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Introduction of *Zea mays* into southwestern Michigan:
A microenvironmental study of plant/human relationships

presented by

Cynthia Lou Adkins

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of the requirements for the

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Introduction of *Zea mays* into southwestern Michigan: A microenvironmental study of plant/human relationships

By

Cynthia Lou Adkins

A THESIS

Submitted to
Michigan State University
In partial fulfillment of the requirements
For the degree of

MASTER OF ARTS

Department of Anthropology

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ABSTRACT

INTRODUCTION OF *ZEA MAYS* INTO
SOUTHWESTERN MICHIGAN:
A MICROENVIRONMNETAL STUDY
OF PLANT/HUMAN RELATIONSHIPS

BY

Cynthia Lou Adkins

The question of how and when corn agriculture arose in southwest Michigan is explored in this thesis. Four origin of agriculture models are reviewed. These models are used to influence the construction of a new model for southwest Michigan and the surrounding region. Definitions for domestication, horticulture, and agriculture are given in an effort to standardize concepts. A detailed study of the past regional environment illustrates ecological changes as a result of natural and human causes. Southwest Michigan is located in a transition zone resulting in a mosaic effect with diverse and rich riverine habitats. Long-term climate variations (i.e., LIA) prohibit a strict delineation between floristic and/or biotic provinces. Five sites, Moccasin Bluff, Wymer West, Schwerdt, Elam, and site 20SA1034 are used to develop a settlement subsistence model for southwestern Michigan. A conclusion is drawn that, due to the variation of climate and the resulting ecological systems, settlement and subsistence patterns are heavily influenced by the composition of the individual river drainage systems and what they had to offer for human manipulation and consumption.

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Chapter 1

Introduction

Prehistoric southwestern Michigan is an area that does not seem to fit archaeological expectations for corn agriculture. Previous research for this region assumed that corn agriculture was immediately adopted and incorporated into the existing Woodland subsistence economy (Cleland 1966; Fitting and Cleland 1969; Yarnell 1964). The environmental data for the period A.D. 1000 to A.D. 1400, however, is inconsistent with this assumption. In fact, there are many unresolved issues regarding the spread of corn (*Zea Mays*) cultivation in the Lower Great Lakes Region. Jeske (1992) suggests that social dynamics and the environment were two factors in determining adoption of corn agriculture in southwestern Michigan and regions further to the south and west.

The question of how and when corn agriculture arose in southwestern Michigan remains an enigma. According to Ford (1985), the transformation from horticulturalists to agriculturalists is not immediately recognized in a culture. The acceptance of corn into the subsistence cycle has more to do with social interaction between cultures than with a purposeful intent to adopt a new item into the subsistence base. The primary question I investigate in this thesis is: is there evidence for corn agriculture at seasonal resource extraction and/or habitation sites with Late Woodland and early Upper Mississippian components on the St. Joseph River Valley ca. A.D. 1000 to 1400? If so, was regular maize cultivation practiced during the five centuries prior to ca. A.D. 1400? Answers to these questions are important because in the late 1960s Fitting and Cleland (1969) developed a settlement/subsistence model based on the biotic provinces in Michigan, in whi

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which they suggest that Moccasin Bluff could be an agricultural village type-site for the Carolinian biotic province. A few years later Bettarel and Smith (1973) published a report, which effectively labels Moccasin Bluff an agricultural village based on two relatively small smudge pit features containing corncobs. However, no cob remains were recovered in any of the other over ninety features excavated at this site; flotation was not done at this time. In the intervening thirty years since the Moccasin Bluff report, several researchers of Late Woodland/Upper Mississippian subsistence in southwestern Michigan have referred to the Bettarel and Smith report as evidence of a large agricultural village in southwest Michigan. This site has been used to reconcile the absence of corn at other sites because it was proposed that Moccasin Bluff must have been the large summer agricultural village from which other fishing camps radiated (Barr 1979; Cremin 1980, 1983; Garland 2001; Parker 2001; Parachini 1981; Waltz 1991).

Following Bettarel and Smith (1973), it became generally accepted that the increase in size and frequency of pits at the site prior to A.D. 1400 established Moccasin Bluff as a large summer agricultural village. The answer to when corn agriculture appeared in southwest Michigan was accepted without question despite the sparse evidence recovered from Moccasin Bluff used to support this conclusion. The conclusion was based on two undated small smudge pit features containing corncobs. New data from the Moccasin Bluff site (Adkins 2003) will be analyzed in conjunction with the original corncob data. New Accelerated Mass Spectrometry (AMS) dates on the cobs from the original excavation are presented to address timing of corn entry into southwest Michigan. To understand Moccasin Bluff in its regional contexts, data from several other sites will be evaluated. Botanical data from the Wymer West site (Parker 2001) is also re-

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re-evaluated. Moccasin Bluff and Wymer West are located within eight miles of each other on the St. Joseph River, Berrien County, Michigan. The Elam (Barr 1979; Parachini 1981) and Schwerdt (Cremin 1980, 1983; Higgins 1980; Walz 1991) sites on the Kalamazoo River will also be evaluated because of references connecting these two sites to Moccasin Bluff and the absence of corn. Carbonized botanical inventories from 20SA1034 and Wymer West are similar, including the occurrence of corn. Occupation dates overlap for the two sites as well. The Late Woodland component for Moccasin Bluff occurs approximately 150 years later in time than Wymer West and 20SA1034. The botanical assemblage and abundance of corn from Site 20SA1034 located on the Flint River in the Saginaw Valley will be used as a comparative to Wymer West and Moccasin Bluff botanical inventories.

Model

According to Rindos' model for the origin of agriculture (1984), people will not choose difficult or inefficient subsistence strategies. However, they may not choose the best or most efficient strategy either. Their choices can only be judged given the *perceptible* options at a given point in time. "This represents the distinction between evolution (the result) and selection (the means)" (Rindos 1984: 86). In order to understand the distinction that Rindos explains it is necessary to take a microenvironmental approach to data analysis. By analyzing soils, prehistoric climate and landcover it is possible to delineate environmental constraints in southwest Michigan ca. A.D. 1000 to A.D. 1400. By analyzing carbonized plant remains from the sites as we

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well as settlement patterns it is possible to define the cultural choices of prehistoric peoples at this time.

In order to use a microenvironmental approach a general understanding of how a particular plant environment and ecology came into existence through time is crucial. Using a microenvironmental approach I will examine the mutualistic and developing symbiotic relationship between the Late Woodland culture in southwestern Michigan and the introduction and eventual adoption of *Zea mays* agriculture into the (late) Late Woodland culture. Looking for cultural and natural constraints, which become options and possibly challenges for prehistoric peoples, may help to define how the introduction of corn fit into the horticultural adaptation system in southwest Michigan.

Chapter Summaries

Chapter two lays the groundwork for a general understanding of domestication. Definitions for domestication, horticulture, and agriculture are given. Following a general discussion of domestication and the Eastern Agricultural complex, Chapter two details the introduction of corn into the eastern United States. While a number of models, beginning with Boserup (1965), propose explanations for the onset of domestication, the coevolutionary model by Rindos (1985) most fully explains the environmental and cultural factors in this process. His model predicts the rate of change between domesticate species and wild plants and their relative contribution (abundance) to a culture's diet.

Chapter three presents a detailed study of the past regional environment and how it came into existence. The focus of this chapter narrows to the environment in southwest

Michigan and the area surrounding the southern end of Lake Michigan. A detailed understanding of the local environment is critical to unravel the relationship between humans, plants, and the local environment. A detailed ecological setting is presented for each site that is used in the subsequent analysis.

A regional cultural overview will be presented in Chapter four. Some issues with respect to the introduction of agriculture into southwest Michigan are discussed. These issues range from the timing of glacial retreat to the diverse and rich riverine habitats to the appropriateness of the Fitting and Cleland settlement model (1969). The main sites in this research as well as comparative sites from other regions in and around Michigan are discussed and a model for southwest Michigan is introduced.

Chapter five is a detailed presentation of the botanical data from the five sites in this study. Pollen data from Wymer West is briefly compared to new pollen data from Moccasin Bluff. An analysis is performed using the ecological model from Rindos resulting in regression models for the data from Wymer West and 20SA1034. Regression on botanical remains from these sites was performed as well as regression for all subsistence remains (faunal and botanical) to look at the proportion of contribution of wild gathered foods to corn and the proportion of all botanical remains to all faunal remains at each site.

Chapter six presents the conclusions drawn from the analysis of the new data from Moccasin Bluff and the other sites. The chapter ends with a discussion linking microenvironmental studies to cultural studies between regions to distinguish previously invisible constraints in prehistory. This discussion leads to the recommendation of a new model for southwest Michigan and the southern end of Lake Michigan.

Chapter 2

The Transition Between Gathering and Horticulture

Domestication, Horticulture and Agriculture

Domestication is a slippery word and carries with it different connotations depending on its use in biological or cultural terms. Domestication refers to animals as well as plants. In most regions of the world the domestication process happened simultaneously with pastoral and agricultural cultures developing in tandem. There are many examples of plant and animal domestication from the Fertile Crescent in the Middle East, the Sudan in Africa, and the Andes in South America (Cowan and Watson 1992). North America is unique in that no large game animals suitable for domestication inhabited the region. However, several plant species were undergoing selective pressure by prehistoric peoples. Selective pressure is evident in species due to a thinning of the seed coat and enlargement of the fruit (Asch and Asch 1987, 1980, 1982; Gremillion 1993; Simon 2000; Smith 1992a, 1992b, 1989, 1985; Smith and Cowan 1987; Wagner 1987).

The word "domesticates" or the concept of domestication is often confusing when sorting out genetic alterations marking full domestication. Some of the starchy seeds found in archaeological contexts such as maygrass (*Phalaris caroliniana*), erect knotweed (*Polygonum erectum*), and little barley (*Hordeum pusillum*) do not appear morphologically different from modern wild counterparts. These species have been found in archaeological contexts outside their modern geographic range (Fritz 1990) indicating they were intentionally selected for and intentionally cultivated (Asch and Asch 1978, 1980, 1982; Smith 1985; Yarnell and Black 1985). However, no phenotypic change occurred. Plants that have undergone phenotypic change in the enlargement of fruit or thinning of seed coat, such as chenopod (*Chenopodium berlandieri*) or sumpweed (*Iva annua*), are considered to be domesticated (Fritz 1995; Smith 1992; Smith and Cowan 1987; Gremillion 1993). Thus some indigenous plants were cultivated and not domesticated while others were domesticated but not necessarily cultivated in large fields. Either situation indicates humans manipulating plants in the environment to fulfill a cultural need.

In reviewing the available literature, there is much confusion between the words and concepts attached to "agriculture" and "horticulture." Some authors use these words interchangeably and other authors strictly delineate between the two. "Agriculture" is often used when referring to large-scale intensive farming activities involving fields. In archaeology the term "agriculture" is typically reserved for corn agriculture (Asch and Asch 1980; Bettarel and Smith 1973; Fitting and Cleland 1969; Fritz 1992, 1994, 1995; Galinat 1985; Garland et al. 2001; Wagner 1986). "Horticulture" is often employed to describe small garden plots or the evidence of indigenous domestication of sunflower, marshelder, and chenopodium (Asch and Asch 1978, 1982; Gremillion 1993; Schroeder 1999; Simon 2000; Smith 1992b). It is now recognized that North America was a center for indigenous domestication. Chenopod, sumpweed, and sunflower have been found in small home garden or horticultural contexts and likely played a significant role in subsistence since ca. 500 B.C. (Smith 1989, 1987; Fritz 1990; Ford 1985).

The dichotomy of agricultural field (large) verses horticultural garden (small) also needs to be addressed. Often scholars estimate prehistoric yields from fields based on early Euro American farming practices that were assisted by the plow or on written his

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historic accounts from first hand estimates of field size or crop yield size. Schroeder (1999) systematically examined historic documents and compared the estimated size of fields and crop yields to Department of the Interior census information. She found the size of fields and yield per acre were greatly over-estimated by many of the historic observations when compared to census information. She concluded that average field size for "historic Native American groups who did not have plows are .59 acre" (1999:512). This means that some groups had much larger *or possibly* smaller areas under cultivation depending on their location and subsistence activities. Estimates for field size and yield appear to be much less than previous archaeologists envisioned for agricultural activities. Schroeder adjusted down the percent of families' annual caloric needs obtained from the size of fields/garden that indicate agriculture (Rindos 1984; Bronson 1977; Cohen 1977) from 33% to less than 20% (Schroeder 1999). By the Middle Woodland period mixed horticultural garden activity would have been well established (Ford 1985). Depending on the region and the culture, mixed horticultural garden activity can be considered agriculture (Ford 1985; Fritz 1990, 1995; Simon 2000; Smith 1989, 1992b).

The knowledge that prehistoric peoples east of the Mississippi were engaged in indigenous domestication of starchy and oily seeds before the adoption of corn agriculture is important. Evidence for prior indigenous domestication reinforces the fact that prehistoric humans' had an intimate relationship to their immediate environment. Understanding social and political mechanisms influencing cultivation practices historically and prehistorically in various regions is a foundational step for paleoethnobotany in the identification and interpretation of subsistence practices in the f

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archaeological record. According to Ford " the transformation of agricultural activities from mixed crop gardens to larger corn fields after A.D. 800 was based on cultural interaction and not simply maize" (1985:353). Readers of the available literature on prehistoric people's activity with plants should remember that most of the activities were focused on the level of horticulture and mixed gardens. Clarification of this point is necessary to understand the physical and cultural environment in which the tropical domesticate *Zea mays* (corn) was introduced into the eastern United States and ultimately adapted for growth in the northern latitudes of the Great Lakes Region.

To summarize, what was originally referred to as corn agriculture is more appropriately corn horticulture in southwest Michigan. Field or garden size varied in prehistory in eastern North America and the Great Lakes Region. Because cultivated species are found in scant quantities in southwest Michigan, the area under cultivation in prehistory is more appropriately referred to as a garden and not a field. I will demonstrate that true agriculture in southwest Michigan probably did not develop until just prior to or during the early historic period. Instead, horticulture seems to have been practiced to varying extents.

Introduction of Corn into the Eastern United States

Across the Great Plains

In order to understand how 8-row Northern Flint corn became genetically adapted for growing conditions in the northern latitudes it is necessary to understand the route along which corn passed from Central America to northeastern North America. The coevolution of corn and humans extends back at least 8,000 to 15,000 years (Galinat

1985). Because of its ability to adapt to a wide range of climate, elevation, varying day length, and varying supply of water, corn evolved into hundreds of races. It is theorized that corn must have been originally adapted to the daylight and long growing season in Central America where it is originally found. Humans were not only selecting traits in seed that would allow for various altitude and growing seasons, they also selected for seed traits such as larger cobs, cobs that do not easily rot in dampness, and large kernels. In order for corn to spread northward into the arid southwestern United States both adaptation of corn and human technology must have taken place (Galinat 1985).

Maiz de Ocho, which is thought to be the New England Flint race of corn, originated in the Southwest. A hybridization of Chapalote and Harinoso de Ocho in the southwest created a race called Pima-Papago. This modified 8-row cob diffused through multiple pathways from the southwest and across the Central Plains probably in riverine areas. Harinoso de Ocho is found to have had genes for pre-adaptation to higher elevations and/ or more northern latitudes (Galinat 1985; Wellhausen et al. 1952). The Pima-Papago hybrid characteristically had large broad kernels on cobs of 8-rows. It is uncertain where the trait of broad kernels derived from because the 8-row trait is primitive before hybridization. However, "Maiz de Ocho derived from the Southwest had a broad genetic base involving various amounts of Chapalote germplasm derived through its hybrid, Pima Papago" (Galinat 1985: 266).

Chapalote, which was instrumental in the hybridization of Maiz de Ocho, is a 12 to 14-rowed popcorn. It is thought to be responsible for the tillering habit of 8-rowed corn that allows for later pollination due to possibly wetter seasonal conditions. In emergent Mississippian and Early Mississippian cultural components found in the

American Bottom area, high proportions of cobs are found to have 10 to 12 rows (Parker 1986). Further to the south in west-central Alabama, The Moundville I phase (900-700 B.P.) maize assemblage is dominated by 10, 12, and 14-rowed cobs. The mean row number is 11.0, which does not reflect the Eastern 8-row complex (Scarry 1986; Steponaitis 1983). Midwestern 12-row is the type designated to describe assemblages with high row numbers and other accepted traits from the primitive Chapalote race (Fritz 1990). According to Fritz, 10 to 12-rowed cobs found in the central Mississippi Valley are probably typical of most of the Eastern Woodlands with the exception of the Fort Ancient and Owasco regions where 8-row cobs dominate (1990:409).

One hypothesized avenue for corn to reach the eastern United States from the southwest is the spread of Maiz de Ocho through the Rio Grande valley at ca. A.D. 370. Moving through the canyons of northeastern New Mexico and southeastern Colorado prehistoric human populations may have carried corn seeds with them to be propagated along a northeasterly route through various canyons leading to the Pirgatoire River and on to the Arkansas River area and eventually to the Mississippi, Missouri, Platte, and Ohio rivers (Galinat and Campbell 1967). This route takes into consideration that the thick prairie sod of the plains region was impenetrable prior to the steel plow (Galinat 1985) so planting was limited to river floodplains.

The central Ohio River Valley is a region in which 8-row maize is found ca. A.D. 300. Mean row numbers in assemblages from the Fort Ancient culture in this region consistently average 8-rows, 85-90% of the time (Fritz 1990; Wagner 1986, 1987). It is concluded that Eastern 8-row/ Northern Flint maize evolved in the northern Midwest or Northeast area (Doebley et al., 1986; Wagner 1986, 1987). While 8-row Northern Flint is th

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is the dominant race found east of the Mississippi and especially in the northern latitudes, it does not appear to be connected with the emergence of the Mississippian culture throughout the Mississippi River Valley. Eastern 8-row maize is also not associated with hierarchical settlement patterns of chiefdoms located in the south, which resemble the Mississippian culture. The dominant race is Midwestern 12-row maize for hierarchical southern chiefdoms (Fritz 1990).

Northern Boundary for Corn in the Southeastern Great Lakes Region

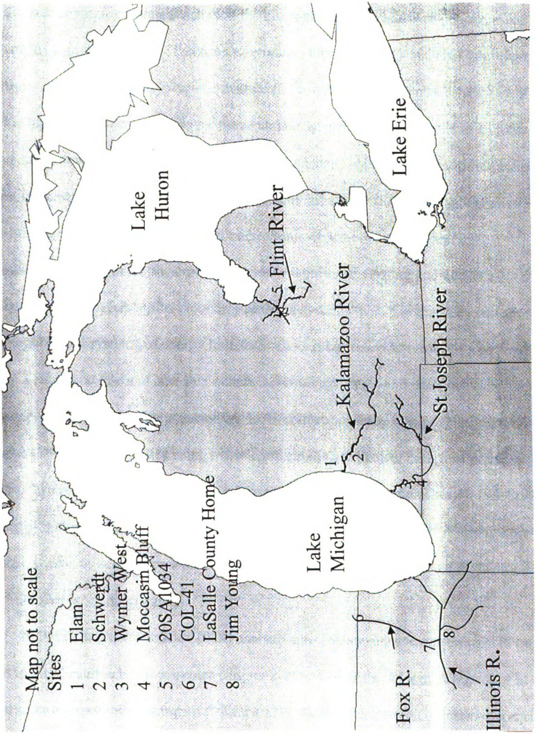
The northern boundary for corn cultivation is somewhat unresolved but better understood in southern Ontario and the New England states to the east of Michigan. Problems arise in the lower Great Lakes Region from the lack of corn at sites in unambiguous contexts earlier than A.D. 1000 (Crawford et al. 1997). Fortunately, AMS dates on corn remains have resolved some of the problems. It is now generally accepted that corn was under cultivation as a crop in the Lower Great Lakes region, including Ontario, Canada by A.D. 1100 (Crawford et al. 1997). AMS dates in southeastern Michigan and southern Ontario have securely dated corn in contexts as early as A.D. 780 at the Grand Banks site, which is located between Lake Ontario and Lake Erie (Crawford et al. 1997). Pollen core information from Gignac Lake, Ontario identifies the presence of *Zea mays* but no pollen grain count is given (Holloway and Bryant 1985). Other sites in the region that have radiocarbon dates from charcoal *associated* with corn are Sissung (A.D. 780), Gard Island 2 (A.D. 670), Indian Island 4 (A.D. 670, 650), and the northern most site Dawson Creek (A.D. 650) (Crawford et al. 1997).

Northern Boundary for Corn Around Southern Lake Michigan

Sites located in the southwestern boundary of the Great Lakes region that have AMS dates from kernels or cupules are the Crane site (A.D. 630) and Holding site (A.D. 0, 60), both located in west central Illinois (Crawford et al. 1997). The Crane and Holding sites are close to Cahokia, which is thought to have been a center for corn agriculture during the Mississippian era. Jeske (1992) reviewed three Illinois sites located to the north on the Illinois River and Fox River (Figure 2-1). The LaSalle County Home site, located on the Illinois River, provided dates of A.D. 938 and A.D. 735 for feature 18 and Jeske (1992) notes that corn was found exclusively in association with this Late Woodland feature. The Young Jim, site also located on the Illinois River and dated ca. A.D. 1000, has a low density of corn occurring. The COL-41 site located much further north on the Fox River in Illinois is dated ca. A.D. 700 through associated pottery types. No corn was found at this Late Woodland site. Jeske notes the lack of the indigenous horticultural complex at all three sites. He concludes that economic security was obtained through broad spectrum use of wild resources and that corn was not an important part of subsistence by as late as A.D. 1000 (Jeske 1992). He suggests that Mississippian sites, located in the large Mississippi River Valley, are the location of permanent villages. Site organization suggests more complex sociopolitical organization allowing for coordinated large-scale agricultural activities than sites in the north (Jeske 1992:62).

Figure 2-1

Sites in northern Illinois and southwest Michigan



Late Prehistoric Settlement Pattern Model

A subsistence-settlement model developed by Fitting and Cleland (1969) emphasizes ecological characteristics of the biotic provinces and the co-adaptation of humans living within them. The biotic provinces of interest are Canadian, Carolinian, and the wide transition zone between the two (Figure 2-2). Fitting and Cleland (1969) use the biotic provinces as a base for the model because they are interested in animals and plants adapted to each province that provide subsistence for indigenous cultural groups, which indicate cultural adaptations to various ecological settings. "We can visualize a cultural adaptation as a vast number in interrelationships between man and his surrounding environment, physical, biological and cultural" (Fitting and Cleland 1969:291). Briefly, this model is loosely based in systems theory in that they discuss studying isolated systems of energy transfer such as subsistence activities of a particular family. Fitting and Cleland note that culturally social dynamics and trade networks were altered during the early historic period by the introduction of the European economic network (1969). They justify using historic information to project back into prehistory because "we recognize this alteration and can control for it in a general way" (1969:292). Settlement pattern and site composition are their basic criteria to be met. Variables are site size, season of occupation and site specialization focusing on gendered division of labor (i.e. sherds vs. debitage).

In the Fitting and Cleland (1969) analysis the Chippewa pattern is thought to be found in the Canadian biotic province (Figure 2-2) and consists of large village sites in the summer occupation focusing on fishing and hunting. The division of labor was equal between men and women. Winter sites would also be equally balanced in the division of labor between sexes but small in size. Small extended family units focused on hunting for subsistence. The Ottawa pattern is thought to be found in the Carolinian-Canadian biotic province(Figure 2-2) and consists of large and small village sites in both summer and winter. Division of labor is unbalanced between the sexes and agriculture and hunting are the primary subsistence activities in the summer. In the winter hunting is the primary subsistence activity. The Miami/Potawatomi pattern is hypothetically found in the Carolinian biotic province (figure 2-2). Village size is hypothesized to be large in summer and winter with a balanced division of labor between men and women. Summer subsistence focused on agriculture (presumably corn?) and hunting and winter subsistence emphasized hunting with some agricultural activity. According to Fitting and Cleland agricultural products are perishable so few remains will be found archaeologically (1969).

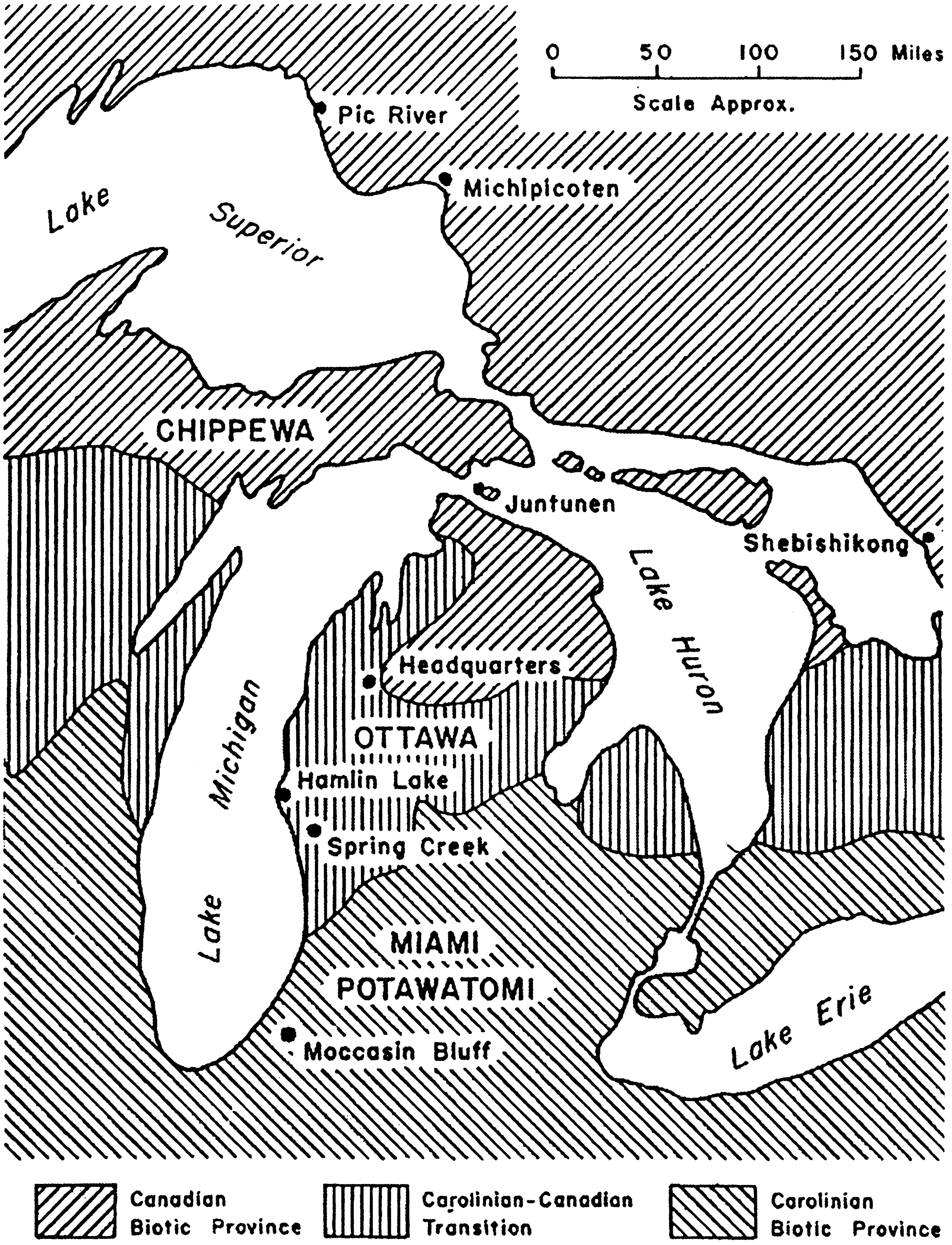
The Fitting and Cleland (1969) settlement/subsistence model may be flawed from the beginning when they assume that early historic culture is not much different than late prehistoric culture. They acknowledge that European economics influenced early historic indigenous cultures. No attempt is stated in the model as to how this variable can or should be controlled although they claim they are able to do so. Ultimately Fitting and Cleland simply project back into prehistory and ignore ecological, botanical, and archaeological evidence that does not fit their model. One example is lack of corn remains and other material artifacts such as grinding stones for sites in southwest Michigan.

One limitation they acknowledge in this backward projection is that late prehistoric patterns are based on agriculture and exchange of products across ecological

Figure 2-2

Biotic Provinces

Fitting and Cleland Model (1969)



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boundaries. For this theoretical model to work *there must be agricultural adaptation as the primary subsistence strategy and a system of product exchange.*

In summary, little is known about the northern boundary of corn cultivation centering on the southern part of Lake Michigan. Thanks to AMS dating of kernels and associated plant parts, we can confidently indicate when corn is found in cultural contexts at the northern limits of hypothesized cultivation but, unless a permanent village and fields are located or other material evidence associated with cultivation is documented, it is impossible to know if corn was grown at a site or acquired by means of trade with cultures located further to the south. Given the intrusion of Upper Mississippian culture into Late Woodland contexts in southwestern Michigan, it is logical that Mississippians brought corn for planting and trade when expanding their settlements into the area. Due to the Upper Mississippian intrusion, the lower Great Lakes Region in general, and more specifically the southern end of Lake Michigan, appear to be an interesting place to sort out and understand the acceptance and eventual adoption of corn agriculture by humans. To do this we must understand the various models for the adoption of agriculture.

Models for the Origin of Agriculture

Various models for the adoption of agriculture have been put forth by scholars. Each model approaches the subject from a different viewpoint. In an effort to develop a new model for southwestern Michigan, I will review four general origins of agriculture models, which take into account points salient to the adaptation of agriculture in southwest Michigan.

Model for population pressure

From her experience with Asian rural cultures, agricultural economist Ester Boserup (1965) proposed a model for the origin of agriculture. Her model (Table 2-1) uses population pressure as an independent factor for the stable and continuing intensification of land use leading to agriculture. Boserup's typology of agricultural stages, which result in increasing frequency of land use are; forest fallow, bush fallow, short fallow and annual or multi cropping. Using fire to burn trees and underbrush in a plot of land is the method of preparation for *forest fallow*. At this time no further land preparation is needed and digging sticks are sufficient for planting crops. Once the plot has been used enough to deplete the soil of nutrients the plot is left uncultivated for several generations until secondary succession forest species have become re-established. *Bush fallow* is a system in which the soil from a plot of land depleted of nutrients is left unused until underbrush and shrubs become re-established. This could be for a period of up to eight years. Because this system encourages the growth of various grasses with dense root systems, roots are difficult to remove and require a hoe. Grasses and edge habitat are established with this type of fallow system, which, also encourages herbivorous animals to take advantage of the fallowing plot for food resources. *Short fallow*, annual, and multi cropping all require the use of a plough and techniques for fertilization.

Boserup bases her logic about decreasing fallow on "the assumption that the transition to more intensive systems of land use took place in response to the increase of population within a given area" (1965: 28). It is her experience with tribal cultures in Asia and Africa that communities almost never used bush fallow if secondary forest growth was available to clear (1965). She further notes that under the forest fallow system the type of crop that is grown is usually different than the crop grown under a short fallow system, indicating a strong degree of cultural crop preference. According to Boserup, crops planted under short fallow are usually cereals, which require less labor but also yield less per acre. She concludes the difference between forest fallow as defined above and the short fallow system is that forest fallow requires less human labor (1965).

This model does not postulate that larger human populations require more intensive land use. Instead Boserup provides two assumptions that are met which enable a changeover to intensive land use. The assumptions are 1) technology is available to people, which enables more intense land use and 2) the potential farmers or horticulturalists are constrained by the amount of time and labor they are willing to devote to the intensification of land use. In other words, horticultural activities leading to agriculture will not intensify until a culture is forced to change through a combination of population pressure and increasing scarcity of land (Boserup: 1965, Bronson: 1977). The incentive of population pressure creating a decrease in available land creates the motivation to participate in activities leading to agriculture. This model lays the groundwork for others who later posit that hunting and gathering is less labor intensive and is a more economical use of time (Cohen 1977). Thus, intensification of agricultural activity is viewed as a response to population pressure on land but not necessarily population increase in an individual culture.

Model for population pressure and instability

Bronson (1977) lists four factors that transform hunter/gatherers into agriculturalists in his general model of opportunity (Minnis 1985). First there is some pre-existing technical knowledge of plant reproduction. Second, people have to act on the idea of future gains as opposed to immediate gains. These two factors are similar to Boserup's model and the decreasing time of fallow. Third, Bronson argues location can be a positive or negative constraint. According to Bronson, a positive constraint is a natural resource located in the immediate vicinity of occupation. A negative constraint is marginal climate or impoverished environment; a condition, which makes a place undesirable for human habitation. Fourth, a desirable botanical commodity is one in which scarcity is created when a group is under a locational constraint. According to Bronson, a locational constraint is created if a group of hunter/gatherers are not permitted to move according to their seasonal subsistence needs. Bronson does not accept increase in population as a sufficient explanation for increase in agriculture. He uses the term demographic pressure, to indicate a density, distribution, and possibly a qualitative function in his model.

Bronson (1977) explains several possibilities cultures use to target certain plants in their environment for horticultural activities leading to cultivation and ultimately agriculture (Table 2-1). He says many factors enter into decisions about subsistence. These factors can relate to cultural perceptions of, for example, risk minimization or prestige within a larger system. He suggests that population decrease due to high infant and/or elderly mortality rate could make it advantageous for a culture to become sedentary. Women with children and the elderly would adopt horticultural activities and others would continue hunting and gathering activities. Bronson concurs with Boserup's explanation that agriculture could be a response to population pressure and the need to increase the carrying capacity in a prime resource location. Finally, Bronson (1977) theorizes that cultures ultimately manipulate resource plants in an effort to minimize risk and buffer against times of scarcity (i.e. instability).

To flesh out complexity and feedback, Bronson reduces the role of demographic pressure to the status of just another variable. Demography is viewed in the same context as locational constraint and environmental constraint. Bronson's constraints are based on a prehistoric culture's *perception* of what constitutes a constraint. Cultivation only indicates that useful species have been deliberately caused to reproduce by humans (Bronson 1977) and agriculture is the substantial dependence on plants intensively grown by humans. Bronson (1977) argues that *cultural perception* in subsistence decisions such as cultivation or agriculture is most certainly subjective, but nonetheless plays a major role in decision- making. Only by ignoring the subjective nature of cultural perception and by focusing on the concepts of cultivation and agriculture can Bronson explain complexity and feedback between agriculture and demography (1977).

Bronson generates several sub-models to examine constraints. One of his sub-models is particularly interesting. He gives the example of a fishing lagoon on an otherwise unproductive coast (Bronson 1977). In Bronson's example a culture moves from a coastal fishing region, which is becoming unproductive to a lagoon that is alive with fish, as well as, containing other diverse aquatic resources. This is a provocative example when considering prehistoric exploitation of riverine and aquatic environments in southwest Michigan. Is the intrusion of Upper Mississippian peoples into southwest Michigan the result of cultural feedback manifest in ecological constraints? Questions revolving around cultural feedback involving perceptions of availability or scarcity could be investigated. Did Upper Mississippians come to southwest Michigan because the region they came from was depleted of staple resources? Did they find new staple resources in southwest Michigan that were worth coming back for every summer? This is one example of complexity and feedback generating new sub hypotheses to be tested.

Model for population pressure and equilibrium

Cohen (1977) views prehistoric people as good ecologists in his description of the process of domestication. From unintentional propagation of seeds by accidental re-sowing while gathering seeds or discarding parts of fruits while eating to distribution of seeds in feces, prehistoric people were aware of how to get plants to grow without direct human participation. The continuum of wild gathered seeds and plants to domesticate is not hard to visualize (Cohen 1977), indicating the transition between hunting and gathering and agriculture probably lies somewhere in the middle.

Cohen discusses benefits of moving from an economy based on gathering to one of agriculture in marginal environments. He cites studies based on modern hunter/gatherers that indicate their diets are balanced even in the marginal environments, which they have been forced into (Cohen 1977). Prehistoric hunter/gatherers had their choice of prime ecological niches to occupy. Additionally, he argues the very complexity of a plant community in a given environment buffers against ecological disaster (Cohen 1977). Complexity means there will always be some edible parts of a variety of plant species available and it insures that droughts, fires, or other natural disasters will not wipe out all potential food resources. By replacing a complex natural plant community with agriculture, diversity in diet breadth is reduced and the food supply becomes unprotected from natural disaster (Cohen 1977).

According to Cohen, labor invested in agriculture is more costly than labor invested in gathering. He cites a study in which hunter/gatherers in marginal environments invest a fraction of their time in gathering activities compared to time required for agricultural activities. From this Cohen concludes agriculture does not produce the copious leisure time that hunting and gathering does. If agriculture reduces diversity and diet breadth, reduces reliability of species during times of natural disaster, and is more labor intensive, Cohen asks the question "What does agriculture actually accomplish?" (1977:141). The only gain in his opinion is that agriculture increases the carrying capacity of a piece of real estate in a particular unit of time. In his opinion the only reason for agriculture is "in response to a situation of need resulting either from population growth or from resource degradation" (1977:141).

Cohen defines a general model of necessity for the origin of agriculture based in systems theory, in which population pressure causes a continuous modification of adaptive strategies (Minnis 1985). In this model cultures have a choice of several strategies at any given point in time. Cohen determines that the best adaptive strategy in the long run is the intensification of resources through the adoption of agricultural techniques (1977). Other adaptive strategies either lead to evolutionary dead ends or eventually lead to the adoption of agriculture (Cohen 1977). While the goal of populations may be to maintain equilibrium between a population and resources, new equilibria are continually redefined. Cohen places several caveats on the rate of population growth, which are culturally determined. They range from a culture needing a larger population (possibly for defensive purposes?) and the prestige of large families to the practice of infanticide to control the population. Thus, according to Cohen, certain levels of agricultural competence may change biological or cultural values (1977).

Model of Coevolution

The model of coevolution, proposed by Rindos (1984), is based in complexity, feedback, and the continuum of change/stability (Table 2-1). The yardstick he measures evolution with is reproduction and fitness of a species; species may include human, animal, or plant species. Rindos defines coevolution as a process in which the establishment of a symbiotic relationship between organisms changes the traits of organisms and increases the fitness of all involved (1984). According to Rindos, symbiosis can be described as cooperation, whether it is acknowledged or not acknowledged by each agent. Rindos argues that coevolution is not a cause of agriculture (1984); however, it provides the potential for agriculture to arise opportunistically. He defines agriculture as human environmental manipulations within the human coveolutionary relationship with plants (1984). This is a broad definition, which includes cultivation and agriculture together. It further indicates that human culture provides a mechanism for the transmission of knowledge regarding Rindos' symbiotic relationship between humans and plants and that the human/plant relationship is dependent on the *total* environment in which both parties exist. Because the total environment is infinitely complex, a web of complexity and feedback is automatically created by his definition.

The Rindos model is based on models from ecology emphasizing abundance and the fact that the interaction between humans and domesticated plants causes an increase in the occurrence of domesticates in the archeological record over time. Further, the relative proportion of domesticates to wild edible plants continues to grow exponentially after a certain point in time.

Rindos' model demonstrates the rate of change between domesticate species and wild plants and their relative contribution to a culture's diet, as identified through their abundance in the archaeological record. The first part of this model deals with the increasing abundance of domesticates in the environment, which are found in the archaeological record. Because of their relationship with humans, domesticates have a larger rate of increase when compared to wild species. Initially, the contribution of domesticates to the diet is very low and increases with time. By measuring the abundance of a domesticate in the environment, the contribution to diet can be assessed without dealing with exact rates of evolutionary change of the domesticate. This model shows a mathematically logical way to understand the increasing contribution of domesticates and the decreasing contribution of wild plant foods in a diet (illustrated in Chapter 5). The model also considers the relationship between fitness of individuals in a population, domestication, and different types of agricultural traditions.

Rindos' model clarifies some of the following dynamics of domestication (Rindos 1984):

1) Negative feedback from incidental domestication lays the groundwork for specialized domestication.

2) Any kind of domestication (intentional or unintentional) encourages the full utilization of available resources, which increases diet breadth.

3) Domestication is not the cause of population growth. It is assumed that *all* resources are used at the highest rate possible. This implies a slow rate of evolution for domesticates because initially they are not used preferentially over other food. Relative contribution to total diet is an important factor here.

His last point is emphasized by understanding that a change in eating patterns and strategies must take place in order to move from consuming all wild plant foods to consuming protodomesticates and so on. This implies that 1) the total plant resource base was not limited and 2) denies population pressure as the impetus to domestication.

Summary and Discussion of Models

A chart comparing the models is found in Table 2-1. A brief description of the main points and assumptions are listed for each model. While all of the models have positive attributes there are some outstanding questions raised with closer inspection.

Table 2-1

Chart of Origin of Agriculture Models
According to publication date

Model	Main points (MP) of model and Assumptions (A)
Boserup (1965)	(MP) Increasing frequency of land use. (A) Technology available. (A) Time and labor constraint.
Bronson (1977)	(MP) What is culture's perception of a constraint? (A) Demographic pressure constraint. (A) Location and constraint. (A) Environmental constraint (Scarce desirable botanical commodity).
Cohen (1977)	(MP) Complexity buffers against ecological disaster. (MP) Agriculture reduces diversity and breath of diet. (A) Agriculture is always the adaptive strategy.
Rindos (1984)	(MP) Coevolution is dependent on total environment. (MP) Coevolution causes increase of domesticates over time. Increase is exponential after a certain point. (A) Humans and plants are co-evolving in their environment (A) Always the potential for agriculture to arise opportunistically. (A) Prehistoric agricultural fields are an average size.

Bronson builds on Boserup's model but he changes the key concept of population pressure to demographic pressure, which seems to add additional layers of growth, distribution, and density of a population. He further adds the concept of constraints, both positive and negative. It is, however, hard to envision a positive constraint (limitation), and his main point, regarding what a culture's perception of a constraint is, seems unanswerable. According to Bronson, adoption of agriculture is a way to minimize subsistence risk. When considering all the reasons a crop can fail (disease, insects, drought, fire, wind, temperature), how can dependence on one or two crops be considered risk minimization? Cohen, however, takes the opposite approach and says that natural plant communities have built in buffers against ecological disaster. He argues that agriculture reduces subsistence diversity and, in Cohen's opinion, for a culture to be adaptive they must adopt agriculture. According to him all other strategies are evolutionary dead ends. However, he also fails to answer his main question: what does agriculture really accomplish?

The early models are based solely in theory without reference to real data and how to apply the model to real data. The "classic" models based in systems theory are still in use today by archaeologists (Cowan and Watson 1992). Alternatively, the model by Rindos takes into account real world data. To test his model it is necessary to convert data to abundance values. Rindos' model is based on symbiotic relationships and increasing fitness for all involved. It is impossible to know all interrelated aspects of symbiotic relationships. Since coevolution is dependent on the total environment, the question can be asked: what if fitness for one or more organisms in the symbiotic relationship is not increased and only one organism benefits from the situation? In another part of his model, Rindos assumed that all cultures have the same average field size and at least 33% of their diet comes from agricultural products. Schroeder's (1999) study of ethnographic and historic data on Native American garden size found the average garden to be a little over half an acre. This translates to agricultural products contributing < 20% of total dietary needs for a family of five.

The early models of Boserup (1965), Cohen (1977), and Bronson (1977) clearly lay a theoretical foundation from which to apply a data based model such as the Rindos model. Since the earlier models were proposed many new technologies have been developed. Flotation and botanical analysis is now a regular part of all archaeological investigations. Microscopic carbonized seed, nut, and charcoal identification, are important techniques in learning the subsistence practices of a prehistoric culture. Clues to prehistoric landscape use can be found in the analysis of the non arboreal pollen (NAP) and microscopic charcoal residue in pollen cores. The development of Accelerator Mass Spectrometry (AMS) dating has helped to securely date botanical remains in archaeological features and pollen cores.

Using the above models as a foundation to investigate the Late Woodland adaptation to corn agriculture in southwestern Michigan along with new and updated technology to help create new types of data, I will examine new botanical and palynological evidence from the Moccasin Bluff site to look for evidence in support of the large agricultural village expected in the Fitting and Cleland model. I will further examine how Moccasin Bluff and Wymer West fit into the late prehistoric subsistence system in southwest Michigan by comparing them to the Elam and Schwert sites on the Kalamazoo River.

Chapter 3

Ecological Context of the Great Lakes Region

Choices that prehistoric people made can only be judged by the perceptible options at a given point in time. In order to understand the options and constraints on Late Woodland and Upper Mississippian cultures, it is necessary to understand how the environment in southwest Michigan came into existence and how it has changed through time. The archaeological record reveals the evolution of a site; the ever-changing environment poses constraints and options. According to Rindos (1984) this represents the distinction between evolution (the result) and selection (the means). To really fully understand the difference it is important to understand the creation of the Great Lakes Region in general.

The Great Lakes region can be described as an area "largely contained within the 75^{th} and 93^{rd} parallels between 41 and 50° north latitude" (Mason 1981:55). The Great Lakes region is situated between the Cordilleran Highlands and the Labrador Plateau in an area known as the east-central part of the Great Central Lowlands of North America. The land around Lake Ontario is the lowest in elevation, averaging only about 150 meters above sea level, and the rest of the region surrounding the Great Lakes averages 300 meters or less above sea level. The lakes drain through the Labrador Plateau by way of the St. Lawrence lowlands (Mason 1981).

While the lakes are fairly recent features, the region itself was carved from very old rock formations. As a result of many glacial advances and retreats the rocks exposed in the northern reaches of the Great Lakes region are of Precambrian age. Much younger rocks of Paleozoic age (570 to 225 MYA) underlie the rest of the region. These rocks consist of limestones, dolomites, sandstones, and shales, as well as some deeply buried salt beds up to 300 m thick (Dorr et al. 1970, Mason 1981, Voss 1934). The surficial geologic record indicates there were at least four major ice advances and retreats with many interstadials during the past 1.6 million years. All plant life was forced out of the region or destroyed with each advance of ice. In many cases the flora had not yet returned before the next advance. The present Great Lakes themselves are referred to by geologists as a new formation and assumed their present form during the most recent deglaciation ca. 15,000 to 10,000 B.P. (Dorr et al. 1970, Mason 1981, Voss 1934).

The ice retreats were geographically irregular and formed a lobate frontal zone. As a result, ice remained longer in areas where it happened to be thicker. While the ice was thickest in the basin area of the Great Lakes and remained longer, real estate located further north and west had become ice-free. Thus pioneer floras established themselves somewhat earlier in some northern areas compared with some areas further south (Dorr et al. 1970).

Floristic and Biotic Provinces

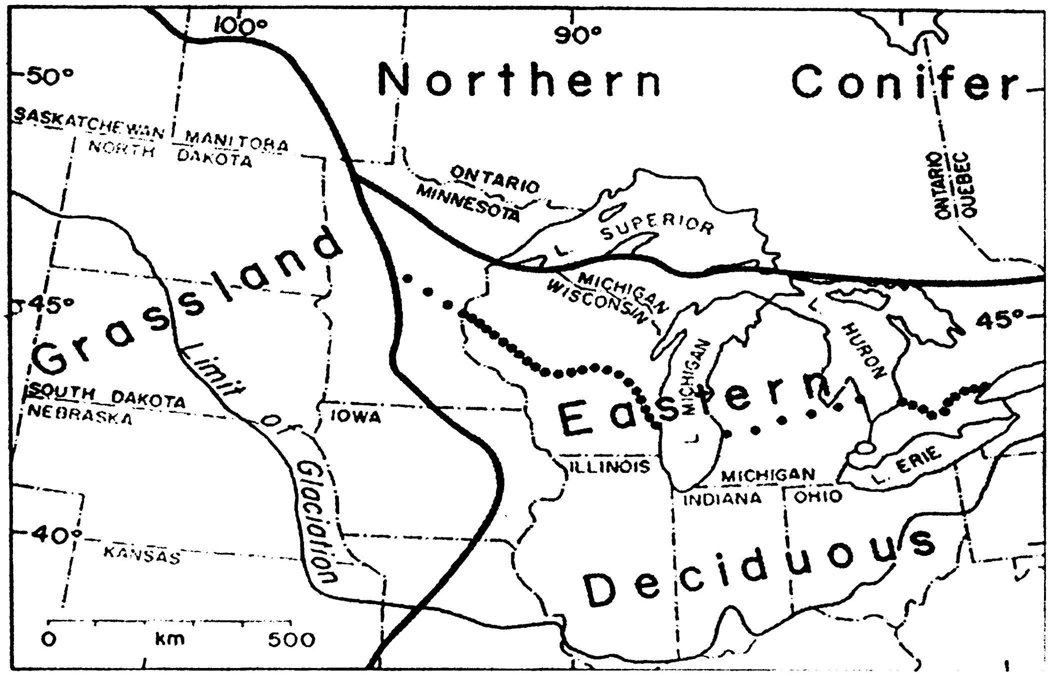
Pollen rain studies are used to reconstruct the flora of a region and to differentiate climatological factors, geographical relationships, and ecological preferences of plants. The flora in the Great Lakes region has often been described by its floristic elements when conveying geographical relationships. Floristic elements can be theoretically defined as "a group of species that share not only a common area of distribution but also a common origin and migratory and even evolutionary history" (Cushing 1965:404).

Climatological factors such as wind, temperature, and precipitation influence species migration routes and geographical relationships. Tolerances of various species in a regional flora can be related to similarities in ecological preferences. More commonly, however, floristic elements are based on the present distribution of species in relation to the area under consideration (Cain 1947).

The Great Lakes region is located within three general biomes or floristic provinces. The floristic provinces (Figure 3-1) are Northern Conifer, Eastern Deciduous, and Grassland province. Plant communities that form the dominant species of the region as well as the prevailing climate characterize these biotic or floristic provinces. According to Cushing "a boundary between two floristic areas is best placed in the zone of highest concentration of range limits of the species in both floristic groups" (1965:403). Floristic provinces represent areas in which floras have reacted to regional environmental factors or environmental gradients. They also provide evidence for equilibrium between the present environment and the distribution of a large number of species. However, plant migration coincides not only with environmental variables but with climatic changes as well.

The density distribution of various species per unit area is pliant and boundaries between floristic provinces are diffuse. According to Cushing (1965) the best-mapped boundary in the Great Lakes region is a "tension zone" in Wisconsin, which separates the Northern hardwoods from an intrusive Prairie-Forest to the southwest (Figure 3-1). This tension zone can be followed across mid Michigan and into southern Ontario. Lines or dots on a map give the impression of a permanent state of existence and can be misleading. Tension zones can be thought of as dynamic but poorly defined ecotones continuously influenced by climatic and environmental factors, which are thus represented by a patchy mosaic that in effect divide two floristic provinces.

Figure 3-1 **Floristic Provinces** Tension Zone(. . . . .) Cushing 1965



Archaeologists recognize three biotic provinces in Michigan, which are environmental areas comparable to floristic provinces in the Great Lakes Region. The northern most biotic province is the Hudsonian, which does not pertain to this research. The other two biotic provinces are the Canadian and the Carolinian (Figure 2-2). A transitional zone runs between the two biotic provinces, which appears to more or less follow the floristic tension zone through the Great Lakes Region (Mason 1981; Fitting and Cleland 1969; Cleland 1966). An awareness of the relationship between the biotic provinces, floristic provinces, and a pliant tension zone is significant because the Fitting and Cleland (1969) settlement subsistence model is based on assumptions about the environment in the biotic provinces.

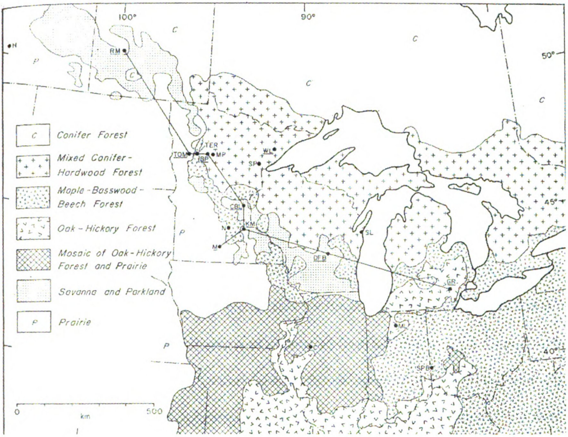
Present vegetation

Present vegetation of the Great Lakes region is classified by its physiognomic formations (Figure 3-2) of grassland, deciduous forest, and coniferous forest. There are two defined tension zones documented to date that span the Great Lakes region. The first is savanna or parkland, which lies between grassland and deciduous forest areas, and the second is mixed conifer-hardwood forest, which lies between deciduous forest and coniferous forest.

The savanna or parkland known as the prairie peninsula (Figure 3-2) is thought to be remnants of two previous intervals of prairie expansion. The first was a result of the last glacial retreat at the time of the Hypsithermal (15-10,000 B.P.). Gleason proposed the second as "resulted from the introduction of prairie fires by the American Indian" (cited in Cushing 1965:408). Borchert also concluded "increased fire frequency was favored by the same climatic changes that favored grassland: thus the importance of fire in pushing back and maintaining the prairie-forest border continues to be recognized" (Curtis 1959:295).

The classification scheme for the mixed conifer-hardwood forest as explained by Cushing "emphasizes the uniformity of a terminal equilibrium state of vegetation (the climax)" (1965:407). However researchers have concluded that species in this region also react to environmental gradients. The result is a mosaic of plant communities with slightly differing floristic compositions. It is clearly difficult to characterize the vegetation of the Great Lakes region with biotic or floristic provinces, which describe only one or two dominant species of the biome. Species that are not dominant can be more sensitive to climate change; therefore, it is necessary to view the environment in a state of flux instead of looking for vegetation climax.

Figure 3-2 **Physiography of the Region** Cushing 1965



Plant Succession in the Region surrounding southwest Michigan

Southwest Michigan lies in the heart of several temporal vegetation shifts including the invasion of prairie grasses. Government Land Office (GLO) surveys indicate this region to be dominated by maple-basswood beech forest with remnant oak-hickory forest and prairie grassland mosaics. Because southwest Michigan is the intersection of several vegetation shifts it is important to understand the vegetation succession surrounding the region in order to visualize the plant succession in southwest

Michigan. Five pollen cores from the surrounding region in Indiana, Illinois, Wisconsin, Ontario and Michigan explicate the dominant vegetation changes.

Williams (1974) identified 3 major temporal pollen zones in a core from Pretty Lake, Indiana, as well as several sub zones (Figure 3-3). Zone 1 was characterized by low arboreal pollen (AP) influx and high non-arboreal pollen (NAP). This portion of the core is dated from 14,000 to 13,300 B.P. Tundra conditions are suggested by the presence of *Eleagnus* and *Saxifraga oppositifolia*. Zone 1b dated to 13,300 to 12,978 B. P. is dominated by black spruce. The lower portion of zone 1c (12,978 to 10,652 B.P.) was correlated with the Port Huron Glaciation and shows a decrease in *Picea*, *Fraxinus* (ash), and *Quercus*. Maximum development of pines and birches is seen in the pollen influx in Zone 2, (10,652 to 9,588 B. P.). Zone 3 has several subdivisions and can be summarized as being dominated by *Quercus* and a decrease in *Pinus* with an increase in NAP at 9,588 to 6,100 B.P. *Fraxinus* and *Ulmus* (elm) dominated from 6,100 to 4,436 B.P. suggesting a mixed mesophytic forest. At 4,436 to 1,685 B.P. oak dominated in an open oak-hickory forest (Zone 3c). Beech-maple assemblages replaced the oak-hickory forest for a short time (1,685-1,670 B.P.) but the oak-hickory forest returned and dominated until forest clearance in historic time

King investigated Chatsworth Bog, Illinois in 1981 (Figure 3-4) (Holloway & Bryant 1985). A 12.7 m core was obtained in which four pollen zones were identified. Zone 1 (14,7000 to 13,800 B.P.) was interpreted as representing either a spruce woodland mixed with tundra or a forest-tundra transition zone. Zone 2 (13,800 to 11,600 B.P.) is characterized by 44% *Fraxinus* pollen and only 2% pine. This suggests a period of slowly increasing temperatures. Zone 3 (11,600 to 8,300 B.P.) was subdivided into two sub-zones (3a and 3b) and reflects a shift from cool-temperate to warm-temperate deciduous forest. Zone 4 (8,300 B.P. to present) is characterized by high percentages of NAP probably due to prairie vegetation that remained dominant once it became established.

An 8.78 m core from Disterhaft Farm bog, Wisconsin, was analyzed by Baker in 1970. Deglaciation was complete by 15,000 B.P. at this site. Between 11,000 and 8,500 B.P. *Pinus* pollen replaced *Picea* and remained dominant until the Hypsithermal period. During the Hypsithermal period (8,500 to 5,300 B.P.) pollen was dominated by *Quercus*, *Ulmus*, and *Ostrya/Carpinus*. From 5,400 B.P. to present the area was dominated by oak forest or oak savanna. Local populations of *Betula* and *Tsuga* appear from 2,850 B.P. to present.

Burden et al. analyzed three cores from Gignac Lake, Ontario, to look at a detailed record of changes brought about by Native Americans and land clearance and later European logging (Holloway and Bryant 1985). Three pollen zones were recognized in the core from Gignac Lake. Zone 3c is dominated by pollen of *Tsuga*, *Pinus*, and *Betula* (12 to 27% each). *Acer* and *Fagus* are present as well as Cupresseaeae and *Ulmus* (3 to 12% each). In this zone over 90% arboreal pollen is present verses less than 10 % non arboreal pollen. Zone 3d is dominated by *Pinus, Betula*, and *Quercus* fossil pollen (8 to 29%). *Tsuga* only accounts for 5-10% pollen in this sub zone. Non-arboreal pollen is dominated by *Pteridium*, which contributes up to 7% in Zone 3d. Gramineae and *Artemisia* contribute 1-3% of the fossil pollen in the lower part of Zone 3d and *Zea* pollen is present but no count is given. The presence of *Zea* pollen is

Figure 3-3 Pollen Diagram from Pretty Lake, Indiana (Holloway and Bryant 1985)

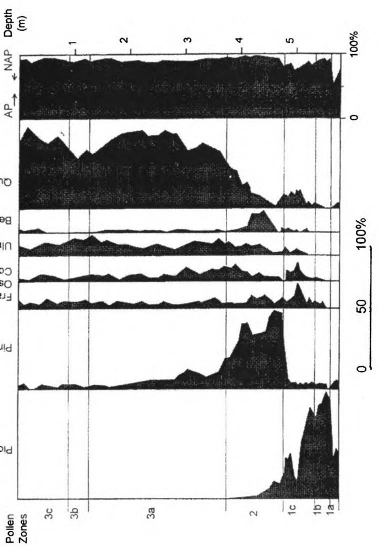
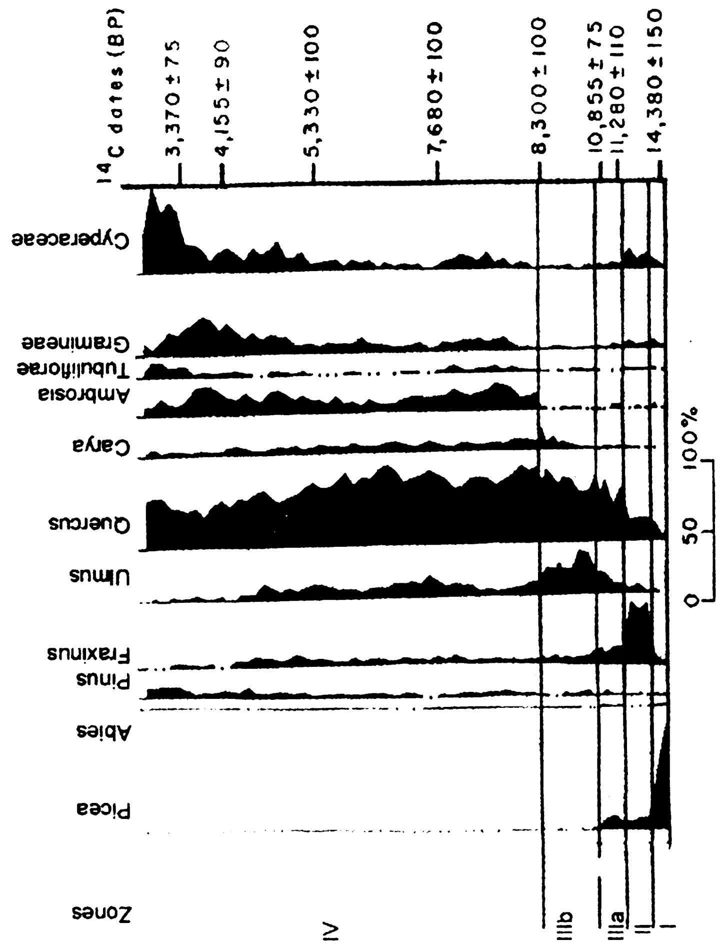


Figure 3-4 Pollen Diagram from Chatsworth Bog, Illinois (Holloway and Bryant 1985)



assumed to represent direct evidence for Native American agriculture in the area. The authors observe that natural forest fires did not produce similar pollen assemblages. Plant successions following natural fires are characterized by the pollen of shade-intolerant plants, which is then quickly replaced by tree pollen. That is not the case at Gignac Lake.

Bailey and Ahern analyzed Chippewa bog, Michigan, in 1981 and the core defined four pollen zones. Zone 1 (10,280 to 9,600 B.P.) indicates spruce/fir forest. Zone 2 (9,600 to 8,100 B.P.) shows an increase in *Quercus* and *Ulmus* but was still dominated by pine. Zone 3 (8,100 to 1,150 B.P.) was divided into three sub-zones in which species changed from an oak-elm-beech forest to an oak-beech-ash forest ending with an increase in pine and a decrease in oak. Zone 4 (1,150 to 550 B.P.) and is characterized by "a pine hardwood pollen assemblage which was probably maintained by periodic fires" (Holloway and Bryant 1985:220).

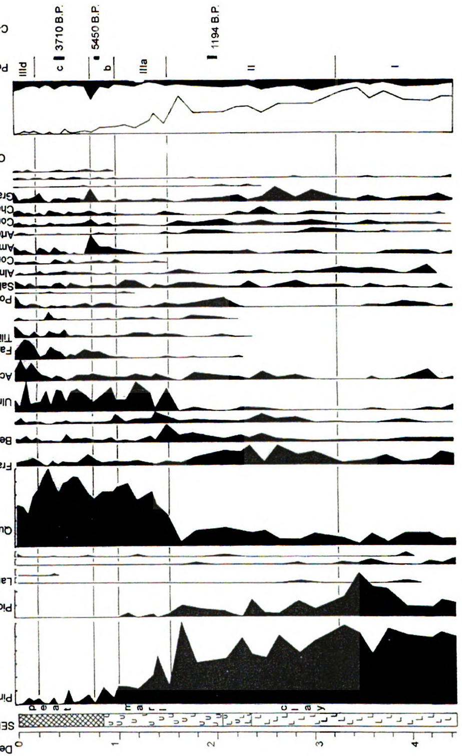
In summary, after deglaciation, tundra covered areas south and west of southwest Michigan. By ca.13,000 B. P. pioneer black spruce forest dominated the region. Pine and birch succeed initial colonization. Sometime after 10,500 B.P. the temperature slowly increased allowing the deciduous forest to invade. At the same time Paleo Indians begin to explore the region. Around 8,300 B.P. prairie grasses invade and dominate where they become well established. To the east in Ontario deciduous forest succeeds pioneering conifers. Non-arboreal pollen quickly increases in Ontario indicating human disturbance, which has added emphasis due to the presence of tropical *Zea mays* pollen at a later date in the NAP.

The Environment in southwestern Michigan

Ahern and Kapp (1990) analyzed a core from Froehlich Bog in Berrien County, Michigan (Figure 3-5). They divided the core into three zones, zone 3 being further divided into four sub zones. During the early post-glacial period (zone 1) the area was a spruce-fir and pine forest with some hardwoods and a low level of non-arboreal pollen. This zone ended at about 13,000 B.P. Zone 2 exhibits a period dominated by pine pollen from 13,000 B.P. to 9750 B.P. Zone 3 gives an indication of the migration of deciduous trees into the region of the St. Joseph River. Sub zone 3a (9,750 to 6,175 B.P.) suggests an early hardwood migration into the area. Sub zone 3a is dominated by approximately 40% *Quercus*, 10 to 15% *Pinus*, 10 to 20% *Ulmus*, and low levels (below 12%) of NAP. Sub zone 3b (6,175 to 5,000 B.P.) is a transitional hardwood sub zone. It is characterized by a slight decline in *Quercus* and increasing *Fagus* pollen. There is increased *Populus* and *Tillia* pollen, and NAP at this time. Sub zone 3c is dominated by a greater amount of *Quercus* pollen (40 to +50 %) and a mixture of other hardwood species. Conifer pollen is rare, suggesting scattered local pine. NAP continues to be significant, which could represent oak openings in the landscape or marsh vegetation. Sub zone 3d represents a change to a Beech-Maple sub zone dated from 2,400 B.P. It is characterized by pollen peaks in *Acer* and *Fagus*. Other significant pollen types are *Tillia, Fraxinus, Populus*, and *Ulmus*. *Quercus* pollen appears to be less abundant.

The climate and environment during the Late Woodland/Upper Mississippian occupation (ca. 1500-500 B.P.) in southwestern Michigan can be described as moister and cooler than previous xerophytic conditions. This is evident by the decrease in oak

Figure 3-5 Froehlich Bog, Berrien Co., MI (Ahern and Kapp 1990)



The climate and environment during the Late Woodland/Upper Mississippian occupation (ca. A.D. 1000 to A.D. 1500) in southwestern Michigan can be described as moister and cooler than previous xerophytic conditions. This is evident by the decrease in oak pollen, with oak being a xerophytic species, and an increase in maple and beech pollen. A close inspection of the Froehlich Bog pollen diagram indicates something more than climatological factors influencing the growth of oaks and maples. Late Woodland and Upper Mississippian peoples may have been manipulating their environment through the use of, for example, prescribed burning of the landscape. This is indicated by an increase in NAP just prior to the historic era. Oak pollen increases slightly at this time and maple and beech pollen decrease. Oaks are known to be a fire tolerant species and maple and beech are fire intolerant. It is reasonable to argue that both cultural and natural factors probably affected the local ecology as reflected in the Froehlich Bog pollen diagram.

Some speculate that Late Woodland and Upper Mississippian maintenance of the landscape through the use of fire could also have encouraged the expansion and maintenance of the prairie peninsula from the southwest at this time. Prairie grass expansion would have created an improved habitat for large mammals. An increase in grass pollen supports this hypothesis (Ahern and Kapp 1990). However, increased root mass of prairie grasses would make significant agricultural activities impossible in southwest Michigan for most open areas with the exception of river flood plains, given prehistoric technology of the Late Woodland and Upper Mississippian peoples. Prairie land was not open to agriculture until the steel plow (Galinat 1985).

The review of archaeological sites from northern Illinois by Jeske (1992) indicates a corresponding pattern. As previously discussed, Jeske (1992) reviewed three Illinois sites located to the north on the Illinois River and Fox River (Figure 2-1). The LaSalle County Home site located on the Illinois River provided a date of ca. A.D. 800 and the Young Jim site dated to ca. A.D. 1000. Both sites had a low density of corn while the COL-41 site located much further north on the Fox River was dated at ca. A.D. 700 had no corn remains. Though corn is found in limited quantities at some Late Woodland and Upper Mississippian sites in northern Illinois, it is not found at others. However, there is evidence for intensive exploitation of aquatic plant resources such as the American lotus (Jeske 1992). Pollen counts from the Chatsworth Bog (Figure 3-4) in Illinois support a pattern of prairie grass pollen and increased oak pollen just previous to the historic period.

Discussion

Early Holocene vegetation in the western portion of the Great Lakes region was characterized by a high percentage of thermophilous deciduous trees. Higher percentages of *Ulmus* might reflect cooler and moister conditions than at present. In Iowa, Van Zant (in Bryant and Holloway 1985) demonstrated that this forest type was short lived and prairie establishment occurred early in the Holocene. The rapid spread of prairie vegetation eastward reached its maximum by 6-7,000 B.P. Deciduous forest appears to have persisted longer in the eastern part of Minnesota. The *Ulmus/Quercus* zone of Kirchner Marsh (located in eastern Minnesota) persisted until approximately 7,120 B.P. At this time western Minnesota vegetation shifted to prairie grassland and much of

Michigan was covered by boreal conifer forest. By 8,100 B.P. deciduous forest became established in southern Michigan while pine still dominated to the north. The eastern region of the Great Lakes was dominated by pine and then succeeded by *Tsuga* by 8,500 B.P. The Great Lakes northern region was still covered by ice and does not have a pollen record until approximately 11,000 B.P. Pollen assemblages for southern Ontario show the boreal forest was established coincident with deglaciation.

During the Lake Algonquin phase of the Great Lakes the presence of Paleo Indians at about 10,000 B.P. is documented at the Parkhill site located in southwestern Michigan (Mason 1981, Shott and Wright 1999). That was a period dominated by *Pinus* and *Picea*. Not much is known about the subsistence practices of the Paleo Indian except lithic evidence that indicates they hunted large game. They probably hunted large and small animals opportunistically. There is no indication in the archaeological record for the exploitation of wild plant foods. However, it is reasonable to assume that berries, tubers, and lichens were exploited, but perhaps not to the same extent as protein resources (Mason 1981, Shott and Wright 1999).

The Great Lakes region does not exhibit a universal response in the mid to late Holocene, when the region became progressively dryer due to less rainfall. Prairie continued to invade Illinois and Indiana. By 5,000 B.P. prairie expansion ceased and *Picea* expanded from the eastern prairie boundary in both northern and southern directions. On other words, at any local point there could have been, and was, species replacement, but regionally this is only exhibited in shifting margins. The Archaic culture period in the mid Holocene was characterized by environmental and cultural change. Early and middle Archaic periods last from approximately 8500 B.P. to 5500

B.P. Fluctuating lake levels are suspected as the reason for few early and middle Archaic archaeological sites (Lovis 1999). Lake water levels for the Great Lakes during the early and middle Archaic were much lower. It is suspected that when the water level raised in the Great Lakes Region many early and middle Archaic sites at or near the lake edge were submerged thus remaining undiscovered (Egan 1993; Lovis 1999; Mason 1981).

Changes from primarily faunal exploitation of Paleo Indians to the inclusion of nut use (hickory, walnut, and acorn) as well as limited evidence for aquatic tuber use indicate a change in subsistence practices for the Archaic peoples (Lovis 1999, Egan 1993b). At this time there is a further marked increase in plant exploitation, which is reflected in the archaeological record. Along with nut and tuber exploitation, edible seeds such as chenopod, sumpweed, sunflower, marsh elder and smartweed as well as wild grape appear in late Archaic middens (Mason 1981, Egan 1993b, Robertson et al. 1999). This coincides with the pollen record from Froehlich Bog. Beginning at 5450 B.P. there is a spike in the NAP that includes increased Gramineae, Chenopod, Compositae and Ambrosia, which are edible plants and many of the seeds appear carbonized from cooking events in the archaeological record.

Conclusion

Occurring in the Late Archaic/ Early Woodland transition, which is approximately 3500-2100 B.P., there is archaeological evidence of early plant domestication. Squash and gourd are introduced from Mexico by 4000 B.P (Mason 1981) and intensive utilization of indigenous plants such as sumpweed, sunflower, and chenopod occur in the Archaic/Early Woodland transition. South of Michigan there is macrobotanical evidence to indicate selection for specific seed traits and the beginning of domestication efforts of the Eastern Agricultural Complex by the Woodland peoples (Asch and Asch 1978, 1980, 1982; Egan 1993a, 1993b; Fritz 1994; Gremillion 1993; Parachini 1981; Smith 1992b; Yarnell and Black 1985). In southwestern Michigan species in the Eastern Agricultural Complex are represented in carbonized botanical remains in the Late Woodland and Upper Mississippian components from the Moccasin Bluff (ca. A.D. 1480-1595) and Wymer West sites (ca. A.D. 1000-1435) (Table 5-1).

The chart in Figure 3-6 is a summary of the dominant crown species of Michigan's forest throughout the Holocene. This chart is highly generalized and represents overall trends across large transitional zones in Michigan. It should be noted that not all areas experience similar plant succession. Temperature and moisture relationships near the lakes were distinct from the areas further inland. In southern Michigan for example, pollen samples from Froehlich Bog indicate increased NAP pollen during the Hypsithermal interval. This could reflect a combination of extensive marshes or open land due to natural or anthropogenic forest fires, or human groups, which progressively populated and disturbed the area.

In general plant successions are thought to be climatically controlled (Holloway and Bryant 1985). The moderating temperatures and general warming trends leading to the Hypsithermal are thought to have greatly influenced successional species from about 8,000 B.P. From around 2,500 B.P. the climate began a rapid change identified as the Little Ice Age (LIA) to cooler and moister conditions, which are present still today. There are, however, a few other factors, which could influence local plant populations.

Moisture and climate change play a major role in species migration but we still do not know how other moderating factors influenced migration rates and patterns. We know that individual plant taxa migrate at varying rates. Present day forest composition may help us to understand microclimates and ecotones created under the proximal influence of the large bodies of water. However, the moderating effect of Lake Michigan during the Late Woodland period is relative to the declining temperatures occurring in the LIA (Bond et al. 2001; Jones et al. 1998). Archaeological evidence for domestication and horticultural activities suggests that humans were responsible for expanding and/or contracting species habitat through accidental or intentional seed gathering and dispersion. The habitat in southwest Michigan could only be manipulated by Late Woodland and Upper Mississippian people within the constraint of declining winter temperatures of the Little Ice Age (Bond et al. 2001; Jones et al. 1998).

Chapter 4

The Environment, Cultural Context, and Model for the Introduction of Corn Into Southwest Michigan

General Overview

The late retreat of glacial ice left the lower peninsula of Michigan with abundant marshy and wetland habitats adjacent to many river drainage systems. Woodland people exploited these habitats for abundant aquatic and terrestrial tubers, wild rice and a vast array of faunal resources. Upper Mississippian people established their presence in southern Michigan sometime during the Late Woodland period. Sometime after ca. A.D. 1000 Upper Mississippian peoples moved north and east from the upper Mississippi Valley into the lower peninsula of Michigan. Their presence and influence is inferred through a change from grit to shell as the tempering agent used in ceramics found at various sites occurring from A.D. 1000 – 1500 (Brashler et al. 1997).

Various types of environments were exploited to meet the subsistence needs of Late Woodland and Upper Mississippian people. Southwest Michigan was an ideal environment in this regard. The transitional zone of southwest Michigan provides a *mosaic* of distinct habitats and distinguishes the transitional nature of the biotic *tension zone* through the southern two thirds of Michigan. The tension zone extends down in the Kalamazoo and St. Joseph river drainages. The transitional character of this zone results in a mix of beech-maple forest interspersed with isolated pockets of oak-hickory forest. Remnants of the Prairie Peninsula also intrude from the west and south.

Southwestern Michigan is abundant in rich riverine habitats from the Grand River drainage and the Kalamazoo River drainage to the St. Joseph River drainage, all emptying into Lake Michigan. This region benefits from the moderating effect on temperature due to Lake Michigan. Combined with arable soils from the many river flood plains, this region was inviting for prehistoric intensive horticulture. On the St. Joseph River in southwestern Michigan we find the presence of two cultural traditions around ca. A.D. 1000. The first is the Late Woodland culture, established with long continuity prior to A.D. 1000 and characterized by grit-tempered pottery. The second is the intrusive Upper Mississippian culture, which appears in the region at approximately A.D. 1000 and characterized by shell-tempered pottery and the appearance of corn in features at archaeological sites.

Five sites will be included in this study in order to re-evaluate introduction of *Zea mays* into Late Woodland and Upper Mississippian culture in southwestern Michigan. Two of the sites, Moccasin Bluff and Wymer West are located in southwest Michigan on the St. Joseph River in Berrien County. Two other sites, Schwerdt and Elam, are located to the north of the St. Joseph River on the Kalamazoo River drainage system. The last site 20SA1034 is located in east central Michigan on the Flint River in the Saginaw Valley (Figure 4-1).

Environmental and Cultural Contexts for the Sites Used in this Study

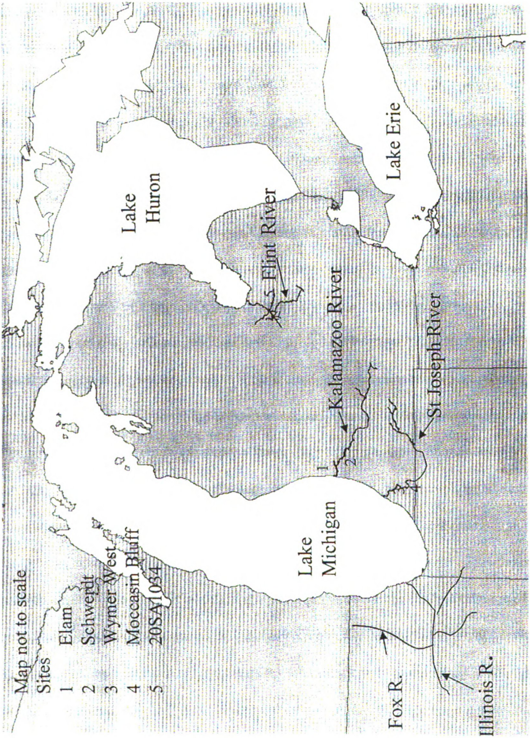
In an effort to answer questions on the coevolution of humans and domesticated corn two fundamental questions of paleoethnobotanical subsistence research will be asked: When did maize arrive in southwest Michigan and when did it become an important food crop? Two regions, the Flint River and the St. Joseph River will be used to compare and contrast the timing of the introduction and adoption of corn in the subsistence cycle. The two regions are interesting because the Flint River lies in a more northern latitude than the St. Joseph River (Figure 4-1). Since corn is found at a site on the Flint River it is logical to assume that corn will be found at sites located south of the Flint River in Michigan.

Site 20SA1034 is located on the east side of Michigan and Moccasin Bluff, Wymer West, Elam, and Schwerdt are located on the west side of Michigan. By setting up a dichotomy between the east side of Lake Michigan and the west side of Lakes Michigan and Huron, climate variations can be explored. Variation in temperature and precipitation influenced by the Little Ice Age (LIA) and large bodies of water such as Lake Michigan and Lake Huron may be reflected in microenvironmental studies of the drainage systems. The environment may have been better suited in the eastern part of Michigan ca. A.D. 1000 than in the western and more specifically southwest region for the adoption of corn agriculture. Radiocarbon dates and frequency of corn and other edible plant species will form the data points for comparison between Wymer West and site 20SA1034.

Ecology and Background of Five Sites

The Moccasin Bluff site is located on a bend in the river on the west side the St. Joseph River. The site is positioned on a terrace approximately 15 feet above the river. The terrace is ringed by a semi-circular group of bluffs on the north, west, and south, creating a radius of approximately 2000 feet (Bettarel and Smith 1973). At this location the St. Joseph River is broad and shallow and according to Bettarel and Smith (1973)

Figure 4-1 Map of Sites in Study



would have been ideal for spring-spawning lake sturgeon. Moccasin Bluff is located in an area of well-drained creeks emptying into the St. Joseph River. The catchment surrounding Moccasin Bluff is a mosaic of Oak-Hickory, Beech-Maple, and Oak-Pine woodlands with prairie or oak openings and swamps or marshes. The topography surrounding the site is a plateau highland containing level sand and gravel plains with fertile, well-drained loams and sandy loams (Bettarel and Smith 1973).

An early report published for Moccasin Bluff (20BE8) by Robert Bettarel and Hale Smith (1973) documented the 1948 excavation of this site. The authors draw several conclusions about modes of subsistence at the site during the Late Woodland period. They hypothesize that Late Woodland cultures commonly practiced agriculture. Referring to corn agriculture, Bettarel and Smith quote Richard Yarnell (1964), "that it (corn) was grown in the late Prehistoric period along with beans and squash seems certain" (1973:130). The authors are conservative in their conclusions, however, when they say that certain elements are absent from their data: location of fields, techniques of cultivation, amounts harvested, and integration of crops into the native subsistence cycle. The authors conclude after A.D. 1000 the increased importance of an agricultural complex of corn, beans, and squash is evident by an increase in pit size. This conclusion is based on the large number of pits at the site and the *inference* of the existence of corn agriculture. They further draw on the faunal study by Cleland (1966) who suggests that the unusually large number of right mandible of young deer present at the site suggest the preparation of maize.

The only botanical analysis conducted at Moccasin Bluff on the 1948 assemblage was wood charcoal identification and an analysis of two features containing fragmentary corncobs. These features, referred to as "corn holes," were thought to be either for smoking hides or smudge pits (Ford 1973). The first excavation of Moccasin Bluff occurred prior to the implementation of flotation for microbotanical remains. Conclusions by Bettarel and Smith (1973) about subsistence and floral remains should be understood within that context. However, conclusions regarding corn agriculture in the region continue to be influenced by the inferred hypothesis of corn agriculture that Yarnell (1964), Cleland (1966), Fitting and Cleland (1969), and finally Bettarel and Smith's (1973) Moccasin Bluff report provided.

For example as previously discussed, Fitting and Cleland published a model (1969) that tentatively offered Moccasin Bluff as an example of a large agricultural village ca. A.D. 1000 to A.D. 1400. This model assumed that projection backward from the early historic period of settlement and subsistence patterns was possible. Fitting and Cleland (1969) assume that since corn was a primary component in historic subsistence, the same opportunity and cultural value for corn existed in prehistoric subsistence. Publication of the Fitting and Cleland model, and the later publication of the Moccasin Bluff site report confirmed Moccasin Bluff to be an agricultural village whose main subsistence was *probably* corn (Bettarel and Smith 1973). The meager data used to form this conclusion were the cobs occurring in two small smudge pits, which were of questionable date. Other sites in southwest Michigan have been subsequently compared to the agricultural village of Moccasin Bluff, even though the conclusions about the site were of a tentative nature.

Eight miles down river of Moccasin Bluff is the location of the Wymer West site. Wymer West is also located on a wide meandering bend in the St. Joseph River. A broad upland zone in southwest Michigan descends onto the well-drained first terrace and the Wymer West knoll (Parker 2001). According to Government Land Office (GLO) surveys, this area was covered prehistorically by primarily climax beech maple forest (Parker 2001). Mixed hardwood swamp, mixed conifer swamp, and grassland are also located within the subsistence catchment for the Wymer West site (GLO survey 1800). A year-round spring fed stream flows past Wymer West on the west side (Parker 2001) and semi aquatic and marsh habitats border the St. Joseph River to the south. Prehistorically, plant cover would have been diverse with a wide range of growing conditions in close proximity to Wymer West (Parker 2001).

Wymer West Knoll has Late Woodland ceramics (Garland 2001) and, according to radiocarbon dates, grit as a tempering agent falls off around ca. A.D. 1070 and then the majority of pottery is composed of shell-tempered ceramics. This crossing or blending of Late Woodland and Upper Mississippian ceramic attributes is also present at Moccasin Bluff (Bettarel and Smith 1973), but grit-tempered ceramics dominate the assemblage (A.D. 1060 to A.D.1600). The Red Bud Trail, originally an Indian trail, connects the two sites. Because the ceramic assemblages differ (grit-temper VS shell-temper) between the two sites, Garland (2001) suggested that the late Woodland period in southwestern Michigan was complicated by an Upper Mississippian intrusion, which was not assimilated into Late Woodland culture over time. Upper Mississippian peoples commonly used shell temper in their ceramics, whereas (Late) Woodland cultures used grit as a tempering agent.

Garland (2001) determined Wymer West Knoll to be an unmixed Upper Mississippian component representing a single cultural phase. Wymer East Knoll constitutes an earlier Woodland component and will not be included in this discussion. Parker (2001) argued that the quantity of corn remains at Wymer West does not seem consistent with intensive processing and storage. She then compared the paucity of corn remains at Wymer West to interpretations of Bettarel and Smith of the *inferred* large agricultural village at Moccasin Bluff.

Eidson Marsh and Froehlich Bog are located in close proximity to the Wymer West site. Pollen cores were taken from the two bogs by Ahern and Kapp (Garland 1990) but there is no mention of corn pollen in either core. This supports Parker's conclusion that corn was not grown in fields near Wymer West.

The Schwerdt site, located on the nearby Kalamazoo River is thought to be closely related to the Moccasin Bluff site (for site dates see Table 5-1). The ceramics from this site indicate strong cultural ties to the Moccasin Bluff site. The analysis of botanical remains from this site by Walz (1991) gives no indication of corn agriculture at what he interprets to be a late spring/early summer aquatic and riparian resource extraction site. The primary plant species represented in feature flotation at the Schwerdt site is the American lotus. Walz (1991) indicates that perhaps the Moccasin Bluff site was the primary large agricultural summer habitation site for these people.

The Schwerdt site is located atop a sand bank upstream from the mouth of the Kalamazoo River in Saugatuck Township (Walz 1991). Located on a pronounced bend in the river, the site is situated in the biotic transitional tension zone, which spans the breadth of the lower peninsula of Michigan. Cremin (1979) modeled the surrounding catchment of the Schwerdt site and reported it to be composed of three principal environmental zones. They consist of a mosaic of Beech-Maple Forest, Oak-Pine

Woodlands and Wetlands. Faunal remains at Schwerdt are dominated by spring-spawning lake sturgeon followed by small quantities of other fish species, turtle, mussels, turkey and gastropods (Walz 1991). Mammal remains were sparse and included white tail deer, beaver, muskrat, raccoon and bear (Walz 1991). Because of the large quantities of spring-spawning lake sturgeon remains, Walz (1991) characterized the Schwerdt site as a spring/summer resource extraction camp in which other animal and plant species were opportunistically exploited for subsistence purposes by the Upper Mississippian people.

The Elam site is also located on the Kalamazoo River approximately 18 miles upstream from the Schwerdt site (for site dates see Table 5-1). The site primarily sits atop a small rise in a low-lying area on the south bank of the river (Parachini 1981). Mixed woodland dominated by oak is located south of the Elam site. A Beech-Maple Forest is interspersed throughout the catchment. Wetland areas border the river to the north and west of the site. The low lying flat to rolling terrain also supports a mosaic of Oak-Pine stands; because of poor soil it would have been an area only marginally useful for agriculture (Parachini 1981).

Elam is interpreted as a warm weather Upper Mississippian seasonal encampment (Parachini 1981). The faunal (Barr 1979) and botanical (Parachini 1981) assemblages indicate that people inhabiting the Elam site were focused on aquatic and riparian resources. Abundant sturgeon and water lily tubers indicate late spring as the season in which most activities took place, but the presence of some berry seeds and fall-ripening nuts suggests that part of the community stayed into summer and fall. Parachini (1981) found no remains of the tropical domesticate corn at this site and remains of local domesticates also are absent.

Site 20SA1034 is not located in southwestern Michigan, but it is contemporaneous with Wymer West and will be useful to use as a comparative to the previous sites (for site dates see Table 5-1). In the Saginaw Valley beginning around A.D. 1000, residential farmsteads appear with evidence of a mixed horticultural and collecting economy (Egan 1993b). Intrusion by the Upper Mississippian people into the Saginaw Valley is documented as it is in southwestern Michigan (Holman and Brashler 1999) and several ceramic traditions are represented. Two varieties of corn, 8-row and 12-row, were reported in these contexts as well as indigenous cultigens of tobacco, sunflower and chenopodium (Holman and Brashler 1999).

Site 20SA1034 is located on the west bank of the Flint River drainage in the Saginaw Valley in the east central portion of Michigan (Dobbs et al. 1993). As with the previous sites, 20SA1034 is located on a small rise on the west bank the Flint River accompanied by a broad floodplain. High bluffs to the west border the site with a low-lying area along the base of the bluffs that may represent a former river channel (Dobbs et al. 1993). Dobbs et al. (1993) notes that fine-scaled vegetation reconstructions for this area are not available. However, the Saginaw Valley is located in the floristic tension zone (Figure 3-1) indicating a broad transition between the Carolinian and Canadian Biotic Provinces spanning mid Michigan. According to Cushing (1965) this is an area of Maple-Basswood Beech Forest likely interspersed with relic mixed Conifer Hardwood Forest and Oak Hickory Forest (Figure 3-2), which would be located in areas of higher elevations.

20SA1034 has an array of plant remains that are consistent with those from Wymer West (Parker 1993). These contemporaneous sites suggest a mixed economy. At 20SA1034 corn was ubiquitous in most features and was accompanied by domesticated native species of chenopod, tobacco cucurbits, and sunflower. A range of wild fruit seeds is also present. Parker notes that this diversity in the botanical assemblage is consistent with the Moccasin Bluff agricultural village type (1996).

Site 20SA1034 is interpreted as a short-term late spring/summer occupation. The meager faunal remains suggest that animal exploitation was not an important function at this site. However, activities centering on aquatic resources such as small fish, muskrat, beaver, aquatic turtles, and riparian flora are indicated in the assemblages. Parker (1993) recovered several domesticated plant remains indicating particular economic strategies. She concludes that domesticates of corn, sunflower, tobacco, cucurbits and chenopod were planted when conditions permitted. Even though several domesticates were found in the botanical inventory resulting from flotation, Parker (1993) states this site does not represent an agricultural base camp. She cites constraints posed from the region's hydrology as a limiting factor for agriculture and that planting of fields would have been at best peripheral to patterns of food collection during the Late Woodland (1993). The analysis of corn remains at 20SA1034 yielded 1122 kernels, 1210 cupules, and many cob fragments. Parker determined that 8-row cobs dominated with some admixture of varieties with higher row numbers (1993).

In summary, all the sites included for this study are located within the broad expanse of a transition zone traversing southern lower Michigan. All the sites are found on rivers with diverse ecological habitats and ecotones. The rich marshy and semi aquatic habitats provide for a wide range of plant species in close proximity to each site. Wide meandering river bends would have been excellent locations to extract spring-spawning fish such as sturgeon. Broad expansive flood plains would have been amenable to human disturbance in the pursuit of horticultural activities. A mosaic of upland tree species such as oak-hickory would provide a subsistence resource through nut masts and also have enhanced the availability of various large game animals near each site. In short, this is the perfect region to look at the coevolution of humans, plants, and animals through time.

Other sites with comparable plant remains for the Late Woodland and Upper Mississippian cultures include sites from the Langford Tradition in northern Illinois such as Zimmerman, Washington Irving, Reeves, Keeshin Farm, and Rock River site (Egan 1993, 1985; Parker 1985, 1996; Simon 1998). These sites, along with Schwerdt, Elam, Wymer West, and Moccasin Bluff, all have the following underlying similarities in plant exploitation strategies:

- All the sites have high quantities of wood charcoal as compared to charcoal derived from nutshell, seeds and corn. Some of the sites have very diverse wood assemblages suggesting a generalized approach to wood collection.
- Nutshell residues are minimal, compared to the rest of the botanical inventory suggesting that nuts were not a major food resource, or that there may have been very irregular exploitation of nut masts.
- Most of the sites have one or more unique small features usually termed smudge pits. They consist of layered bark (sometimes) and fragmentary corncobs with small amounts of wood or nutshell.

Site locations suggest that aquatic resources (such as lotus tubers and wild rice) were important to these cultures. Additionally there are many small terrestrial corms, bulbs, and tubers that do not preserve well in the archaeological record.

Hallmarks for the Upper Mississippian culture are shell tempered pottery, corn, and a diverse subsistence base. These hallmarks appear in southwest Michigan and it is postulated that the Mississippification in the region took place sometime after A.D. 1000 (Brashler et al. 1997). This is reflected by the presence of new ceramic technologies and styles as well as the incorporation of corn into the subsistence cycle. In a general review by Simon (2000) for southern and central Michigan she notes that there is little evidence for plant cultivation pre-dating about A.D. 1000. She further notes that stable isotope data from the lower eastern Great Lakes indicates that corn was present earlier, ca. A.D. 700. Additionally, Simon later states Late Woodland components in southern Michigan are marked by a high reliance on wild plant resources such as seeds and fleshy fruits (2000). Her survey of sites in southwestern Michigan indicates that prehistoric people were more dependent on cultivation of chenopods, sunflower and squash (ca. A.D. 1100) than they were of maize. Simon (2000) argues that further data are required to clarify the relative timing of corn utilization in the Southern Great Lakes Region.

Simon (2000) notes the early reliance on corn in southeastern Michigan (ca. A.D. 700) and the relative absence of corn in southwestern Michigan as late as A.D. 1100 in the Late Woodland culture implying a cultural and/or environmental dichotomous situation between east and west Michigan. The intrusion of the Upper Mississippian culture occurs at Wymer West ca. A.D. 1070 and corn remains are noted in features from this time. While the first excavation of Moccasin Bluff revealed the presence of eight-row Northern Flint variety of corn dated at ca. A.D. 1400 (Ford 1973) in smudge pit features, subsequent excavation located at the northern end of the site (as were the "corn holes") in 2002 found no corn remains in three features from the midden or general midden flotation samples. In light of the existing literature and new data from the 2002 excavation of Moccasin Bluff it is reasonable to test the hypothesis that Moccasin Bluff functioned as an agricultural village.

In 2002 Jodie O'Gorman conducted a field school at the site, from which the author analyzed new botanical data. In this thesis the issue of the date for the cobs from the 1948 excavation is revisited. In light of the new data from Moccasin Bluff previous conclusions about the occurrence of corn and agriculture in southwest Michigan need to be reconsidered.

A model for southwestern Michigan

The transformation of a culture's subsistence system from gatherers to horticulturalists/agriculturalists is not immediately recognized in the archaeological record (Ford 1985). There will be a lag between when a culture begins to change its subsistence cycle to the moment it is discernable in the archaeological record (Rindos 1985). Additionally, social interaction (e.g., intermarriage) has a greater influence on something like the integration of corn into a culture (Ford 1985) as opposed to other readily available resources.

Southwestern Michigan, ca. A.D. 1000 to 1400, appears to be rich in preferred floral and faunal species habitat. Considering the dates of the Upper Mississippian sites of Schwerdt (ca. A.D. 1420) and Elam (ca. A.D. 1215 – 1487) where no corn is found, increasing population does not seem to be a reason for the adoption of corn agriculture in this region. Given the abundance of aquatic and terrestrial starchy tubers and archaeological evidence of cultural exploitation of these resources, corn appears to be of minor importance. By examining the question, is there evidence for corn agriculture at seasonal resource extraction or habitation sites of the Late Woodland and early Upper Mississippian components of the St. Joseph River Valley ca. A.D. 1000 to 1400, and if so, was regular maize cultivation being practiced during the five centuries prior to ca. A.D. 1400; a web of plant and human complexity unique to southwestern Michigan should come to light.

In order to sort through the botanical data to determine if and when corn agriculture was adopted in southwestern Michigan a mathematical model is employed. The model allows the explicit identification of dependent and independent variables and for assumptions. The mathematical model for this study will be drawn from a model presented by Rindos (1984). His model is based in theoretical ecology and measures of abundance. Rindos' model emphasizes feeding behavior of humans and a subsequent change in diet with the adoption of agriculture. Accordingly he believes "the recognition that the maintenance and even the intensification, of traditional modes of foraging behavior will ultimately serve to maximize the potential growth of agricultural systems" (1984:190). By cultures choosing to "not" become agricultural, they can maximize their effect on the evolution of the plant communities in which they live. In other words, the foraging activity of humans is a mechanism that promotes and/or intensifies seed dispersal for plants *possibly* resulting in accidental domestication or greater potential for domestication.

The model reconciles the gradual process of domestication with the sudden appearance of agriculture in the archaeological record. Further, Rindos' model makes clear that the introduction of domesticates into the diet and subsequent adoption of a domesticate into the subsistence cycle for cultivation does not increase linearly; introduction of domesticates into a diet increases in a non-linear fashion. According to Rindos, interactions with domesticates can be conceived as another form of foraging, only gradually increasing, until a certain takeoff point is reached. If corn horticulture was in the process of adoption by Late Woodland people and used successfully by Upper Mississippians new to the region then the model produced from the data should show a gradual increase in corn abundance until a point when there is a dramatic increase.

The notation for domesticates in Rindos' equation is D and the notation for wild plant foods is W. Time is represented by t whereby t – 1 is earlier time and t + 1 is later time. The rate of increase is represented by k. The proportion of domesticates in the diet is represented by r. To find the change in the contribution of wild resources to the diet over time the equation is the following: $W_{t-1} = k_w W_t$. To find the change in the contribution of domesticates to the diet over time the equation is also: $D_{t-1} = k_d D_t$. To start the clock and look at the rate of increase in domesticates in the diet over time the following equation is used:

$$D_{t+1} = k_d D_t = k_d^2 D_{t-1} = k_d^3 D_{t-2} = \ldots = k_d^{t+1} D_0$$

By substituting W for D, we can use the same equation for wild plant foods.

As previously stated, the relative contribution of domesticates to the diet is what is important in considering the rise of an agricultural system. Because *Zea mays* is introduced and not easily grown in the northern latitudes, the presence of corn as an indication of subsistence dependence in a prehistoric culture has many implications. It is generally accepted that domestication of indigenous starchy and oily seeds was under way in portions of eastern North America by prehistoric peoples (Ford 1985; Smith 1895, 1989, 1992; Gremillion 1993; Asch and Asch 1978). Small garden plots would have been common in a mixed horticultural and collecting economy. If the people of southwestern Michigan were participating in this type of economy they could all be considered horticulturalists, in some sense, through mixed horticultural garden activity including indigenous and tropical domesticates. Thus the term agriculture *signifies* a greater dependence on domestication than was probably the case in southwest Michigan ca. A.D. 1000 to A.D. 1400.

Focusing on corn as the *introduced* domesticate I am identifying agriculturalists by a substantial dependence on corn. According to Rindos (1984), at least 1/3 of the diet should be composed of this domesticate. However, Rindos' estimate is not specifically based on traditional Native American farming practices and garden size. Ethnographic and historic data on Native American garden size was collected and analyzed by Sissel Schroeder (1999) in a study of maize productivity and eastern Woodland culture. She found the mean garden size for families with an average of five people, without the aid of a plow, was .59 acre. Schroeder calculated the average edible yield per acre. By taking into account some post harvest rot, sharing with other families who were in need, and retention of some seed for the following year, she came up with 10 bu/acre. Acres cultivated and yield per acre is much lower than older estimates based on European immigrant farming practices. Her study indicates that families "relying on edible yields of 10 bu/acre obtained less than 20 percent of their calories from maize" (1999).

The important contribution from Schroeder for this model is in stating that there is not a predictable percent of starchy calories to be expected from a domesticate such as maize. Data indicate that Late Woodland cultures in southwestern Michigan relied heavily on riparian resources such as starchy tubers and a variety of fruits and starchy seeds. In seasonal resource extraction sites at this time Late Woodland people as well as Upper Mississippians practiced a mixed subsistence strategy. In light of Schroeder's study the relative contribution of corn in the diet will be adjusted from Rindos' expected 33% to Schroeder's <20% of the diet.

According to Rindos' model, to find the relative contribution of corn to the diet at any given point in time the proportion of domesticates in the diet can be assessed with the following equation:

$$r_{t+1} = \frac{D_{t+1}}{W_{t+1}} \quad .$$

There are two reasons to look at the relative contribution of domesticates to the overall diet. First, the archaeological data can be used to test the model; that is, with the usual cautions as to problems with preservation and recovery. Second, we have a measure of coevolutionary processes using the quantity k_d. This measures the interaction between humans and domesticate. Without interaction with humans, a domesticate will cease to exist. To measure relative fitness of humans as a result of domesticates in the diet we can look at k_d / k_w. If cultural preference changes from all wild plant foods to the inclusion of domesticates, then population growth can take place because of the additive value of domesticates in the diet. Log *e* is used to plot the relative contribution of a domesticate to the diet as a function of time, which is non linear.

Rindos emphasizes that understanding the increase in abundance over time is integral to understanding the evolution of agricultural systems. "The yield of domesticates that may be obtained at any given point in time is a function of all the genetic modifications that have occurred while these plants were adapting to a symbiosis with humans" (Rindos 1985:203). His model sets up a hypothetical maximizing subsistence strategy to measure population fitness that can compare to a [real world] variable subsistence strategy to measure population fitness.

Populations using a maximizing strategy, such as agriculture, will increase quickly while a population using a variable strategy, such as gathering, face an extinction risk for a longer period of time before the population begins to increase. When a maximizing strategy evolves (such as incorporating the domesticate corn into the subsistence cycle) it will replace other less efficient strategies within the context of other variables. An example that might force maximizing strategies to be used is expansion of a new culture into a region. The expansion would impact available land used for gathering as well as other natural resources. Fitness within a population is as important as fitness between populations. Groups that are maximizing wild resources have the same chance at population increase as groups that are maximizing a range of wild and domesticate plant resources. Understanding economic subsistence tradition is key to understanding maximizing strategies in a culture.

Subsistence tradition passed along in a culture is *cultural inheritance* (Rindos 1985). This varies from genetic inheritance in that information (subsistence tradition) is often passed between unrelated members in a culture or, depending on kinship and social relations, may skip generations. Thus subsistence traditions are not necessarily linear in cultures. There is interaction within cultures (populations) and between cultures (populations) at the individual and group levels. Variables, such as cultural inheritance, for maximization of resources are complex. Rindos (1985) argues that, while dietary maximization will increase fitness in a population, it is also maladaptive in the evolutionary long run. He emphasizes that evolution may well produce an economically less-optimal result.

Logic used by Rindos is helpful in sorting out subsistence patterns from A.D. 1000 to A.D. 1400. If subsistence traditions are not linear and pass within and between cultures then we should be able to find variation in subsistence not only within the Late Woodland and Upper Mississippian cultures but also between them. Similarity in subsistence strategy should be evident as well.

Chapter 5

Data and Analysis

The five sites selected for this study are riverine sites situated in similar ecological settings (Figure 4-1). The sites are each located at a major river bend and are surrounded by less mesic upland environments and lowland marshy embayments. Prehistorically, a diversity of edge habitat would have been abundant to support large and small mammals, birds, various aquatic species and fish. The botanical analysis and the relevant information from each site is summarized below and followed by my analysis of wild seeds VS corn at Wymer West and site 20SA1034. A brief analysis of faunal VS floral remains is included in an effort to understand to total prehistoric subsistence package.

Elam (20AD195)

The Elam site is located on the south bank of the Kalamazoo River, in Allegan County, Michigan. Plant remains from the Elam site were analyzed by Kathryn Parachini and presented in a Master's thesis in 1981 at Western Michigan University, Kalamazoo, Michigan. The following is a summary of her data.

Prehistoric plant remains were recovered by water flotation and hand picked from 1/8 in mesh screens at the time of excavation (1981). Flotation samples were taken from the second half of each feature. Flotation volume was determined by the size of the feature. At least 4 liters of soil in each feature was taken for flotation, though usually 8 to 12 liters were collected in each zone for flotation purposes. A total of 31 features were sampled for flotation for a total of 818 liters of feature fill. Total botanical remains, mostly wood charcoal, weighed 1371.72 grams.

Three feature types were recorded for the Elam site. These feature types are consistent across all the sites in this study. The first feature type is circular or oval in plan view with a basin shape and one or more fill zones. The second feature type is small shallow, basin-shaped pits, which consisted of only one fill zone, and the third type is large shallow, basin-shaped pit, rimmed by oxidized red sand. An additional unique feature type is present at Elam. It is circular in plan view with straight sides, over ½ meter deep with a flat bottom.

One hundred forty-seven pieces of wood charcoal were recovered from Elam weighing 270.42 grams represented 6 taxa. Carbonized resin, tree buds, and unidentified tree bark also occurred at this site. Wood charcoal remains consisted of ash (*Fraxinus* sp.), bur oak (*Quercus macrocarpa*), white oak group (*Quercus* sp.), maple (*Acer* sp.), white oak (*Quercus alba*), walnut/butternut (*Juglans* sp.), swamp white oak (*Q. bicolor*), birch (*Betula* sp.), and American elm (*Ulmus americana*).

Carbonized plant tubers or rhizomes were recovered in 6 features for a total of 11.43 grams. The carbonized plant tubers occurred in four pit features and two large shallow basin-shaped pits rimmed with oxidized red sand. These two types of features are defined as roasting pits (Parachini 1981). All carbonized tubers were recovered from either the bottom of each feature or just above the fuel zone.

There were 133 carbonized seeds in the flotation samples. Due to the relatively small number of carbonized seeds recovered in flotation, Parachini suggests them to be a result of natural seed dispersal and not the result on anthropogenic disturbance. Carbonized seeds consist of *Chenopodium* (72 seeds), *Polygonum* (9 seeds), *Rubus* (13 seeds), *Crataegus* (12 seeds), *Galium* (13 seeds), *Phytolacca* (7 seeds), *Carex* (9 seeds), *Lespedeza* (3 seeds), *Vitis* (1 seed), *Toxicodendrom radicans* (1 seed), *Rhus* (1 seed), *Potamegoton* (1 seed), and *Smilax* (1 seed). The range of seeds found at Elam is consistent with seeds found at the other four sites in this study, which probably indicates their presence in features represent deposition from human use and not just natural seed dispersal.

Schwerdt (20AE127)

The Schwerdt site is located on the Kalamazoo River just down stream from the Elam site (Figure 4-1). Plant remains from the Schwerdt site were analyzed by Gregory Walz and presented in a Master's thesis in 1991 at Western Michigan University, Kalamazoo, Michigan. The following is a summary of his data.

Flotation samples were taken from the second half of each feature. One hundred sixty-seven samples totaling 2,534 liters of feature fill were processed from the Schwerdt site (Walz 1991). Additional samples were also randomly taken from the midden across the site. A total of 40 pit features and 5 postmolds were sampled for flotation for a total of 2,034 liters of feature fill. Non-wood fragments (N=3,393) weighed 55.1 grams and over 3,400 grams of wood charcoal was recovered from 35 roasting pits.

Feature classes of pit, roasting pit, surface hearth, and postmold were defined at the Schwerdt site. A feature class labeled "roasting pit" was dominant at Schwerdt and showed variation in size and volume. All roasting pits are basin shaped and have one to several fill zones. Concentrations of oxidized sand occur in pit walls and often a charcoal-rich deposit (primary fuel zone) was found in the bottom of the pit. Walz's roasting pit features are comparable to Parachini's pit feature and large shallow-basin feature.

Waltz notes the amount of wood charcoal (3,400 grams) recovered from roasting pits but gives no analysis of the wood charcoal remains. Carbonized tubers totaling 161 fragments and weighing 23.57 grams were recovered from flotation. Tuber fragments were identified as pieces from the aquatic plant *Nelumbo lutea* (American Lotus). *Nelumbo lutea* occurs in 14 (40%) of the roasting pits.

One hundred-six carbonized seeds from Schwerdt represent twenty-two taxa. The taxa are *Rubus* spp. (53 seeds), *Cornus florida* (13 seeds), *Cyperus esculentus* (13 seeds), *Similax* spp. (4 seeds), *Crataegus* spp. (2 seeds), *Rhamnus alnifolium* (2 seeds), *Aronia* spp (2 seeds), *Calla palustris* (2 seeds), *Brassica nigra* (2 seeds), *Prunus* sp. (1 seed), *Helianthus annuus* (1 seed), *Vaccinium* spp. (1 seed), *Acalypha* spp. (1 seed), *Arisaema triphyllum* (1 seed), *Podophyllum peltatum* (1 seed), *Solanum* spp. (1 seed), *Sisymbrium altissium* (1 seed), *Polymina candensis* (1 seed), *Celtis occidentalis* (1 seed), Cyperaceae (1 seed), Graminae (1 seed), and Compositae (1 seed). Walz's analysis is focused on the carbonized remains of *Nelumbo lutea* and gives no indication as to accidental seed dispersion in the features or anthropogenic disturbance. However, the seeds occurring in features at Schwerdt are consistent with human disturbance related to subsistence activities. This conclusion is supported by the varied seed inventories from Wymer West, Moccasin Bluff, and 20SA1034.

Wymer West (20BE132)

Wymer West is located on the St. Joseph River, eight miles down stream from Moccasin Bluff. The Wymer West Knoll was excavated in 1998 by Garland (2001) for MDOT for the US-31 highway corridor. The following is a summary of the final 2001 report of the data analyzed by Kathryn Parker from the Wymer West project.

Flotation sampling included collection of the entire second half of excavated features, or at least multiple ten liter samples from each observed fill zone (Parker 2001). A total of 72 Upper Mississippian features were excavated and 2,354 liters of sediment were floated to recover macrobotanical remains. Fifty-six features contained identifiable botanical remains, which yielded 569.37 grams of wood charcoal and nutshell. However, seeds and nutshell occurred much less frequently than wood charcoal. The 854 carbonized seeds represent thirty-four plant taxa (Appendix B) Wood species, nutshell, and seed taxa are listed in Figures 10 and 11. Two pollen cores were taken and analyzed by Ahern and Kapp (1990) at the time of a 1991 investigation of Wymer East Knoll and will be used in this study.

Feature classes represented at Wymer West are as follows. Pits (N=21) are defined as ovate, basin-shaped features. Evidence of *in situ* burning enabled further subdivision within this class to fire pit (N=37) and smudge pit (N=14). Additionally, three large flat-bottomed trash pits are also recognized. No features class designated as roasting pit was identified. However, that does not mean that oval basin-shaped pits were not roasting pits.

A total of 298 maize fragments were recovered from Wymer West, which is a relatively small sample size for the number of features excavated (Parker 2001).

Fragments include cupules, glumes, cob fragments and kernels. Corn kernels number 213 of the 298 maize fragments. Twenty-eight tobacco seeds recovered from two features provide additional indications of plant husbandry at Wymer West.

20SA1034

Site 20SA1034 is located on the west bank of the Flint River in Saginaw County, Michigan. This site is contemporaneous with Wymer West, and even though 20SA1034 is located in the east central portion of Michigan, botanical inventories resulting from analysis of the two sites indicate they are highly comparable. The SA1034 site was excavated by Clark Dobbs for the Great Lakes Gas Transmission Limited Partnership to assist the Federal Energy Regulatory Commission in meeting its obligations to protect historic properties under the provisions of the National Historic Preservation Act of 1966 (Dobbs et al. 1993). Excavation strategy for this site included 100% flotation of all fill from cultural features. Kathryn Parker analyzed a total of 665 flotation samples (1045.2 liters of fill) from 28 features (1993).

Feature types consisted of three broad categories: small shallow basin-shaped pits, larger basin-shaped pits, and puzzling concentrations of artifacts and staining. Within each broad category types and subtypes were further defined. Small shallow basin-shaped pits were subdivided as follows: 1) low volume features with only trace amounts of corn and nutshell, 2) slightly larger volumes with clear evidence of burning, 3) features with high concentration of wood charcoal from large pieces of bark, suggesting the function to be a smudge pit, and 4) features with the largest volume for small shallow pits, which had a high density of artifact and seed remains. Larger basin-shaped pits were divided into similar subtypes. The puzzling concentrations of artifacts and staining were large and amorphous making them difficult to delineate in the field.

Wood species, nutshell and seed taxa are listed in Appendix C. A total of 2,474 maize fragments were recovered from SA1034. Fragments include cupules, glumes, cob fragments and kernels. Corn kernels numbered 1,122 of the maize fragments. Additional indications of plant husbandry at 20SA1034 are provided by the 42 tobacco seeds and cucurbit rind fragments recovered from flotation.

Moccasin Bluff (20BE8)

The Moccasin Bluff site is located atop a terrace on the west side of a bend in the St. Joseph River. In 2002 Michigan State University conducted a field school at the Moccasin Bluff site under the supervision of Jodie O'Gorman. The following is a complete summary of prehistoric plant remains, which were analyzed by the author (Appendix A). The purpose of the 2002 field school was to: 1) document the spatial extent and changing pattern of site use through time; 2) determine the feasibility of further research at the site and in the region; 3) to gather additional data on subsistence patterns at the site through the use of flotation. A total of three Late Woodland features were excavated from a midden area (O'Gorman and Warner 2003; O'Gorman 2003). The full second half of each feature was taken as flotation. For general samples located above the midden, in the midden, and below the midden, 8-liter flotation samples were taken from the east wall of unit 112. When it was possible the excavators collected botanical samples by hand. A pollen core was also taken from a marshy embayment adjacent to the site (see Appendix E and F).

The three Late Woodland features were classified as basin-shaped pits (Appendix A). Seventy-six liters of flotation was taken from Feature 1013. Analysis of flotation revealed a high wood charcoal density as well as fruit and starchy seeds. Feature 1015 was the smallest of the three features with a total flotation sample of 19 liters. Wood charcoal was also abundant in Feature 1015 and fruit and starchy seeds were present. Thirty-two liters of flotation was taken from Feature 1014. Wood charcoal, fruit and starchy seeds were present but occurring in a much lower frequency than in features 1013 and 1015. A total of 4 nutshells (Carya sp.) were found in feature 1014 and 1 nutshell (Carya sp.) was found in feature 1013. Because the Moccasin Bluff site is located in an area of relic oak/hickory forest the inclusion of so few nutshells is taken as accidental and no cultural inferences should be made.

The three 8-liter flotation samples taken from unit 112 wall (Appendix A) contained little of interest except one piece of squash rind that was in zone I, located above the midden. Squash rind does not preserve well in archaeological contexts. The presence of rind at this site can help to infer horticultural activities. However, the depth this float was taken at was 17-38 cmbd, which is well above the prehistoric midden and the contents should not be considered prehistoric in nature. Other botanical remains found in the samples taken from the 112 unit wall in zone I are 6 small dried fruits, 1 chenopod, 8 pokeberry seeds, and 29 pieces of carbonized wood weighing 0.5 grams. Zone III flotation, which is located in the midden contained one raspberry seed and one pokeberry seed coat and 14 pieces of carbonized wood weighing 0.3 grams. Zone IV, which is located below the midden contained one small dried fruit, one raspberry seed and 48 pieces of carbonized wood weighing 1.1 grams. No evidence of corn agriculture was found in 151 liters of flotation or 60.4 grams of hand collected samples (Appendix A). Seeds from the Eastern Agricultural Complex (sunflower, sump weed) are small and do not appear to be domesticated. Carbonized chenopods recovered from the three features are lenticular in profile indicating the seeds were not under selection for the characteristic rectangular profile found after carbonization from fire.

Summary of Sites

In general, flotation methods were consistent across the five sites in this study. The most intensive flotation came from the 20SA1034 site with 100% of the feature taken as flotation. Frequency and variety of plant species is expected to be greater from this site than from, for example, Wymer West, a site in which either the whole second half of a feature was sampled or multiple 10-liter samples from each fill zone were taken for flotation. The number of features excavated and liters taken for flotation for each site varied with the size of the excavation. Wymer West has 56 cultural features (763 liters), 20SA1034 has 28 cultural features (1,045.2 liters), Elam has 31 cultural features (818 liters), Schwerdt has 40 cultural features (2,934 liters), and Moccasin Bluff 2001 has 3 features (127 liters) of interest for this analysis. The number of features/liters for each site is important to consider when comparing frequency/abundance of plant remains across sites.

Four similarities in sites were mentioned in Chapter 4 for sites in southwest Michigan. The similarities were: 1) high quantities of wood charcoal (diverse assemblages suggesting generalized collection strategies) as compared to charcoal derived from nutshell, seeds, and corn; 2) features contain minimal nutshell residues indicating they were not a major food resource or at the very least there was irregular exploitation of nut masts; 3) small shallow basin-shaped pits are a common feature type at all the sites in this study. The diameter and depth of the basin shaped pits varies and some pits have oxidized soil around the outer edge indicating a hot fire for cooking or roasting. Wood charcoal was usually abundant either in a bottom fuel zone or in a zone close to the bottom. Some of the shallow basin-shaped pits contained only one fill zone in which charcoal is abundant throughout; and 4) most of the sites have a unique feature called smudge pit, which consists of fragmentary corncobs. Three of the sites, Moccasin Bluff, Wymer West, and 20SA1034 have one or more of these small unique features; some were lined with bark.

Analysis

For this study I have constructed a chart of C^{14} dates (Table 5-1) of previously analyzed features from the various sites. I will use this information to plot point data to address whether there is evidence for corn agriculture at seasonal resource extraction or habitation sites of the Late Woodland and early Upper Mississippian components of the St. Joseph River Valley. Moreover, to what extent does the introduction of corn fit into the horticultural adaptation system in southwest Michigan? In order to answer these questions it is necessary to briefly consider the total food package (faunal and floral remains) that was exploited at each site.

Returning to the model for agriculture by Rindos, which was explained in Chapter 2, the following equation will be used to look at the contribution of domesticate plant species to the diet:

$$D_{t+1} = k_d D_t = k_d^2 D_{t-1} = k_d^3 D_{t-2} = \ldots = k_d^{t+1} D_0$$

Table 5-1

Summary table of sites (features) and dates

(Date is calibrated to 1 sigma when range is stated)

Schwerdt dates – feature 9 – A.D. 1420 Upper Mississippian
feature 16 – A.D. 1422 Upper Mississippian
– Berrien Phase of southwestern Michigan (Walz 1991:4)

Elam date – (Parachini 1981:8) – A.D. 1265 Upper Mississippian
(Jeske 1992:22) – A.D. 1487
A.D. 1450
A.D. 1432
A.D. 1422
A.D. 1321, 1367, 1388
A.D. 1282
A.D. 1215

20SA1034 – (Dobbs et al. 1993:193)
features 31 – A.D. 1154-1161 Late Woodland
31 – A.D. 1171-1190 Late Woodland
32 – A.D. 1154-1215 Late Woodland
10 – A D. 1038-1093 Late Woodland
10 – A.D. 1116-1141 Late Woodland
10 – A.D. 1148-1262 Late Woodland
12 – A D. 1257-1289 Late Woodland
27 – A D. 1278-1283 Late Woodland
19 – A.D. 1257-1289 Late Woodland

Wymer West dates – (Garland et al. 2001)
Fea 91-66 – A.D. 894-1025 Upper Mississippian
Fea 91-51b – A.D. 1020 – 1213 Upper Mississippian
Fea 98-10 – A.D. 1070 – 1241 Upper Mississippian
Fea 98-81 – A.D. 1163 – 1281 Upper Mississippian
Fea 98-79 – A.D. 1215 – 1281 Upper Mississippian
Fea 98-100a – A.D. 1218 – 1294 Upper Mississippian
Fea 98-8 – A.D. 1259 – 1294 Upper Mississippian
Fea 98-106 – A.D. 1284 – 1382 Upper Mississippian
Fea 98-23 – A.D. 1280 – 1398 Upper Mississippian
Fea 98-40 – A.D. 1284 – 1393 Upper Mississippian
Fea 98-62 – A.D. 1302 – 1426 Upper Mississippian
Fea 98-49 – A.D. 1331 – 1435 Upper Mississippian

Moccasin Bluff dates – (O'Gorman 2001 unpublished)
unit 112 general midden – A.D. 1480 – 1595 Late Woodland
Bettarel & Smith (1973:116) – A.D. 1490 Late Woodland
A.D. 1529 Late Woodland
A.D. 1556 Late Woodland
A.D. 1634 Late Woodland
Adkins (2003) cob from corn hole A (1948 excavation)
A.D. 1480 – 1640 Late Woodland

Table 5-2

Predicted probability for corn over time
Site 20SA1034

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.0973	0.00330	866.2914	<.0001
date	1185	1	0.4051	0.00330	15025.0982	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
date 1185 vs 1273	2.248	2.219	2.278

Predicted probability for wild food over time
Site 20SA1034

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.7205	0.0309	7754.9409	<.0001
date	1185	1	-0.4999	0.0309	261.8722	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
date 1185 vs 1273	0.368	0.326	0.415

Table 5-3

Predicted probability for corn over time
Site Wymer West

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	6.9604	0.1774	1538.7678	<.0001
date	1	-0.00805	0.000140	3292.8068	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
date	0.992	0.992	0.992

Predicted probability for wild food over time
Site Wymer West

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-32.5885	0.0341	911875.574	<.0001
date	1	0.0253	0.000025	1030394.97	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
date	1.026	1.026	1.026

And the following equation will be used to look at the contribution of wild plant species to the diet:

$$W_{t+1} = k_w W_t = k_w^2 W_{t-1} = k_w^3 W_{t-2} = \ldots = k_w^{t+1} W_0$$

The data for 20SA1034 and Wymer West are binomial and Table 5-2 and Table 5-3 are the result of a log regression. For site 20SA1034 the data are considered categorical because there are only two dates between the six dated feature samples. Wymer West dates are treated as continuous because there are five features with different dates. The data were grouped into two categories, corn or wild food. Wild food category contains all wild gathered seeds, nuts, and fruits. All P-values are significant at < .0001. The coefficient for corn at the Wymer site is –0.00805. A negative coefficient in the model means the probability of corn occurring at the site as time goes by is decreasing. The coefficient for wild gathered food at the Wymer site is 0.0253 indicating the probability of wild food occurring at the site is increasing through time. The opposite occurs in the 20SA1034 site model with a positive coefficient (0.4051) for corn through time and a negative coefficient for wild gathered foods (-0.4999).

A model for the predicted probability for wild gathered food and corn at Wymer West is illustrated in the plots in Figures 5-4 and 5-5. There is not a perfect fit to the model through time (Figures 5-6 and 5-7) with the real data. One reason for the poor fit could be that the samples are small and do not have much statistical power. Given a larger sample of features and dates the real frequency could fit the predictive model better as illustrated in Figures 5-8 and 5-9 for site 20SA1034.

Other reasons should be considered aside from sample size for the poor fit. Ice core data indicate that the Little Ice Age (LIA) began just prior to A.D. 1000 in the

Figure 5-1

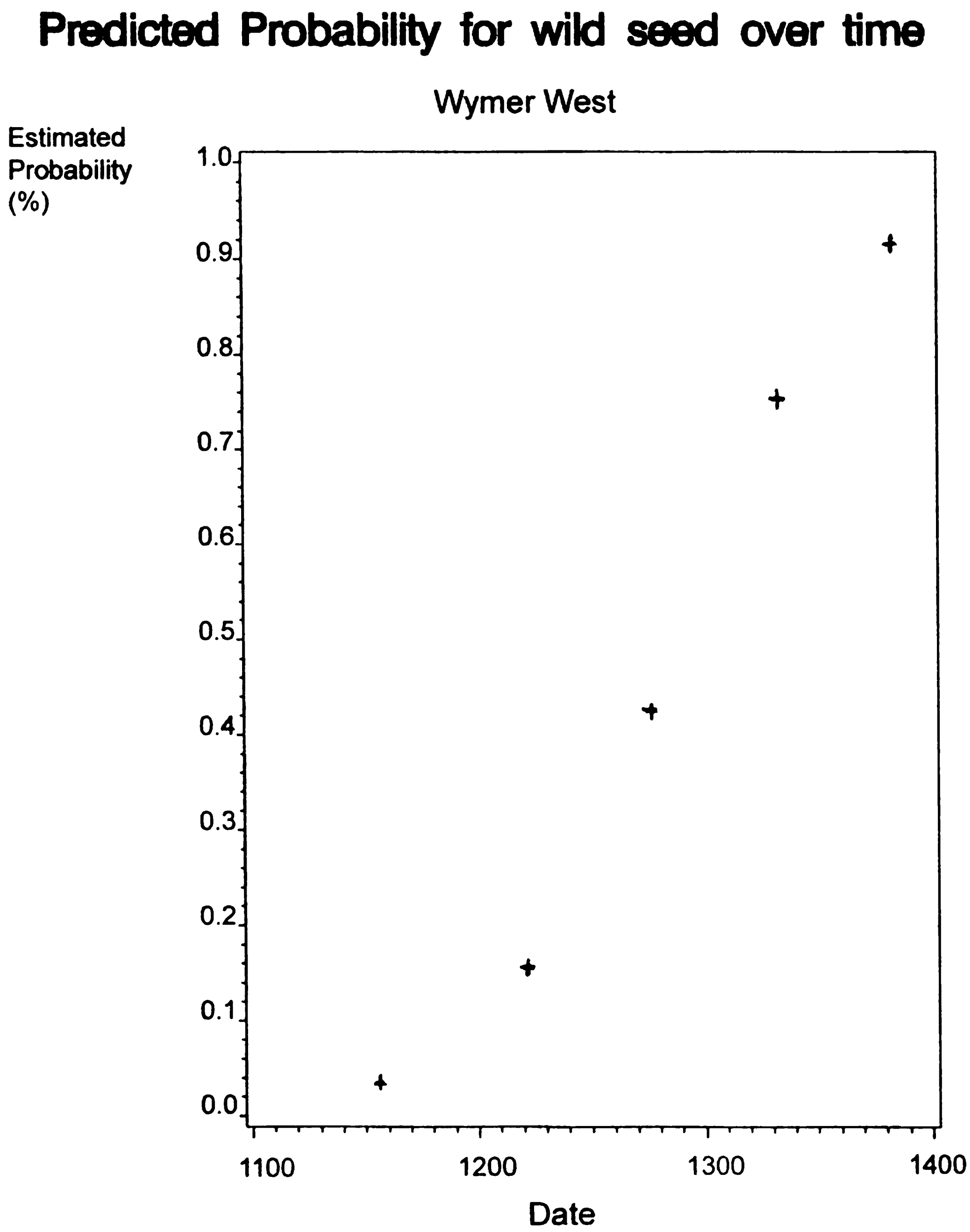

Predicted Probability for wild seed over time
Wymer West
Estimated Probability (%)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1100
1200
1300
1400
Date

Figure 5-2

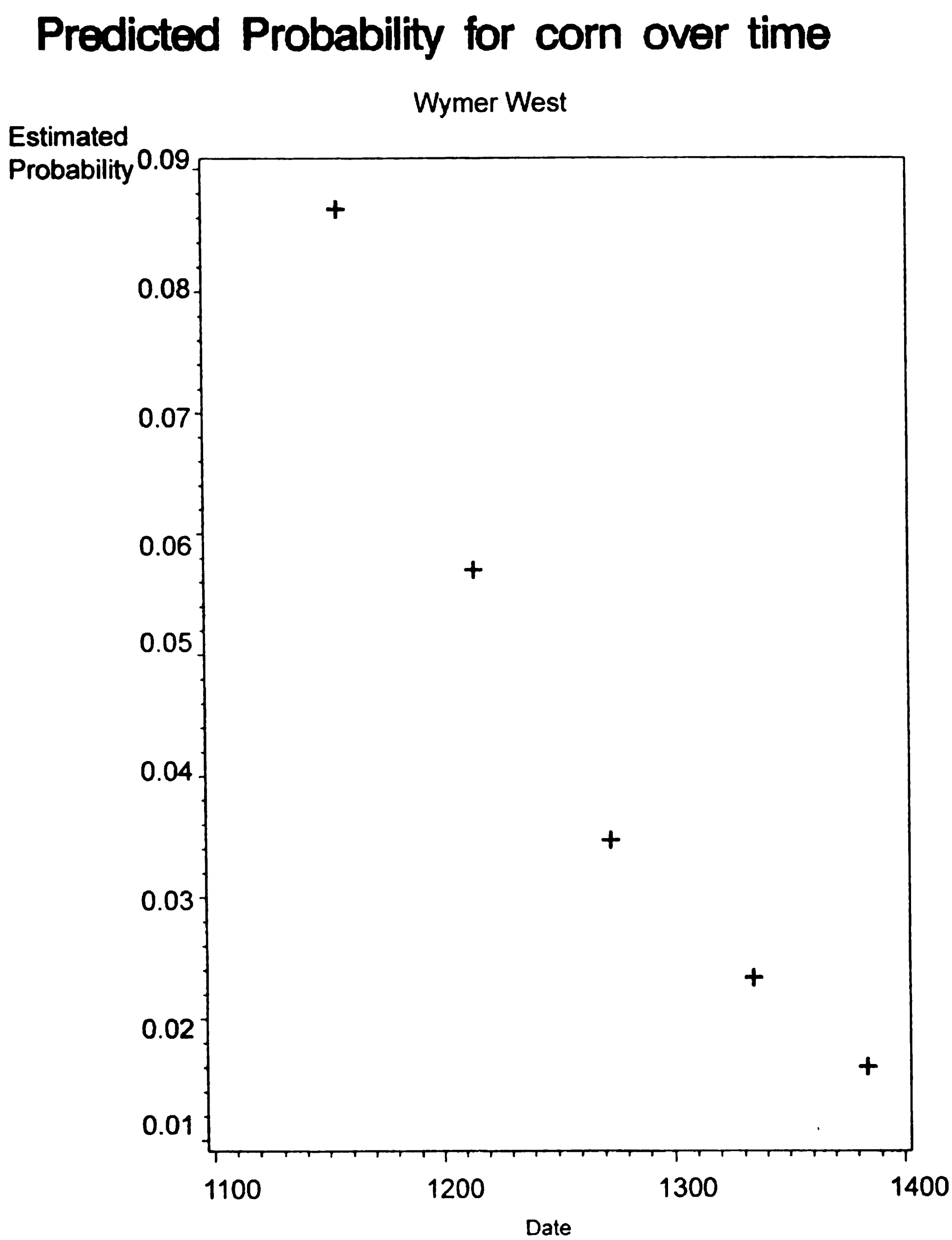
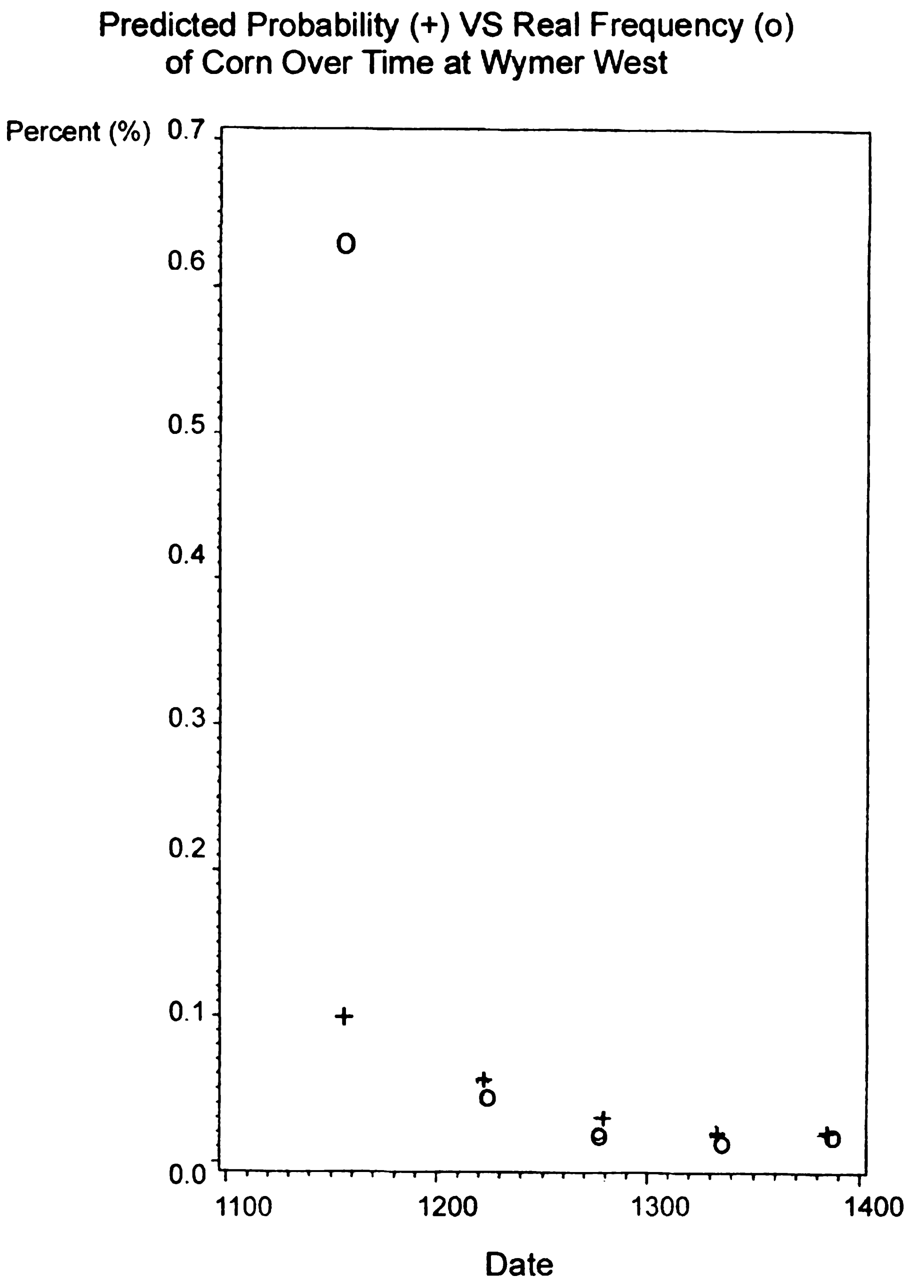
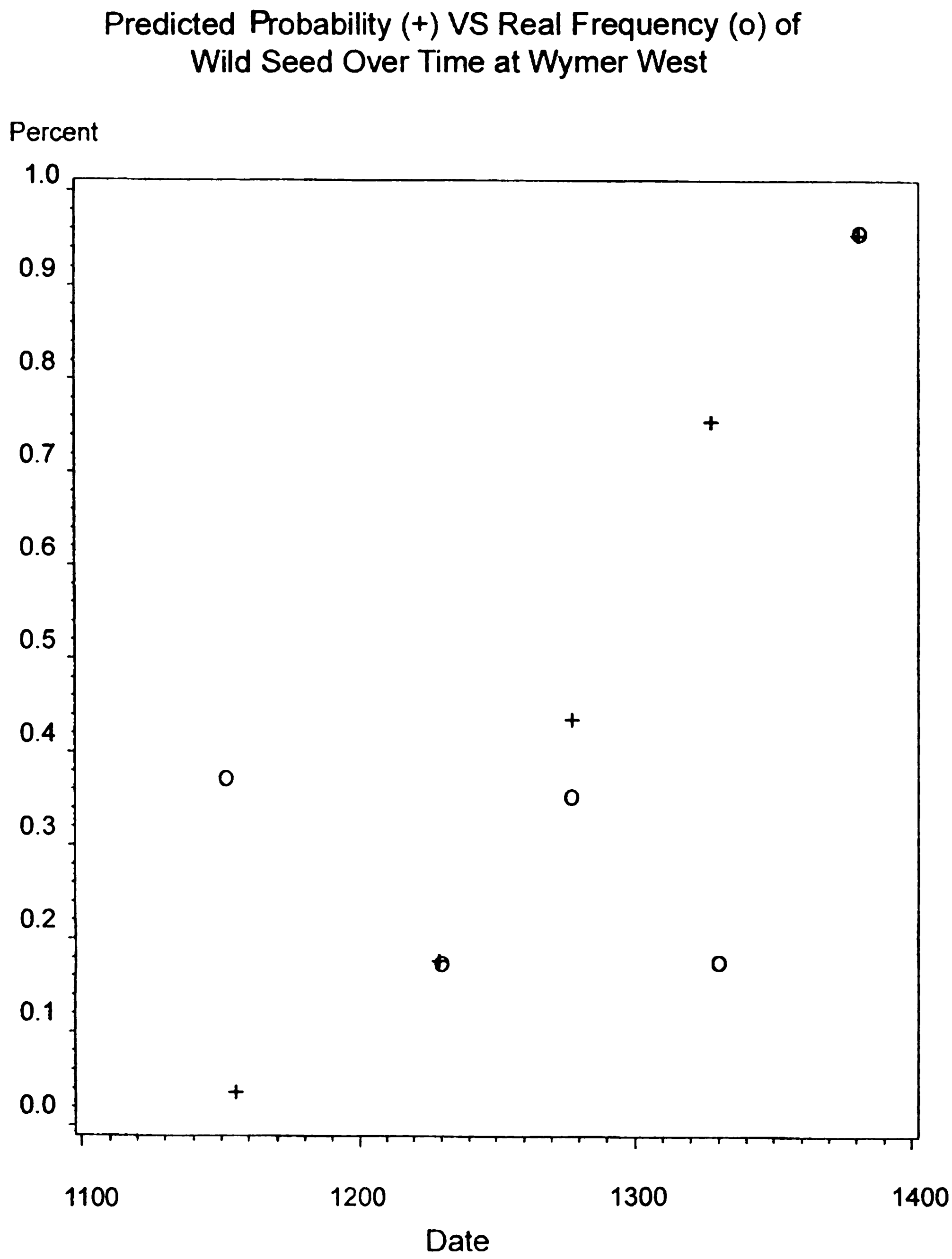

Predicted Probability for corn over time
Wymer West
Estimated Probability
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
1100
1200
1300
1400
Date

Figure 5-3



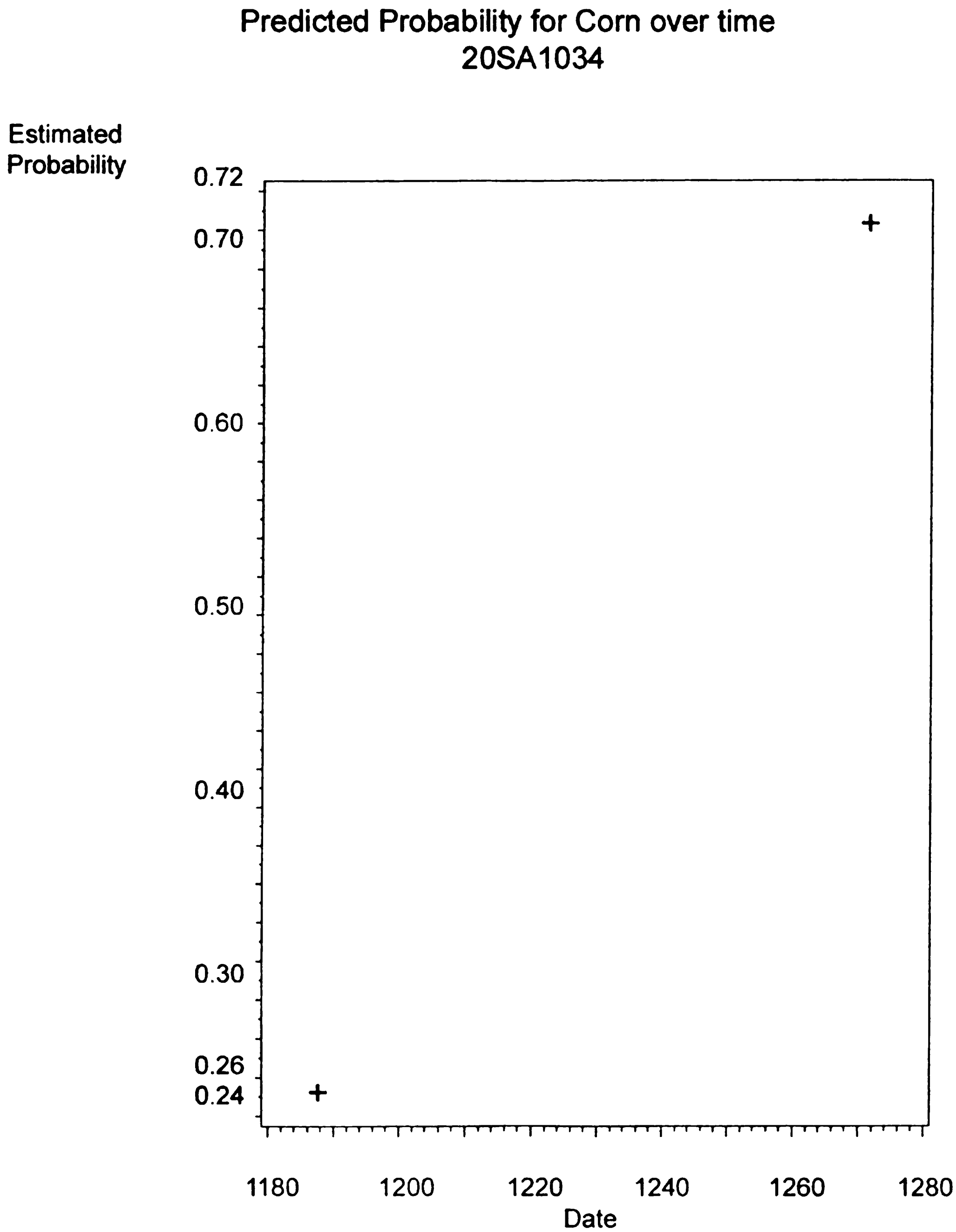
Predicted Probability (+) VS Real Frequency (o)
of Corn Over Time at Wymer West
Percent (%)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1100
1200
1300
1400
Date

Figure 5-4



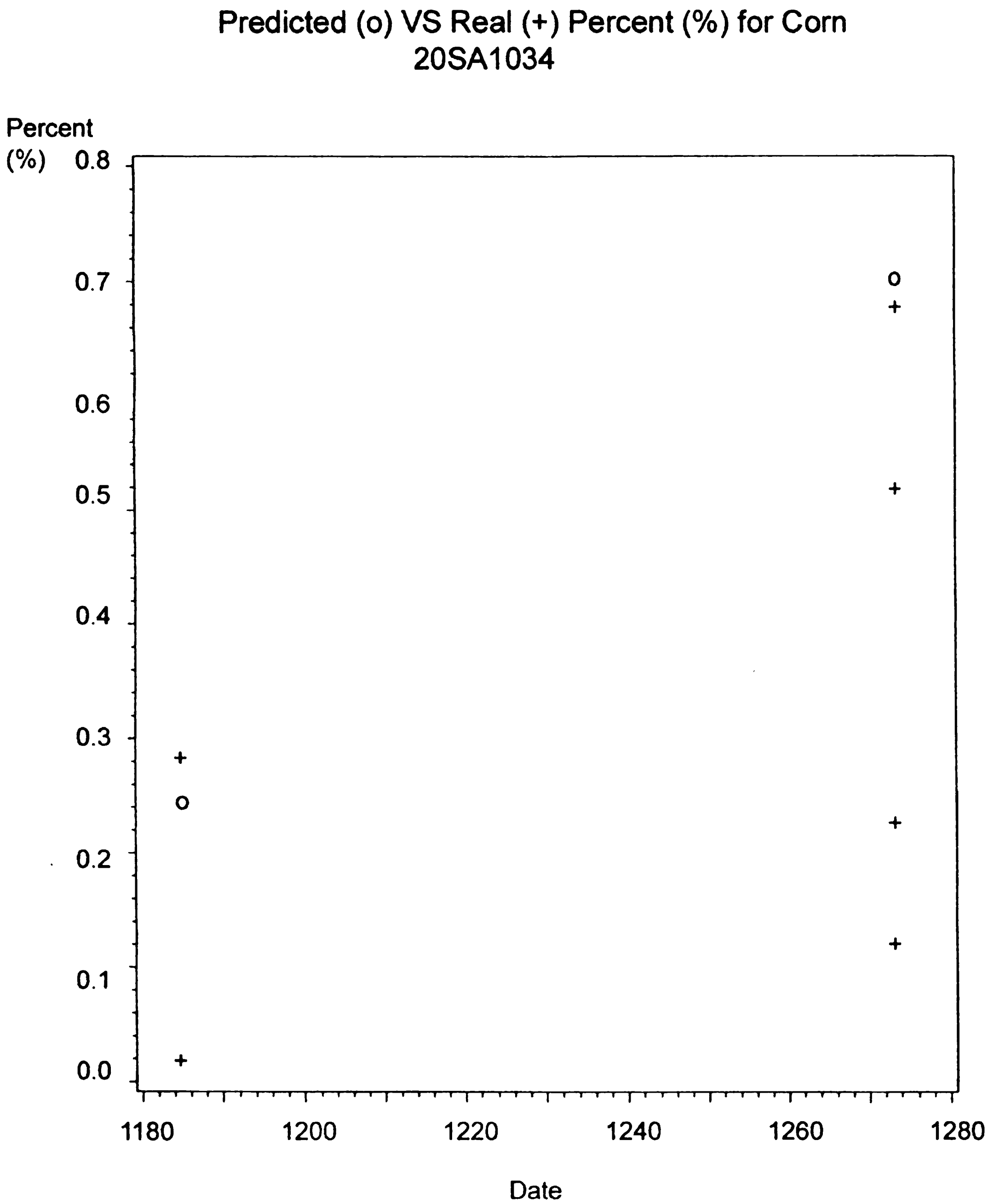
Predicted Probability (+) VS Real Frequency (o) of
Wild Seed Over Time at Wymer West
Percent
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1100
1200
1300
1400
Date

Figure 5-5



Predicted Probability for Corn over time
20SA1034
Estimated Probability
0.72
0.70
0.60
0.50
0.40
0.30
0.26
0.24
1180
1200
1220
1240
1260
1280
Date

Figure 5-6


Predicted (o) VS Real (+) Percent (%) for Corn
20SA1034
Percent
(%)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1180
1200
1220
1240
1260
1280
Date

northern hemisphere (Bond 2001). While there was oscillation from year to year, the extreme winter temperature dropped by as much as 2° F between A.D. 1000 and A.D. 1500. The ameliorating result of lake effect weather in southwestern Michigan is relative to real temperature. Oscillation in real temperatures may be reflected in the ability to grow corn one year and crop failure the next due to cooler temperatures and less frost free growing days. Deteriorating temperatures could have been a constraint on the ability for corn to grow at its northern limits during this period in time. Likewise, increased winter and/or summer precipitation could be another constraint. The Ahern and Kapp (1990) pollen diagram (Figure 3-4) indicates a change from xerophytic species to mesic. At ca. 2400 B.P. *Quercus* (oak) begins to steadily decline and an *Acer* (maple) and *Fraxinus* (beech) sub zone developed indicating a change to a cooler climate.

Cultural constraints should also be considered when comparing the fit of the data to the predicted model. Origin and development of the Upper Mississippian culture is not well understood therefore multiple working hypotheses on the introduction of corn into southwest Michigan are appropriate. Possible hypotheses for Upper Mississippian intrusion into southwestern Michigan include considering the importance of wetland and riverine resources to the Upper Mississippian culture and building social relationships between populations through intermarriage. Questions of inbreeding depression resulting in declining yields of corn could be the result of not enough trade between regions.

Based on the lack of or paucity of corn remains at sites there is a possibility that *Zea mays* was never grown in southwestern Michigan prior to A.D. 1400. Given its scarcity at sites it could have been a trade item. While corn kernel remains are found at Wymer West in decreasing amounts prior to A.D. 1400, Parker concludes they do not occur in sufficient numbers at Wymer West to have been *regularly* cultivated there. The AMS date for cobs at Moccasin Bluff in *Corn Hole A* is A.D. 1480 to 1640 (Appendix F and Adkins 2003). This date is consistent with 2002 field school midden date of A.D. 1480 to A.D. 1595 (Table 5-1). No corn kernels or cobs were found in either the Moccasin Bluff midden flotation samples or in three features (see Appendix A). Additionally, no Zea mays pollen was found in the pollen core (Appendix F) taken from a marshy embayment adjacent to the Moccasin Bluff site or in the Ahern and Kapp pollen core (1990) taken near Wymer West. Once again, the sample from Moccasin Bluff is small and could be biased. More features at Moccasin Bluff need to be excavated and floated to address the issue of when corn actually occurs at the site and in what quantities.

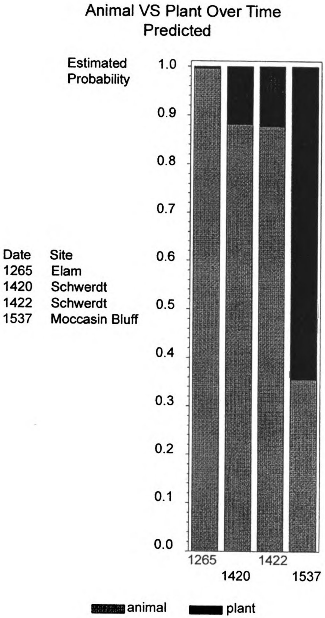
Site Function

The Schwerdt and Elam sites on the Kalamazoo River are classified as Upper Mississippian sites with a mix of grit and shell temper pottery present at the sites. According to Walz (1990) and Parachini (1981) intensive harvesting of the American lotus tuber took place at these Upper Mississippian sites. Based on co-occurrence of botanical (American lotus) and faunal (sturgeon) evidence from the Elam site, Barr (1979) posits a late spring and early summer habitation for this site. Likewise, Higgins (1980) finds the Schwerdt site to be a short-term late spring/early summer fishing camp based on the occurrence of sturgeon and other spring spawning fish. Elam and Schwerdt appear to function as short term fishing camps in which soils were probably not amenable to agriculture according to a GIS survey of sites by Chapman et al. (2000).

The Wymer West site and Moccasin Bluff site are located in an area of sandy loam soils (Chapman et al 2000) and the GLO survey from ca. 1800 indicates each site is located either in close proximity to or within a large area of grassland. Wymer West and Moccasin Bluff are not as easily defined in terms of site function as Elam and Schwerdt. According to the botanical and faunal data they represent a generalized adaptive system (Adkins 2003; Cleland 1966; Garland 2001). Subsistence remains indicate spring occupations longer in length than Schwerdt and Elam. Fall seed bearing plants such as chenopods and amaranth as well as a high percentage of deer remains indicates habitation extended into the early to mid fall at Moccasin Bluff. Two pit features at Wymer West yielded nutshell concentrations from at least one intensive harvest and processing event. While percentages of fish and reptile remains out number mammal remains at Wymer according to the faunal analysis the variety of deer bone present indicates whole deer were processed at Wymer West.

To further understand the emerging subsistence picture in southwest Michigan the total food package of plant and animal remains should be considered. Bar graphs have been constructed for the five sites (Figure 5-10 through 5-15). The bar graphs illustrate predicted models based on the frequency of plant to animal remains and the real frequency for plant and animals remains in the features, which are dated. Based on measures of abundance, the model predicts that plant remains will increase and animal remains will decrease through time. The Wymer West site (Figure 5-12), which has the

Figure 5-7



Animal VS Plant Over Time
Predicted
Estimated
Probability
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Date Site
1265 Elam
1420 Schwerdt
1422 Schwerdt
1537 Moccasin Bluff
1265
1422
1420
1537
animal
plant

Figure 5-8

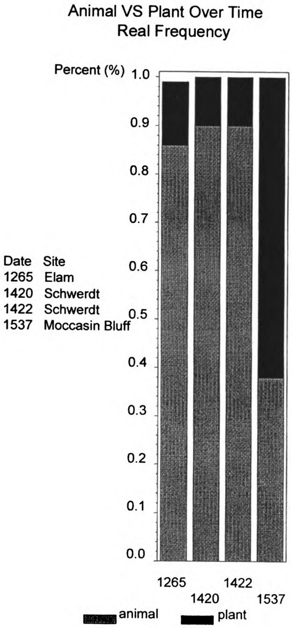

Animal VS Plant Over Time
Real Frequency
Percent (%)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Date Site
1265 Elam
1420 Schwerdt
1422 Schwerdt
1537 Moccasin Bluff
1265
1420
1422
1537
animal
plant

Figure 5-9

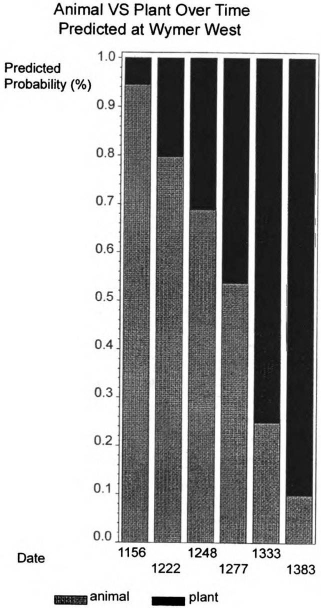

Animal VS Plant Over Time
Predicted at Wymer West
Predicted
Probability (%)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Date
1156
1222
1248
1277
1333
1383
animal
plant

Figure 5-10

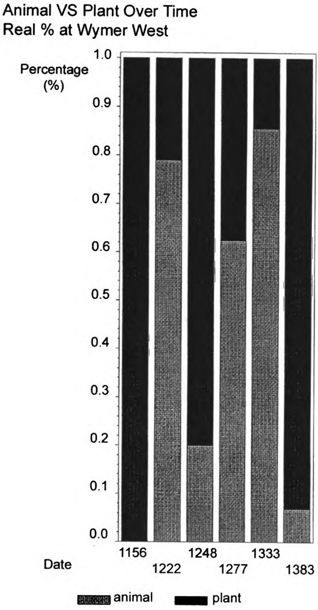
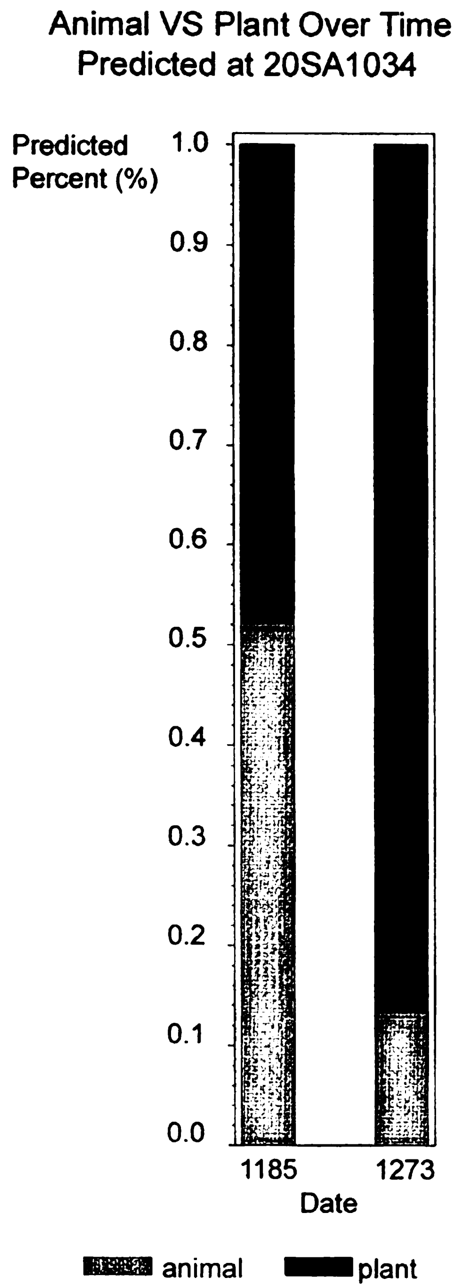
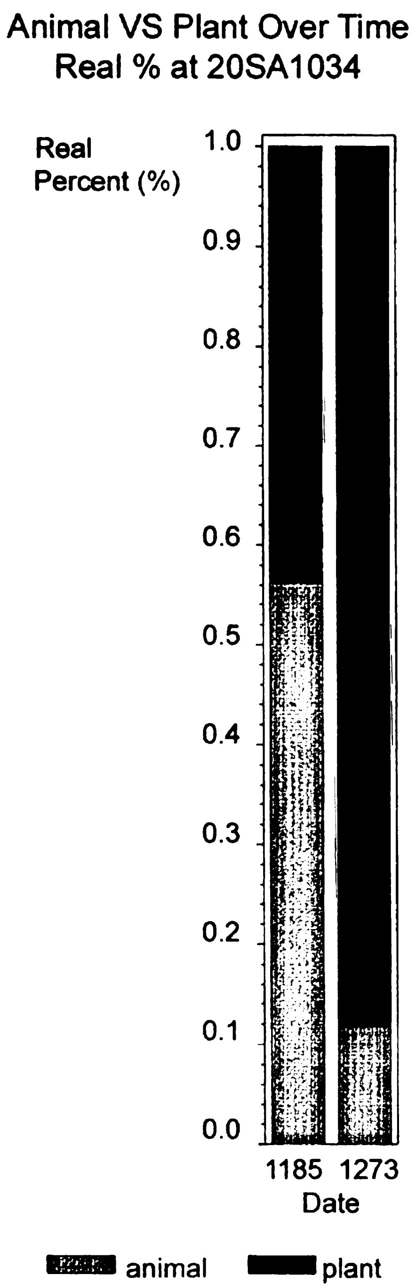

Animal VS Plant Over Time
Real % at Wymer West
Percentage (%)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Date
1156
1222
1248
1277
1333
1383
animal
plant

Figure 5-11



Animal VS Plant Over Time
Predicted at 20SA1034
Predicted Percent (%)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1185
1273
Date
animal
plant

Figure 5-12


Animal VS Plant Over Time
Real % at 20SA1034
Real
Percent (%)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1185
1273
Date
animal
plant

most dates available for features, does not seem to fit the predicted model at all. Perhaps if the sample were larger at the other four sites we would see a similar trend. Given the range of dates for the Wymer West bar graph, there are a couple of possible explanations.

Oscillating weather patterns impacting the plant environment would seem to be the easiest explanation. However, because Wymer West is considered to be occupied for more than one specific season and purpose (Garland 2001), an over abundance of fish in any given season could mean people were focused on fishing and not as focused on plant resources, or (corn) horticulture at that particular time. Another possibility is that varying population densities from one decade to the next could impact the emphasis placed on plant or animal resources. Smaller populations could mean all available humans were needed for fishing and less labor was available for horticultural endeavors. More dated features from the other sites in the region are needed in order to fully evaluate the ratio of plant to animal remains. It is clear, however, that Elam and Schwerdt were sites that functioned differently in terms of length and intensity of occupation when compared to Moccasin Bluff and Wymer West.

Chapter 6

Conclusion and New Model for Southwest Michigan

As with many other types of data in archaeology, the botanical data are scant for determining the entry and timing of corn agriculture in southwest Michigan. The small amount of data makes it difficult to determine when corn was accepted into the subsistence cycle. Interaction between cultures provides opportunity to accept corn as a new subsistence item by the Late Woodland culture, but more data are needed to confidently determine how long it took before intensive corn agriculture was established.

The Ahern and Kapp (1990) pollen diagram from Berrien County indicates that climatic conditions could have been a constraint for Late Woodland/Upper Mississippian cultures if they were trying to grow corn. A wetter climate is indicated according to the pollen diagram with the decrease in oak pollen and an increase in maple and beech (zone IIId). Lake effect weather should create an ameliorating climate but the pollen diagram indicates a period of species change inconsistent with an improving climate. Ice core data (Bond 2001) confirms lower temperature extremes in the northern hemisphere between A.D. 1000 and A.D. 1500.

Moccasin Bluff residents were finding suitable subsistence strategies regardless of climatic change because wild seeds never drop out of the archaeological record. Wild plant species act as built in buffers during rapid or oscillating climate change. If the climate becomes too extreme and a preferred or valued wild food species becomes scarce, then other wild species, which flourish in the altered climate, will fill the empty niche and serve the same subsistence purpose.

So far the botanical data from Moccasin Bluff do not indicate that it was the large agricultural village prior to A.D. 1400 whose main subsistence was corn. Moccasin Bluff, however, can be considered a village in which horticultural activities took place at this time. For now, horticultural activities at Moccasin Bluff are restricted to intensive harvesting of wild plant species. Until more data is gathered from Moccasin Bluff, those activities seem to have been focused on plant species from the Eastern Agricultural Complex and also the probable gathering of other aquatic plant resources such as the American lotus tuber. If corn was indeed grown at Moccasin Bluff between A.D.1000 to A.D.1400 it was probably grown more as a peculiarity than as a staple. It could have been an item in a mixed garden that perhaps, if it grew well one year, provided a nice change from the usual marsh, woodlot and edge habitat fare. If growing conditions (too much rain followed by too much heat) were such that it didn't pollinate well to produce fruit, then wasn't missed. Regardless, "corn agriculture" was not practiced at Moccasin Bluff prior to ca. A.D. 1400.

A similar subsistence pattern is found at the Wymer West site. Corn occurs in decreasing abundance through time (A. D. 1156 to A.D 1383) and tobacco seeds are found in at least one feature. According to the GIS soil analysis by Chapman et al. (2000) the St. Joseph River Valley is a region of sandy loam soil, which is amenable for agriculture. However, Parker (2001) concluded that corn was not regularly cultivated at Wymer West. The Kalamazoo River drainage, where the Schwerdt and Elam sites are located, has a higher percentage of muck (Chapman et al 2000). Interestingly, Wymer West (Garland 2001), Schwerdt (Cremin 1980; Walz 1991), and Elam (Parachini 1981) are all considered Upper Mississippian sites, with the latter two sites termed resource extraction sites for sturgeon and American lotus tubers. It would seem that in light of a declining but oscillating climate (temperature and precipitation), Upper Mississippian peoples in southwest Michigan shifted their focus from corn agriculture to a naturally occurring root crop (American lotus). This conclusion is based on: 1) the fact that corn occurs at Wymer West in decreasing quantities through time, 2) Parker (2001) concludes it was not regularly cultivated, 3) corn is only documented after ca. A.D. 1500 at Moccasin Bluff in the form of cobs in smudge pits, and 4) Upper Mississippians concentrated on exploiting the American lotus tuber at Schwerdt and Elam.

Regionally, *Zea mays* could have been a valued or preferred food item prior to ca. A.D. 1500. It could have been valued because it took skill and care to get corn to grow in southwest Michigan prior to A.D. 1500 due to deteriorating weather conditions, bringing prestige to the successful gardener. Or, valued because it was a coveted trade item, bringing variety to the prehistoric diet. This simplified scenario only helps to illustrate the available choices and constraints that inhabitants in southwest Michigan faced ca. A.D. 1000 through the period of European contact.

An important part of archaeology is to build models, which are testable with data. While the Fitting and Cleland model (1969) sounds good in theory, the *prehistoric* agricultural village type (Moccasin Bluff) is not supported by the data. This conclusion is reached only after implementing a macro regional study using ice core data combined with a microenvironmental study involving soil, pollen and carbonized seed data and material cultural remains from the four sites in southwest Michigan and one site in the Saginaw Valley.

Many site analyses have been linked to the Fitting and Cleland settlement/subsistence model (1969) via reference to Moccasin Bluff as an agricultural village (Barr 1979; Bettarel and Smith 1973; Cremin 1980,1983; Garland 2001; Higgins 1980; Parachini 1981; Walz 1991). The Fitting/Cleland model (1969) of the biotic provinces is a very general model. The model does not focus on climate change, microenvironments, or consider fluctuations in climate creating ecological constraints. However, focus on the climatological context provides a different picture.

Corn cultivation in southwest Michigan ca. A.D. 1000 appears as a *new* subsistence *possibility* in the ecosystem and is concurrent with the appearance of multi-seasonal sites like Wymer West and Moccasin Bluff. Because the Upper Mississippian culture is thought to be intrusive into southwestern Michigan it is logical to assume that this culture migrated from some area south of southwest Michigan bringing with them agricultural knowledge and traditions. By evaluating microenvironments in these other locations to understand a combination of ecological and cultural constraints resulting in choices that Upper Mississippians were faced with, reasons for expansion into southwest Michigan, which have not been considered, could become apparent.

New Model

Linking microenvironmental studies to cultural studies between river valleys could distinguish previously invisible constraints in prehistory. With the aid of new technologies such as programs like GIS, better dating techniques, climate data from ice cores and collaboration with specialists in various areas of archaeology, rethinking previously assumed boundaries are possible.

If, according to Rindos, subsistence traditions are not linear and pass within and between cultures, then variation should be expected across a region such as southwest Michigan. In this study variation is found between sites, or more properly between sites on different drainage systems (St. Joseph, Kalamazoo, and Flint). Variation is also found within sites like Wymer West between plant and animal remains over time. Cultural maximizing strategies for subsistence (Rindos 1985) could be the reason for variation.

As much as possible, a microenvironmental study was done for the Wymer West, Schwerdt, and Elam sites. These sites reinforce new conclusions drawn about regional activities at Moccasin Bluff prior to A.D. 1400. At Wymer West, which is located 8 miles down stream from Moccasin Bluff, corn abundance decreased between A.D. 1000 and A.D. 1400. The Schwerdt and Elam sites are approximately contemporaneous with Wymer West and botanical studies indicate the American lotus tuber was the preferred, or valued, botanical species harvested. Soil studies reinforce the notion that agriculture was not a priority at Schwerdt and Elam due to the high percentage of muck occurring in a one-mile catchment area of the site (Chapman et al. 2000). According to Schroeder (1999) the size of a prehistoric indigenous agricultural garden (field) is smaller than that probably envisioned by Bettarel and Smith. Gardens could have been as small as maybe 8 feet square or possibly as large as ½ an acre. In other words, past researchers may have been looking for large fields, which never existed. The GIS analysis (Chapman et al 2000) illustrates suitable soils for agriculture were available at Moccasin Bluff, however they were limited to the floodplain.

While the same environmental data were not available for the site from the Saginaw Valley, 20SA1034, prehistoric peoples from that region appear to have operated under different constraints. Their ability to produce a greater amount of corn when they were located latitudinally further north possibly indicates different environmental and cultural constraints.

This study illustrates a type of microenvironmental model based on variability and opportunity. It uses river drainage systems as a unit of analysis connecting a culture to the natural environment. This model could be successfully used not only in southwestern Michigan but also northwest Indiana, and northeast Illinois where questions about corn agriculture are unresolved.

Garland hints at a warm weather settlement/subsistence model in southwestern Michigan based on variability and opportunity. "It may be that Wymer West Knoll site, neither a village nor an extractive site as these are narrowly defined, represents a St. Joseph Valley variant, a warm season habitation of several months duration" (Garland 2001:334). New data from Moccasin Bluff indicates residents practiced warm season occupations for periods of several months as well. This is evident by the range of carbonized seeds in feature flotation and faunal remains. Seeds from the Eastern Agricultural Complex are found in the carbonized seed inventory at Moccasin Bluff. It is logical to conclude that some level of horticulture and gathering, as well as hunting and fishing took place at Moccasin Bluff ca. A.D. 1000 to A.D. 1400.

With oscillating temperatures, which were declining with the onset of the Little Ice Age (LIA), the environment was in flux. Detailed studies of soil data, hydrology, and land cover for the time period in question should accompany material, floral, and faunal archaeological data in order to understand natural and cultural constraints, which prehistoric cultures faced with the onset of the LIA in southwest Michigan. By using new technology and a collaborative methodology to test models based on the culture and ecology of river drainage systems we gain greater insight to answer several of the yet unanswered questions of why corn agriculture takes so long to become an important part of subsistence for later indigenous cultures in this region, and how this fits with proto historic and historic subsistence patterns.

APPENDICES

Appendix A	Moccasin Bluff site 20BE8								
	remains analyzed by Cindy Adkins								
	May-03								
Feature	1015		1013						
Zone									
Flotation Number									
Volume (liters)	19		76		95				
	count	weight	count	weight	Total count	Total weight	density count	density weight	
Nutshell Total	0		1	0	1	0	0.010526	0	
Carya sp. (thick-shelled Hickory)			1		1	0	0.010526	0	
JUGLANDACEAE (Walnut family)					0	0	0	0	
Quercus sp. (Acorn)					0	0	0	0	
					0	0	0	0	
Wood Total	2894	62.6	4041	52	6935	114.6	73	1.206316	
Acer sp. (maple)					0	0	0	0	
Betula			1		1	0	0.010526	0	
Carya sp. (thick-shelled Hickory)	3		14		17	0	0.178947	0	
C. illinoensis					0	0	0	0	
Celtis sp. (hackberry)					0	0	0	0	
Castanea spp. (chestnut)			5		5	0	0.052632	0	
Fagus grandifolia	35		74		109	0	1.147368	0	
Gymnocladus dioicus (coffee-tree)					0	0	0	0	
Juniperus sp. (Cedar)			4		4	0	0.042105	0	
Plantus occidentalis (Sycamore)					0	0	0	0	
Prunus serotina (Black Cherry)			2		2	0	0.021053	0	
Quercus sp. (oak)			6		6	0	0.063158	0	
Quercus sp. (Red Oak)	4				4	0	0.042105	0	
Quercus sp. (White Oak)	8		19		27	0	0.284211	0	
Tilia	9				9	0	0.094737	0	

Appendix A continued	Moccasin Bluff site 20BE8							
	remains analyzed by Cindy Adkins							
	May-03							
Feature	1015		1013					
Zone								
Flotation Number								
Volume (liters)	19		76		95			
	count	weight	count	weight	Total count	Total weigh	density cou	density weight
Ulmaceae (Elm)	1		4		5	0	0.052632	0
Total Identified					0	0	0	0
Diffuse porous			5		5	0	0.052632	0
Ring porous			4		4	0	0.042105	0
Unidentified					0	0	0	0
Unidentifiable			2		2	0	0.021053	0
grape vine					0	0	0	0
bark			5		5	0	0.052632	0
					0	0	0	0
Starchy seed total	54		106		160	0	1.684211	0
Chenopodium berlandieri (goosefoot)	54		94		148	0	1.557895	0
Phalaris caroliniana (maygrass)			1		1	0	0.010526	0
Polygonum erectum (erect knotweed)			7		7	0	0.073684	0
Amaranthus			4		4	0	0.042105	0
					0	0	0	0
Oily seeds					0	0	0	0
Iva annua (sumpweed)			1		1	0	0.010526	0
Helianthus annuus (sunflower)			2		2	0	0.021053	0
					0	0	0	0
Other seeds					0	0	0	0
Viburnam dentatum (arrow wood)	1				1	0	0.010526	0
Scirpus sp.					0	0	0	0
Polygonum sp.					0	0	0	0
Panicum sp.					0	0	0	0
Euphorbia sp. (spurge)	1				1	0	0.010526	0
Galium sp. (bedstraw)	7				7	0	0.073684	0
Mollugo verticillata (carpet weed)			1		1	0	0.010526	0
Portulaca sp.					0	0	0	0

Appendix A continued	Moccasin Bluff site 20BE8							
	remains analyzed by Cindy Adkins							
	May-03							
Feature	1015		1013					
Zone								
Flotation Number								
Volume (liters)	19		76		95			
	count	weight	count	weight	Total count	Total weigh	density cou	density weight
Prunus pennsylvanica	1				1	0	0.010526	0
Silene anthirrhina (catchfly)					0	0	0	0
Phytolacca americana (pokeberry)	12		4		16	0	0.168421	0
Eleocharis obtusa (spikerush)					0	0	0	0
Rubus sp.	13		41		54	0	0.568421	0
grass seed			3		3	0	0.031579	0
					0	0	0	0
Total identified seeds	89		158		247	0	2.6	0
unidentified seed	80		88		168	0	1.768421	0
unidentifiable seed	30		36		66	0	0.694737	0
Total seed count	199		282		481	0	5.063158	0
					0	0	0	0
Pokeberry embryo	3				3	0	0.031579	0
Pokeberry seed coat	8				8	0	0.084211	0
Chenopodium seed coat	4				4	0	0.042105	0
CUCURBITACEAE Rind (squash/gourd)					0	0	0	0
					0	0	0	0
Monocot stem	3				3	0	0.031579	0
					0	0	0	0
Vegetative parts					0	0	0	0
capsule					0	0	0	0
seed coat			3		3	0	0.031579	0
bud					0	0	0	0
dried fruit	1				1	0	0.010526	0
fungal fructification					0	0	0	0
						0	0	0
						0	0	0
Grand Total	3112	62.6	4326	52	7602	114.6	80.02105	1.206316

Appendix A continued		Moccasin Bluff site 20BE8							
		remains analyzed by Cindy Adkins							
		May-03							
Feature	unit 112		unit 112		unit 112			1014	
Zone	I		III		IV				
Flotation Number									
Volume (liters)	8		8		8			32	
	count	weight	count	weight	count	weight		count	weight
Nutshell Total		0				0		4	0.1
Carya sp. (thick-shelled Hickory)								4	0.1
JUGLANDACEAE (Walnut family)									
Quercus sp. (Acorn)									
Wood Total	29	0.5	14	0.3	48	1.1		243	2.7
Acer sp. (maple)	4		2		4				
Betula									
Carya sp. (thick-shelled Hickory)								14	
C. illinoensis					2				
Celtis sp. (hackberry)	1							2	
Castanea spp. (chestnut)									
Fagus grandifolia	1				2			8	
Gymnocladus dioicus (coffee-tree)	5		1						
Juniperus sp. (Cedar)								4	
Plantus occidentalis (Sycamore)									
Prunus serotina (Black Cherry)									
Quercus sp. (oak)	1		4						
Quercus sp. (Red Oak)								4	
Quercus sp. (White Oak)	2		3		8			26	
Tilia	3		1		3			9	

Appendix A continued		Moccasin Bluff site 20BE8							
		remains analyzed by Cindy Adkins							
		May-03							
Feature	unit 112		unit 112		unit 112			1014	
Zone	I		III		IV				
Flotation Number									
Volume (liters)	8		8		8			32	
	count	weight	count	weight	count	weight		count	weight
Ulmaceae (Elm)									
Total Identified									
Diffuse porous								1	
Ring porous	3		1						
Unidentified									
Unidentifiable			2		1			9	
grape vine									
bark									
Starchy seed total	1				1			4	
Chenopodium berlandieri (goosefoot)	1				1			4	
Phalaris caroliniana (maygrass)									
Polygonum erectum (erect knotweed)									
Amaranthus									
Oily seeds									
Iva annua (sumpweed)									
Helianthus annuus (sunflower)									
Other seeds									
Vibumam dentatum (arrow wood)									
Scirpus sp.									
Polygonum sp.									
Panicum sp.									
Euphorbia sp. (spurge)									
Galium sp. (bedstraw)									
Mollugo verticillata (carpet weed)									
Portulaca sp.								1	

Appendix A continued		Moccasin Bluff site 20BE8						
		remains analyzed by Cindy Adkins						
		May-03						
Feature	unit 112		unit 112		unit 112			1014	
Zone	I		III		IV				
Flotation Number									
Volume (liters)	8		8		8			32	
	count	weight	count	weight	count	weight		count	weight
Prunus pennsylvanica									
Silene anthirrhina (catchfly)	1				1				
Phytolacca americana (pokeberry)	8							6	
Eleocharis obtusa (spikerush)	4								
Rubus sp.			1		1			7	
grass seed									
Total identified seeds									
unidentified seed								1	
unidentifiable seed									
Total seed count									
Pokeberry embryo									
Pokeberry seed coat			1						
Chenopodium seed coat									
CUCURBITACEAE Rind (squash/gourd)	1								
Monocot stem									
Vegetative parts									
capsule									
seed coat									
bud									
dried fruit	6				1				
fungal fructification									
Grand Total									

Appendix A continued	Moccasin Bluff site 20BE8							
	remains analyzed by Cindy Adkins							
	May-03							
Feature	unit 112 hand collected samples							
Zone	level 2		level 3		level 4		level 5 area B	
Flotation Number								
Volume (liters)								
	count	weight	count	weight	count	weight	count	weight
Nutshell Total								
Carya sp. (thick-shelled Hickory)								
JUGLANDACEAE (Walnut family)								
Quercus sp. (Acorn)								
Wood Total	6	1.1	1	0.4	13	1	34	14.4
Acer sp. (maple)								
Betula								
Carya sp. (thick-shelled Hickory)			1		7		2	
C. illinoensis							1	
Celtis sp. (hackberry)								
Castanea spp. (chestnut)								
Fagus grandifolia					4		9	
Gymnocladus dioicus (coffee-tree)								
Juniperus sp. (Cedar)								
Plantus occidentalis (Sycamore)								
Prunus serotina (Black Cherry)								
Quercus sp. (oak)								
Quercus sp. (Red Oak)								
Quercus sp. (White Oak)								
Tilia	5						6	
Ulmaceae (Elm)								
Total Identified								
Diffuse porous								
Ring porous								

Appendix A continued	Moccasin Bluff site 20BE8							
	remains analyzed by Cindy Adkins							
	May-03							
Feature	unit 112 hand collected samples							
Zone	level 2		level 3		level 4		level 5 area B	
Unidentified								
Unidentifiable	1							
grape vine					2			
bark								

Appendix A continued					Moccasin Bluff site 20BE8			
					remains analyzed by Cindy Adkins			
					May-03			
Feature	Unit 112 hand collected samples							
Zone	level 5 area A		level 6 area F		level 6 area D		level 6 area C	
Flotation Number								
Volume (liters)								
	count	weight	count	weight	count	weight	count	weight
Nutshell Total								
Carya sp. (thick-shelled Hickory)								
JUGLANDACEAE (Walnut family)								
Quercus sp. (Acorn)								
Wood Total	15	2.3	60	20.9	5	2.5	25	8.1
Acer sp. (maple)								
Betula								
Carya sp. (thick-shelled Hickory)	2		3					
C. illinoensis							7	
Celtis sp. (hackberry)								
Castanea spp. (chestnut)								
Fagus grandifolia	5		9		4		3	
Gymnocladus dioicus (coffee-tree)								
Juniperus sp. (Cedar)								
Plantus occidentalis (Sycamore)			3					
Prunus serotina (Black Cherry)			1				6	
Quercus sp. (oak)								
Quercus sp. (Red Oak)								
Quercus sp. (White Oak)								
Tilia	7							

Appendix A continued					Moccasin Bluff site 20BE8			
					remains analyzed by Cindy Adkins			
					May-03			
Feature	Unit 112 hand collected samples							
Zone	level 5 area A		level 6 area F		level 6 area D		level 6 area C	
Flotation Number								
Volume (liters)								
	count	weight	count	weight	count	weight	count	weight
Ulmaceae (Elm)								
Total Identified								
Diffuse porous								
Ring porous								
Unidentified								
Unidentifiable			4		1		4	
grape vine								
bark								

Appendix A continued		Moccasin Bluff site 20BE8				
		remains analyzed by Cindy Adkins				
		May-03				
Feature		unit 112 hand collected samples				
Zone	level 6		level 7		level 7 area E	
Flotation Number						
Volume (liters)						
	count	weight	count	weight	count	weight
Nutshell Total						
Carya sp. (thick-shelled Hickory)						
JUGLANDACEAE (Walnut family)						
Quercus sp. (Acorn)						
Wood Total	18	3.3	16	5.2	11	1.2
Acer sp. (maple)						
Betula						
Carya sp. (thick-shelled Hickory)					1	
C. illinoensis						
Celtis sp. (hackberry)						
Castanea spp. (chestnut)						
Fagus grandifolia	10		4		6	
Gymnocladus dioicus (coffee-tree)						
Juniperus sp. (Cedar)						
Plantus occidentalis (Sycamore)						
Prunus serotina (Black Cherry)	1					
Quercus sp. (oak)					2	
Quercus sp. (Red Oak)			1		1	
Quercus sp. (White Oak)					1	
Tilia	6				10	

Appendix A continued		Moccasin Bluff site 20BE8				
		remains analyzed by Cindy Adkins				
		May-03				
Feature		unit 112 hand collected samples				
Zone	level 6		level 7		level 7 area E	
Flotation Number						
Volume (liters)						
	count	weight	count	weight	count	weight
Ulmaceae (Elm)						
Total Identified						
Diffuse porous						
Ring porous						
Unidentified						
Unidentifiable			1			
grape vine						
bark						

Appendix B (Parker 2001)

Wymer West summary of seeds

SEEDS	Number
Amaranthus sp. (pigweed)	1
Amelanchier spp. (serviceberry)	3
Amphicarpa bracteata (hog peanut)	1
Andropogon spp. (bluestem/broomsedge)	3
Carex spp. (sedge)	5
Carpinus caronlinana (hornbeam/blue beech)	1
Chenopodium berlandieri (chenopod)	89
Cornus spp. (dogwood)	3
Crataegus spp. (hawthorn)	7
Cyperus spp. (nut-grass)	7
Desmodium spp. (tick trefoil)	2
Euphorbia spp. (spurge)	11
Festuca spp. (fescue)	4
Fragaria spp. (strawberry)	3
Galium spp. (bedstraw)	17
Gaylussacia baccata (huckleberry)	1
Helianthus annuus (sunflower)	2
Hypericum spp. (St. John's wort)	2
Ilex verticillata (Michigan holly)	1
Juncus sp. (rush)	1
Labiateae (mint family)	2
Nicotiana sp., cf. rustica (tobacco)	28
Panicum spp. (panic grass)	2
Phytolacca americana (pokeweed)	4
Poaceae (grass family)	15
Polygonum sp. (knotweed)	2
Ranuculus spp.(crowfoot/buttercup)	2
Rhus spp. (sumac)	42
Rubus spp. (blackberry/raspberry)	52
Rumex spp. (water dock)	2
Sambucus canadensis (elderberry)	10
Solanum sp., cf. ptychanthum (black nightshade)	51
Typha sp. (cat-tail)	1
Verbena sp., cf. hastate (vervain)	474
Vitis spp. (grape)	3
Total	854

<u>Wymer West summary of wood charcoal</u>

Wood type	number
Acer spp. (maple)	150
A. rubrum (red maple)	12
A. saccharum (sugar maple)	69
Betula spp. (birch)	3
Carpinus caroliniana (hornbeam/blue beech)	14
Carya spp. (hickory)	24
Celtis occidentalis (hackberry)	9
Cornus spp. (dogwood)	3
Fagus grandifolia (beech)	158
Fraxinus spp. (ash)	71
Fraxinus sp., cf. nigra (black ash)	17
Juglans spp. (walnut/butternut)	27
Ostrya virginiana (hop hornbeam/ironwood)	8
Platanus occidentalis (sycamore)	6
Quercus spp (oak)	16
Q. erythrobalanus (red oak subgroup)	38
Q. lepidobalanus (white oak subgroup)	33
Ulmaceae (elm family)	18
Ulmus spp. (elm)	70
U. americana (American elm)	17
Total wood (N)	763
Total Wood wt. (g)	

<u>Wymer West summary nutshell</u>

Nut type	number
Carya spp. (hickory)	492
Fagus grandifolia (beechnut)	1
Juglandaceae (hickory/walnut family)	2,007
Juglans cinerea (butternut)	741
J. nigra (black walnut)	1,087
Quercus spp. (acorn)	1
Total nutshell (N)	4,329
Total nutshell wt. (g)	

Appendix C (Dobbs et al. 1993)

20SA1034 summary of seeds

Acalypha spp. (copperleaf)	2
Ambrosia trifida (giant ragweed)	1
Amphicarpeae bracteata (hog-peanut)	8
Asteraceae (aster family	12
Astragalus spp. (milk-vetch)	7
Carex spp. (sedge)	35
Caryophyliaceae (pink family)	5
Ceratophyllum demersum (coontail)	2
Chenopodium spp. (chenopod)	317
Convolvulaceae (morning glory family)	2
Cornus spp. (dogwood)	6
Cornus candensis (bunchberry)	1
Crataegus spp. (hawthorn)	5
Cyperaceae (sedge family)	31
Datura stramonium (jimson-weed)	1
Desmodium spp. (tick-trefoil)	24
Echinochloa spp. (barnyard grass)	7
Euphorbiaceae (spurge family)	4
Fabaceae (bean family)	44
Galium spp (bedstraw/cleavers)	107
Gaylussacia baccata (huckleberry)	76
Hamamelis virginiana (spicebush)	3
Helianthus spp. (sunflower)	6
H. annuus (common sunflower)	8
Hypericum sp. (St. John's wort)	1
Hypoxis hirsute (yellow stargrass)	2
Ilex verticillata (Michigan holly)	3
Labiatae (mint family)	4
Nicotiana rustica (tobacco)	42
Panicum spp. (panic grass)	109
Poaceae (grass family)	70
Poaceae type Q & X (long)	78
Polygonum spp. (knotweed/smartweed)	24
Potamogeton sp. (pondweed)	6
Prunus sp. (plum)	1
P. pensylvanica (pin cherry)	3
Ranunculus spp. (buttercup)	6
Rhus spp. (sumac)	48
Rosaceae (rose family)	4
Rubus spp. (blackberry/raspberry)	27
Rumex spp. (dock)	12
Sambucus Canadensis (elderberry)	36

Appendix C continued

	(Dobbs et al. 1993)
Scirpus sp. (bulrush)	129
Smilax spp. (catbrier)	2
Solanum americanum (black nightshade)	654
Sparganium sp. (bur-reed)	2
Vaccinium spp. (blueberry)	5
Verbena spp. (vervain)	131
Viola spp. (violet)	13
Vitis spp. (grape)	16

<u>20SA1034 summary of wood taxa</u>

Acer spp. (maple)	53
A. rubrum (red maple)	16
A. saccharum (sugar maple)	4
Betula spp. (birch)	7
Carya spp. (hickory)	18
Celtis occidentalis (hackberry)	45
Fagus grandifolia (beech)	1
Fraxinus spp. (ash)	213
F. Americana (white ash)	39
Juglans spp. (walnut/butternut)	14
Pinus spp. (pine)	25
P. strobus (white pine)	3
Platanus occidentalis (sycamore)	20
Quercus spp. (oak)	53
Q. Erythrobalanus (oak, red subgroup)	384
Q. Lepidobalanus (oak, white subgroup)	24
Salix/Populus (willow/poplar)	3
Ulmaceae (elm family)	59
Ulmus Americana (American elm)	61
Bark	70
Diffuse Porous	34
Ring porous	161
Unidentifiable	194
Total wood (N)	35,987
Total Wood wt. (g)	460.54

<u>20SA1034 summary of nutshell</u>

Carya spp. (hickory)	44
C. ovalis (pignut hickory)	2
Juglandaceae (hickory/walnut)	95
Juglans cinerea (butternut)	141
J. nigra (black walnut)	31
Quercus spp. (acorn)	711
Total nutshell (N)	1,024
Total nutshell wt. (g)	13.94

Appendix C continued (Dobbs et al. 1993)

Other botanical materials	
Cucurbit rind	3
Equisetum spp. (scouring rush)	96
Monocot stem	279
Dicot stem	109
Grass stem	25
Tuber/corm	22
Aplos Americana (groundnut) tuber	1
Tree bud	49
Pedicel	17
Twig/flowering stem tip	624
Fungus	120

Appendix D – Summary Sheet for Data Points

Wymer West – Upper Mississippian – St. Joseph River

Feature	10	81	79	8	106	49 (1 tobacco seed)
liters	25.5	388	50	204	200	120
Date	***1156***	***1222***	***1248***	***1277***	***1333***	***1383***
Corn	.63	.05	0	.02	.005	.016
Nutshell	.15	.06	0	.017	.05	.9
Starchy seeds	.03	.08	.4	.17	.06	.006
Fruits	.19	.02	.4	.169	.03	.009
Mammal	0	.56	.2	.258	.23	.055
Reptile	0	.02	0	.137	.22	.0001
Fish	0	.18	0	.05	.34	.006
Bivalve	0	.008	0	.175	.07	.001
Birds	0	.01	0	0	0	0
Total	32	1744	5	336	188	3299

Moccasin Bluff – Late Woodland – St. Joseph River

Feature	1013	1014	1015
liters	76	32	44
Date	***1480-- 1595***	***1480-- 1595***	***1480-- 1595***
Corn	0	0	0
Nutshell	0	.04	.005
Starchy seeds	.3	.04	.56
Bean	0	0	0
Fruits	.15	.21	.23
Mammal	.14	.7	.14
Reptile	.04	0	0
Fish	.28	.01	.07
Bivalve	0	0	0
Birds	.07	0	0
Total	176	100	196

20SA1034 – Late Woodland – Saginaw Valley

Feature	31	32	10 (32 tobacco seeds)	12 (6 tobacco seeds)	27	19
liters	475	963	826	1244	534	568
Date	***1185***	***1185***	***1273***	***1273***	***1273***	***1273***
Corn	.02	.655	.14	.82	.69	.13
Nutshell	.003	.09	.23	.02	.1	.18
Starchy seeds	.001	.04	.09	.09	.09	.3
Bean	0	.009	.004	.009	.007	.05
Fruits	.027	.156	.4	.03	.04	.05
Mammal	.223	.019	.06	.02	.05	.18
Reptile	.67	.01	.03	.005	.007	.02
Fish	.05	.004	.03	.003	0	.07
Bivalve	0	0	0	0	0	0
Birds	.001	.002	.008	0	0	.005
Total	547	415	1459	502	142	168

Appendix D – Summary Sheet for Data Points continued

Schwerdt – Upper Mississippian – Kalamazoo River

Feature	9	16
liters	32	28
Date	***1420***	***1422***
Corn	0	0
Nutshell	0	0
Starchy seeds	.04	0
Bean	0	0
Fruits	.06	.1
Mammal	.02	.475
Reptile	0	.1
Fish	.88	.275
Bivalve	0	.05
Birds	0	0
Total	48	40

Elam – Upper Mississippian – Kalamazoo River

Feature	23
liters	26
Date	***1265***
Corn	0
Nutshell	0
Starchy seeds	.1
Bean	0
Fruits	.03
Mammal	0
Reptile	.5
Fish	.3
Bivalve	0
Birds	0
Total	77

Appendix D – Summary Sheet for Data Points continued

Wymer West – Upper Mississippian – St. Joseph River

Feature	10	81	79	8	106	49 (1 tobacco seed)
liters	25.5	388	50	204	200	120
Date	***1156***	***1222***	***1248***	***1277***	***1333***	***1383***
Corn	.63	.21	0	.05	.04	.02
Nutshell	.16	.29	0	.05	.35	.96
Starchy seeds	.03	.39	.5	.45	.42	.007
Fruits	.18	.11	.5	.45	.19	.01
Total	32	380	4	128	26	3087

Moccasin Bluff – Late Woodland – St. Joseph River

Feature	1013	1014	1015
liters	76	32	44
Date	***1480-- 1595***	***1480-- 1595***	***1480-- 1595***
Corn	0	0	0
Nutshell	.006	.19	0
Starchy seeds	.70	.19	.68
Bean	0	0	0
Fruits	.29	.62	.32
Total	155	21	81

20SA1034 – Late Woodland – Saginaw Valley

Feature	31	32	10 (32 tobacco seeds)	12 (6 tobacco seeds)	27	19
liters	475	963	826	1244	534	568
Date	***1185***	***1185***	***1273***	***1273***	***1273***	***1273***
Corn	.36	.66	.16	.84	.73	.18
Nutshell	.07	.09	.25	.02	.11	.24
Starchy seeds	.03	.25	.10	.10	.10	.42
Bean	0	.01	.005	.01	.007	.07
Fruits	.45	.16	.47	.03	.04	.07
Total	28	398	1259	488	134	121

Appendix D – Summary Sheet for Data Points continued

Schwerdt – Upper Mississippian – Kalamazoo River

Feature	9	16
liters	32	28
Date	***1420***	***1422***
Corn	0	0
Nutshell	0	0
Starchy seeds	.4	0
Bean	0	0
Fruits	.6	1.0
Total	5	4

Elam – Upper Mississippian – Kalamazoo River

Feature	23
liters	26
Date	***1265***
Corn	0
Nutshell	0
Starchy seeds	.81
Bean	0
Fruits	.18
Total	11

Appendix E

Ethnobotanical and Palynological Methods

Collection and processing of ethnobotanical data (flotation)

The development of flotation has been called a recovery revolution in archaeology (Watson 1976:76). Prior to the development of flotation techniques in the 1970s microscopic analysis of botanical remains was not practiced. Subsistence studies could only be addressed through the opportunistic gathering of faunal remains, wood charcoal or carbonized nutshell. Since the invention of flotation new data and information are available to archaeologists about prehistoric subsistence. To make possible some kind of comparison between sites, ethnobotanists have tried to use uniform procedures for collection and processing of flotation. However, it has been found that *direct comparisons* using identical recovery techniques between sites are impossible due to differences in soil, prehistoric behavior patterns, and post depositional histories (Wagner 1988). When materials from different sites are collected and processed in a uniform manner, they can be compared using *indirect methods* such as ubiquity, frequency, density, and proportions (Pearsall 1989; Wagner 1988).

It is common practice in North American archaeology to take flotation samples from the second half of the feature after all soil zones have been identified. Flotation samples vary depending on the size of the feature and can range from less than 10 liters to whatever the size of the second half of the feature happens to be. Excavators normally take at least one 10 liter sample from each zone. Water flotation is the technique of separating micro organic remains from soil matrix. "When properly practiced, flotation allows for recovery of all size classes of botanical material preserved in a sediment sample, making quantitative analysis possible" (Pearsall 1989:19). Standard flotation recovery uses some type of a barrel system and forty-mesh ($0.24mm^2$) screen to recover botanical remains in the light fraction. The non-floating material (heavy fraction) is scanned using low magnification and any charred plant materials are removed and added to the appropriate light fraction (Pearsall 1989).

Standard botanical analytic procedures are used to identify carbonized remains. Each light fraction is size graded into > 2mm and < 2mm in size. Remains that were > 2 mm are sorted, typed, and weighed. All specimens > 2mm are identified as specifically as possible. In the case of wood, 20 pieces from each float are randomly selected and identified. Remains that are < 2mm in size are scanned for seeds or other plant parts under 30 x magnifications. Seeds are identified to the lowest taxonomic level possible. Comparative collections are used for reference as well as identification manuals such as Hoadley 1990 and Martin and Barkley 1961.

Collection and processing of pollen data

In contrast to microbotanical analysis, in which direct comparison is not possible and indirect methods using measures of abundance are necessary, fossil pollen is directly comparable. Fossil pollen is directly comparable because post-depositional processes do not affect pollen in the same manner as macro botanical remains. Further, the sampling methods for pollen are standardized. The same diameter sample is taken each time and the core is divided into equal 2 cm segments for flotation. The process for pollen flotation is as follows: one quarter of each 2 cm increment is divided out. 10% hcl is added to each sample to rid it of any carbonates. After rinsing each sample thoroughly in distilled water zinc chloride is then added to each sample and stirred. This process creates a heavy liquid and allows the pollen to float to the top of the sample, separating it from heavier debris. Samples are then centrifuged for 15 minutes to speed the separation process and pollen is then extracted from the top layer and put in a smaller test tube. Each sample is washed with distilled water and centrifuged for 10 minutes three times. The pollen sample is then stained and washed again 3 times to dilute excess stain. Glycerin jelly is added to each sample and one slide prepared for each sample. After microscopic inspection of several slides a determination is made as to whether the flotation process should be done a second time because not enough pollen was rendered from the first flotation. The flotation process could then be repeated and microscope slides constructed for each 2 cm sample. Finally, a piece of wood located at or near the bottom of a core can be sent for AMS dating.

AMS dating and botanical remains

Developing chronologies of the introduction of corn is a necessary component for understanding change in subsistence. According to Smith, AMS dating is a way to directly date small carbonized samples, thus eliminating error when dating plant remains through association with material cultural remains in pit features. The Eidson site (Garland 1990), for example, is reported to have early evidence of corn remains (one cupule). The cupule was dated by association with a C^{14} date of A.D. 300 ± 70 from charcoal remains in the same feature. If the cupule itself could have been AMS dated it may have been found to be intrusive into an earlier feature. Unfortunately, AMS dating is expensive and was not often used at the time of this excavation. Smith (1992) credits

Richard Ford and others with the reanalysis of maize introduction in eastern North America. According to their work the arrival date of maize was pushed forward in time (Smith 1992). However, there are still conflicts with the reanalysis of maize introduction and material cultural record that remain to be sorted out.

It is logical to assume that the contents of a feature are deposited at or near the same time that the carbonized remains are deposited. AMS dating at sites has not been done regularly in the past. In order to use previously excavated data it is, unfortunately, necessary to use features with C^{14} dates from each archaeological site. In this study features will only be considered if they have a C^{14} date. This will reduce, as much as possible, the uncertainty of the date of deposition of feature contents. Using C^{14} dates and measures of abundance will then allow for data to be transformed for statistical analysis.

Appendix F

Lab notes

1) **AMS date** on corn cob remains from 1948 excavation, **"corn hole A,"** sent to Beta Analytic. Findings are as follows:

Beta Analytic lab number: Beta-183336
Conventional radiocarbon age: 340 +/- 40 BP
2 sigma calibrated result: Cal AD 1450 to 1650 (Cal BP 500 to 300) 95% probability

Intercept data
Intercepts of radiocarbon age with calibration curve:
Cal AD 1520 (Cal BP 430) and
Cal AD 1590 (Cal BP 360) and
Cal AD 1620 (Cal BP 330)

1 Sigma calibrated result: Cal AD 1480 to 1640 (Cal BP 470 to 310) 68% probability

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2) **AMS date** on wood found at bottom of **pollen core** taken during O'Gorman 2002 field school and sent to Beta Analytic. Findings are as follows:

Beta Analytic lab number: Beta- 172903
Conventional radiocarbon age: 3450 +/- 40 BP
2 sigma calibrated result: Cal BC 1880 to 1670 (Cal BP 3830 to 3620) 95%probability

Intercept data
Intercept of radiocarbon age with calibration curve:
Cal BC 1750 (Cal BP 3700)

1 sigma calibrated result: Cal BC 1770 to 1700 (Cal BP 3720 to 3650) 68% probability

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3) **Notes on pollen core**, flotation, slide preparation, and results from looking at slides are as follows: Pollen core collected on 6-10-02 from marshy embayment located south and adjacent to the Moccasin Bluff site.
Used a Davis Sampler and the parallel core method. Sample cores were taken in 36 cm increments.

Hole A	Hole B
Surface – 36 cmbs	36 – 72 cmbs
72-108 cmbs (water)	108 – 144 cmbs
144 – 180 cmbs	180 – 216 cmbs (wood at bottom)
216 – 252 cmbs	252 – 288 cmbs
288 – 324 cmbs (wood at bottom, end core)	

Michigan State Paleobotany Maceration numbers for slide prep:
Four preliminary pollen floats from various depths in the core were sampled as a preview. Made one slide for each PB number.

Maceration #	depth	Notes
PB15459	288-324 cmbs	1 cm piece of wood at bottom of core used for AMS date. This sample was 2cm just above wood.
PB15460	surface-36 cmbs 8-10/10cm	
PB15461	108 – 144 cmbs	first two cm of core segment was floated. 72 – 108 cmbs was water.
PB15462	180 – 216 cmbs	1 cm of wood located at bottom of core segment. 2 cm above the wood was floated.

PB15470	surface-36 cmbs 6-8/10 cm	
PB15471	4-6/10 cm	
PB15472	2-4/10 cm	
PB15473	0-2/10 cm	

PB15463	36-72 cmbs 0-2/13.5 cm	
PB15464	2-4/13.5 cm	
PB15465	4-6/13.5 cm	
PB15466	6-8/13.5 cm	
PB15467	8-10/13.5 cm	
PB15468	10-12/13.5cm	
PB15469	12-13.5/13.5 cm	

	72-108 cmbs, water	

Sample slide PB15460 was examined. No pollen count taken because I am looking for presence/absence of *Zea mays* pollen. Types of pollen noted in this sample are as follows: several pine and fern spores, many small grasses, many composits, chenopodium, birch, maple, oak, chestnut, basswood, willow. No corn pollen was found in this sample.

All slides were scanned for presence of corn pollen. No corn pollen is found.

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