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ENVIRONMENTAL RESOURCES AND RANGE SIZE: A STUDY OF MODERN AND ANCIENT HUNTER GATHERERS

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Archaeological surveys should be designed to better understand how past people interacted with their environment. An accurate survey should cover a group's range size in order to get a true representation of the diversity of the group's activities. Range size is defined as the total area of land over which a group moves and procures resources. Past studies of hunter gatherer range have focused on stylistic boundaries of pottery and stone tools. Optimal Foraging Theory has been used to better understand hunter gatherer territoriality and it can be used as a frame of reference for understanding range size as well. By examining two modern hunter gatherer groups, the G/wi and the !Kung, it becomes obvious that subtle environmental differences have large consequences in the group's range size and subsistence base. Archaeologists will be able to design more accurate surveys by better understanding the ancient environment and how it would have affected past hunter gatherers.

Pit hearths eroding out of arroyo walls are a fairly common archaeological feature of the Oglala National Grassland in Northwestern Nebraska (Fig. 1). Analysis of these features and their contents can help archaeologists determine their probable use. Pollen and phytolith analysis can help determine the past landscape. Faunal and macrobotanical remains can be analyzed to determine what types of things were processed in these hearths and the seasons in which they were used. Fire altered rocks and lithics can be examined in order to better understand the techniques that were used by the hearth constructors. Finally, charcoal and geomorphology can be examined in order to determine the age of the features and the processes that have affected their remains. In order to truly understand how these past peoples interacted with their environment, researchers must understand how the people were distributed on the landscape. Otherwise, we may be over-representing the significance of the hearths. For example, the pit hearths may merely represent a series of short, seasonal excursions to exploit a certain resource that was found only in the vicinity of the Oglala National Grassland (the hearths do seem to show only single use). There may be a better archaeological representation of these past hunter gatherers in the Niobrara region to the South or the Blackhills of South Dakota to the North.

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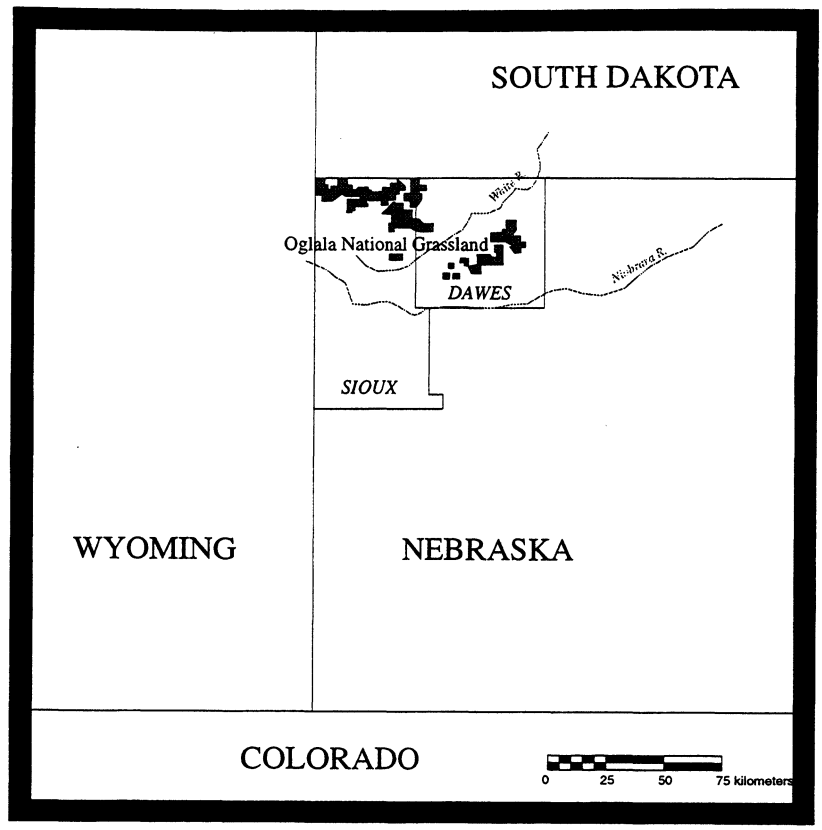

Figure 1. Location of the Oglala National Grassland, Northwestern Nebraska.

We cannot truly understand the lifeways of a group of past hunter gatherers if we do not know where to find archeological representations of these past cultures. Therefore, archaeological survey should not be conducted in order to find 'sites', rather, it should be used in order to better understand how people have interacted with the landscape in the past. The hearths of the Oglala provide evidence of a hunting and gathering existence in the area approximately 2000 years ago. In order to understand these hearths and their relationship to the past landscape, a survey must be accurately designed.

The fundamental question of an archaeological survey is, "What area will be surveyed?" It is essential to create an appropriate sampling universe. Most survey designs are based on Cultural Resource Management (CRM) issues, landowner boundaries, or monetary and time constraints. To statistically justify our interpretations of past hunter gatherer land use it is essential that the survey cover the group's total range (Thomas 1976; Plog et al. 1978; Binford 1964; Dunnell and Dancey 1983). It could be argued that geographical boundaries would suffice for determining group range, although, in large and relatively

unbounded areas (i.e., Northwestern Nebraska) this proves to be a problem. Also, study of hunter gatherer populations has shown that the use of ecotonal areas is an important adaptation in many cases. This would mean that hunter gatherers are not constrained by geographical boundaries, therefore archaeologists cannot be constrained either. In order to make archaeological survey more than a mere treasure hunt, archaeologists must better understand the concept of range size. By acknowledging how the total area covered by a hunter gatherer group relates to the subsistence base available, researchers will be able to better create survey designs and more realistically represent past behavior.

The Concept of Range Size

Historically there has been a certain amount of confusion between the concepts of range size and territoriality. Range size is defined as the total area of land over which a group moves and procures resources (Hitchcock 1994a). Territoriality is the tendency for a group to claim exclusive rights to an area of land and to protect this land by either overt perimeter defense or social boundary defense (Cashdan 1983). Most past studies of land use have focused on the level of territoriality among hunter gatherer groups. This has been due to the eagerness of researchers to apply the concepts gained by ethnology to the study of modern hunter gatherers. Specifically this is an attempt to use Optimal Foraging Theory as a means of explaining behavior (Dyson-Hudson and Smith 1978; Thomas 1986). This paper will explore some of the problems in a direct application of this theory to human populations.

Both range size and the degree of territoriality are affected by three factors: the abundance of resources, the predictability of those resources, and the population density of the group (Hitchcock 1994a). Researchers have debated the level of relatedness between the environmental factors and territoriality (Dyson-Hudson and Smith 1978; Cashdan 1983; Thomas 1986). The main problem is the fact that unlike animals (from which the model was developed), humans have several ways of spacing people out over a landscape and reducing pressure on resources. These methods include regulation of birth spacing (both biologically and culturally), elaborate marriage systems, as well as overt perimeter defense. These different techniques are not easily quantified, making it difficult for researchers to assign a level of association.

Unlike degree of territoriality, range size is not difficult to quantify. It is merely the total area covered by a group of people as they seek to subsist. There are other aspects associated with range size that become more complex as they are put into numbers. These include concepts such as degree of coverage and the role of hunter gatherers as resource managers. However, the basic idea of range size is fairly easy to establish. Range can best be described as three concentric circles placed on the landscape (Fig. 2). The first of these is the core area. This is the region that is intensively used by the group. The next largest circle is known as the home range

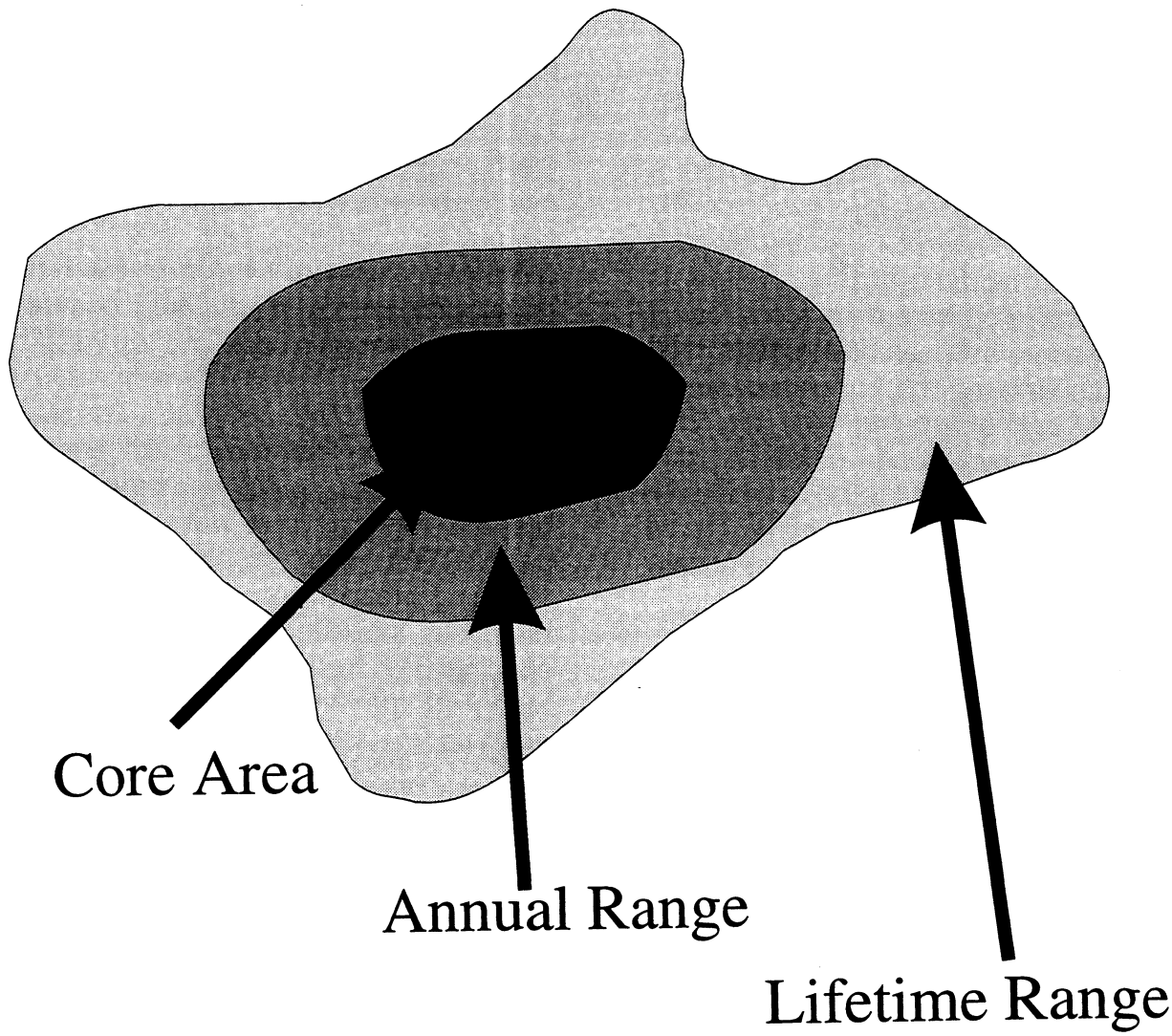

Figure 2. Hypothetical map showing the concentric arrangement of core area, annual range, and lifetime range (Sampson, 1988).

or annual range. This is the entire area used by the group under normal circumstances (i.e., over the course of an average year). The largest circle is the total range or lifetime range. This is the area that the group has used over an average member's life span (Sampson 1988; Hitchcock 1994a).

Like territoriality, the differences in the size of range between different groups of hunter gatherers is dependent on demographic and environmental factors. However, the group's subsistence base plays a key role in the way the land is used and the size of land necessary. The resources available will determine

the group's percentage dependance on fauna and its dependence on fishing. The availability of resources and the predictability of these resources will determine the size of the group's range.

Past Studies of Hunter-Gatherer Range

There have been a number of different studies of hunter gatherers that have touched on the important aspects of range size and how this could affect the archaeological record. These investigations have approached the problem using a wide variety of techniques. Differences in approaches have been both theoretical and methodological. These past studies will be examined and discussed.

In his study of hunter gatherer boundaries, C. Garth Sampson uses stylistic differences in pottery patterns to determine the ranges of past groups. His study is impressive because he first addresses the theoretical implications of range and creates a model. He then tests his hypotheses over an extremely broad survey area in South Africa (Sampson covered an area the size of the state of Delaware). His examination of stylistic patterns proved to be fairly successful at determining range size of past hunter gatherer groups (Sampson 1988). However, the majority of past foraging groups did not have culturally distinct stylistic markers that have preserved in the archaeological record. Pottery is usually characteristic of a more sedentary lifestyle. Its heavy weight and friability make it a high transportation cost item among the majority of highly mobile hunter gatherers. For example, in the past two summers of excavation and survey on the Oglala National Grassland (an area with significant evidence of past hunter gatherer activity) only one small piece of pottery was found.

Some people have suggested that stone tools could serve as cultural markers that would be identifiable on the landscape and would indicate a certain group's presence in the past. This is based on the idea that a certain group of people would all learn how to make stone tools in the same way. Each new toolmaker would therefore have the same "ideal" notion of the tool. Every time a group member made a stone tool they would seek to create an approximation of the "ideal" and therefore all of their stone tools would look the same (Stiles 1979). The main problem with this argument was raised by the Bordes / Binford debate on Mousterian assemblages. The role of a projectile point as a tool makes it difficult to distinguish between style and function in its shape. The "ideal" tool may just happen to be the most functional form for a specific task. The widespread location and temporal span of certain tool types shows the problems of using stone tools to distinguish cultural groups (i.e., Clovis points are found from Washington State to Tierra del Fuego. Certainly these points could not be used for determining a particular group's range).

Optimal foraging theory is a method that has been used in the past to study territoriality among hunter gatherers. This is basically an economic cost / benefit model that was borrowed from environmental ecology and the study of animal behavior. Rada Dyson-Hudson

and Eric Alden Smith were the first to apply the model to hunter gatherer territoriality. They identified resource abundance and resource predictability as the two factors that would determine the level of territoriality exhibited by a cultural group (Fig. 3). Dyson-Hudson and Smith identified four territorial responses that were conditioned by the amount and availability of resources. There is a great discrepancy in the way that researchers have identified and quantified the level of territoriality. This is due to the fact that human groups use social boundary defense as well as force as a form of territoriality (Cashdan 1983). For example, perimeter defense as was common among the cultures of the North American Northwest coast is different than the social boundary defense of elaborate Australian aboriginal greeting ceremonies and the reciprocal altruism of their section systems. However, the two methods achieve the same end result of insuring resources for their respective populations. When it was developed, optimal foraging theory was used by ecologists who had the ability to control and/or monitor the resources available in the observed population. Archaeologists are dealing with an historical science and are forced to project their assumptions into an unknown past. Ideally, pollen and phytolith research would be able to provide a perfect picture of the past ecology. However, these techniques are far from perfect and at best paint an environmental picture with very broad brush strokes.

A New Model

Sampson's theoretical patterns of hunter gatherer land use are undoubtedly correct. The problem is with his application of the theory using style as the distinguishing mark of culture. In areas of low population it would be possible to distinguish these boundaries merely by the presence of archaeological material on the landscape. It would become crucial to establish specific temporal controls in order to perform such an examination of range. Thanks to radiocarbon dating, hearths provide a very good means of establishing temporal control over a population. Unlike Sampson's model, hearths cannot be distinguished by stylistic features. Their variation in construction is almost surely a matter of function rather than one of aesthetics. Nevertheless, by looking at the hearths of a particular population (and their associated assemblages), researchers may still be able to realistically approximate the lifeways of past peoples.

The archaeologist still needs to know the size of the area to be surveyed. This can only be determined by observing modern hunter gatherers and trying to understand the reasons for their behavior. Researchers can then make middle range linkages and apply this knowledge to past cultures. This must be accomplished scientifically and that requires an easily identifiable and measurable cause and effect relationship to be established.

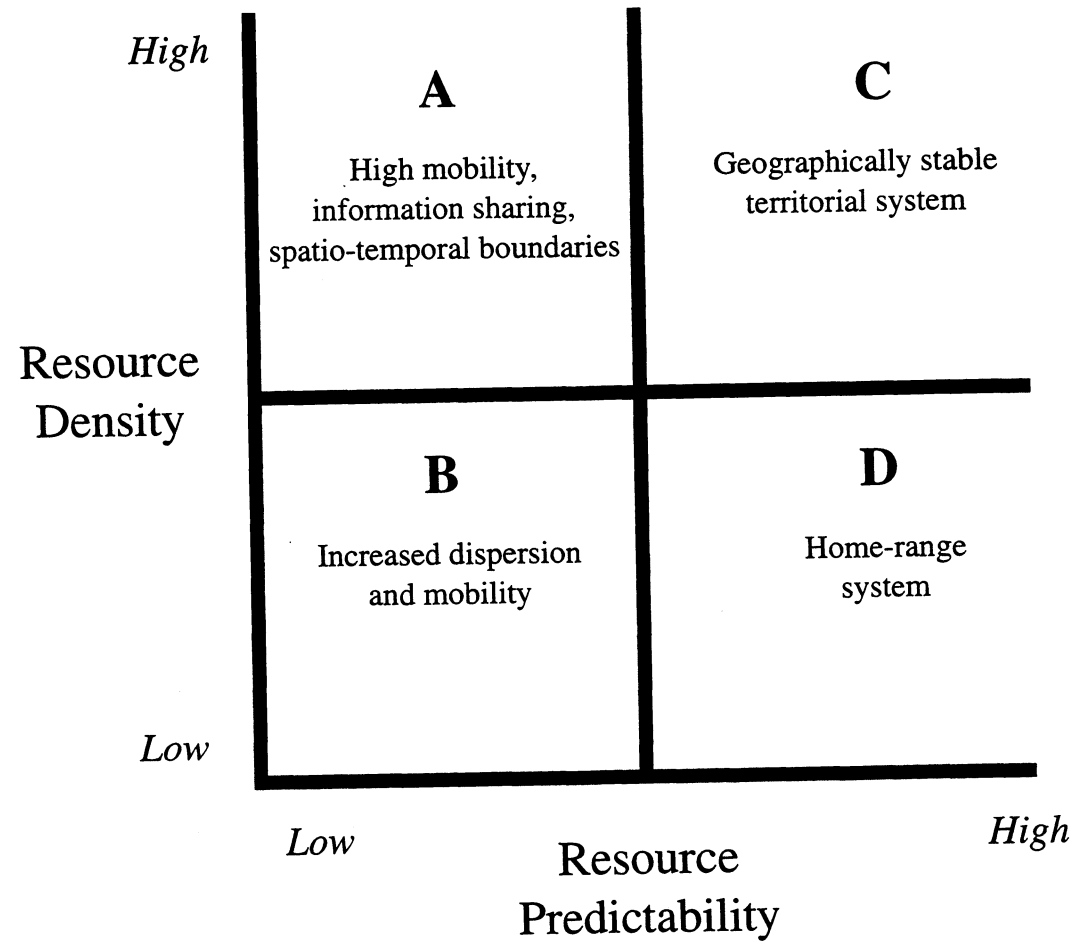

Figure 3. Optimal Foraging Theory model used for determining degree of territoriality among hunter gatherers based on resource density and predictability (Dyson-Hudson and Smith, 1978).

For example, an archaeologist could do a preliminary investigation of an area and note the kinds of assemblages present. This information could provide a starting point for middle range linkages. If a number of temporally coexistent hearths contain bison bone then the archaeologist should investigate bison behavior. The nature of the subsistence base (in this case bison) can be investigated in order to place the group on a revised version of Dyson-Hudson and Smith's model. This requires an understanding of animal ecology, a knowledge of necessary growing conditions for plants, etc. This will enable the researcher to place the subsistence base in one of the quadrants resulting from the comparison of resource density and resource predictability. For example, bison travel in large herds and are therefore a very dense resource but also a very unpredictable resource. Therefore, the people who subsisted on this resource would have had to be highly

mobile, share information, and have storage or preservation capabilities placing them in quadrant A of the model (Fig. 3). Theoretically there should also be a similar range size (based on population density because of variable group size) among ethnographic groups with comparable resource bases. This association of range size with subsistence base is not nearly as simple as it may first appear.

Applying the Model to Two Bushman Groups

In a 1983 article, Elizabeth Cashdan looked at territoriality among four bushman groups and compared the previously recorded data to Dyson-Hudson and Smith's model (Dyson-Hudson and Smith 1978; Cashdan 1983). She looked at rainfall as one of many conditioning factors that affect the degree of territoriality between these different groups (Cashdan examined ethnographic data on the !Kung, G/wi, !Ko, and the Nharo). In her results she found that groups with the most territorial behavior were the ones with the fewest resources - a finding that does not fit neatly into Dyson-Hudson and Smith's model. I would argue that the model was not a means of neatly categorizing each hunter gatherer group. Rather, it is meant as a frame of reference that can be used to describe human behavior. To see how this frame of reference works with regard to range size I will examine two bushman groups (the G/wi and the !Kung). These two groups are separated geographically by only a few hundred kilometers, yet their resources (and consequently their range sizes) are different enough to be significant (Fig. 4). I will evaluate both the G/wi and the !Kung in regard to this revised model.

The G/wi

The G/wi are a bushman group living in the Ghanzi district of Botswana (in the vicinity of the Western half of the Central Kalahari Game Reserve). Water is the primary environmental limiting factor in this area. There is very little surface water and no permanent water holes. Rainfall in the central Kalahari is erratic both annually and in terms of vicinity. The region has a mean annual rainfall of 250-350 mm but this number is virtually useless. The variation of annual rainfall is 50-80% (Silberbauer 1981). This creates a series of "boom and "bust" years throughout the Kalahari. Drought years occur in two out of every five years and severe drought occurs in one out of every four years (Lee 1972). The G/wi have porous sandy soil in their region and therefore have no permanent standing water.

The environment of the G/wi is a combination of grasslands, savanna, and dune woodland. The G/wi are organized into bands with an average group size of 57 during the rainy season (Silberbauer 1981; Hitchcock 1994b). They choose their range based on five conditioning factors: the availability of food plants, the access to water sources, the proximity of grazing lands that would attract ungulates, the quantity of trees available for shade, fire, and shelter, and finally, they insure that they have sufficient space to get the resources in the quantity

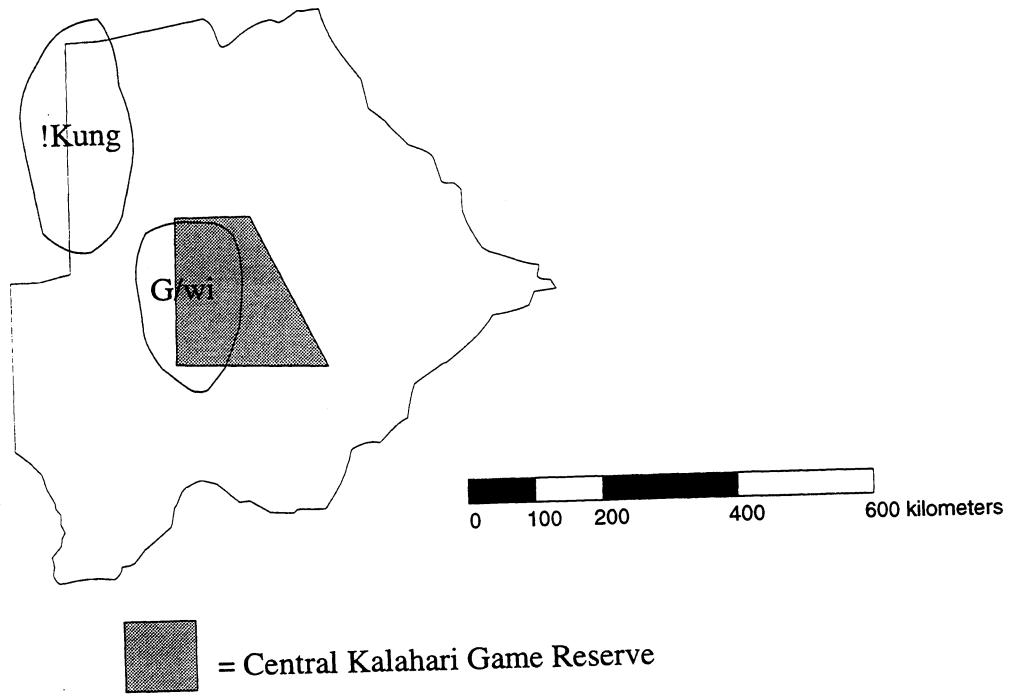

Figure 4. The distribution of the G/wi, !Kung, and other bushman populations (Tanaka, 1980).

that is necessary (Silberbauer 1981). A lack of any one of these five resources is a limiting factor and would cause the group to move to another location.

The G/wi require a large amount of space in which to procure their resources. This is due to the fact that all of their resources are scattered across the landscape and are very few in number. They have a mean population density of .07 persons per square kilometer (Silberbauer 1981). Even though great numbers of migrating ungulates pass through their territory each year, the G/wi are primarily dependent on plant resources. Approximately 85% of their diet is gathered plant food, and the other 15% is hunted (Kelly 1983).

The G/wi cannot truly be understood by looking at averages. They are a society that lives in a series of extremes. Their range size, diet, social grouping, and behavior are all dependent on their environment. The bushmen of the central Kalahari divide their year into five seasons based on the availability of certain resources. For purposes of this paper I will divide their year into two main periods - a wet season and a dry season. The wet season last from November/December until March. It is characterized by more plants available and more meat consumed per capita. During the wet season the band lives together in an average group size of 57. Their range size is approximately 780

square kilometers (Silberbauer 1981; Hitchcock 1994b).

During the dry season the resources in the area become harder to find. The G/wi eat less meat and fewer plant resources are available. The end of the dry season is characterized by extremely hot temperatures and very little water. The G/wi cope with the dry season by splitting up into household groups so as not to deplete all the resources in one area too quickly. During this period the group as a whole probably covers the same amount of range as they did when they were together and moving more frequently.

Therefore the G/wi can be characterized as having a range of variation in resource density, resource predictability, and local population density between the wet and dry seasons (Fig. 5). During the wet season the group is congregated, eats more meat, has more plant resources, and has greater access to water. During the dry season the G/wi divide up into smaller groups and disperse across the landscape in order to cope with less vegetable and meat resources and less water.

The !Kung

Although they are separated from the G/wi by only a few hundred kilometers, the !Kung have a different way of dealing with their particular Kalahari environment. The !Kung occupy the border region between Botswana and Namibia in an area Northwest of the G/wi (Fig. 4). This area is similar to the region inhabited by the G/wi, while the !Kung have the added benefit of two main additional resources. The difference in their environment is due to the fact that they have some permanent water holes (a result of the geology of their region) and the mongongo nut is an abundant local resource. Most of the other environmental factors are similar. The Kalahari in this region is still characterized by a dry season and a wet season. Drought is still a common feature and "boom" and "bust" years occur sporadically. However, the addition of a more reliable water source and a superabundant plant resource (the mongongo nut) are enough to cause the !Kung to have a different approach to their range size and subsistence practices.

In the wet season the !Kung are more likely to separate into smaller sized groups. They spend this time foraging for plant resources and hunting for kudu, wildebeest, and gemsbok (Lee 1993). During the dry season they tend to congregate in larger group sizes around the permanent water holes. Their diet is similar to that of the G/wi in that they are primarily dependent on plants (70% plants, 30% meat (Lee 1993) or 80% plants, 20% meat (Kelly 1983)). The mongongo nut accounts for 28% of the !Kung diet and therefore is easily their most important food resource (Lee 1993). To find their subsistence, the !Kung rely on an area of land somewhat smaller than that required by the G/wi. The !Kung have an average range size of 450 square kilometers with an average population density of .43 persons per square kilometer (Lee 1979; Hitchcock 1994b). This means that the !Kung are more densely congregated in a smaller

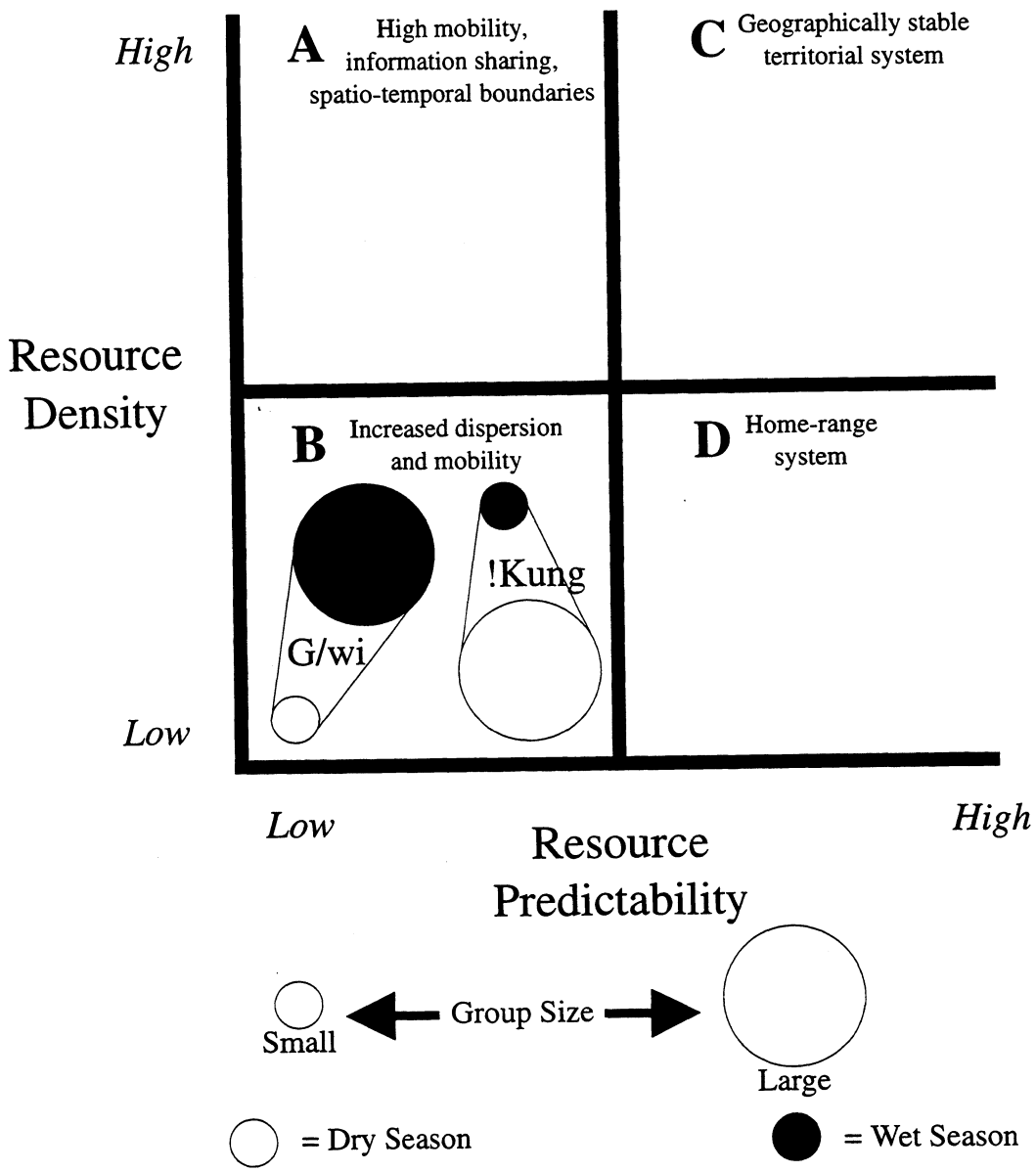

Figure 5. Range of variation exhibited by the G/wi and the !Kung during wet and dry seasons (from Dyson-Hudson and Smith, 1978).

area than the G/wi as a result of these two additional natural resources (permanent water and the mongongo nut).

Therefore, the !Kung can be seen as existing on a range of variation between the wet and dry seasons. They congregate around permanent water

during the dry season and spread out in the wet season when resources are more abundant (Lee 1972) (Fig. 5). This is not only a result of the availability of water. There was a period of time when the G/wi had access to permanent water sources in their area as well. Silberbauer describes a time when there were a number of bore holes dug into the central Kalahari. These bore holes yielded potable water and there were large drums that were filled up with water for use by the G/wi. These features attracted people from up to 160 kilometers away, leading to a great deal of friction and a shortage of food because of overcrowding and resource depletion among the G/wi (Silberbauer 1981). Therefore it is clear that the permanent water and the mongongo nut in combination are what allow for the congregation of the !Kung during the dry season.

Discussion

It is clear that subtle differences in natural resources are a major factor in the way that hunter gatherer groups adjust their range size and subsistence patterns. The five environmental factors identified by Silberbauer are a good starting point for evaluating past hunter gatherer behavior. Silberbauer identified the following:

1. Adequate variety, number, and density of food plants available year round

2. Sufficient grazing to attract herbivores

3. Trees to provide shade, shelter, and firewood

4. Proximity to permanent water

5. Sufficient space to contain these resources in an adequate quantity (Silberbauer 1981)

I would argue that some other factors could be added to this list when hunter gatherers are faced with different environments. For example, with increasing latitude or altitude hunter gatherers will become more concerned with the availability of resources for clothing. As hunter gatherers have increased contact with other cultures they are sometimes forced to adapt their behavior to cope with the laws or circumstances imposed by other groups. It has become clear that there are many subtle factors that affect the decision making among hunter gatherer groups. The G/wi and the !Kung show that two groups living in environments that are only subtly different can have different methods of adaptation. Will archaeologists of the future be able to distinguish the subtle differences between the land of the !Kung and the land of the G/wi? And if so, will they be able to recognize the significance of these differences?

The results of this investigation have implications in the study of past hunter gatherers in Northwest Nebraska. It is clear that a better understanding of the nuances of environment will be necessary if we are to ever know the exact way in which past people behaved. Nonetheless, we may be able to look at

what we do know about the environment and use that information (along with our knowledge of the factors that affect the lives of the G/wi and the !Kung) to make some general predictions about the range size of these past hunter gatherers.

While water is not exactly plentiful in Northwest Nebraska, it is not that hard to come by either. There are a number of drainages that run intermittently as well as several standing water sources. Plant foods are scattered across the landscape in patches. Prickly pear, yucca, prairie turnip, and sego lily are common and grasses are abundant. Two thousand years ago the American prairie was teeming with animal life: bison, pronghorn, deer, rabbits, and a number of birds were all common. A rarer resource would be trees for firewood (the hearths do show that wood was being burnt rather than some alternative fuel such as bison droppings, etc.). Pine is most commonly found on the high points along the landscape. Smaller trees and bushes are found in the drainages with running water. Therefore past hunter gatherers were probably casually linked to the drainages because of the number of resources that they held. However, this connection to water was probably not as significant as it is for the !Kung due to the fact that water is generally more abundant in the American prairie. There is no known superabundant plant resource in the area that would allow for a densely congregated population (however, bison might have been a superabundant yet fairly unpredictable animal resource). Obviously more information is needed about how people make decisions in a prairie environment.

Researchers investigating the past hunter gatherers of Northwest Nebraska could incorporate the basic trends of !Kung and G/wi environments (and their corresponding range sizes) in the design of an archaeological survey. Since prairie peoples would have been less linked to water than the !Kung (and also without a superabundant plant resource), they most likely had a larger range size. These past hunter gatherers had a greater year round access to water than the G/wi, therefore they probably did not separate into small groups over a portion of the year. Archaeologists could begin an investigation of the Oglala Grassland by surveying a 600 square kilometer region (the range size of the !Kung) using random sampling procedures and temporal controls to see if there is any corresponding drop off in site frequency. Evidence of past groups should be visible due to a probable congregation of all group members. Survey should seek to examine a correspondence between past drainages and sites. The survey could be expanded if the number of sites remains constant throughout the survey area.

Conclusion

This examination of range size has shown that there are a number of different factors that affect the decision making of hunter gatherers. In the past, researchers have often been quick to accept new models that neatly arrange human cultures into separate categories. Models such as Dyson-Hudson and Smith's "Optimal Foraging Theory Territoriality Quadrants" should be used only as a frame of reference. Some

researchers tend to pigeonhole and classify rather than recognize the many different variables at work in the human experience and note the range of variation between and within different cultures. Future cross-cultural examinations should not seek to categorize but rather to identify factors that affect range size, subsistence base, and other decisions made by hunter gatherers.

It is only by recognizing the environmental forces at work on modern cultures that researchers will be able to make assumptions about the past. Clearly, a better understanding of past environment will be necessary for a clear interpretation of past hunter gatherers. Pollen, phytolith, and geomorphology investigations should be conducted with specific questions in mind. Archaeologists should ask questions such as "Was the ground in this area capable of holding permanent water?" and "Were there any plants in this area that were capable of providing year-round human subsistence?" rather than merely sending their samples off to the lab to be processed. Hopefully these scientific analysis techniques will become more refined as time progresses and will be capable of recreating the past environment in finer definition.

In the mean time researchers need to identify general associations between humans and their environment. This includes recognizing the main factors that influence culture group choices. This will enable researchers to ask pertinent questions of the archaeological record via analytical techniques. The answers to these questions will allow us to create more realistic interpretations of how past peoples interacted with their environment.

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