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Scientific Research Programmes: Toward a Synthesis and Evaluation of CRM Archaeology

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Scientific Research Programmes:  
Toward a Synthesis and  
Evaluation of CRM Archaeology  

Alan J. Osborn  

INTRODUCTION  

A central issue in CRM for several years centered on the apparent problem of reconciling management and research aims or goal. The problem really existed in the form of a dilemma: how to collect or develop scientifically useful data within the constraints of a contract specifying that only a highly delimited area be studied?... Keel (1979) states the problem succinctly, pointing out that most "contract" archaeological research is necessarily circumscribed geographically and by data collection requirements, and that data so collected are basically for management of compliance purposes.... From a strictly management perspective, this position is defensible; but it glosses over a much more basic question, one which underlies most of the management versus research quandry, that is, why are cultural resources being protected, conserved, and managed at all? (Fowler 1982:21)  

Archaeologists involved in conservation archaeology and/or cultural resource management have frequently been confronted with the dilemma described by Fowler (1982). Cultural resource management projects most generally have to be conducted within a restricted geographical area within a specified period of time.  

Many archaeologists have chosen to deal with the resource management dilemma in one of three ways. First, there are those that have chosen to view cultural resource management primarily as a professional service. Practitioners of "service" archaeology conduct archaeological surveys and excavations in order to determine the frequency, location, and extent of cultural remains within a specified area. Investigations conducted by service-oriented archaeologists are primarily designed to satisfy the inventory, mitigation, and clearance requirements of federal agencies and private industry. Second, a number of archaeologists have managed to develop creative research designs within which they have been able to address scientific questions about the past while fulfilling their contractual agreements with the federal government and/or private industry. And, third, many other
professional archaeologists particularly those affiliated with
universities have chosen not to become involved in CRM projects at the "ivory tower" and "real world" archaeologists has been money.

Now that CRM/contract archaeology is disappearing we must ask if this dilemma was resolved. And, if so, what has CRM funds for numerous legislatively-mandated CRM projects which archaeology ultimately contributed to our understanding of the past?

In the following discussion the implications of the research/management dilemma for American archaeology is examined. As a result, the concept of "research programme" is suggested as a tool applicable for assessing the ultimate success of CRM in resolving the research/management dilemma. A research programme developed for the investigation of prehistoric adaptations in the Great Plains is presented as an illustration of the analytical concepts and management potential.

"Real World" Versus "Ivory Tower" Archaeology

The emergence of CRM/conservation archaeology has created a schism in the discipline of archaeology which has separated academic archaeologists as "full-time" versus "part-time" professional "corporate" archaeologists who were to soon predominate in the archaeological discipline. This rather absurd dichotomy separates archaeological record and states, "Cultural resources may be "containers" of information, or potential information, about past human activities." Hill (1972:64) discusses the broader theoretical and methodological implications of such an empiricist perspective and states,
The implications of this view for archaeology is that artifacts and features (and even artifact associations) are regarded as discrete independent entities, each having a single meaning to be discovered. It is then, our task to perceive this inherent meaning. In a sense, then, our inferences about the data are contained in the artifacts and features themselves.

A number of archaeologists have argued that the appearance of CRM archaeology marked the resurgence of the normative, empiricist archaeology. Keene and MacDonald (1980:1) state that most of the archaeological work currently conducted under the (inaccurate) euphemism 'cultural resource management' is strictly and rigidly empiricist, almost totally devoid of theoretical interest, and largely irrelevant to anthropological research. We know that there are, in fact, a number of CRM projects that have contributed both theoretically and substantively to archaeology. A discussion of these specific contributions to our understanding of the past is beyond the scope of this chapter. However, what we might ask at this point is to what extent has the overall approach to CRM studies in archaeology brought us closer to the goals of anthropological archaeology aimed at explanation of past human behavior? Is there any effective way in which archaeologists could proceed within the recognized constraints of CRM archaeology toward this goal of behavioral explanation? I believe that several philosophers of science have provided us with an effective scientific framework in which research design is to use theoretical arguments to develop expectations about the world, and then to test them by collecting systematic data that either do or do not conform to the theoretical expectations, the ultimate goal being to add to our store of scientifically-true about nature.
Frequently, archaeologists have attempted to develop research designs within a narrow inductivist perspective (cf. Hempel 1966:11-15, 18). And, they have equated research designs with "puzzle solving" activities (cf. Kuhn 1970). As Kuhn (1970:35-42) emphasizes, puzzle-solving focuses on questions which lack broader explanatory significance. Archaeologists conducting CRM investigations have frequently generated "research designs" which have been concerned solely with site-specific questions that have little, if any, relevance to regional-level behavioral problems. Empirical generalizations and particularism characterize much CRM research.

Harris (1979) argues that the concept of scientific research strategy be used by anthropologists instead of paradigm. A research strategy is "...an explicit set of guidelines pertaining to the epistemological status of the variables to be studied, the kinds of lawful relationships or principles that such variables probably exhibit, and the growing corpus of interrelated theories to which the strategy has thus far given rise" (Harris 1979:26-27). Unlike scientific paradigms, research strategies are utilized by investigators in a very deliberate and explicit way. Research strategies are consciously changed in response to the feedback between ideas and empirical observations.

The concept of research programme was proposed by philosopher of science Imre Lakatos in the early 1970s. Lakatos (1970a; Lakatos and Musgrave 1970) was reacting primarily to Thomas Kuhn's (1962a, 1962b) concept of scientific paradigm and the nature of scientific revolutions. Kuhn (1962a, 1962b) viewed the history of Western science as a series of oscillations between periods of normal science and revolution. Kuhn's (1970) writing have served as a basis for interpreting epistemological changes in the discipline of archaeology (e.g., Leone 1972; Metzer 1979; Binford and Sabloff 1982).

During periods of normal science, a community of specialists share a common body of theory and confirmatory tests. Alternative explanations, anomalous and contradictory evidence, and novelties accumulate during periods of normal science but they are generally ignored. Revolutions in science occur as a consequence of irreconcilable differences between theory and evidence.

Lakatos and others did not find Kuhn's ideas about the structure of scientific revolutions very helpful. For example, Suppe (1977:645) states in this regard, "I have solved Kuhn's aspects of scientific discovery. Furthermore, Lakatos believed that scientists could control the process of discovery. The notion of serendipity has been overemphasized. Urbach (1978:99), like Lakatos, suggests that scientists may utilize a "forward-looking" methodology for assessing the relative merits of scientific theories. Unlike the Kuhnian view of science, Lakatos sees the scientist as a self-conscious researcher equipped to differentiate between robust and non-robust explanatory theories.

Lakatos describes scientific research programmes as sequences of interrelated theories and basic assumptions which form the "hard core", as well as negative and positive heuristics. The "hard core" is maintained in a research programme even if empirical evidence appears to contradict it.

The positive heuristic consists of a body of ideas ...about how to 'fill in', make more precise, draw consequences from, these statements, and also about how to elaborate on them, introduce new assumptions... that...apply to new fields, and how to modify them when difficulties arise (Worrall 1978:59).

The negative heuristic consists of statements regarding research directions and sets of theory that have proven to be unproductive.

Scientific research programmes are deemed better than their rivals if they exhibit "greater empirical content" or predict "new, hitherto unexpected facts" (Radnitzky and Andersson 1978:9). In other words, a robust sequence of theories and the enhancement characteristics of the positive heuristic enable us to go beyond the knowledge that served as the background for the original, individual theories. We are able to predict new facts and to identify new interrelationships in the empirical world. The heuristic power and explanatory capabilities of a scientific research programme are certainly greater than the sum of their parts.

Therefore, the application of scientific research programmes will greatly enhance our abilities in anthropology and archaeology to integrate, test, and go beyond what we currently know about human
behavior. Empirical laws allow us to explain the interrelationships between two or more variables. Scientific theory systematically integrates a sequence of these empirical laws and it defines the explanatory limitations of these empirical laws. As a result, theory exhibits much greater explanatory power than empirical laws. And scientific research programmes can now be used to expand further our discovery, integrative, and explanatory capabilities in behavioral science.

The concept of scientific research programmes is proposed as an effective means for evaluating the contributions that CRM investigations have made to anthropology and archaeology. We should ask how CRM archaeology has served the short-term needs of management and industry and carried out research that furthered our scientific understanding of past human behavior.

**PREHISTORIC ADAPTATIONS IN THE GREAT PLAINS: A RESEARCH PROGRAMME**

Science is not a static enterprise (cf. Suppe 1977:670), and neither is archaeology. The Great Plains region, however, constitutes one of the least disturbed theoretical backwater areas of North American archaeology. The issues raised in North American archaeology during the late 1960s and the early 1970s went unnoticed on the Plains. Explanation of past human lifeways on the Plains was equivalent to locating one's archaeological observations on the master time-space-content grid. At best, archaeological explanation was nothing more than "thick description" - literally and figuratively.

The traditional interpretations of prehistoric and historic lifeways in the Great Plains are based heavily on ethnohistoric accounts. Many of these descriptions of aboriginal lifeways in the Plains have now been accorded status as "divinely inspired truth". Few people have seriously questioned the anthropological abilities of these EuroAmerican observers.

For example, George Catlin lived among the villagers of the Middle Missouri for years during which time he accurately documented aboriginal life in paintings and in his journals. Yet Catlin left these groups behind thinking that they were the descendents of Madoc, son of the Prince of Wales! The reliability of all EuroAmerican accounts of Plains life must be subject to close scrutiny. Anthropologists and archaeologists must make use of contemporary behavioral theory in order to delineate anomalies and inconsistencies in the ethnohistoric record.

Much of Plains prehistory was written decades ago and little effort has been made to revise it. Childe's (1936) ideas about the "neolithic revolution" and agriculture form an integral part of extant interpretations of past lifeways in the Central Plains and the Middle Missouri sub-area. Archaeologists and anthropologists unquestioningly adopted Childe's reconstructions of Neolithic life.

Wedel's (1978) writings reflect the impact of the "neolithic" concept on Plains culture history. He (1978:187) states,

> In the mixed and tall-grass prairies of the eastern Plains, where climate and soils were suited to maize horticulture, there were settled communities of village Indians. Fertile, easily worked valley bottom soils made possible an increasingly productive subsistence economy, often with sufficient crop surpluses to support trade with nonhorticultural bison hunters to the west... Their way of life, in its horticultural practices and crops, its houses and settlement patterns, its ceramic and other industries, reveals strong relationships with the eastern Woodland cultures of the Mississippi-Ohio valley....

This reconstruction is based on generalizations proposed by Childe in the early 1900s that have now been rejected. Archaeologists have been quick to assume that a handful of charred maize kernels, bison scapula "hoes", and numerous subterranean "cache" pits are irrefutable evidence for a "neolithic revolution" along the floodplains of the Missouri River.

In keeping with ethnohistoric accounts, archaeologists in the Plains have adopted the view that prehistoric peoples practiced a "schizophrenic" pattern of specialized maize farming and bison hunting. It is difficult to understand why two specialized subsistence strategies would be practiced in this region particularly when both would require significant inputs of labor for processing the resources prior to storage. Summer-fall communal bison hunts would conflict with weeding and harvesting activities. Furthermore, these specialized strategies tend to be an "all-or-nothing" adaptive response to a region characterized by short growing seasons and long food-poor winters.

There are additional reasons for skepticism regarding the traditional interpretations of past Plains lifeways. We know for example that there was considerable variability in aboriginal settlement/subsistence systems that have not been accommodated within the traditional view.

For example, Hurt (1969:32) in a description of the Hidatsa/Crow in the early 1800s speaks of the ancestors of the Awatixa, Awaxawi, and the Mirokac as both village agriculturalists/nomadic...
hunters, agricultural villagers, and nomadic River Crow/agriculturalists. This range of adaptive variation, as well as future directions(s) of this research can be plotted.

The existence of previously unanticipated land use systems cannot be accommodated within the usual farmer/hunter dichotomy of the

normativist perspective.

There has been a plethora of paleopathological studies in the past five years that have focused on aboriginal dependence on agriculture (e.g., Cook and Buikstra 1973, 1979; Turner 1978, 1979; Lallo and Rose 1979; Larsen 1982; Cohen and Armelagos 1984). Based on these studies we would expect to observe a number of pathologies e.g., Harris lines, enamel hypoplasias, porotic hyperostosis, and caries in maize horticultural populations. Furthermore, we should expect to observe high ratios of strontium to calcium and low 13C/12C carbon isotope ratios among Plains Village Tradition peoples if maize had been a dietary staple.

Few studies of prehistoric diet and paleopathologies have been conducted to date in the Plains. However, preliminary analyses of prehistoric dentition for Central Plains groups suggest that prehistoric agriculture (e.g., Cook and Buikstra 1973, 1979; Turner 1978, 1979; Lallo and Rose 1979; Larsen 1982; Cohen and Armelagos 1984) has recently examined teeth wear patterns for 5 prehistoric/historic individuals (22 Woodland/Lower Loop, Nebraska Phase, and 17 Pawnee) spanning more than 3,500 years. The central Niobrara drainage exhibits considerable patchiness and ecological diversity within a more homogeneous regional Plains environment. Precipitation decreases along this east-to-west gradient and it becomes more unpredictable. Deciduous vegetation exhibits a "dwarf effect" due to increased xerophytism toward the west. Ponderosa pine extend eastward to the limits of their distribution along the rugged, sheltered terrain of the Niobrara trench.

The disparity between our expectations for aboriginal Plains life and many aspects of the traditionalist interpretations warrants a great deal of further investigation. For this reason I began to examine a series of interrelated issues in Plains archaeology and anthropology. These studies began in the context of formulating research problems for several CRM projects in the Plains.

The following discussion of these studies of Plains adaptation is meant to illustrate how archaeologists might approximate a research programme. There is insufficient space to offer the complete theoretical bases for these investigations but brief references will be made to certain bodies of theory when possible. The most important aspect of this "research programme" is the set of interrelationships which link each study to a central problem and to each other. It is through this set of interrelationships and the

Ecological Diversity and Aboriginal Foraging Behavior

In the real world, environments are patchy. Factors influencing the proximate physiological or behavioral state or the ultimate fitness of individuals exhibit discontinuities on many scales in time and space. The patterns of these discontinuities produce an environmental patchwork which exerts powerful influences on the distributions of organisms, their interactions, and their adaptations. (Wiens 1976:1)

The Niobrara River valley parallels the north-south transition between the Pine Ridge Escarpment of southern South Dakota and the vast Sand Hills region of north-central Nebraska (Figure 2.1). This spring-fed and deeply entrenched stream crosses the Hundredth meridian which coincides with the boundary between eastern tall grass prairies and western shortgrass plains.

Results of this study were compared with those obtained for 66 prehistoric/historic individuals examined by Smith (1984). None of the Woodland/Lower Loop and Nebraska Phase individuals exhibit evidence for horticultural adaptation. The Pawnee individuals appear to occupy an intermediate position between hunter-gatherers and horticulturalists. All individuals examined show little, if any, evidence for caries and dental insult attributable to horticulturalists.

The disparity between our expectations for aboriginal Plains foraging behavior and ecological diversity within a more homogeneous regional Plains environment. Precipitation decreases along this east-to-west gradient and it becomes more unpredictable. Deciduous vegetation exhibits a "dwarf effect" due to increased xerophytism toward the west. Ponderosa pine extend eastward to the limits of their distribution along the rugged, sheltered terrain of the Niobrara trench.

The central Niobrara River valley provides archaeologists with a very suitable natural laboratory in which to examine the relationships between environmental patchiness and human foraging behavior. It was in this portion of the Plains that a cultural resource survey of more than 26,000 acres was conducted. This survey was for the Bureau of Reclamation's proposed Norden Reservoir Project.

Ecological Theory

In the late 1970s, ecologists were developing and testing models of optimal feeding strategies as an integral part of evolutionary ecology. These ecological concepts were used to develop a model of aboriginal foraging. This model was felt to be useful in examining the underlying causes of subsistence variability within the Niobrara region.
Wiens (1976), for example, has emphasized that patchiness is a relative concept. Patches result from the discontinuous distribution of resources in environmental space and ecological time. The scale used was based on the foraging radii of known pedestrian hunter-gatherers. Therefore, patchiness in this case pertains to the distributional properties of resources considered to be relevant to foragers travelling on foot in this region.

Forager adaptation to environmental patchiness is referred to by Wiens (1976:85) as grain response which "...is interpreted as a behavioral response to an environmental mosaic." These grain responses can either be fine grained in which resources are exploited in proportion to their occurrence in space and time; or, coarse grained in which resources are exploited disproportionately. A fine-grained response tends to exhibit a more random spatial pattern of occurrence and is a generalist strategy. A coarse-grained response, on the other hand, tends to exhibit a non-random spatial pattern and is considered a specialist strategy.

In addition, ecologists have devoted considerable attention to the concept of ecological diversity and related aspects of communities (e.g., MacArthur 1965, 1972; Pianka 1966; Margalef 1968; Pielou 1975). McIntosh (1967:392) states, for example, that,

Diversity has been said to increase in a successional sequence to a maximum at climax, to enhance community stability, and to relate to community productivity, integration, evolution, niche structure, and competition.

Considerable debate surrounds the underlying bases for such interrelationships between ecological diversity and community dynamics and structure (cf. May 1973; Pielou 1975; Pianka 1983). However, such ecological correlations can still be utilized to generalize about the character of a community given its diversity.

Table 2.1 summarizes a number of these ecological interrelationships between diversity (plant/animal) and community dynamics and structure. Given these characteristics of ecological communities we can begin to predict what kinds of environmental patches would be better suited for prehistoric hunter-gatherer residential and logistical site location. Low species diversity communities are more apt to contain aggregated resources that will be relatively abundant. For example, grassland communities will contain large areas dominated by one or two species of grass suited for supporting large herbivore populations e.g., bison or antelope. More diverse forest communities will exhibit greater species diversity, greater equitability, and more evenly distributed resources. These communities are most apt to contain greater
Table 2.1  Ecological diversity and community dynamics and structure (Odum 1969:265, Table 1).

<table>
<thead>
<tr>
<th>Community Characteristic</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross production/respiration</td>
<td>or 1</td>
<td>Ca. 1</td>
</tr>
<tr>
<td>Gross production/biomass</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Biomass/unit energy flow</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Net production yield</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Food chains</td>
<td>Linear</td>
<td>Web-like</td>
</tr>
<tr>
<td>Total organic matter</td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td>Species diversity-variety</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Species diversity-equitability</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Biochemical diversity</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Spatial heterogeneity</td>
<td>Unorganized</td>
<td>Organized</td>
</tr>
<tr>
<td>Life cycles</td>
<td>Short</td>
<td>Long</td>
</tr>
<tr>
<td>Nutrient exchange rate</td>
<td>Rapid</td>
<td>Slow</td>
</tr>
<tr>
<td>Reproductive strategy</td>
<td>r-selected</td>
<td>K-selected</td>
</tr>
<tr>
<td>Nutrient conservation</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Stability</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Entropy</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Information</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

diversity of biochemical resources e.g., resins, alkaloid poisons, and medicinal items.

**Behavioral Expectations**

Given this ecological background, we can present several expectations for aboriginal behavior concerning land use along the central Niobrara drainage (cf. Table 2.2). High bulk, aggregated resources like bison, antelope, prairie dogs, cattails, wild rice, or grass seed would be found in low diversity settings. Their exploitation would require cooperative labor for procurement, processing, and transport. This labor would be recruited from a coresident group of producers and consumers. Residential sites associated with such land use practices would be "large" and would exhibit a relatively diverse archaeological assemblage. We would expect to observe features e.g., hearths, pits, middens, burials, and shelters at such locations in addition to artifactual assemblages reflecting a broad range of maintenance activities. Archaeological evidence for logistically-organized activities e.g., procurement of raw materials, herbs, resins, and "chemicals" would probably consist of a number of "small" unobtrusive sites e.g., isolated finds. These would most likely be located in settings characterized by greater ecological diversity.

Given these ideas we might propose the following hypotheses:

1. Archaeological site size (as well as complexity/internal differentiation) should vary inversely with associated ecological diversity.

2. Artifactual assemblage size and diversity should vary inversely with associated ecological diversity.

**Archaeological Analyses/Tests**

Archaeological data collected during the Ft. Niobrara National Wildlife Refuge survey was used to test these anthropological/ archaeological hypotheses. The first test involved data presented in Table 2.3. A linear regression of site area (area of surface artifact scatter) and setting diversity (i.e., associated vegetative diversity, H') demonstrated that ecotonal sites (site situated in transition between two or more vegetative communities) constituted anomalies (cf. Figure 2.2). If these sites are removed from the present analysis, we find that the correlation coefficient (r) equals -0.88 (R = 0.77; df = 5; p > .001). This means that 77 percent of the variability in observed site size can be explained in terms of associated vegetative diversity.

A second test was performed to test the expected relationships between site assemblage diversity and associated vegetative diversity (Table 2.4). Artifactual assemblage diversity computations are provided in Table 2.5. It should be pointed out
**Table 2.2.** Archaeological correlates of grain responses to patchy environments.

<table>
<thead>
<tr>
<th>Archaeological Correlates</th>
<th>Patch Species Diversity</th>
<th>Site Designation</th>
<th>Size/Area</th>
<th>Setting</th>
<th>Vegetative Diversity (H')</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site size</td>
<td>Low Large</td>
<td>25CE222</td>
<td>30,000</td>
<td>14.86</td>
<td>Grassland</td>
</tr>
<tr>
<td></td>
<td>High Small</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site frequency</td>
<td>Low</td>
<td>25CE230</td>
<td>15,182</td>
<td>13.88</td>
<td>Grassland</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site distribution</td>
<td>Nonrandom</td>
<td>25CE229*</td>
<td>3,864</td>
<td>11.91</td>
<td>Grass./M. forest</td>
</tr>
<tr>
<td></td>
<td>Random</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation episodes</td>
<td>Multiple</td>
<td>25CE226</td>
<td>760</td>
<td>9.56</td>
<td>Lowland forest</td>
</tr>
<tr>
<td></td>
<td>Single/Few</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation duration</td>
<td>Long-term</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short-term</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artifact assemblage diversity</td>
<td>High</td>
<td>25CE223</td>
<td>700</td>
<td>9.44</td>
<td>Lowland forest</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrasite variability</td>
<td>High</td>
<td>25CE227</td>
<td>386</td>
<td>8.59</td>
<td>Mixed forest</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intersite variability</td>
<td>Low</td>
<td>25CE223*</td>
<td>385</td>
<td>8.58</td>
<td>Grass./M. forest</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Features</td>
<td>Present</td>
<td>25CE231*</td>
<td>333</td>
<td>8.37</td>
<td>Grass./M. forest</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Visibility&quot;</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistical sites</td>
<td>Few</td>
<td>25CE228*</td>
<td></td>
<td></td>
<td>Grass./M. forest</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential sites</td>
<td>More</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Numerous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ecotonal sites*
Table 2.4. Archaeological assemblage diversity and vegetative diversity, Ft. Niobrara National Wildlife Refuge, Valentine, Nebraska (Osborn 1979).

<table>
<thead>
<tr>
<th>Site Designation</th>
<th>Environmental Setting</th>
<th>Assemblage Diversity (H')</th>
<th>Vegetative Diversity (H')</th>
</tr>
</thead>
<tbody>
<tr>
<td>25CE232</td>
<td>Grassland</td>
<td>2.3694</td>
<td>1.1022</td>
</tr>
<tr>
<td>25CE230</td>
<td>Grassland</td>
<td>1.3928</td>
<td>1.1022</td>
</tr>
<tr>
<td>25CE227</td>
<td>Mixed Forest</td>
<td>1.2177</td>
<td>1.3747</td>
</tr>
<tr>
<td>25CE231*</td>
<td>Grassland/Mixed Forest</td>
<td>1.6382</td>
<td>2.3571</td>
</tr>
<tr>
<td>25CE229*</td>
<td>Grassland/Mixed Forest</td>
<td>0.9033</td>
<td>2.3571</td>
</tr>
<tr>
<td>25CE223*</td>
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*Ecotonal sites

Table 2.5. Archaeological assemblage diversity for sites located on the Ft. Niobrara Wildlife Refuge, Valentine, Nebraska (Osborn 1979).

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</tr>
<tr>
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<tr>
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<td>Ozt</td>
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<td>0.4103</td>
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</tr>
<tr>
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<td>Cy</td>
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= 1.3928 = H'
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<td>D</td>
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<td>187/.73</td>
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<td>Qzt*</td>
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<td></td>
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<td>SW</td>
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<td>Ct</td>
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<tr>
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<td>D</td>
<td>Misc.</td>
<td>9/.23</td>
<td>0.4863</td>
</tr>
</tbody>
</table>

1. Artifact categories include: D, debitage; T, tool (complete or incomplete).
2. Raw material types include:
   - Chalcedony - Cy
   - Plate chalcedony - PCy
   - Quartzite, local Bijou Hills variety - Qzt
   - Quartzite, non-local - Qzt*
   - Chert - Ct
   - Silicified wood - SW
   - Silicified sediment - SS
   - Jasper - J
   - Hematite - Ht

Figure 2.2 Graphical Plot of Site Size and Associated Vegetative Diversity for Ft. Niobrara National Wildlife Refuge, North-Central Nebraska.
that in each of these analyses all \( \log_2 \) values were transformed into antilog values for Pearson product moment correlational analysis (1985). In order to evaluate the relative dependence upon maize in this case, the correlation coefficient (r) equals -0.601 (R = 0.3). In horticulture a more effective use of prehistoric house floors is accounted for (cf. Figure 2.3). Recent studies by ethnologists of domestic settings. This anomalous finding may be informing us about locational behavior associated with logistically-organized extraction activities along ecotones. Unexpectedly large sites along these ecotones may have been produced through accretion - repeated use of the same general area along the borders of several juxtaposed vegetative communities. Without a set of a priori expectations grounded in ecology we would not be able to isolate these cases to study their broader implications.

The ecologically-based model for aboriginal foraging and land use described in this study enables us to examine not only the degree to which archaeological data fits our ideas about hunter-gatherer land use but also about the obverse situation i.e., horticulture. The central Niobrara drainage in north-central Nebraska does not contain prehistoric village sites, tipi ring sites, burial mounds, or large bison kills. It probably was used by residentially-mobile foragers and by logistically-organized collectors throughout prehistory. The degree to which the archaeology fits our ideas regarding ecological diversity and grain response tells us about the relative use of this region by hunter-gatherers versus specialized horticulturalists.

Prehistoric Household Size and Horticultural Labor Demands in the Eastern Plains

Considerable effort has been expended by archaeologists in order to gain some insight into prehistoric subsistence patterns and diet. Much of this work has focused directly on the recovery of floral and faunal remains (e.g., White 1952, 1953a, 1953b, 1955; Gilbert 1969; Falk 1969, 1977; Angus 1975; Chomko 1974; Benn 1974; Nickel 1974, 1977; Peterson 1980; Mick 1983; Dallman 1983). Many of these studies demonstrate, however, that a strictly empiricist approach poses a number of operational problems. How do we compare charred cobs, stalks, and kernels of maize with plant seeds, husks, or nut shells?

The following study is designed to escape a number of such theoretical and methodological problems associated with analyses of archaeological subsistence remains (cf. Cohen 1972-1974; Binford 1977; Binford 1978, 1981, 1984; Carbone and Keel 1977; Pasternak 1983). Many of these studies demonstrate, however, that a strictly empiricist approach poses a number of operational problems. How do we compare charred cobs, stalks, and kernels of maize with plant seeds, husks, or nut shells?

The following study is designed to escape a number of such problems through the use of empirical and methodological approaches which systematically link house floor area and prehistoric village sites, tipi ring sites, burial mounds, and Wendland 1970). Short growing seasons, however, would greatly restrict the time available for planting, replanting, weeding, harvesting, and storing food required to over-winter in the Plains. The short growing season and concomitant long over-wintering time would impose a "bottleneck" on aboriginal labor (cf. Tiffen 1975; Norman, Simmons, and Hays 1982; Stone, Johnson-Stone, and Netting 1984). The environmental constraints which impose this bottleneck phenomenon on horticulture involve variation and predictability of late spring-early fall killing frosts. Late spring killing frosts are particularly critical for maize horticulturalists. If the last spring frost occurs after maize plants reach six inches in height, there would not be sufficient time to replant crops in many areas of the Eastern Plains. Mean length of the frost-free season is useful as a measurement of the environmental stress imposed on prehistoric/ historic Plains horticulturalists.

Behavioral and Archaeological Expectations

If maize was an important over-wintering food, then we should expect to observe associated adjustments of household size to shorter, more unpredictable growing seasons. In subsistence horticultural societies, households must recruit necessary labor from adult producers within the domestic unit.
population size (e.g., Cook and Treganza 1950; Naroll 1962; Cook and Heizer 1965, 1968; Soudsky 1964, 1966, 1969; LaBlanc 1971; Ember 1973; Wiessner 1974; Casselberry 1973; Milisaskas 1972; Divale 1977; Kelly 1982). Such approaches have also been applied on the Plains (e.g., Deetz 1965; Krause 1970; Lippincott 1976, 1978; Ludwickson 1978; Roberts 1977; Wedel 1978b, 1979; Richtsmeier 1980).

In areas characterized by shorter growing seasons an increased dependence on larger households should be observed. House floor areas would increase as the mean length of the growing season decreases in the eastern Plains. Although house floors need not be translated into estimates of absolute population size they do reflect household composition, i.e., the relative number of adult producers. Therefore, household size reflects the domestic group's ability to meet the labor organizational needs for maize production.

Archaeological Analyses

Our behavioral expectation is that intensive aboriginal dependence on maize (ripe) horticulture as a basis for overwintering in the eastern Plains will be reflected by a pronounced positive relationship between household size and labor intensity. In other words, as the mean length of the growing season (a measure of horticultural labor intensity) decreases, aboriginal house floor area (as a measure of domestic group size) should increase.

A linear regression analysis was performed using archaeological data for 156 Plains Village Tradition (A.D. 900-1675) houses located along the Missouri River drainage between the White and Knife-Heart Rivers (Figure 2.1). Regression analysis results ($r = 0.462; R = 0.213; df = 154; p = .001; K = 0.887$) indicate that the horticultural strategy predicted by traditional Plains archaeological theory is not met. More than 88 percent of the variability in house size is not explained by the south-to-north decrease in mean length of the growing season.

A second linear regression of mean house floor areas for 50 archaeological components (occupations) provides similar results ($r = 0.40; R = 0.16; df = 48; p = .005; K = 0.92$). This analysis suggests that less than 16 percent of the variation in average house size/household size could be explained as an effort to establish optimal labor groups to meet the requirements of maize farming.

A third regression analysis involving only Initial Middle Missouri Variant (A.D. 900-1400) houses was conducted. These houses were singled out for analysis because Lehmer (1970) has suggested that these people originally moved into the Middle Missouri area in order to farm following the amelioration of climate during the neo-Atlantic episode. Such climatic changes were
supposed to have been particularly well suited for maize production. Regression results do not suggest a specialized horticultural strategy ($r = -0.49$; $R = 0.24$; $df = 21$; $p > .01$; $K = 0.87$). The coefficient of alienation ($K$) tells us that 87 percent of the variation cannot be explained using a horticultural argument.

In summary, these preliminary regression analyses indicate that prehistoric/ethnohistoric peoples in the Middle Missouri sub-area of the Plains were not meeting the labor demands necessary for specialized maize production. Greater variation in aboriginal diet and feeding strategies is indicated. Certainly, we cannot rely solely on these preliminary analyses to nullify existing interpretations of past Plains lifeways. The point of this discussion is, however, that archaeologists have become too complacent about what we think we know about the past in this region.

Prehistoric Ceramics and Maize
Horticulture in the Eastern Plains

There is perhaps no other "culture trait" which has been assigned greater interpretative significance in archaeology than shell-tempered ceramics in eastern North America. Its spatial and temporal distribution has been viewed primarily as a result of spread and/or migration from the American Bottoms or "Mississippian Culture heartland" centering on Cahokia (e.g., Holmer 1886a, 1886b, 1903; Griffin 1937, 1943, 1952; McKern 1934; Haas 1962; O'Brien 1978; Brose 1978; Walthall 1980; Prüfer and Shank 1970).

Shell-tempered ceramics in the eastern Plains have been attributed to "Mississippian" influences and/or population movement from the eastern woodlands, the Mississippi Valley, and the Steed Kisker sites near Kansas City (e.g., McKern 1934; Strong 1939; Wedel 1935, 1959; Bell and Gilmore 1936; Griffin 1937, 1943; Henning 1967, 1970; Calabrese 1969; Gibbon 1972, 1974; O'Brien 1978).

In general, archaeologists working in the eastern Plains have regarded variability in artifactual assemblages, in this case involving shell-tempered ceramics, to reflect differential contact and resulting adoption of ideas/culture traits. Henning (1967:185) states, for example, The traits (e.g., polished jars...decorated with trailed curvilinear designs...seed jars, bowls, plates, and "bean pots"...) alluded to above will be used as indicators of the degree to which Mississippian peoples might have influenced occupants of the eastern margin of the Central Plains.

Mississippian Adaptations
The observed distribution of shell-tempered ceramics in eastern North America and along the margins of the eastern Plains can be explained more productively in terms of ecological/nutritional relationships (Osborn 1981, 1986). More specifically, shell-tempered ceramics represent an adaptive technological response to the problems associated with increased dependence on maize and food storage along the margins of the eastern deciduous forests.

Recent archaeological studies have called for a relatively extensive revision and reformulation of our ideas regarding Mississippian cultures throughout the eastern woodlands (cf. Peebles and Kus 1977; Smith 1978). There is considerable archaeological evidence for marked population growth throughout the Midwest, the Lower Great Lakes, and the Mississippi-Ohio River drainages between A.D. 800-1400.

Accompanying this population surge we see intensification of maize horticulture, intensive exploitation/overexploitation of the terrestrial trinity - whitetailed deer, turkey, and raccoon; expansion of the diet to include smaller, less optimal foods including aquatic resources; increased socio-religious/socio-political complexity; the appearance of larger population aggregates; and increased evidence for a deterioration of nutrition and health (cf. Peebles and Kus 1977; Smith 1978; Cohen and Armelagos 1984).

Maize Diet and Nutritional Disorders
Like many cereals, maize is deficient in certain essential nutrients including tryptophan, lysine, the B-vitamin niacin, ascorbic acid, calcium, iron, and zinc. It exhibits a low protein score (41) in comparison to eggs (100) and fish (70). Maize consumption has been casually linked to the nutritional disorder Pellagra (e.g., Goldberger 1914; FAO 1953; Roe 1973; Katz, Hediger, and Valleroy 1975; Robson et al. 1976; Sebrell 1981). Pellagra is a very debilitating physiological disorder involving dermatitis, dementia, and diarrhea. It was originally thought to have been caused by a niacin deficiency and was a particular problem in populations heavily dependent on maize or sorghum and deficient in animal protein (Goldberger 1914; Roe 1973; Sebrell 1981).

Pellagra has also been linked to imbalances in other amino acids that affect the tryptophan-niacin metabolic pathway in the liver. Some investigators suggest that pellagra results from excessive levels of leucine and the resulting imbalance of leucine and isoleucine (Gopalan and Srikantia 1960; Rao 1972; Gopalan and...
Most recently, pellagra has been attributed to fungal contaminated grain and trichothecene toxicosis (Schoental 1980).

Maize Consumption and Shell-Tempered Ceramics:

Systemic Interrelationships

More than a century ago Mexican physician Ismael Salas described in detail the methods used to prepare and cook maize in Mesoamerica. It was this method of preparation that Salas attributed to the absence of pellagra in Mexico and Central America (Roe 1973). Since that time others have investigated the alkali processing techniques used in Latin America and in North America (e.g., Cravioto et al. 1945; FAO 1953; Behar 1968; Katz, Hediger, and Valleroy 1975; Carpenter 1981).

It has been pointed out that alkali processing serves to soften the tough outer kernel, to free lysine and tryptophan, to improve amino acid balance i.e., leucine and isoleucine, and to add calcium, potassium, magnesium, phosphorus, copper, and zinc to the treatment of maize (FAO 1953).

A cross-cultural analysis conducted by Katz, Hediger, and Valleroy (1975) demonstrates that alkali processing is high correlated with high production/consumption levels of maize. The geographical distribution of shell-tempered ceramics is defined by a precipitation threshold of the 21 cm (8 inch) mean summer (June, July, August) isogram (Jenkins 1941). This approach to maize distribution is isomorphic with aboriginal maize-based adaptations. Prehistoric shell-tempered ceramics used throughout much of North America including the Iroquois and Huron in the Northeast and the western edge of aboriginal maize farming (Yarnell 1964). The eastern woodlands of North America may have served the same function. In the "Mississippian" case burned, freshwater mollusk shells were added directly to the paste of prehistoric ceramic vessels probably served to detoxify any food contaminated by lethal subsistence variation and the absence of the extending mycotoxins - particularly aflatoxins produced by Aspergillus sp. and Fusarium spp. fungi (Schoental 1980). Alkalai processing is one of the few known methods for detoxifying mycotoxins. The technological response would serve to enhance the nutritional value of maize, to reduce the manufacturing costs of culinary vessels, and possibly to increase their usefulness. In addition, the eastern Plains bordering the "Oteot" find that alkali processing affected by shell-tempered culinary vessels is extremely interesting. The paucity of such ceramics, vessels probably served to detoxify any food contaminated by lethal-and-of itself, does not necessarily mean that maize farming was practiced. However, if we also consider the evidence for nutritional food quality, one begins to wonder. Yet, the marked absence of shell-tempered ceramics extremely toxic substances cause a number of physiologic problems that are almost identical to those associated with pellagra (Schoental 1980).
Ecology of Fire and Whitetailed Deer: An Alternative Determinant of Central Plains Adaptations

Prehistoric peoples of the Central Plains Nebraska and Upper Republican regional variants (cf. Krause 1969) have generally been labelled "sedentary/semi-sedentary" maize horticulturalists (e.g. Wedel 1940, 1941, 1961, 1978a, 1979; Krause 1969; Wood 1969; Gradwohl 1970). These prehistoric groups did grow maize but little, if any, attempt has been made to determine how intensively it was used. We know that throughout much of the Central Plains "over-wintering" presents evolutionary, adaptive problems for all life. Production stops during the winter and forage becomes less accessible due to snow cover. McCabe and McCabe (1984:117) state, "Movement in snow greatly increases energy expenditure, prehistoric Central Plains peoples, then what did?" I have suggested, and still believe, that Nebraska and Upper Republican regional variant groups solved this problem by exploiting one mammal species that successfully over-winters in the eastern Plains - the whitetailed deer (Odocoileus virginianus).

Archaeologists are certainly aware that whitetailed deer were included in the diet of prehistoric/historic Plains peoples. One nutrient in particular, phosphorous, sodium, chlorine, potassium, sulfur, iron, copper, cobalt, manganese, selenium, chromium, fluorine, nickel, silicon, vanadium, tin, arsenic, molybdenum, vitamins A, D, and E (Verne and Ullrey 1984:116). Deer energy demands are a function of body weight. Was it consumed throughout the annual cycle and in what proportions? To what extent did it comprise a major over-wintering food resource? Answers to such questions will enable us to better understand aboriginal adaptation(s) to ecological constraints in the Central Plains, Menzel (1984:450) states, "Movement in snow greatly increases energy expenditure, prehistoric Central Plains peoples, then what did? I have suggested, and still believe, that Nebraska and Upper Republican regional variant groups solved this problem by exploiting one mammal species that successfully over-winters in the eastern Plains - the whitetailed deer (Odocoileus virginianus)."

Whitetailed Deer Ecology

Local quantities of suitable forage impose limitations on whitetailed deer particularly during the winter months. Plant wintering" presents evolutionary, adaptive problems for all life. Production stops during the winter and forage becomes less accessible due to snow cover. McCabe and McCabe (1984:117) state, "Movement in snow greatly increases energy expenditure, prehistoric Central Plains peoples, then what did? I have suggested, and still believe, that Nebraska and Upper Republican regional variant groups solved this problem by exploiting one mammal species that successfully over-winters in the eastern Plains - the whitetailed deer (Odocoileus virginianus)."

Whitetailed Deer derive the greatest portion of their diet from forage. Whitetailed Deer Ecology

Significance of Whitetailed Deer for Aboriginal Adaptation(s)

McCabe and McCabe (1984) estimate that aboriginal populations of Canada and the United States killed approximately 4.6-6.4 million whitetailed deer each year during ethnohistorical times. This annual deer harvest provided more than 194 million kilograms (427 million pounds) of meat to approximately 2.34 million persons occupying 7.8 million km² (3 million miles²). Grumly (1971) estimated that the Huron of the Great Lakes region required approximately 7 hides/person/year or a total of 62,000 deer skins/year for clothing.

Whitetailed Deer Ecology

Whitetailed Deer Ecology

Marchinton and Hirth (1984:134) state in this regard, Heavy use of deer yards is associated primarily with cold temperatures rather than snow depth, although the two factors often are related (Ozoga and Gysel 1972). In most years deer enter the yards in January and leave in...
March. However, the timing of the arrival and departure depends on the severity of the winter.

Yarding is perhaps best understood in terms of behavior designed to reduce threats from predators e.g., wolves and to reduce energy loss during periods of extensive snow cover. Moen (1976) points out that deer conserve up to 1,000 kcal/day and from 0.25 to 0.50 kg of forage by yarding.

**Fire Ecology**

Fire ecology involves the interrelationships between natural and human-induced fires and their impact on the structure and dynamics of ecological communities. Fire became an important component of ecological dynamics in North America during the late Cretaceous/early Tertiary periods (cf. Komarek 1965:170). Intense mountain building and alterations in air circulation patterns over North America produced squall line thunderstorms in the interior regions. Decreased precipitation and increased lightning activity particularly during the summer months - produced the Great Plains grasslands (Komarek 1965).

The significance of lightning fires cannot be underestimated with respect to the environment. For example, the number of lightning fires per year in the United States ranged from 5,159 to 11,459 fires between 1951 and 1960; the average number of lightning fires per year was 8,391 (Komarek 1966:98). Given these figures we find that there was one lightning fire for every 90,500 acres of forest in the country (Komarek 1966:98).

**Effects of Fire on Deer Habitat**

Whitetailed deer utilize forest stands in inverse proportion to their age (Carmichael 1981:8). Natural and/or human-induced fires of low to moderate intensity greatly enhance the quantity and quality of forage required and preferred by whitetailed deer. Fires reduce overstory shading effects and expose the forest floor to great amounts of solar radiation. A number of studies provide us with more detailed information about changes in soils, species composition, productivity, and nutrient availability following burns (e.g., Storer 1932; Shantz 1947; DeWitt and Derby 1955; Dills 1970; Taber and Murphy 1971). A number of these effects of fire on forest/grassland communities are presented in Table 2.6.

Dills (1970) studied the effects of a low intensity forest fire in the Catoosa Wildlife Management Area in Tennessee. He (1970) found that three types of preferred whitetailed deer browse i.e., red maple, sourwood, and sassafras increased from 173 lbs/acre before the burn to 598 lbs/acre approximately 16 months later. During the third year following the burn, forage standing crop increased to 93 lbs/acre or more than a 538 percent increase (Dills 1970:540).

<table>
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<th>Table 2.6. Summary of the effects of fire on deer habitat.</th>
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<tr>
<td>Increased organic content</td>
</tr>
<tr>
<td>Improved physical properties</td>
</tr>
<tr>
<td>Increased nutrients - nitrogen, calcium, potash, phosphorus, magnesium</td>
</tr>
<tr>
<td>Reduced Shading Effect</td>
</tr>
<tr>
<td>Stimulates seed germination</td>
</tr>
<tr>
<td>Causes vigorous growth of sprouting plants</td>
</tr>
<tr>
<td>Allows increased light for herbaceous growth</td>
</tr>
<tr>
<td>Elimination of Majority of Understory Plants</td>
</tr>
<tr>
<td>Increased forage production (350-550 percent)</td>
</tr>
<tr>
<td>Decreased species diversity of understory</td>
</tr>
<tr>
<td>Improved Forage Quality</td>
</tr>
<tr>
<td>Increased protein content (25-145 percent)</td>
</tr>
<tr>
<td>Decreased fiber content</td>
</tr>
<tr>
<td>Increased carrying capacity (300-700 percent)</td>
</tr>
<tr>
<td>Improved Deer Health Status</td>
</tr>
<tr>
<td>Increased body weight</td>
</tr>
<tr>
<td>Increased fertility rate</td>
</tr>
<tr>
<td>Increased resistance to parasites/disease</td>
</tr>
</tbody>
</table>

Deer population may increase considerably following a forest fire. For example, Black-tailed deer in Oregon increased from 2 to 27 per square mile in a New Jersey forest that had been logged and burned. Floodplain forests invade the Central Plains via the more deeply incised valleys which provide protection from grass fires. It is, then, along this grassland/forest edge that we find optimal whitetailed deer habitat created by frequent, low intensity burns. Additional, but perhaps less productive deer habitat can also be found along stream margins where meanders, oxbow lakes, marshes, and erosion create a patchwork of young forest stands. This secondary area would offer Central Plains hunter-gatherers an additional area for deer hunting. Optimal locations for winter residences would probably be in uplands areas near areas of maximal topographic relief e.g., near the confluence of two or more drainages. These areas would provide a maximum amount of "edge" for optimal deer habitat within the foraging radius of the residence.

Implications for Interpretations of Central Plains Archaeology

One of the most significant adaptive problems for prehistoric Central Plains peoples would have been over-wintering. Over-wintering can either be solved through recourse to food storage or exploitation of animals that have already solved the problem (Binford n.d.). I have argued here that Central Plains peoples most probably made use of "edge" the latter adaptive strategy. Encounter hunting of whitetailed deer would have obviated the need to adopt a labor intensive food storage strategy based on maize farming or specialized bison hunting.

In addition, Central Plains peoples most probably made use of fire in order to increase the productivity and accessibility of winter herds of whitetailed deer. Schalk (1984:42-47) has discussed a similar adaptive response which was made by prehistoric hunter-gatherers in the Middle Kootenai River valley in northwest Montana. Fire technology was probably used in the eastern Plains to maintain optimal deer habitat and to affect deer yarding behavior in winter.

Most interestingly, however, we must investigate the implications of such an over-wintering strategy for traditional interpretations of Central Plains archaeology. Archaeologists have applied the neolithic revolution notions to this region. Substantial, rectangular earthlodges, subterranean pits, pottery, and scattered charred maize have been interpreted as irrefutable evidence for sedentary horticultural lifeways (Wedel 1940, 1941, 1961, 1978a,
Archaeology was undergoing significant theoretical and methodological change when current CRM archaeology emerged in the early 1970s. Keene and MacDonald (1980) have vehemently argued that "cultural resource management" archaeology was for the most part the antithesis of processual or new archaeology. Hunting along the forest/grassland edge is accorded secondary, not insignificant, subsistence importance. If maize horticulture was not the basis for Central Plains tradition subsistence - particularly for the Nebraska region - then Plains archaeologists have their work cut out for them. First, Central Plains population estimates have been based on dreams that were sent out in advance of development projects to amounts of arable farmland (e.g., Wood 1969:103; Krause 1969) clear the path of insignificant, as well as significant, cultural resources. Much could be said about the anthropological aspects of archaeologists behavior during the past decade. However, the intent here has been to explore the potential of the scientific research programme concept.

The foundation of the research programme presented here is the early work on intensive critical evaluation and synthesis of CRM archaeology. If archaeology was for the United States. We are in the twilight years of nearly a decade of well-funded, intensive archaeological investigations. It is no longer that many problems addressed during the course of CRM projects and archaeological fieldschools have been outlined. A study of ecological time to ask ourselves about the ultimate returns we have reaped. Diversity and hunter-gatherers along the central Niobrara River from such an enormous expenditure of funds and human labor. Hurricane enabled us to compare our expectations about foraging well have archaeologists managed to solve the service/research dilemma? How much have we learned about past human behavior?

I have proposed that such a synthesis and critical evaluation of CRM inventory surveys along the Niobrara River. This research was conducted in the context of two concept of scientific research programmes. This philosophy of House floor data from the Middle Missouri sub-area of the science concept might be used in order to assess our overall success in conducting productive research - that which produced "the shoreline of the Oahe Reservoir to test traditional assumptions facts". Furthermore, the development of a scientific research programme would enable archaeologists to integrate much of what we already know about the past. And, such a concept will current survey information. Archaeological data from the Central Plains was added later in order to examine the nature of house size.

CONCLUSIONS

I have suggested in this paper that it is now time to begin an intensive critical evaluation and synthesis of CRM archaeology. In the preceding discussion, four distinct, yet related, research programmes have been outlined. A study of ecological time to ask ourselves about the ultimate returns we have reaped. Diversity and hunter-gatherers along the central Niobrara River from such an enormous expenditure of funds and human labor. Hurricane enabled us to compare our expectations about foraging well have archaeologists managed to solve the service/research dilemma? How much have we learned about past human behavior? I have proposed that such a synthesis and critical evaluation of CRM inventory surveys along the Niobrara River. This research was conducted in the context of two concept of scientific research programmes. This philosophy of House floor data from the Middle Missouri sub-area of the science concept might be used in order to assess our overall success in conducting productive research - that which produced "the shoreline of the Oahe Reservoir to test traditional assumptions facts". Furthermore, the development of a scientific research programme would enable archaeologists to integrate much of what we already know about the past. And, such a concept will current survey information. Archaeological data from the Central Plains was added later in order to examine the nature of house size.
and climate along a south-to-north gradient from the Smoky Hill area in Kansas to Knife River in North Dakota.

The argument concerning shell-tempered ceramics and dependence on maize horticulture arose during archaeological field-school investigations in the Weeping Water locality of southeastern Nebraska. Nebraska phase sites in southeastern Nebraska contain little, if any, shell-tempered ceramics. I began to investigate the geographical and temporal distribution of such ceramics e.g., Otoe and Mississippian in order to address this problem. The systemic interrelationships between ceramic technology, diet, nutrition, and disease offer archaeologists a number of problems for future investigation. This argument also allows us to make inferences about relative dependence on maize based on ceramic data in the eastern Plains.

Finally, the argument concerning fire ecology and whitetailed deer suggests the basis for a significant and overlooked "over-wintering" strategy for Central Plains inhabitants. It is not enough to suggest that maize horticulture was an insignificant component of Central Plains adaptation(s). This study of fire ecology and deer along the eastern Plains margins is offered in order to explain the conclusions produced by the study of house floor area, climate, and horticultural labor organization.

The positive heuristic for this research programme derives primarily from the interconnections which link ecological theory involving patchy environments/grain responses, hunter-gatherer land use, fire/wildlife ecology, and maize horticulture with human nutrition/physiology and anthropological theory regarding domestic groups and labor organization. These various theories possess additional empirical and theoretical implications. This web of ideas and empirical correlates serve to "fill in" and elaborate on the initial set of theories which guide the research programme. These interconnections also serve to generate "new facts".

And, finally, the negative heuristic or unproductive research directions in this case would include the culture historical approach in archaeology. For more than a century Plains archaeology has made intensive use of the normative concept of culture, "ethnohistoric" analogy, and an empiricist philosophy. This culture historical approach has not successfully organized the archaeological record in spatial and temporal terms. Its reconstructions of past lifeways are questionable and they exhibit limited research potential.

The concept of scientific research programme in contrast offers archaeologists a means for making most effective use of CRM archaeology. The challenge which lies ahead involves
synthesis and evaluation. Much CRM archaeology has been published in relatively obscure "technical papers series" and "laboratory notebooks". Regional syntheses will probably have to be completed by individuals who were directly involved at the geographical level. The ultimate challenge, however, will entail use of CRM information to evaluate and test contemporary explanations of human behavior. The research programme concept will greatly facilitate this work.

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