have correctly determined the causal conditions of these behaviors, and if can assume those conditions were true of the past, then the assumptions are provisionally valid.

Notice I said provisional, and that brings us to the second use of ethnographic data. Although the archaeology of hunter-gatherers is beyond the scope of this book, understanding the sources of the variability present in ethnographic data will allow us to develop more accurate methods of reconstructing the past. Archaeologists continually try to develop methods, often referred to as *middle-range theory*, that relate material remains to the behavior that produced them. In this way, we seek signatures of particular kinds of behavior. For example, archaeologists try to use spatial distributions of debris or hearths to reconstruct group size or the length of time a site was occupied (e.g., Kelly, Poyer, and Tucker 2005, 2006). Likewise, the treatment of faunal remains by living peoples can be used to develop methods to sort out hunting, scavenging, and the activities of nonhuman predators and to recognize the signs of meat sharing, butchering, and storage. Since we know that hunter-gatherer behavior can be variable, we can also expect hunter-gatherer societies to produce a variety of archaeological signatures, meaning that there are no simple material correlates of behavior. The archaeological remains from hunting could vary depending on whether the population sees meat as a source of calories or protein, on whether or not they store food, or on how meat is shared (this is in addition to variability that is related to differences in the animal itself; e.g., mobility, size, or fat content).

Lewis Binford repeatedly argued that methods of interpreting archaeological remains cannot be divorced from an understanding of the variability in hunter-gatherer behavior (see also O'Connell 1995). He showed, for example, that the criteria for recognizing residential sites archaeologically – the amounts and kinds of debris left behind, as well as the type of housing used – depend on whether foragers are more residentially or logistically mobile (Binford 1980, 1990). As described in Chapter 4, the organization of group and individual movement is predicated on ecological and demographic variables. Thus, the construction of methods to make inferences from archaeological remains is inextricably linked to an understanding of variability in behavior. One cannot reconstruct the past without simultaneously tackling an explanation of human behavior.

So, it is best to make the theoretical bias explicit. We need to study hunter-gatherer prehistory in terms other than broad typological categories such as generalized versus specialized, simple versus complex, storing versus nonstoring, or immediate versus delayed return. Our approach must allow us to continually expand our knowledge of the diversity of human behavior, for ethnographic data undoubtedly do not record the full range of ways that prehistoric foragers lived. We should approach archaeology not with the goal of assigning a site or time period to a particular typological pigeonhole but rather with the intention of reconstructing different cultural elements – diet, mobility, demography, land tenure, social organization – as best we can, then assemble them, like piecing together a jigsaw puzzle with no picture on the box.

If this sounds difficult, it is; but it frees us from the error of uncritical analogy, from the error of seeing the most ancient hunter-gatherers through the lens of some imaginary original human society. An evolutionary approach helps us discover unanticipated organizational forms associated with prehistoric hunting and gathering, forms that may be related to ecological conditions that no longer exist, or to interaction with kinds of societies that no longer exist, or, for premodern humans, to cognitive capabilities that were unlike those of humanity today. In approaching the study of modern and prehistoric hunter-gatherers from an evolutionary framework, we will continually add to our knowledge and understanding of the development and diversity of humanity. And that, after all, is the reason we do anthropology.

Notes

Chapter 1: Hunter-Gatherers and Anthropology

1. Researchers have used the term "!Kung" extensively since 1965. There has always been debate over whether this is the correct term. Richard Lee, the primary ethnographer of the !Kung, has elected to use the term "Ju/'hoansi," which seems to be the term that the people, referred to as !Kung, prefer. Therefore, I use Ju/'hoansi (and Lee's choice of spelling) in this book. Since publication of the first edition of this book, Ju/'hoansi has become widely used.
2. See, e.g., Hamilton 1982b; Barnard 1983; Arcand 1988; Myers 1988b; Burch 1994.
3. For a discussion of the role of cosmology and religion in aboriginal land-claims cases, see Wilmsen (1989b,c) and Layton (1986); in subsistence ecology and ideology, see Mosko (1987) and Bird-David (1990, 1992a,b); and in individuals' negotiation of cultural precepts in light of changing ecological and social circumstances, see Tanner (1979), Sharp (1981), Ridington (1987), and Myers (1988a: 274–5).
4. Hobbes was not talking about hunter-gatherers specifically but rather about his vision of a time "before society." Indeed, he could not have been thinking about hunter-gatherers because the very concept of hunter-gatherer did not exist until much later (see Barnard 2004). Still, Hobbes's sorry image of life in the distant past came to be linked to early ideas of hunter-gatherers.
5. Henry Maine and Lewis Henry Morgan were practicing lawyers. Their interest in primitive society was perhaps stimulated by European colonialism and American expansion (Kuper 1988). Colonial governments had to decide what rights indigenous peoples of Africa, India, and the New World had to the land and raw materials that colonial powers wanted. Since these people were viewed as being evolutionarily "behind" Europeans, those in legal professions were forced to think about the nature of "early" forms of property ownership. In this light, it is not surprising that notions of property figure prominently in early evolutionary schemes.
6. This was not evolution in the Darwinian sense because it did not incorporate natural selection operating on cultural variability to produce differential transmission of cultural norms over time.
7. The European Upper Paleolithic, or Late Stone Age (40,000–10,000 years ago), is divided into several time periods based on differences in material culture. The Aurignacian, for example, dates from 45,000 to 35,000 years ago; the Magdalenian from 18,000 to 10,000 years ago.

8. A variety of other theoretical assumptions permitted the alignment of cultures into a sequence; for example, Spencer's homogeneous-heterogeneous principle (heterogeneous societies were more advanced than homogeneous ones, which, of course, required defining what a society was – larger ones will be more diverse) or Tylor's assumption that language was conservative, especially kin terminologies.
9. However, only three of the nine hunter-gatherer societies that Steward considered could be labeled patrilineal bands (1955).
10. It is difficult to know which terms to use in referring to different groups because these terms can be politically loaded. "Eskimo" and "Inuit" are a case in point. "Eskimo" is popularly translated as "eaters of raw meat" but there is actually no evidence for this (see Damas 1984a). In fact, the origin of the term is mysterious and may be a French or English translation of a Spanish term (from Basque fisherman who worked the Grand Banks) that was a version of a word taken from the Montagnais (whose name has its own issues). In Canada, the term is considered offensive, and "Inuit" (singular Inuk) is the self-referential term preferred by those people who speak Inupiaq (or Iñupiaq; a group of related dialects from the north coast of Alaska, across the Canadian high arctic to Greenland). Politically, First Nations peoples in Canada have preferred "Inuit" for some time over Eskimo. "Eskimo," however, is still used in Alaska, especially among speakers of Yupik (in southwestern and western Alaska, and the tip of Siberia). Aleut, incidentally, refers to speakers of the Aleut language; they live in far southwestern Alaska and on the Aleutian Islands.
11. One could say Radcliffe-Brown willfully ignored variability, as he did when he ignored the presence of non-Aranda-type marriage customs among the Aranda (Rose 1988: 195).
12. Patrilocal postmarital residence was emphasized at the conference, but the message of several influential papers (e.g., Damas 1968; Helm 1968) was the importance of bilocal residence (usually including a period of brideservice, during which residence was matrilocal).
13. Nearly every introductory textbook written since 1968 regards hunter-gatherers as living near-perfect lives (a belief that has spilled over into the popular press; supermarket tabloids, for example, often hail the virtues of "caveman" diets).
14. In this regard, archaeology drew on work from ecology and economics, especially Esther Boserup's (1965) population-pressure theory of the origins of agriculture. But I suspect it was the new model of the foraging lifeway that made Boserup's theory attractive to archaeology since it fit so well with the characterization of foragers as affluent.
15. It is easy to see that Lee's definition of work was unintentionally derived from Western notions of work: it is what people do away from home. This matters, because how one defines work can dramatically alter estimates of labor. Allen Johnson, for example, found that depending on which definition he used, the Machiguenga worked anywhere from 2.5 to 8 hours a day (1975). It is best to break down the nebulous category of work into specific activities (see, e.g., R. Bailey 1991: 43).
16. It is also clear that subarctic and Arctic peoples have a hard life, dangerous at times, and always with a heavy workload (Rasmussen 1931: 134–9; J. Smith 1978).
17. On undernourishment, see Stini (1981) and Howell (1986b, 2010). On seasonal fluctuations, see Wilmsen (1978, 1986), Hausman and Wilmsen (1985), Spielmann (1989), Hurtado and Hill (1990), and Speth (1990); see also Chapter 7.
18. See Warner (1931), Swadesh (1948), Ember (1978), Ferguson (1984), Mitchell and Donald (1985), Knauft (1987), Donald (1997, 2000), Chindina (2000), and Griffin (2000).
19. Eugene Hunn (1981) notes that the ethnographic atlas (Murdock 1967) undercounts the contribution of plant food, demonstrating this point by comparing Plateau subsistence reconstructed from ethnographic data to the atlas's codes. Nonetheless, plants are still not a significant part of the diet for many people who live at high latitudes.
20. The "correct" term for the hunter-gatherer Khoisan peoples changes constantly as terms take on new meanings in the politically charged atmosphere of southern Africa. At one time, Bushmen and San were used freely but were dropped in favor of Basarwa. Basarwa is an innovated term, coming from Mosarwa but, by changing the prefix Mo to Ba, linguistically tries to avoid connotations of

inferiority. But it translates as "serf" to some and has been dropped in favor of the previous one, Bushmen (Robert Hitchcock, personal communication, 1993). This was true for the first edition of this book and still appears to hold true; I will continue to use it.

21. See J. Peterson (1978), Abruzzi (1980), Bahuchet and Guillaume (1982), Griffin (1984), Hoffman (1984), Hart and Hart (1986), Bailey and Peacock (1988), Bailey et al. (1989), and Headland and Reid (1989).
22. See Richard Grinker (1990, 1994) for a thorough ethnography of the relationships between a tropical foraging group, the Efe, and their horticultural neighbors, the Lese. Although it is true that no ethnographically known tropical-forest foragers live without trading, it does not necessarily follow that it is impossible to live solely by foraging in the tropical forest (see, e.g., Brosius [1991]; papers in Headland and Bailey [1991], Hill and Hurtado [1996]). Archaeological studies, in fact, show that hunter-gatherers did indeed live in the rain forests long before agriculture was practiced anywhere in the world, although they often succeeded by introducing economically useful plants and animals (e.g., Spriggs 2000) or by husbanding indigenous plants to increase productivity (Politis 1996, 2007).
23. This raises the intriguing question of whether hunter-gatherers existed in the interstices or along the edges of prehistoric state polities as, for example, in northern Mexico (W. Taylor 1972), and if people who live largely as hunter-gatherers will be with us for some time to come as groups who opt out of the dominant social order and occupy empty niches (see Asch 1982, Feit 1982, Bird-David 1988).
24. The term was made popular by Richard Fox (1969) (see Seligman and Seligman [1911], Schrire [1980, 1984a], Wilmsen [1983, 1989a,b,c], Denbow [1984], Gordon [1984], Parkington [1984], Headland and Reid [1989]).
25. See Leacock and Lee (1982b), Wilmsen (1989c), Headland and Blood (2002), Sercombe and Sellato (2007), and Biesele and Hitchcock (2011). Others work toward the development of viable livelihoods in the face of development (e.g., Tucker 2007a,b; Tucker, Tsimitamby, Humber, Benbow, and Iida 2010). Some insightful and important literature on the inequalities forming between the descendants of foraging populations and colonial powers, as well as within indigenous populations, comes from Australia (see, e.g., Altman 1989).
26. Wilmsen may have overstated his case; see responses by Solway and Lee (1990), Harpending (1991), Lee and Guenther (1991, 1993), Silberbauer (1991), Kent (1992), and Lee (1992).
27. Marx argued that capitalism contained an inherent contradiction. The value of a product was correlated with the amount of labor that went into it. As labor was reduced to increase efficiency in order to compete, products declined in value, as did the overall profit in the system – encouraging owners to save even more by paying less for labor. Marx deduced that capitalist organizations would respond by subsuming others, thus becoming larger in size and fewer in number. They would also respond, Marx argued, by shifting production to cheaper labor markets and extending their influences to distant areas, incorporating many noncapitalist societies, including foraging societies, into a world economic system. (However, hunter-gatherers did not have to wait for the appearance of capitalism to be incorporated into distant economic systems.)
28. See also M. Martin (1974), C. Ember (1978), Winterhalder and Smith (1981: 4), R. Bailey (1991: 2), and E. Smith (1991: 4–5).
29. Marvin Harris, for example, argues that Godelier's analyses of Australian Aboriginal section systems and the BaMbuti mode of production are ultimately grounded in ecology (1979: 231–2).
30. For example, Meehan (1982); O'Connell and Hawkes (1981, 1984); Altman (1987); Bailey (1991); E. Smith (1991); Bliege Bird et al. (2002); Bliege Bird and Bird (2002, 2008); Bliege Bird (2007); and Bliege Bird, Codding, and Bird (2009).

Chapter 2: Environment, Evolution, and Anthropological Theory

1. See Ellen (1982) for a thorough treatment of early ecological thought in anthropology.

2. Shortly after Wissler's study was published, Davidson (1928), who had read Wissler's work closely, published a similar study of Australian Aboriginal culture areas.
3. As a result, the culture-area concept could only have encouraged the view that cultures were static or, at least, were static once they were adjusted to their environment. This is not to say, however, that the culture-area concept has no use in anthropology. Peterson (1988) makes interesting use of the concept for Australian Aboriginal society, but only because he recognized the need for an ecological framework for analyzing the interaction between a society and its environment, while allowing for the role of historical contingency and cultural factors.
4. For subsistence studies on the Ituri Forest, see Bicchieri (1969a,b); Harako (1976, 1981); Tanno (1976); Abruzzi (1980); Terashima (1980, 1983); and Ichikawa (1983). For the Kalahari, see Lee (1969, 1979); Lee and DeVore (1976); Marshall (1976); Tanaka (1980); and Silberbauer (1981a,b). For Australia, see Gould (1968) and Meehan (1977a,b, 1982, 1983). For the Arctic, see Balikci (1970).
5. Cultural ecology's emphasis on homeostasis encouraged "diachronic blindness" (Winterhalder 1984: 307). Historical studies, or the study of human responses to hazards (e.g., droughts), could correct this (Vayda and McKay 1975), although such studies are difficult because they require time frames longer than the life of the average ethnographer and require the use of archaeological or ethnohistoric data (e.g., Amsden 1977; Winterhalder 1977; Hitchcock and Ebert 1984; Schrire 1984a; Hitchcock 1987a,b). However, it is not clear that even with long-term data, cultural ecology could go beyond long-term anecdotal description.
6. The Ache are mentioned frequently in this book; early on, the research focused on what the Ache do while on hunting treks. In the first edition of this book, we knew much less about what occurred in the mission settlement – where the Ache spend more than 75 percent of their time. This has now been corrected, and studies of Ache in the settlement (see, e.g., Gurven, Hill, and Kaplan [2002]) give us a more detailed picture of Ache life.
7. These are known as *hypergynous* marriages, marriages between men of a high-status group and women of a low-status group; they are fairly common among living hunter-gatherers, who are often perceived as having lower status by their neighbors. Ten percent of Ju/'hoan women are married to Bantu cattle herders, for example, and, in the Philippines, up to 25 percent of Batak and 18 percent of Casiguran Agta women are in hypergynous marriages (Bailey 1988).
8. It is not clear when humans became cultural, although it was certainly by the Upper Paleolithic; it is also not known if our ancestors became fully cultural, as we understand the term, at a single point in time.

Chapter 3: Foraging and Subsistence

1. Latitude, however, is a poor proxy measure of environment. Louisville, Kentucky, and Tonopah, Nevada, are at the same latitude, but one is a humid deciduous forest, the other is a dry sagebrush and greasewood desert.
2. A difference between surface and deep-water temperatures creates upwelling coastal currents that bring up nutrients that support a productive aquatic food chain; see Yesner (1980).
3. For case studies, see Winterhalder and Smith (1981); E. Smith (1983, 1991); Hawkes, Hill, and O'Connell (1982); Hames and Vickers (1983); O'Connell and Hawkes (1984); Winterhalder (1986a,b, 1987); and Smith and Winterhalder (1992b); also various works by Bird; Bliege Bird; and O'Connell, Hawkes, and Blurton Jones.

   Early in the history of optimal-foraging models, researchers used a version known as *linear programming* (e.g., Reidhead 1979, 1980; Keene 1979, 1981; Belovsky 1987, 1988), which the first edition of this book covered. However, linear programming did not take the field in a useful direction and I have elected to drop discussion of it here.
4. The physicist's measure of calorie (the "small calorie") is the amount of energy it takes to raise one gram of water by one degree centigrade; the nutritionists' Calorie (with a capital C) is 1,000 small calories (i.e., kilocalorie [kcal]).

5. For example, in the boreal forest (Winterhalder 1981), the Amazon (Hames and Vickers 1982), Malaysia (Kuchikura 1987, 1988), the central Australian desert (O'Connell and Hawkes 1981, 1984), California (Broughton 1999), and the Arctic (E. Smith 1991).
6. If seeds offer such low return rates, why is it that some seeds – such as those of maize, rice, and wheat – went on to become major agricultural crops that literally sustain the bulk of the world's 7 billion people today? Keeley (1995) concluded that seeds are some of the last plant foods to be added to hunter-gatherer diets – and that those foragers generally live in areas where they cannot obtain sufficient game or are landlocked (and thus lack access to marine foods), who need to store food, and who live under high population densities. By intensifying their use of some seeds, husbanding, and eventually domesticating those with particular genetic capacities, foragers eventually created the world's major agricultural plants through the process of natural selection that increased the productivity of the wild varieties of seeds. The wild ancestor of maize, for example, is *teosinte*, a plant that grows wild in southern Mexico and produces a "cob" no larger than your pinky finger.
7. This can be overcome through practice and by repeating experiments until the researcher has reached a maximum return rate. Return rates based on very few experiments should be considered only rough estimates (Madsen and Schmitt 1998). In addition, for some foods, it is not clear how ancient peoples harvested and/or processed them. There are different ways of collecting some kinds of shellfish, for example, by removing them individually or by "stripping" them in sheets; likewise, they might be shucked and then cooked, or cooked in the shell (see, e.g., Bird and Bliege Bird [1997], Bettinger et al. [1997], Thomas [2008]). In these cases, it is best to conduct experiments under different conditions and look at the range of return rates.
8. Grasshoppers rarely provide this high return rate. During boom years, thousands of grasshoppers fly out over lakes; when they land, they drown and then wash up on shore, forming windrows that can be many meters long and a half meter or more high. The insects can be simply scooped up in baskets and roasted over coals. In this specific case, we would have to consider how many grasshoppers a person could eat at any one time, since they contain a large percentage of indigestible chitin.
9. See Draper (1975); Blurton Jones and Konner (1976); Marshall (1976); Tanner (1979); Heffley (1981); Silberbauer (1981a: 271); Meehan (1982); Morren (1986: 120); see also Mithen (1990).
10. This is especially true for tubers composed of complex carbohydrates (starches and fructans, especially inulin). Baking these tubers converts the carbohydrates into the simple sugars fructose and glucose that are more easily digested (Wandsnider 1997). Without cooking, much of the food value of tubers is lost. Hence, the return rate of an uncooked tuber can be quite different from that of a cooked one. In fact, most return rates are based on uncooked portions of food. Cooking often increases a resource's caloric value to the human digestive system (Wrangham 2009) and it would, in fact, be best if return rates were based on cooked rather than raw portions.
11. In the terms of calculus, the mean environmental return rate establishes the derivative of X and signifies when the forager should leave the patch.
12. It is true, as a number of authors have pointed out, that the marginal-value theorem implies that hunter-gatherers should not overexploit their resource base or hunt a species to extinction; it is not necessary to appeal, as some have, to an inherent conservation ethic among hunter-gatherers (see Chapter 4).
13. Archaeologists also need to consider that although they deal with data that come from time periods of varying length, these periods are always much longer than those of ethnographic studies, and they are aggregates of male and female behavior. These facts matter in terms of how long it takes a forager to obtain an optimal diet. There is always variance in the kinds and amounts of resources harvested from day to day, season to season, and year to year. Hunter-gatherers frequently gorge on certain resources, especially meat and honey. Over the course of a year, a group may eat a diversified diet, but at any one time, people may consume a very limited number of food items. What should be the time period studied? We have few data to guide us here, although Smith's (1991) analysis of Inujjuamiut diet pointed out that the diet-breadth model was a more accurate predictor of diet over fine, as opposed to coarse, temporal (and spatial) scales.

14. These central-place foraging models have been crucial for archaeology because they help predict which resources might be evident in a prehistoric camp (e.g., Cannon 2003). I used such models to determine that piñon was not used in the Stillwater Marsh in western Nevada even though it might have been only 30 km away – because at 30 km, the hulls should have been left on the nuts and removed in the camps, where we would have found them in the charred plant remains – but did not (Kelly 2001). Likewise, several studies show that low-return-rate shellfish with high processing costs appear in shell middens more commonly than expected – because the high-return-rate ones – those with low processing costs – are shucked on the coast and only their meat transported to the camp (Bird and Bliege Bird 1997; Bird, Richardson, Veth, and Barham 2002); nothing remains in the residential camp that points to their collection.
15. In general, foraging models rank resources in terms of their postencounter return rates that take a resource's complete processing (short of cooking) into account. To be as specific as possible, however, we should use the return rate of a resource that has been field processed as much as is necessary for transport. The rest of the processing could be done at camp, during a time when there is no foraging opportunity cost. Although it has not been examined, in all likelihood, the return rates of field-processed and completely processed foods are correlated and thus should make no difference in their relative ranking.
16. For example, de Garine and Harrison (1988); Huss-Ashmore, Curry, and Hitchcock (1988); Minc and Smith (1989); Cashdan (1990).
17. In any case, a resource does not have to be actively included in the diet for it to be a backup resource. When their maize crops failed, many Puebloan peoples of the American Southwest, for example, relied on wild plant foods that were not normally included in their diets. Information on backup strategies and starvation foods can also be encoded into a society's mythology, folklore, and ritual (e.g., Minc 1986); the resources need not be continually used to serve as backup foods.
18. See also Keene (1979, 1981); E. Smith (1979); Foley (1985); Sih and Milton (1985); Belovsky (1987); Gragson (1993).
19. Sponsel finds that 39 percent of tropical animals weigh less than 5 kg, 54 percent are solitary, 73 percent are nocturnal, and 44 percent are arboreal (1986). These facts do not add up to an impressive faunal resource base or one that is easy to exploit. This, by the way, may account for the use of extremely large arrows as shock weapons, and poison in the tropical forest, since tropical hunters must shoot game at distances much farther than the 30 to 40 feet that bow hunters prefer. It may also have much to do with the quick acceptance of shotguns by tropical-forest peoples. And most tropical-forest horticulturalists are probably clearly in need of protein: Bantu villagers trade three calories worth of agricultural produce with pygmies for a single calorie worth of bushmeat (Bailey 1991).
20. Archaeology could similarly benefit from this approach. Take the case of fish in Tasmania. About 3,500 years ago, the aboriginal inhabitants of Tasmania apparently stopped eating fish (Jones 1978). European colonists found that the Tasmanians considered fish inedible. Were fish tabooed or just low-ranked relative to other foods? Or, was the population of Tasmania, once cut off from the mainland by rising sea levels of the terminal Pleistocene, too small to maintain knowledge of fishing technology (Henrich 2004; see response by Read 2006)? Optimal-foraging models could predict the conditions under which fish should drop out of the diet for purely energetic reasons and thus help test these hypotheses. Likewise, swordfish may have held special symbolic meaning to the ancient Chumash of southern California and may have been taken from expensive plank canoes more for its symbolic meaning than its food value (see Davenport, Johnson, and Timbrook 1993; Pletka 2001).

Chapter 4: Mobility

1. Settlement-pattern studies had been around since at least Gordon Willey's (1953) seminal study of the Virú Valley in Peru; these studies reached an apogee in the 1970s.

2. Ingold (1987) and Cribb (1991) discuss conceptual differences between the mobility of hunter-gatherers and the mobility of pastoralists.
3. In this book, we use the term "forager" alternately with "hunter-gatherer"; we use it in Binford's sense only in this section of this chapter.
4. Just before his 1980 paper appeared in print, Binford warned me that although it wasn't his goal to create a typology of foragers, many would use his scheme that way. He was right. His intent was to get archaeologists to think about mobility in a way that would allow them to make sense out of landscape-scale spatial patterns in the archaeological record.
5. Additionally, Bettinger and Baumhoff propose an alternative to the forager-collector continuum with their traveler-processor continuum (1982; see also Bettinger 1991). Travelers have high mobility (presumably both residential and logistical) and take only high-return-rate food resources, especially large game. Processors have lower mobility and use a diversity of resources, especially plant foods. The difference in subsistence generates differences in demography, with high rates of female infanticide lowering the growth rate among travelers. Travelers may characterize colonizing populations, whereas processors could encompass Binford's foragers and collectors. Bettinger (1991: 102) claims that his model has the advantage of specifying precise relationships between population and resources, and settlement and subsistence.
6. In the first edition, primary biomass was calculated from two regression equations using the primary production and biomass of major biomes that were grouped into arid and humid categories (Kelly 1983). Humid environments were those with more than 400 millimeters of precipitation per year and ET values from 8 to 12.5 or from 19.5 to 26. Arid environments were those with ET values of 12.5–19.5, as well as those within the ET ranges of humid environments that have less than 400 millimeters a year of precipitation (tundra and Arctic environments excluded):

   Arid Environments:

   $$\log_{10} \text{Primary Biomass } (\text{g/m}^2) = 2.66 + 0.0009x$$

   Humid Environments:

   $$\log_{10} \text{Primary Biomass } (\text{g/m}^2) = 4.2 + 0.00013x$$

   where x = net above-ground primary production ($\text{g/m}^2/\text{yr}$) calculated from global maps of evapotranspiration. In a few borderline cases, I chose to ignore the equation determined by the climatic data and to use the other if I thought it described a group's environment more accurately. These were crude measures, and Binford went to some lengths to produce more accurate estimates of primary biomass from local weather record data. There is, however, a good fit between his estimates and my previous ones ($r = 0.86$, $p < 0.01$), and the patterns that arose from the first edition remain unchanged. In one case, that of the Mrabri, I thought Binford's estimate was off and I recalculated it using a regression equation generated from Binford's and my previous estimates; with the y-intercept set to 0, $y = 0.792x$, where x = my 1995 estimate and y = Binford's estimate.
7. One of the difficulties of cross-cultural analysis is that of "cultural phylogeny." A pattern in data can arise that appears to be related to, say, environmental variables when in fact it is a product of common cultural descent. If all the cases that comprise a pattern are culturally related, then the pattern could be a function of shared cultural ideas rather than convergent evolution and adaptive response. The Northwest Coast does contain many different groups speaking different languages and hence are of different cultural origins, so perhaps shared cultural descent is not a problem in this case.
8. I admit to some uncertainty over the Baffinland data, which come from Hantzsch (1977). In Baffinland in 1911 to collect botanical specimens, Hantzsch made the group move more frequently than perhaps they wanted. After Hantzsch's death, the group returned to the coastal port from which they had started in half the time. Whether they were now moving at a regular pace or more quickly to report Hantzsch's death is not clear. Even if the former, it would not raise the estimate to the level of other low-ET groups. In addition, they may have been covering more of the interior than this marine-mammal hunting group might normally have done.

9. This observation has implications for the formation of regional archaeological records of hunter-gatherers (see Binford 1983).
10. Lee 1968: 31; Tindale 1972: 245; McClellan 1975: 100; Tanaka 1980: 66; Irimoto 1981: 127; Hitchcock and Ebert 1984; Endicott and Endicott 1986: 150; Morren 1986: 120; Cane 1987: 395; Kuchikura 1987; Vickers 1989; Marlowe 2006, 2010. I also think Grimstead's (2010) analysis is unrealistic. Although she carefully calculates the caloric cost of walking out and back (returning with a load), she does not include the time that long foraging trips require. Let's say that a single deer provides 122,521 kcals and that foragers walk at a rate of 5 km/hr. Let's also keep things simple and say the forager expends 300 and 390 kcal/hr for walking out and returning with a load, respectively. For a 100-km roundtrip at 5 km/hr, this means 10 hrs each for the outbound and return trip. For a 100-km roundtrip, this means a net acquisition rate of ((122,521 − (300 × 10) − (390 × 10))/ 20 hrs = 5,781 kcals/hr. Not bad. But a 10-hour trip out and back implies two travel days and at least another day to hunt and process the deer (which would probably entail drying the meat since that reduces the weight by 60 percent) – three days total. So, this 100-km roundtrip requires at least three days. Our forager would also have to feed himself (let's assume he's alone), reducing the food by at least 4,000 kcals (2,000 kcals for day two and three). So, the forager actually has expended three days (72 hrs) and 8,900 kcals in walking and provisioning (3,000 + 3,900 + 2,000) for a return rate of (122,521 − 8,900)/72 = 1,578 kcals/hr. A viable rate, but there are probably better foraging options closer to home.
11. Hunter-gatherers only occasionally work this long at collecting and processing food (refer to Table 1–1), and then only a few days a week. Winterhalder's (1986a) simulation also suggests that this kind of daily work effort would not be adaptive. At this point, however, it does not matter, since shortening the work day would change the absolute returns relative to needs but not the relationship between the two – and it is the latter that concerns us here. Additionally, the model does not require that foragers work every day.
12. We assume that the calories collected cover the energy needs of the forager plus his or her dependents; the energy costs of foraging are over and above the basal needs. Adding the energetic costs of foraging into the equation allows the analysis of different foraging and camp-move costs. We also assume that adults collect all food for children; although children do some of their own foraging in some societies, they do very little in others (Blurton Jones, Hawkes, and O'Connell 1989). The factors determining when children forage are too complex to enter into the simple model used here (see Chapter 7). It should be apparent from the text, however, that the less food adults have to bring back for children (and the less they are burdened by children while foraging), the farther they can forage from camp. This will probably affect women's more than men's foraging.
13. Catchment analysis in archaeology commonly uses a standard foraging radius of 5 or 10 km, based usually on data from the Ju/'hoansi. It should be clear from this model, however, that the length of the effective foraging distance is not a constant – although 10 km is perhaps a maximum daily radius.
14. Ritual needs can also increase the time it takes to break camp down. The Cree, for example, make sure that they clean up camp and properly dispose of any faunal remains so as not to insult the spirits of animals. This is necessary to ensure that game will return to the area (Tanner 1979: 74; see also Leacock and Rothschild 1994).
15. For example, if housing must be substantial (e.g., in Arctic climates), then mobility decreases; conversely, if mobility must be high, then housing must be less substantial and easily transportable. The decision depends on the materials available for housing and/or for transport; thus, the technology of housing and mobility influence one another. Horses helped make Plains Indian life possible because it reduced mobility costs and made possible the transport of the materials needed for housing on the Plains.
16. For examples, see Woodburn (1968, 1972: 205); Lee (1976); Morris (1982: 178–79); Griffin (1989); Vickers (1989); and Kent and Vierich (1989).

17. The correct term is *sedentarism*. However, the term *sedentism* has a lengthy history in anthropology and I elect to continue it.
18. Ingold (1986) suggests that these behavioral dimensions have conceptual ones as well, in terms of how hunter-gatherers see themselves as related to a particular place.
19. Some osteological studies of prehistoric human skeleton remains suggest that males were more mobile prehistorically than females, even in prehistoric sedentary agricultural societies (Larson and Kelly 1995). But it still remains to be seen if the ethnographic pattern is a phenomenon of sedentism itself or colonial encapsulation.
20. That some foragers learn these areas extremely well is attested to by the maps some Arctic foragers draw from memory encompassing hundreds of square kilometers (see, e.g., Boas [1888: 236–40]; Nelson [1899: 197]; Carpenter [1955]; Petersen [1984]; Lovis and Donahue [2011]).
21. For mobility as helping to maintain insurance networks, see Yengoyan (1976); Wiessner (1977, 1982a,b); as maintaining trading partners, see Park (1938: 629); Woodburn (1968: 106, 1972: 205); Lee (1976: 96); Yellen (1977: 64); as instructing children, see Gould [1969b: 87].
22. A circle with a radius of 6 km represents an area of 113.04 km^2 and 28,260,000 calories. Assuming an average of 2,000 kcal/person/day, a group of 25 needs 50,000 kcal; 28,260,000/50,000 = 565.2, or for a half-radius pattern as we modeled here, 282 days. The length of stay for the 3-km radius area is figured similarly. The values employed here can be used to construct a depletion curve of the type used in the MVT. It is difficult to decide what the overall environmental return rate should be since it must take travel time into account – but in an area of homogeneous resource distribution, travel time is a function of the size of the foraged area. Nonetheless, using a range of values, the MVT still predicts movement before a year's occupation – in fact, it always predicts movement at a considerably shorter occupation time than the half-foraging-radius model.
23. The central-place foraging model and the MVT may seem to contradict one another: in the former, decreasing return rates shorten the effective foraging radius and increase group movements; in the latter, higher overall rates of return produce the same result. How can both high and low return rates produce the same result? Look back at Figure 3-5. Here, we saw two different patches in the same environment, one (B) that produces higher returns per unit time than the other (A). Holding the mean environmental return rate constant, the poorer patch (A) would be occupied for shorter periods of time than the better patch (B). Of course, people remain in the better places longer than in the poorer places. But everything is relative: one can imagine that if the overall environment improved in Figure 3-5 (if the slope of the mean environmental return rate *increased*), then both patches A and B would be occupied for shorter periods of time (although A would still be occupied for less time than B).
24. At the same time, one group's decision to become sedentary could leave some land open, permitting others to continue to forage in the interstices between sedentary villages. The extent to which this is possible depends on how patches of resources are distributed. It is common for horticultural communities to be surrounded by nomadic foragers (or pastoralists) for whom trade relations with horticulturalists become an integral element of their foraging economies.

    Archaeologists have also sometimes seen sedentism as an evolutionary threshold from which foragers could not retreat. In Chapter 6, we will discuss how sedentism may increase population growth rates and hence encourage a commitment to sedentism. However, from the perspective outlined here, it should be apparent that changes in resource configurations and/or population density could result in a reversal of a trend toward sedentism back to a more residentially mobile lifeway (e.g., see Ames 1991).
25. However, the sedentary coastal Tlingit used dance to parody interior boreal-forest peoples who, in their opinion, wandered about in a pathetic search for food (McClellan 1975: 96). And the recently settled G//ana of the Kalahari likewise "speak disparagingly of residents of the Central Reserve who have no fixed home base as 'moving around like animals'" (Cashdan 1984: 323).

26. Governments attempting to settle formerly nomadic peoples would do well to realize the role of mobility as an expression of cultural norms and uniqueness and its importance to a people's psychological as well as physical well-being.
27. See discussion in Barry, Child, and Bacon (1959) and Lee and DeVore (1968: 337–38); for hunter-gatherer studies, see Draper (1975, 1976); Condon (1987); Burbank (1988); Hames (1988); Hewlett (1991a,b, 1992b); Hewlett and Lamb (2005); Keith (2005); and Winn, Morelli, and Tronick (1990). Some of these are concerned with childhood in societies undergoing rapid acculturation.
28. Foragers can have very complex and subtle understandings of the relationship between themselves and the natural world. Rane Willerslev (2007) provides a detailed description of the way the Siberian Yukaghirs view the relations between people and animals.
29. This is an important issue because many indigenous peoples around the world, especially former hunter-gatherer peoples, are well aware that some anthropologists, following the affluent-forager model, label them as natural conservationists and argue that resource-conservation laws should not apply to them, setting up tension and debate between these indigenous peoples and conservation organizations. However, even if we find that resource conservation among foragers results from foraging efficiency rather than intentional management, this would *not* mean that foragers or their descendants, living with growing populations that are circumscribed by agricultural or industrial societies and with access to extensive data (both their own and that collected by land-management organizations), do not or could not structure their harvesting so as to manage food resources. Indeed, quite a few have been successful at doing so.

Chapter 5: Technology

1. Another version of this chapter appeared as Kelly (2012).
2. See Binford (1979); Bamforth (1991); Nelson (1991); and Carr and Bradbury (2011).
3. For a sample of the variety of technology among other hunter-gatherers, see Marlowe (2010) on the Hadza; Orquera and Piana (1999) on the Yámana; Hudson and Blackburn (1982–87) on the Chumash; Driver and Massey (1957) on North American Indian material culture; Emmons (1991) on the Tlingit; Eells (1985) on the Puget Sound region; Fowler and Matley (1979) on the Paiute; Barrett and Gifford (1933) on the California Miwok; Barrett (1910) on the Klamath; Politis (2007) on the Amazonian Nukak; and Olson (1927) on the Northwest Coast canoes and houses.
4. See Torrence (1983, 1989, 2001); Shott (1986); Vierra (1995); Bamforth and Bleed (1997); Osborn (1999); Collard et al. (2005); and Read (2008).
5. A weighted digging stick has a stone, often doughnut-shaped, fixed to the lower portion of the stick to give it greater mass and hence more power in digging. It is most useful when digging shallow tubers; see Rippen (1918: 76).
6. In the late fall of 1928, William Duncan Strong fell through the ice while hunting ptarmigan with the Naskapi on the Labrador peninsula just as darkness fell: "Crossing the bay I paid the penalty of my inexperience and walked into an open lead formed by the creek about an eighth of a mile from the station. It was about several degrees below zero and with my skin boots and fur clothes it was impossible to get up on the firm ice. My frantic swimming soon opened a large hole but just as my hands were hopelessly numbing, I reached a place where the ice bent but did not break, and by cautious squirming found it possible to worm my way to firm ice. The noise had been heard at camp and two of the boys came out to help me in. Aside from losing my shotgun, recovered eight months later from thirty feet of water, there were no bad after effects. It served however, to increase my admiration for the Labrador hunter who constantly faces, and nearly always avoids, such dangers in his daily path" (Leacock and Rothschild [1994: 28]; see also Burch [2006: 151] on the danger of hunting on sea ice).
7. See Torrence (1983, 2001); Bousman (1993); Bamforth and Bleed (1997); Collard et al. (2005); and Tomka (2001b).

8. Lee gathered his data from interviews, and times are given in terms of units of time, such as one month, a year, five years, rather than actual measurements. I therefore used the Spearman's rank test rather than another measure of correlation. Male and female times were averaged, and some items (e.g., nutting stones) that have no manufacture or maintenance times are left out. Lee estimated the "cost" of store-bought items by the time needed to manufacture enough ostrich-eggshell beads to purchase them in trade. The correlation is still significant ($p = 0.001$) even if we remove the flint-and-steel kit with its high total maintenance cost.
9. We described stone-boiling in Chapter 3. Usually, this requires a watertight basket or a pit lined with a thick hide. The Naskapi used the gutted upper body cavity of a caribou as a container (Leacock and Rothschild 1994: 103).
10. A gillnet is a net that catches fish behind their gills as they attempt to swim through the net. As a fish enters one of the squares of the mesh, it feels the line and, in attempting to escape, catches the mesh behind its gills. A gillnet catches fish only of a certain size. Smaller fish swim through the mesh whereas larger fish swim around it.
11. On projectile points, see Allchin (1966); Churchill (1993); Bartram (1997); Griffin (1997); Greaves (1997); Hitchcock and Bleed (1997); on other stone tools, see Gallagher (1977); Hayden (1979, 1987); Miller (1979); Gould (1980); Hayden and Nelson (1981); Binford and O'Connell (1984); Flenniken and White (1985); Binford (1986); Griffin (1997); Hampton (1999); Sillitoe (1982); Tindale (1985); Watson (1995); Weedman (2002); on fish weir and house construction, see Olson (1936); on fish traps, see Rippen (1918); on twine, rope, and hide preparation, see Turney-High (1941) and Leacock and Rothschild (1994).
12. For example, many archaeologists, including myself (Kelly 1988), once argued that bifaces are more efficient sources of hand-held flake tools than are amorphous cores. Thus, we argued that bifaces are more likely to be used by nomadic peoples, who, we expected, try to minimize the amount of stone carried. But, with experimental assemblages, Mary Prasciunas (2007) found no significant difference in the efficiency of bifaces versus amorphous cores as sources of flake tools. Some arguments now need rethinking because we did not initially collect the necessary technological data.
13. We often heard talk of wild boars but never saw any in the forest, nor evidence of them in any camp. I never saw the large spear points used as spears, since they were never needed as such. I did, however, frequently see men pull the spearhead off (it was fitted to the shaft in a socketed joint, and not hafted) and use it as a knife.

Chapter 6: Sharing, Exchange, and Land Tenure

1. Also translated as "God's meat."
2. When Mikea cook meat inside their houses, which they always did, even though one could smell the cooking meat outside, the cultural rule was that if you could not see it, you had to act as if you were not aware of its existence.
3. Eric Smith approached this question using game theory (1988; Smith and Boyd 1990). It will come as no surprise that if a few foragers hoard while others share, the hoarders come out best. Sharers have only two options: continue sharing (and continue to be exploited) or switch to a hoarding strategy. Smith showed that hoarding will eventually become the dominant strategy, even when sharing provides the greatest good for the greatest number (Smith 1988: 240). Smith's simulation implies that all foraging systems will tend toward communities of hoarders over the long run. But this is contrary to the ethnographic record. What holds hoarders in check?

   The answer is time and memory. When the simulation is run over time, and human memory of debts and obligations are added to it, the sharers soon learn not to share with hoarders, and eventually the tables are turned. Hoarders find themselves left out in the cold, socially speaking, and a hoarding strategy is replaced by a sharing one. Therefore, "the existence of collective goods is . . . dependent on a system of monitoring, ongoing expectation of reciprocity, and costly sanctions against free-riders" (E. Smith 1988: 240).

It is also possible that dunning leads to ambivalence toward material goods, or even a dislike for possessions. It could also lead to many modern hunter-gatherers saving cash rather than the goods cash can buy (Altman and Peterson 1988), since a person can hide cash, even put it in a bank, and avoid demand-sharing by appearing to be cash-poor.

4. Market value can confuse sharing patterns if it is ignored. The Mikea, for example, sell hedgehogs and honey collected in the forest at nearby markets. Thus, these resources have cash as well as food value (Tucker 2004). See also footnote 10.
5. This does not mean that meat from large game will always be shared, although that is the case in the ethnographic record. Instead, the model predicts that in cases where hunters are always equally successful, meat sharing should be infrequent.
6. Winterhalder (1986a) also found similar limits on sharing, as did Hegmon (1991) for Hopi horticulturalists; Burch (2006: 272) found that in periods of widespread famine and hunger, the distribution system broke down, families hoarded food, and some tried to steal the stores of others or even to kill the owners.
7. See Hawkes (1990, 1991, 1992a,b, 1993a,b); Bliege Bird and Bird (1997); Smith and Bliege Bird (2000); Hawkes et al. (2001a,b); Bliege Bird, Bird, Smith, and Kushnick (2002); Bliege Bird, Codding, and Bird (2009); Hawkes and Bliege Bird (2002); Burch (2006: 272); and Bird and Bliege Bird (2009).
8. For a while in the 1990s, anthropologists, including myself, argued that hunters gave away most of their meat. This was based on data from the Ache, the first group for whom quantified data on food sharing were collected. Ache men only keep about 10 percent of the meat they acquire for their own families. However, those data reflect what the Ache do while on treks in the forest. When living in their horticultural settlements, where they spend 75 percent of their time, the Ache give away much less (see Gurven and Hill [2009], and response by Hawkes et al. [2010]). And those who trek together tend to be families that share while in the settlement; thus, the early Ache data are a biased sample of the general population (Gurven, Hill, and Jakugi 2004).
9. A refined variant of this hypothesis is that parents should share most with children of the sex that has the greatest chance of passing genetic material on to future generations.
10. It is perhaps universal that refusing to share food – even when the request is not socially legitimate – is an unforgiveable act. If committed, it could affect others' decisions to share in the future with the person who refused. The degree to which this is true will help determine the social costs of sharing; that is, the cost of defending a resource may not always be intrinsic to the resource itself. We see this with the Mikea. The hedgehogs are often collected during the dry season, when they are aestivating in tree hollows. Men "hunt" them by tapping on trees with an axe, listening for scratching as the creature awakens briefly. They then chop the tree open, pull the hedgehog out and drop it in a container; there is no need to kill it, and it will continue to sleep quietly. Thus, the hedgehog's value (as food or marketable produce) does not diminish with time, as dried meat would; the same is true for honey. These are resources that a family should keep since their value does not diminish with increasing quantities; and yet, they are shared if one demands it (Tucker 2004).
11. See Smith and Bliege Bird (2000); Bliege Bird, Bird, Smith, and Kushnick (2002); Hawkes and Bliege Bird (2002); Smith et al. (2003); Bliege Bird and Smith (2005); Bliege Bird et al. (2009); and Bird and Bliege Bird (2009). Hawkes argues that her "show-off" hypothesis, in which Ache men use meat to garner extramarital mates and increase their inclusive fitness, is a form of costly signaling. But it can also be seen as straightforward reciprocal altruism – women gain a nutrient-dense resource and men garner an additional mating opportunity (Smith and Bliege Bird 2000).
12. In discussing the paternity data, Hawkes (1990: 16) notes that "informants' reports may well be biased." However, even if good hunters do not really father more children, it is noteworthy that Ache women *name* good hunters as possible or likely fathers more frequently than they name poor hunters. Thus, all involved (the Ache and their anthropologists) may believe that good hunters father more children: it may not matter whether the paternity data are biologically accurate.

    Women, who generally collect plant food that does not have to be shared (although it may be), may use sex as a way to build support networks. Jane Collier and Michelle Rosaldo argue that in brideservice societies (a form of marriage said to be common among hunter-gatherers; see Chapter 8) "women are most likely to use sexual skills in an attempt not to win power from men but, rather, to escape constraining marital bonds and build the networks of affection and support that will assure them considerable freedom throughout life" (1981: 317; see also Goodale 1971: 131). Extramarital affairs can be as much a female as a male strategy. However, there are no published data with which to address this issue.

13. Hawkes and her students argued early on that Ache men could maximize their caloric returns by gathering palm starch instead of hunting (e.g., Hawkes, O'Connell, and Blurton Jones 2001b). They hunt, Hawkes suggested, not to provision their families – they should collect palm starch if they wished to accomplish that – but to acquire extramarital affairs and increase their reproductive fitness (e.g., Hill et al. 1987; Hill and Kaplan 1988a,b). It now seems that the palm starch return-rate data were in error and that men achieve their highest return rates through hunting (Gurven and Hill 2009). Hawkes counters that we should discount the contribution of meat relative to that of palm starch because meat is shared whereas palm starch is used entirely by the family. By doing so, the amount of food *provisioned to the household* is maximized by taking palm starch rather than by hunting. Thus, she argues that Ache men still eschew provisioning their families in favor of a strategy more in line with costly signaling (Hawkes et al. 2010).
14. For men, see Hart and Pilling (1960: 34); Dwyer (1983); Howell (1986b); and Ohtsuka (1989). For women, see Biesele and Howell (1981); Howell (1986b); and Hawkes, O'Connell, and Blurton Jones (1989). There is, however, variability among hunter-gatherer societies in how much work the elderly do. Hawkes and her coworkers (1989) note that whereas elderly Hadza women actively forage, providing food for their grandchildren, elderly Ju/'hoan women do not, possibly because the Kalahari is a much harsher foraging environment than Hadza territory. Elderly Ju/'hoan women spend more time than Hadza women in babysitting while the younger mothers forage.
15. For territories as adaptations to the fur trade, see Leacock (1954, 1980, 1982); but see Knight (1965); see also Scott (1986) for comments on commodity production and privatization. For the Lillooet and other groups in interior British Columbia, see Hayden (1992: 545). Harris (1968: 359) notes that Speck's later writing favored Leacock's interpretation. For the Siberian Evenki, see Turov (2010: 93). Also, Cooper (1946) later retracted his support for pre-Columbian territories.
16. Radcliffe-Brown's earlier writings on Australian social organization show that he recognized that boundaries between hordes were permeable – people could move between hordes. However, in his later writings, and when writing more generally, hordes were described as closed groups, with particular individuals using only particular tracts of land (see Peterson and Long 1986: 16).
17. Territorial marking may have occurred after Euroamerican settlement restricted land available to Native Californians, but this still suggests the conditions under which marked territories would form. Similar processes could be at work among Sri Lanka's Vedda.
18. See also Williams (1982, 1986) on the Yolngu; Hamilton (1982a) on the Pitjandjara; Silberbauer (1994) on both the Pitjandjara and G/wi.
19. This is not unique to Australia, for many Arctic peoples also express feelings that they belong to a place (Riches 1982: 119). Boas, for example, noted that "it is peculiar to the migratory habits of the Eskimo that almost without exception the old man returns to the country of his youth, and consequently by far the greater part of the old people live in their native districts" (1888: 58). The Malaysian Batek also express affection for their *pesaka*, or childhood home (Endicott and Endicott 1986: 155). And so do the Bushmen, as attested to by the quotation at the head of this chapter.
20. See Barker (1976) for a more general discussion of the relationship among estate, range, and criteria of affiliation in Aboriginal Australia.
21. A logical question is whether a Ju/'hoansi's well-being is related to his or her number of hxaro partners or the spatial distribution of these partners; to the best of my knowledge, such data do not exist.

22. By high resource predictability, Dyson-Hudson and Smith mean resources whose timing and location can be known in advance with a high degree of probability, as is true for piñon. The two-year fruiting cycle of the piñon cone, in fact, permits prediction more than a year in advance.
23. We have very little information on what happens when times are bad – when allowing someone into a territory would have a detrimental effect on the host population. One cannot give a gift if doing so jeopardizes one's own survival.
24. This is not so much for using resources without permission but rather for using resources without incurring the obligation to reciprocate sometime in the future. That is, the host group would not be retaliating for the loss of food but instead for the loss of a future debt and, hence, security.
25. This is an assumption, of course, since the costs and benefits of social-boundary defense are difficult to measure. No one to my knowledge has done so.
26. It is even more likely that trade relations will focus on specific nutritional concerns (e.g., protein versus carbohydrate), since the ability to produce a surplus of food to be traded indicates that calories are not the limiting factor for some populations. Thus, to analyze trade relations among hunter-gatherers or between foragers and their neighbors, we should consider nutritional as well as energetic complementarity.

Chapter 7: Group Size and Demography

1. Methods exist for calculating ages, and they appear to be reasonably accurate; see, e.g., Blurton-Jones et al. (2002); Hill and Hurtado (1996: 119–32); and Howell (1979). Incidentally, the problem works both ways; when I once told a Mikea man my age – thirty-six at the time – his jaw dropped. "Impossible!" was all he said, but I could not discern if he thought that was too young or too old.
2. The term "band" runs throughout the anthropological literature on foragers from about 1930 through the 1970s. The term was used casually from 1850 (e.g., Bollaert 1850) through the early twentieth century. It began to take on an anthropological significance in 1915, with Frank Speck's work on Algonkian family hunting bands. Here, the term "band" referred to a small, coresidential group of people who shared a hunting territory. The term became locked into anthropological literature, however, in 1936, with Julian Steward's seminal article on hunter-gatherer bands. Here, however, Steward (1968, 1969b, 1970) was thinking of a social grouping (especially patrilineal bands) larger than what he called the "family level" of social integration (see Binford 2006), and he conceived of the "band" as an endogamous, land-holding group of some 250 persons. By *Man the Hunter*, anthropologists routinely used "band" to refer to small, residential groupings of about twenty-five persons. Beginning with *Man the Hunter*, the figure 500 became associated with maximal bands (e.g., Hunn 1994), and the unmodified "band" came back to mean a smaller, coresidential group of people – the sort of residential groupings found among the Ju/'hoansi and other Kalahari peoples.
3. Birdsell based reconstructions of tribal populations on the dialectical tribe, a population unit defined by linguistic boundaries and that Birdsell assumed to be genetically isolated. Leaving aside the question of genetic isolation, later researchers found little support for dialectical tribes in Australia itself (Berndt 1972). Second, the data Birdsell had on tribal areas and populations were not altogether trustworthy (and certainly not numerous). In fact, there were "too few estimates of the population size of aboriginal tribes to work directly with density as a dependent variable" (1953: 177). His best estimates of Australian Aboriginal tribes ranged from about 175 to 1,000 persons, and he discarded anomalous cases based on whether they fit his model, not on the quality of the data (1953: 178). Third, Birdsell's original argument is fraught with algebraic errors and circular reasoning (K. Kelly 1994).
4. Winterhalder looks only at the effects on group size of variance reduction via pooling of resources. Information processing, reproductive issues, defense, the number of habitable places (e.g., water holes in deserts), or cooperative foraging could also influence group size.

5. Hegmon's analysis of Hopi horticulturalists uncovered a similar pattern (1991); she found that the benefits of sharing did not increase when more than six households shared food (see also McCloskey 1976).
6. An implication of this model is that as population grows, before we see an increase in average group size, we should see an increase in the number of groups – for as groups grow in size, a limit will be reached at which the variance in daily foraging returns is no longer reduced while the rate of local resource depletion continues to increase. Under such circumstances, as noted in the text, group fissioning would probably be the first response.
7. One early model, known as *Horn's model* (Horn 1968), provided an answer to the question. Developed to explain the nesting patterns of blackbirds, the model predicts how settlement size and location should change with changes in food-resource distribution by seeking to minimize the average round-trip distance between a forager and resource-extraction locales. Horn's model predicted that when foragers depend on evenly spaced, stable resources, they live in small, evenly dispersed groups, but when relying on aggregated and mobile resources, they live in larger, centrally located groups. Humans are not blackbirds, of course, but the principles are the same, and researchers have applied the model to several ethnographic cases (Heffley 1981; Dwyer and Minnegal 1985; Vickers 1989). Applications required some modifications in part because measuring the variables is difficult, and Cashdan (1992) points out a difficulty with the equation used.
8. For an outstanding biography of Turnbull, see Grinker (2000).
9. This is not the only curve that applies to group foraging. It could, for example, be the case that per capita return rates only decline where group size is greater than one; alternatively, the curve could be bimodal. We present this curve as the most general case.
10. Archaeologists might also consider how the technology of communal hunts is related to labor requirements and foraging efficiency. Communal hunts require some number of beaters or drivers. If an insufficient number of people is available, technological aids may have been employed to substitute for drivers. Fire, for example, is sometimes used by modern equatorial groups to drive large game (Mills 1986). The Inuit as well as Plains bison hunters placed stone cairns strategically on the horizon and decorated them with cloth to simulate hunters. Confused caribou and bison react to the cairns predictably, by running from them, and are thus channeled into ambush sites. The horse also helped by providing the mobility necessary to cover long distances quickly – making up for the drivers who would otherwise be needed to move a herd of bison to where they could be dispatched.

    Alternatively, technological aids like cairns may be a way to *limit* the number of foragers with whom the collectively acquired food must be shared. By simulating hunters, cairns can effectively bring group size to N and maximize foraging efficiency; the food, of course, would then be divided among fewer than N people. Therefore, communal hunting technology could be a way to either make up for the lack of additional foragers or a way to keep them out.
11. Another factor that could be considered is interspecific competition for food. In a reanalysis of Baumhoff's data, for example, Timothy Gage (1979) found that a model including a competitive relationship between humans and deer for acorns gave more accurate predictions of Californian aboriginal population sizes. In reality, food was not as abundant as Baumhoff thought because some of that food, acorns for example, is consumed by other, nonhuman foragers, such as deer. The foraging population is below carrying capacity only if we measure carrying capacity in an environment with no competitors.
12. Archaeologists will find it interesting that a change in diet breadth in this model results in a transitional period of rapid change between foraging for one versus two resources (this period becomes shorter in the simulation as the work day is increased in length until it is nearly nonexistent).
13. Belovsky (1988) uses linear programming as the basis for a population-dynamics model similar to that of Winterhalder's. In his model, changes in population and food density alter the amount of time spent foraging and produce changes in the dietary ratio of meat to vegetable foods. As this ratio changes, so does the amount of harvestable primary production. This change in diet composition

in turn alters the amount of energy available to the population for conversion into births. The model's most sensitive parameters are the harvestable primary production, the group's nutritional requirements, and the age at which children become active foragers.

Belovsky's model predicts more fluctuation in population density than does Winterhalder's over the same period (300 years). One of the interesting facets of Belovsky's model is that population fluctuates widely when productivity = 200 and 800 g/m^2, whereas it fluctuates less at 100 and 400 g/m^2. There are limits to population growth, but populations do not simply grow and then remain at equilibrium, and the nature of the fluctuations is of greater interest than the upper limits of the cycles. At a high level of productivity, population fluctuations are more dramatic than at low levels. This suggests that as effective food density increases, populations go through "boom-and-bust" cycles. If population declines happen over such short time spans that they could be perceived, people may respond to them, perhaps by altering subsistence technologies (e.g., through agriculture) and increase their environment's productivity. The result could be continuous population growth rather than stable-limit cycles.

14. See, for example, Carr-Saunders (1922); Van de Velde (1954); Balikci (1967); Birdsell (1968); Freeman (1971); Denham (1974a,b); Riches (1974); Schrire and Steiger (1974a,b, 1981); Acker and Townsend (1975); Dickemann (1975); Cowlishaw (1978); Chapman (1980); Helm (1980); Hawkes (1981); Yengoyan (1981); Remie (1985); Morales (1987); and Irwin (1989).

15. Presumably, the husband and father could be different individuals. Since Tiwi women initially marry very old men, they take a number of younger men as lovers (Goodale 1971: 131) and differentiate between the man who allegedly "made" the baby, the biological father, and the woman's husband, the social father.

16. The accuracy is established by cross-checking the informants' accounts. Based on Bugos and McCarthy's (1984) kin diagram, the infanticide rate is about 38 percent (not including eight cases where the gender is unknown); 28 percent of all females were killed at birth, whereas 40 percent of all male infants were killed.

17. Data presented by Bugos and McCarthy (1984) also suggest a secondary sex ratio of 125:100 for the Ayoreo. The Ache ratio quickly reached parity after settlement and, despite the researchers' best efforts, the precontact ratio could reflect some informant reporting bias against females killed at birth. Although we expect the ratio to be 100:100, worldwide, it is empirically closer to 105:100; variation in the at-birth sex ratio could be due to a variety of factors, such as the side effects of hepatitis B virus (see review by Martin [1994]). We can also expect extreme ratios in small populations simply as a result of random chance.

18. Helm's (1980) discussion also relies on testimonials in the records of early Hudson's Bay traders and explorers. These accounts mention that female infanticide used to be practiced frequently by local people but that the Europeans put a stop to it. It is conceivable that the Europeans convinced themselves that a heinous behavior existed (as Rasmussen did) based on a limited number of cases, then credited themselves for having halted something that never existed or was rare.

19. Among the polygynous Tiwi, however, young men marry older women. As these men age, they are allowed, by older men, to marry younger and younger women, until they reach an advanced age when they marry the youngest women (Hart and Pilling 1960; Goodale 1971).

20. If female infanticide were performed for this reason, we would predict it to occur early in the birth sequence, with its frequency decreasing as a function of the number of males already born. To my knowledge, data to test this idea are not available.

21. Infant death can occur through neglect by weaning a child early, by giving it less nutritious food, or giving it less attention when sick or injured than that given to other offspring. The result can be a systematically higher rate of infant and toddler mortality of one gender.

22. This suggests a difference in parental attitudes toward females. In the Arctic, female infanticide is accompanied by some very severe attitudes toward women in general. It is difficult to sort out the issues of sex-ratio balance, the value of one gender relative to another, and cultural notions of men and women, much less specify the cause of female infanticide (Irwin 1989). In addition,

cross-culturally, there is only a weak association of female infanticide with warfare; see Hawkes's (1981) critique of Divale and Harris (1976); see also the Chapter 8 discussion of warfare and postmarital residence.

23. Other factors can intervene for first births. A young woman's decision to kill a firstborn infant is partly related to how much support she can expect to receive. She may be more likely not to keep a newborn since she still has her entire reproductive life ahead of her. Later in life, however, a woman may not wish to restrict her reproductive potential and, still later, a woman may have acquired what she thinks is the appropriate number of children and feel that she cannot work hard enough to support more. For example, among those Ayoreo women who practiced nonpreferential infanticide, the infanticide rate dropped from 65 percent among fifteen- to nineteen-year-olds to 22 percent among twenty-five- to thirty-four-year olds, and then increased to 31 percent among thirty-five- to thirty-nine-year olds (Bugos and McCarthy 1984).

    There are other possible explanations of first-birth infanticide. Working in Australia, Gillian Cowlishaw (1978) found that infanticide was most often directed at firstborn children regardless of gender. She gives a psychological explanation that is based on Australian cultural notions of "women's business" (which includes childbirth), and the need for women to exercise their autonomy, an important element of Aboriginal culture. They do this by controlling their reproductive powers. We must understand, Cowlishaw argues, that women in Aboriginal society have little control over their lives, including their marital partners. They must follow the wishes of their fathers, brothers, and husbands. Cowlishaw argues that control over their reproductive abilities is the sole power women have over men. By killing her firstborn, an Aboriginal women denies "her brother a niece to bestow, or her husband a son to follow him in his ceremonial life" (1978: 279; see also Strathern, in Gelber 1986: 119). However, not all Australian ethnographers agree with this characterization of Australian Aboriginal gender relations.

24. Some studies suggest that increases in fertility are not a function of a reduction in the birth interval but rather an increase in women's childbearing years, a product of the lowering of the age at first birth (a function of marriage age and/or age at menarche) and/or an increase in the age of last birth (Roth 1981). Additionally, some variability in birth spacing can be attributed to variability in ovarian-cycle length, which is still not fully understood (Campbell and Wood 1988; Ellison, Peacock, and Lager 1989; Ellison 1990, 1994, 2001; Wood 1994).

25. See, for example, the negative response of Nisa's, a Ju/'hoan woman, father to the news that her mother intended to kill a newborn (Shostak 1981: 56), or Van de Velde's (1954) account of an Inuk father's decision to kill a newborn female, or Australian Aboriginal debates over family size (Burbank and Chisholm 1992).

26. Balikci (1967: 621) also noted that child homicide may occur among the Netsilingmiut by a woman's second husband.

27. Also, Hill and Hurtado (1996: 302) found that Ache men who were better hunters had more surviving older offspring than did men who were poor hunters. As aggregate data, however, the cross-cultural pattern (Marlowe 2001) may indicate that men are using their control of a desirable food – meat – to acquire extramarital opportunities, as among the Ache. However, I am not convinced that this "cad" strategy would necessarily result in the observed ethnographic pattern: an increase in men's contribution resulting in an increase in fertility. Sharing data now show that the majority of food a man provides remains in the family; some may be used for other mating opportunities, but the wife and family will still benefit.

28. Discussions of fertility revolve almost exclusively around the factors affecting women. Less attention, and less medical research, is devoted to men. However, research suggests that the factors considered here for women, diet and activity, could affect male fertility (see Campbell and Leslie 1995). This area merits further research, but it is likely that the most important factors at a population level are those affecting women.

29. For the Ju/'hoansi, see Wilmsen (1978, 1986) and Van der Walt, Wilmsen, and Jenkins (1978). For Turkana pastoralists, see Leslie and Fry (1989). For the Ache, see Hill and Kaplan (1988a,b; 1993).

For Lese horticulturalists, see Ellison, Peacock, and Lager (1989). For the Hiwi, see Hurtado and Hill (1989).

Birth seasonality studies are difficult to assess if they do not demonstrate that the rate of copulation remains constant throughout the year. Condon and Scaglion (1982), for example, argue that birth seasonality among the Samukundi Abelam of New Guinea and the post-1970 Copper Eskimo were produced by the seasonality of labor and settlement patterns that directly affect the rate of copulation and hence the probability of conception. Brainard and Overfield (1986) make a similar argument for pre-1955 Western Alaskan Eskimo (who manifest the opposite seasonal pattern of the Copper Eskimo). However, the rate of copulation does not appear to have any bearing on the Ju/'hoansi, Ache, Turkana, or Lese cases.

30. The Casiguran Agta are an unfortunate case in which chronic malnutrition and drunkenness have increased the frequency of childhood diseases by decreasing parental care.

31. Although they avoid acute, severe diseases that result in death, children in sedentary villages may, however, suffer more chronic health problems related to poor hygiene in a sedentary settlement (Kent and Lee 1992). Although respiratory ailments affected fewer than 1 percent of Ache children living a nomadic lifestyle, 27 percent are affected today on reservations (Hill and Hurtado 1996).

32. Lee (1979) argued that to be fair in the comparison, we should include people killed in wars; doing so for the Vietnam era, he found that the U.S. rate was 100/100,000 – and would be even higher if we included those who survived what might have been a lethal attack because of rapid medical care.

33. My guess is that the Semai data are not sufficiently accurate to calculate a rate, although I also guess it is closer to Dentan's than Knauft's estimate.

34. Some suggest that this dissociative violence reflects temporary brain dysfunction (see Knauft 1991: 400) and in this regard is not unique to hunter-gatherers.

35. Wrangham et al. (2006), for example, list the Ju/'hoansi's homicides as intergroup aggression, whereas Lee's (1979) account makes it clear that these deaths resulted from individual disputes over women or insults.

36. Previous cross-cultural analyses came to different conclusions. Ember (1978) argued that only 10 percent of forager societies were "peaceful," but she includes feuding and revenge murders to define warlike cases. Almost half of her sample was drawn from nonegalitarian and/or equestrian societies, but even without these, war is rare among only 19 percent of her cases. Keeley (1996) also makes the case that foragers are nowhere near as peaceful as *Man the Hunter* portrayed them. His point is well taken, but he too includes feuding and revenge killings.

37. The standard cross-cultural sample does not include data on warfare for all thirty-six of the foraging societies included in the sample. In addition, the data are not entirely comparable. The standard cross-cultural sample was put together with avoidance of "Galton's problem" in mind; that is, with acquiring ethnographic cases that were not culturally or historically linked so that the sample does not overrepresent one particular geographic region or culture (it does not achieve this perfectly). But the sample does not consider whether the ethnographic data are comparable. For example, the table contains both the Ju/'hoansi and the Gros Ventres. Data on the Ju/'hoansi were collected by ethnographers who witnessed a "living" foraging society; data on the Gros Ventres come largely from Kroeber's (1908) ethnography, in which he is quite up-front about not actually witnessing anything that he writes about – it is all based on informant memory.

38. As hunter-gatherers (and other indigenous populations) are incorporated into the world cash economy, men spend more time away from home working in factories, mines, the military, and so on. Given the arguments presented in this and other chapters, we can expect this to have an effect on population growth as well as on child enculturation.

Chapter 8: Men, Women, and Foraging

1. Leacock (1983) makes this point most forcefully, implying that any nonegalitarian relationships between men and women in foraging societies are a product of contact with colonial powers. She

overstated the case but, in the early 1980s, it was important to overthrow some simplistic ideas about the fundamental role of genes in determining the differences between men's and women's labor and status.

2. We know little about the effect of foraging on sharing or the division of labor where only small game is available, such as among the Mikea. Most ethnographically known foragers have access to at least some large game, game that is the focus of men's work.
3. Bliege Bird and Bird argue that Martu women's taking of goannas constitutes hunting rather than gathering. I don't wish to quibble about terms, but goanna "hunting" is not the same as hunting kangaroo, let alone bison, giraffe, or whales. The pursuit times are short because the payoff is small, but the frequency of encounter is high, hence the activity is "interruptible" without a large opportunity cost. It is compatible with childcare and that, rather than whether the target is meat or vegetable, is perhaps what matters.
4. Dobkin de Rios and Hayden (1985) suggested that female odors associated with pregnancy, menstruation, and lactation prevent women from hunting by scaring game away, and that the number of menstrual taboos reflected male dominance. However, using a sample of foraging and nonforaging societies, Peggy Sanday (1981) found no significant relationship between male dominance and the number of menstrual taboos. In fact, many of the taboos appear to be posthunt, and it's not clear why men's odors would not have the same effect as those of women (Kelly 1986).
5. As noted in Chapter 5, traditional weapons used to hunt land animals among hunter-gatherers usually do not kill on impact. Instead, they bleed the animal to death or, if poisons are used, gradually weaken the animal so it can be easily dispatched. This means that game must be tracked, sometimes over long distances, and the hunter must be prepared to go wherever the trail leads, staying out overnight if need be.
6. Hawkes, O'Connell, and Blurton Jones (1989) suggest that this increases the grandmother's fitness by contributing to the well-being of her grandchildren.
7. There is more to this because certain behaviors – hunting versus gathering – do become culturally associated with males or females. If men control access to hunting (e.g., by denying women access to the tools and knowledge when young), it is not due to their desire to be the breadwinners but rather to their desire to live out a proper "male" role by participating in the public system of prestige competition.
8. Sanday (1981) points out that male dominance tends to be stronger in those societies where men primarily hunt large game – and thus have the resources with which to compete and acquire prestige.
9. It is difficult to determine from the short-term data of ethnography which men are indeed the "good hunters" (Hill and Kintigh 2009; Koster 2010). Return-rate data may not always be accurate over the short time spans of ethnographic data collection, and men develop their skills as they age (so a man should be compared to his age-mates, not to his elders). Consensus rankings offer another approach, in which group members rank men in terms of their perceived hunting skill.
10. Clastres (1972: 169) even claimed that Ache (Guayaki) men were tabooed from eating meat that they themselves killed. However, the Ache's extreme meat sharing is not found among other foragers and may reflect an Amazonian pattern.
11. As argued in the preceding section, biological differences between men and women create different costs and benefits of large-game hunting. By placing men in a position to share more outside the family, large-game hunting allows men to acquire the prestige and debts that sharing constructs, and it could lead men to have greater control over extrafamilial relations. Combined with the ethnocentric bias of early ethnography, this could lead to the assumption that men are naturally dominant – an important element of the patrilocal-band model.
12. Patri/matrilocal refers to postmarital residence of the couple in the community that the father/mother came from, whereas viri/uxorilocal refers to living in the household or community where the groom's/bride's parents reside. We are combining the terms patrilocal with virilocal and matrilocal with uxorilocal, since they are often one and the same for foragers.

13. This could create discrepancies in ethnographers' accounts depending on the specific instances and history of the local group studied. For example, although Perry (1989) classifies the Beaver as having matrilocal residence, Ridington (1981) points out that the recruitment process, through which older members try to enlist as many young people as possible, including their daughters' and sons' spouses, creates a bilaterally extended household. A couple with only daughters might very well convince their daughters' husbands to live with them, making their group appear to have a matrilocal postmarital residence "rule."
14. Conversely, Jones (2011) argues that matrilocal residence is a product of external warfare because it permits men to build alliances with men beyond their male kin and thus create social solidarity across what might otherwise be separate patrilineal villages. Jones is concerned primarily with nonforaging societies, and especially with cases in which neighbors are significantly different "ethnic" groups (on the basis of, e.g., religion). That is, matrilocal postmarital residence could be a product of women aligning themselves with their related female kin for support in childrearing, or it could be a product of men expanding their patrilineal networks for purposes of defense. For foragers, I think that the process is more likely to be dominated by women's childrearing needs since foragers are not generally military expansionists.
15. John Martin and Donald Stewart (1982) point out that unilineal groups also permit group movement as a response to environmental fluctuation. They argue that patrilineal descent is a function of small-group demography coupled with polygyny. Assuming that polygyny is permitted, they argue that the sons of polygynous males will also become polygynous both because of enculturation and the fact that they will be able to acquire more wives by having more sisters to exchange for wives. By creating a shortage of wives in a group, some males are forced to seek wives elsewhere. If the regional population exists as a number of small groups, then random variation will alter group sex ratios, occasionally leaving a shortage of male hunters in some bands. Under these conditions, some groups will seek to recruit young males as hunters and thus offer them wives on the condition that they live matrilocally. Martin and Stewart argue that polygynous men will remain in the territory of their fathers and form patrilineal/patrilocal descent groups consisting of polygynous men, their brothers, patrilateral parallel cousins, and sons. Thus, they argue, patrilineal bands form among strongly polygynous hunter-gatherers living in small groups, with a stable or growing population that has a preference for viri/patrilocal residence. A problem with this model is that although polygyny is commonly permitted among foragers, it is not commonly practiced. It would not seem to be a strong enough force to create patrilineal bands.
16. Jeremy Keenan (1977) points out that where band membership is flexible and fluid, the *basis* for social relations must be stable. People who belong to a particular band may not live together continually, and the band's existence is not contingent on its members remaining together. Instead, identification with a particular band may be shorthand for identifying some of the sorts of reciprocal obligations one could expect of certain individuals (given their gender, age, and band affiliation).
17. Pitjandjara descent, incidentally, is undergoing change in recent years from a place-based to a father-based system of affiliation.
18. But polygyny may come at a fitness cost to women. James Chisholm and Victoria Burbank (1991) found that in an Australian Aboriginal community in Arnhem Land, women in monogamous marriages (including serial monogamy) raised more offspring to age five than did women in polygynous marriages. (Of the latter, women in sororal polygynous marriages raised a greater percentage of their offspring to age five than did women in nonsororal polygynous unions.) This suggests that other factors being equal, and considering the matter in the simplest terms of reproductive fitness, women should prefer monogamy.

Chapter 9: Nonegalitarian Hunter-Gatherers

1. Evidence of prehistoric nonegalitarian foragers is often based on differential mortuary treatment and public, monumental architecture. Some Early and Middle Woodland societies of the central eastern

United States – for example, complexes known as Adena or Hopewell – are best known through the elaborate burial treatment of some of their members, as well as burial mounds and earthen enclosures. Subsistence data suggest that the majority of their diet was derived from hunted and gathered foods. For more general discussions of "complex" foragers, see Price and Brown (1985a); Arnold (1993, 1995a,b, 1996a,b, 2001a,b, 2004, 2007, 2009); Ames (1994); Hayden (1994, 1995, 1998, 2001); and Roscoe (2006, 2009).

2. See, for example, Woodburn (1980); Myers (1986, 1988a, b); Altman and Peterson (1988); Lee (1988); Bird-David (1992b); and Peterson (1993).
3. Walker and Hewlett (1990) also found that high-status males had fewer caries compared to low-status males, indicating yet another level of inequality in Aka society. However, although some men and women may have eaten less meat than some men, it is not clear whether this had a significant nutritional impact.
4. Collier and Rosaldo (1981), however, found no evidence of a concept of women as "Source of All Life" in foraging societies.
5. The Calusa of southern Florida did not practice substantial food storage (Widmer 1988); they lived in a less seasonal environment, however, where storage was not as necessary.
6. Thus, Hayden (1990) suggested that r-selected species are the initial targets for intensification.
7. For those of a more Marxist bent, intensification merely accelerates an inevitable process of socioeconomic change toward inequality (Lourandos 1985: 412, 1988; see Bender 1985).
8. Like Service's explanation for the patrilocal band, arguments about the evolution of inequality sometimes appeal to the natural predisposition among men to compete and dominate; women apparently do not have this predisposition. This predisposition is sometimes argued to be rooted in the selective pressures of early (sometimes even prehominin) human evolution. Although we cannot go into detail here, even if it were true that men in all societies are more competitive and domineering than women, it would not demonstrate that this was a function of selective pressures in the Plio-Pleistocene.
9. As noted in Chapter 7, Johnson (1982) identified six as the number of organizational units that require a special leader, but research by Hamilton et al. (2007a) suggests that the number may be closer to four.
10. Similarly, Boone (2000: 87) points out that "social status is not something that a particular person can have but resides in the perceptions that others have about that person."
11. Thus, Legros's (1985) demonstration of socioeconomic inequalities among the Tutchone, who live in a harsh, "nonaffluent" environment, is beside the point. Also, Hayden (1981a) once argued that complex hunter-gatherers are associated with increased resource reliability–decreased resource fluctuations. Demonstration of the existence of significant variability in salmon and periods of starvation among the Lillooet Indians of interior British Columbia, however, encouraged him to alter this position (Hayden 1992: 538).
12. R. C. Kelly (2000) found no relationships between mobility and warfare; however, his data were not statistically analyzed and, for very circumscribed cases, we might expect, as we described in Chapter 8, that foragers who find themselves fighting too frequently will find ways to resolve issues other than through fighting – such as competitive feasting. Thus, we might not expect a straightforward relationship between mobility and warfare. Additionally, he includes internal and external warfare; not all cases of the latter may be valid for this hypothesis. External warfare is often warfare to control European trade and leads to some cases being more warlike than they would have been in the precontact situation. He admits this for the Slave Indians, who were attacked by the Cree and Chipewyan. Likewise, the Apache and several Plains groups (e.g., Comanche) were clearly under territorial pressure by European settlers and/or were fighting to control trade with Europeans. Otherwise, the process we describe in the text fits Ember and Ember's (1992) observation that warfare is linked to natural disasters: as population grows, it takes less and less of a perturbation to produce a disaster.

13. These are known as first-order and second-order free-rider problems. First-order refers to slackers taking advantage of others' labor; second-order refers to some group members allowing others to take on the cost of punishing the slackers. Based on games, Marlowe (2009) found that Hadza individuals punish free-riders (by not cooperating with them), but they do not punish those who free-ride on another's labor; he suggests that such punishment could not be sustained by individuals and requires a communally supported specialized labor force (e.g., police).
14. It bears pointing out, in addition, that I do not think that the evolutionary perspective outlined here is at odds with Marxist perspectives. However, unlike Marxist perspectives, it makes clearer the conditions under which intensification, competition, exploitation, inequality, and ideologies occur.
15. To put this into simpler terms, think about charitable giving in cash economies. Ten thousand dollars is a small amount of money to Bill Gates; he can easily give it away in return for the prestige that comes from making donations. However, ten thousand dollars is a relatively large sum for, say, the average college professor; he or she will probably not give it away.
16. This is all explained with unabashed honesty in Niccolò Machiavelli's *The Prince* (1532).
17. The intensity of resource fluctuations independent of population density can also affect this relationship. In addition, the number of parties with whom social relations are viable will in part be a function of the localization of resources; the more localized resources are, the greater the relative number of groups who will want them.
18. One implication of this proposal relevant to archaeology is that nonegalitarian societies, as with sedentary villages, form in clusters, not in isolation. Also, within Keeley's ethnographic sample, there is no gradual gradient between egalitarian and nonegalitarian societies (1988). Instead, there is a sharp break between these two groups, suggesting (but not demonstrating) that the evolutionary transition between the two social forms may be quick and pervasive.
19. The nature of the meeting of Northwest Coast and European society would have been different had aboriginal society on the coast been more egalitarian. Such a society is easier to penetrate from outside since members of an egalitarian society are pressured to not control one another (Brunton 1989).
20. Similarly, European traders sometimes gave boats to those Eskimo men who were most likely to pay off their debt through hunting and trapping, eventually producing a notion of leadership among some Eskimo that "rested not so much on the leader's special productive competence, but more on his abilities in negotiating important facilities from the European trader" (Riches 1982: 145).
21. Keen (2006) finds that polygyny in Australia is more common under conditions of resource abundance and high population density. Polygyny may be a way to garner more labor, although it might also be a way, as noted in Chapter 8, for lower-ranking men to link themselves to high-ranking men. Wives also try to increase household productivity. Where polygyny does occur, the first wife may encourage her husband to take another wife to ease her burden. The second wife falls under the control of the first as the relationship between husband and wife is now replicated between the first and second wives.
22. See, for example, Schalk (1981); Richardson (1982); Ames (1985); and Kelly (1991). For slave owning, see Donald (1983, 1985); Mitchell (1983, 1984, 1985); and Mitchell and Donald (1985, 1988). On warfare, see Ferguson (1983, 1984, 1997). Eugene Ruyle (1973) even suggested that the Northwest Coast had incipient if not fully developed social stratification in places.
23. Reconstructing the prehistoric resource base of the west coast of Britain, Peter Rowley-Conwy and the late Marek Zvelebil also find that salmon runs in different streams are not synchronized and that "as the geographic scale decreases, the coefficient of variability increases, i.e., the more local the level of consideration, the more marked is the interannual variability" (1989: 43).
24. For example, payment for the murder of a common man might entail ten strings of dentalium shells (twelve shells on each string), twenty red-headed woodpecker scalps, and a boat. The death of a

man of standing might require fifteen dentalium strings, a red obsidian biface, a woodpecker scalp headband, and other property, plus a daughter (Kroeber 1925: 28).

25. Maschner (1991) finds that evidence for social inequality appears when the population aggregated along the northern coast in large villages that were well situated for fishing and defensive purposes. The bow and arrow may have come into use at the same time and may have served in warfare. These cultural changes are correlated with a period of climatic instability that presumably could have increased the intensity and/or frequency of resource fluctuations.
26. Hayden and Gargett (1990) noted this lack of relevant data and attempted to test the proposition that big men keep their position because they fulfill the function of providing for peoples' needs in times of stress. They did this by examining the role of high-ranking individuals of the modern Maya cargo system in southern Mexico. They concluded that there is no evidence that high-ranking individuals provided for others; indeed, they note that high-ranking individuals bettered themselves during droughts and times of starvation by exploiting others' desperation.
27. Archaeologists, for example, commonly speak of the presence of exotic goods (e.g., in burials) as signs of social alliances between groups. However, these exotic items can be signs of several different kinds of social relationships – e.g., gift-giving, competitive feasts, bridewealth, raiding – that signal different kinds of evolutionary forces and selective conditions.
28. Some notable efforts are being made in the archaeology of the Chumash of southern California (e.g., Arnold 2001, 2004, 2009; Kennett 2005), the Northwest Coast (Coupland and Banning 1996; Ames and Maschner 1999), the U.S. Plateau (Prentiss and Kuijt 2004), southern Alaska (Fitzhugh 2003a,b), Florida (MacMahon and Marquardt 2004), and Japan (Habu 2004). The "kick" in some of these studies appears to be environmental change that lowers productivity or access, increases population pressure rapidly, and encourages the control of defensible locations (e.g., Fitzhugh 2003a,b; Kennett 2005; Nolan and Cook 2010).

Chapter 10: Hunter-Gatherers and Prehistory

1. For example, Martin 1974; Hamilton 1982b: 236; Barnard 1983; Schrire 1984b; Arcand 1988; Myers 1988b; Testart 1988.
2. Robin Dunbar (1998), for example, used a linear relationship between primate neocortex and group size to argue that humans have difficulty coping with a group size beyond 150 (from a range of 100 to 230).
3. These are all part of the large and growing field of "pop evolutionary psychology." Google "hunter-gatherer mind" and find out about the hunter-gatherer cure for depression, how to eat like a hunter-gatherer, how to sleep like a hunter-gatherer, the hunter-gatherer theory of shopping, how foraging explains differences in how men and women reckon space, how our hunter-gatherer minds are designed to intermingle with those of animals – and even with plants and landscapes. You can also learn about "tribal fitness" – because we have hunter-gatherer bodies as well as minds, and why girls "prefer" pink over the boys' blue. There is the "paleodiet" fad, which is actually rooted in some excellent understanding of physiology (Cordain et al. 2005) but marketed with evolutionary trappings. Most of these are based on misguided or limited knowledge of hunter-gatherers; e.g., that men don't hunt (or that women don't just gather); that all hunter-gatherers were tall, healthy, and lived long lives; that they witnessed no violence; worked three or four hours a day; and slept communally. Most of these accounts would be humorous if it were not for the fact that they reflect desperate efforts to correct the ills of modern life.
4. If genetic clocks are correct, a speciation event about 7 million years ago separated the hominin line from other primates.
5. Perhaps humans were living in the New World by 40,000 years ago, although I find evidence for an occupation older than 15,000 years to be tenuous.

6. Prehistory textbooks are replete with examples as their authors strive to present an ethnographic snapshot of what, for example, Magdalenian, Kebaran, or North American Archaic societies were like.
7. Agent-based modeling (e.g., Kohler and van der Leeuw 2007) offers an approach to using the insights of human behavioral ecology to individual decision making in order to translate those "up" to the large-scale, long-term record that archaeology can recover.

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