

UNCERTAINTY AND RISK-BASED DECISION-MAKING: HUNTER-GATHERER ADAPTATION TO
SPATIOTEMPORAL HETEROGENEITY

By

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ABSTRACT

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Hunter-gatherer land use and diet decision-making is tightly coupled with temporal (i.e., seasonal) and spatial (i.e., landscape) resource variability. This spatiotemporal variation, driven by climatic and hydrological processes poses considerable uncertainties and risks for hunter-gatherer economic success. In this dissertation, I use these contextual and behavioral variables to explore hunter gatherer social responses to resource uncertainty and risk in the Saginaw Bay Drainage of Michigan.

Hunter-gatherer economic decision-making is often framed as responses to nutritional requirements, exploitation efficiency, and as a normative response to environmental conditions (resource constraints and abundance). This project explores decision-making through an alternate basis; of economic security explored through behavioral strategies intended cope and buffer against spatiotemporal risk and uncertainty. To this end, I model cultural and resource landscapes and simulate hunter gatherer economic choices in order to understand the role that uncertainty and risk plays on land use and diet. Further, these models are compared against archaeological material culture (i.e., site locales and features, fauna and flora). Cumulatively, these models are used to better understand economic decision-making during the Late Archaic (5000-2500 B.P.), Early Woodland (2500-2100 B.P.) and Middle Woodland (2100-1500 B.P.).

First, the resulting landscape models indicate considerable large-scale wetland environments that fluctuate seasonally and on a long term basis. Both, the Late Archaic and Middle Woodland periods are heavily wetland influenced, with considerable regional and localized effects. Next, the behavioral model suggests that economic choices intended to address uncertainty and risk are strategies aimed at tackling boundary conditions (i.e., worse case scenarios) and are likely baseline criteria for economic decision-making. Highly effective strategies include a combination of high and low risk resource exploitation with seasonally adjustable diet breadth (large ungulates and diverse plant foods concurrently through a gendered division of labor).

Last, comparative analysis with archaeological materials indicates that hunter-gatherers employ an ever-increasing complex resource and land use strategies over time intended to adapt to both, long term and short term seasonal and spatially variable resource distributions. These behavioral responses results in changes in hunter-gatherer economy including resource and land use diversification, specialization of mobility patterns, expanding exchange networks, and pooling strategies. Further, the research outcomes highlights the benefits of systematic, long-term and regional studies that results in implications for the archaeology that highlight the resilience, and longevity of the hunter-gatherer economy.

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Chapter 1: Introduction and Research Problem

Introduction

Hunting, fishing and gathering has been the dominant economic mode throughout much of human history. The diversity and longevity of foraging practices have been and continue to be a focus of anthropological inquiry, where the foremost approach employed is the study of economic behavior with a focus on subsistence and settlement. These behaviors are adaptive; continually changing in response to the changing natural environment and to the broader cultural system, driven by goals that seek to satisfy basic livelihood requirements. Goals that drive economic behaviors include both short and long term strategies including economic security, efficiency and prestige.

Economic security (i.e., reliability), the consistent acquisition of minimum caloric requirements, is perhaps the key goal that influences economic behavior among the various other complementary strategies, including efficiency or maximization of economic return, biological factors (i.e., nutrients and energy), and social factors (i.e., prestige, status). Security is attained through social and economic coping and buffering practices, including the use of mobility, pooling and diversification of resources, storage, and the exchange of social relationships and resources for security (Agrawal 2001; Halstead and O'Shea 1989b). Further, hunter-gatherer (HG) individual agency and social organization through a division of labor plays an important role in attaining security. The need for economic security and linked social and economic practices are, therefore, important for our understanding HG adaptations.

Economic security can be best studied in contexts that feature environmental instability. Contexts with non-homogenous biophysical environments where resources are spatiotemporally variable are ideal. Resources in temperate wetlands are a case in point, with striking spatiotemporal variability, where the distribution and density of wetlands play an important role for availability of resources. Further, the seasonality of temperate environments and linked animal and plant dynamics also contribute to resource instability. The challenges posed by the environment provide a context for the exploration of processes and the role of coping and buffering strategies for attaining economic security. Therefore, the research presented here seeks to understand HG economic and social practices in variable environments, through role of buffering and coping responses to spatiotemporal heterogeneity in dynamic wetland environments during the Late Archaic (5000-2500 B.P.), Early Woodland (2500-2100 B.P.) and Middle Woodland (2100-1500 B.P.) periods in the Saginaw Bay Drainage (hereafter 'SBD') of Michigan. This research is undertaken through the development of models aimed at recreating probable past contexts, behaviors, and analysis of land use and diet choices in SBD, thus addressing both problems in ecological and social environment. This introductory chapter presents an overview of this project by stating the problem, theoretical framework employed, approach taken, and questions posed.

The organization of the volume is intended to address the research problem in an approach that individual chapters build upon each other. The first four chapters entail 1) introduction and problem, 2) theory-uncertainty and risk, 3) methodological review -modeling, and 4) effective social and ecological environment. These background chapters are followed by three analytic chapters. These chapters are organized in a standard format: methods, results

and discussion. Methods relate to the immediate approach that has been employed, results are the products of analysis and discussions are the interpretation of key questions framed in current and previous chapters. This way, each chapter builds upon the others, culminating in the final conclusions and implications section and suggestions for future directions for research.

The Research Problem

Ethnographic and archaeological studies demonstrate HG groups actively choose to pursue their lifeways given the presence of alternative adaptive strategies (i.e., low level food production, agriculture, intensification, sedentism etc.). These societies employ flexible social and economic strategies to maintain the flexibility afforded by hunting and gathering. The continuation of HG mode of production is often understated and undervalued due to greater focus on agricultural domestication and due to the lack of understating of the processes and factors that contribute to HG continuity and longevity (Hitchcock and Ebert 1984; Raymond and DeBoer 2006). In fact, the processes and factors that sustain HG economy can provide an evaluative basis for alternative economic strategies. HGs in SBD are case in point, with considerable challenges to their economy originating from both the ecological and social environments.

Ecologically, the study area is a region with extensive spatial heterogeneity and ecotonal variability. First, the SBD contains an extensive heterogeneous wetland area with dramatic changes in the distribution and density of wetlands from the Late Archaic through the Early Woodland period. In the Middle Woodland, the landscapes rapidly transformed back to

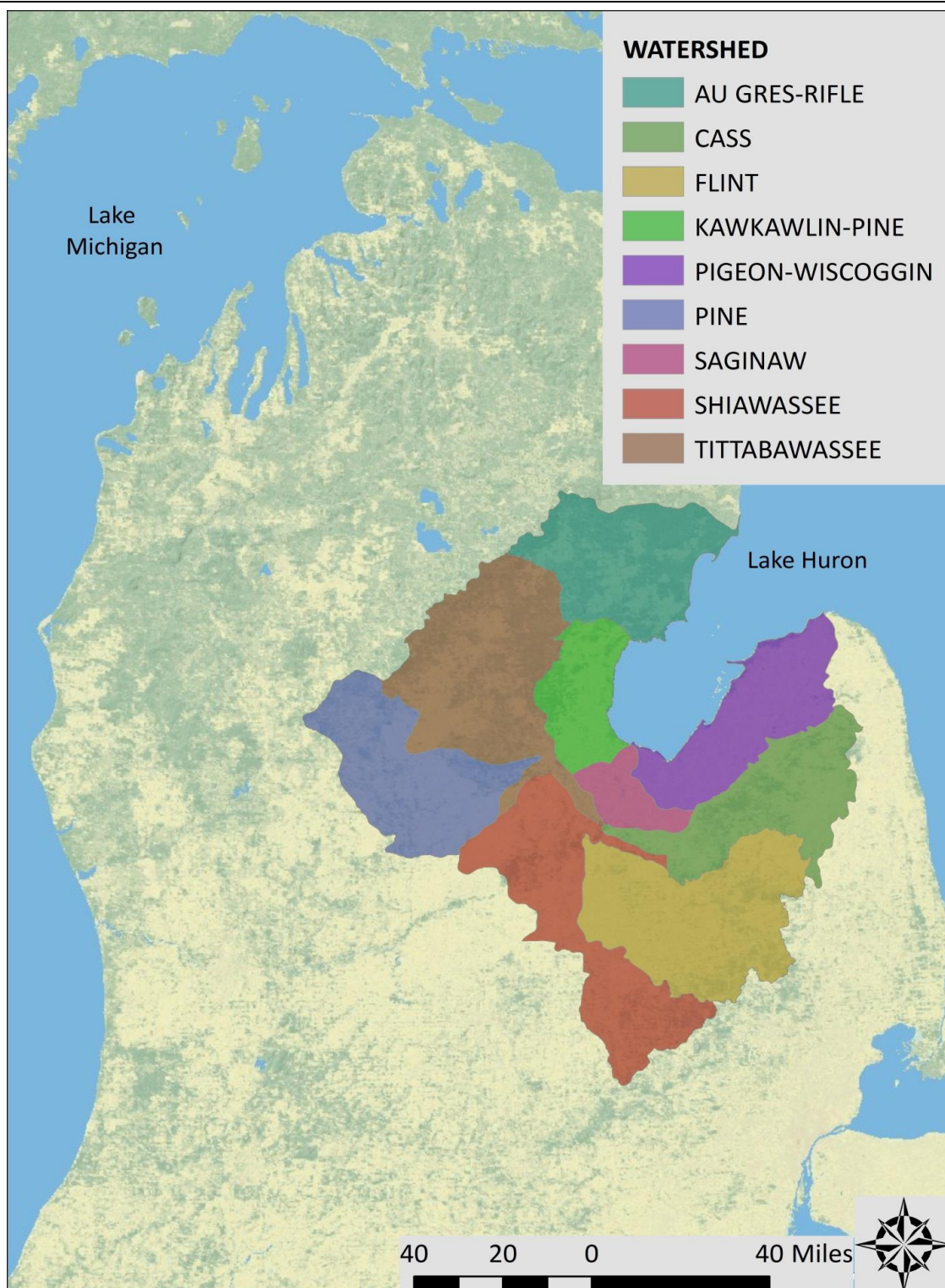


Figure 1. Study area

For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

Inundated areas due to higher lake levels (Garland and Beld 1999; Kingsley, et al. 1999; Lovis, et al. 2001; Monaghan and Lovis 2006; Robertson, et al. 1999). Further, information on the hunting and gathering economy and ethnographic analogs of wetland environments is limited due to the lack of scholarship and contemporary analogs (but see (Nicholas 1991)). The role of wetlands in economic adaptation is understated despite evidence of early human society's dependence on these environments (Bernick 1998; Brown and Vierra 1983; Clark 1954; Kelly 1990). Without reference to the role of wetlands and complex environments, the knowledge of foraging adaptations and the diversity of social and economic practices remain incomplete. Even with the intensive and long-lived archaeological efforts in the SBD, an explicit and systematic inquiry about the role of spatiotemporal resource variability of wetland environments on HG economy has yet to be undertaken. Systematic inquiry in the area is made difficult from poor preservation in wetland landscapes. This lack of understanding leaves incomplete information about the factors that influence land use and diet choice over time.

Second, the SBD is located at the northern fringes of the effective growing environment for agriculture, further complicating the resource environment. Both archaeological and environmental research reveals that ecotonal environments are excellent indicators of environmental perturbations of varying magnitudes, largely reflected by changed plant and animal biogeography. Plants and animals selected for consumption allow us to identify the shifting plant and animal communities and social and economic practices from Late Archaic to Middle Woodland periods. Wetlands, hydrology and marked seasonality, and a marginal growing environment exacerbate the environmental uncertainty of SBD by introducing spatiotemporal variability.

Socially, the environment of the Eastern Woodlands poses further challenges for hunting and gathering continuity. SBD groups persisted as HGs despite social changes, including the likely exchange of key exotic and indigenous domesticates and economic changes in adjacent cultural areas including the advances in food production through the use of key exotic and indigenous domesticates; increased sedentism; social hierarchy and introduction of ceramics; and development of incipient social complexity (i.e., inequality, marked hierarchy). These problems are studied through two coupled modeling approaches. First, the ecological environment is reconstructed in the SBD of Michigan to explore the structure of changing wetland landscapes and resources (see Chapter 3 and Chapter 5).

The resulting ecological and social environments, drawn by ethnographic analogs, provide a predictive landscape for land use and context for diet choices. Diet and land use decision-making are based on available resources identified through habitats, microenvironments and niches derived from soils and climate for the availability of economically important plant and animal resources at both local and regional scales during the Late Archaic, Early and Middle Woodland periods. The predictive landscape is driven by understanding the distribution of wetland environments and linked biotic and abiotic inventories. This model will provide prehistoric wetland context for SBD HG choices regarding land use and diet selection.

Next, a heuristic model is employed, in the form of a behavioral simulation based upon Optimal Foraging Theory (OFT) concepts of diet and patch breadth models. The decision-making simulation of possible selections of plant and animal resources provide land use and diet patterns in a changing wetland and resource context. These approaches generate models

that can be evaluated against archaeological, site and diet (i.e., faunal and floral) datasets to generate interpretations about culture and, specifically, economic and social practices employed by SBD HGs to buffer against and cope with changing landscapes. The comparison of models to archaeological data will allow for the understanding of the role of wetland uncertainty and risk, and coupled social and economic coping and buffering strategies. The diet selection provides us with a possible diversity of animals and plants that have been exploited and spatiotemporal strategies and implications for changing diet and land use. The development of these models requires the consideration of the factors that plays a role in economic decision-making.

Uncertainty and Risk-Based Economic Decision-Making

This project employs an economic security framework as the basis of decision-making rationale. Decision-making is an evolutionary cognitive process resulting in the selection of an action from a number of alternatives. Decision-making modeling approaches strive to understand the social and biological factors (causal or correlative) resulting in economic practices and linked social relations of groups. Decision-making about SBD land use and diet can have significant implications for economic and social relations, therefore the culture of prehistoric HG communities. Further, effective decision-making is observed to contribute to the adaptive capacity of HGs. Archaeological scholarship addressing these issues are problematic due to a number of factors; vagaries of preservation, and the focus on highly visible, easily accessible, and large material inventories (Binford 1978a; Binford 1981; Schiffer 1976)..

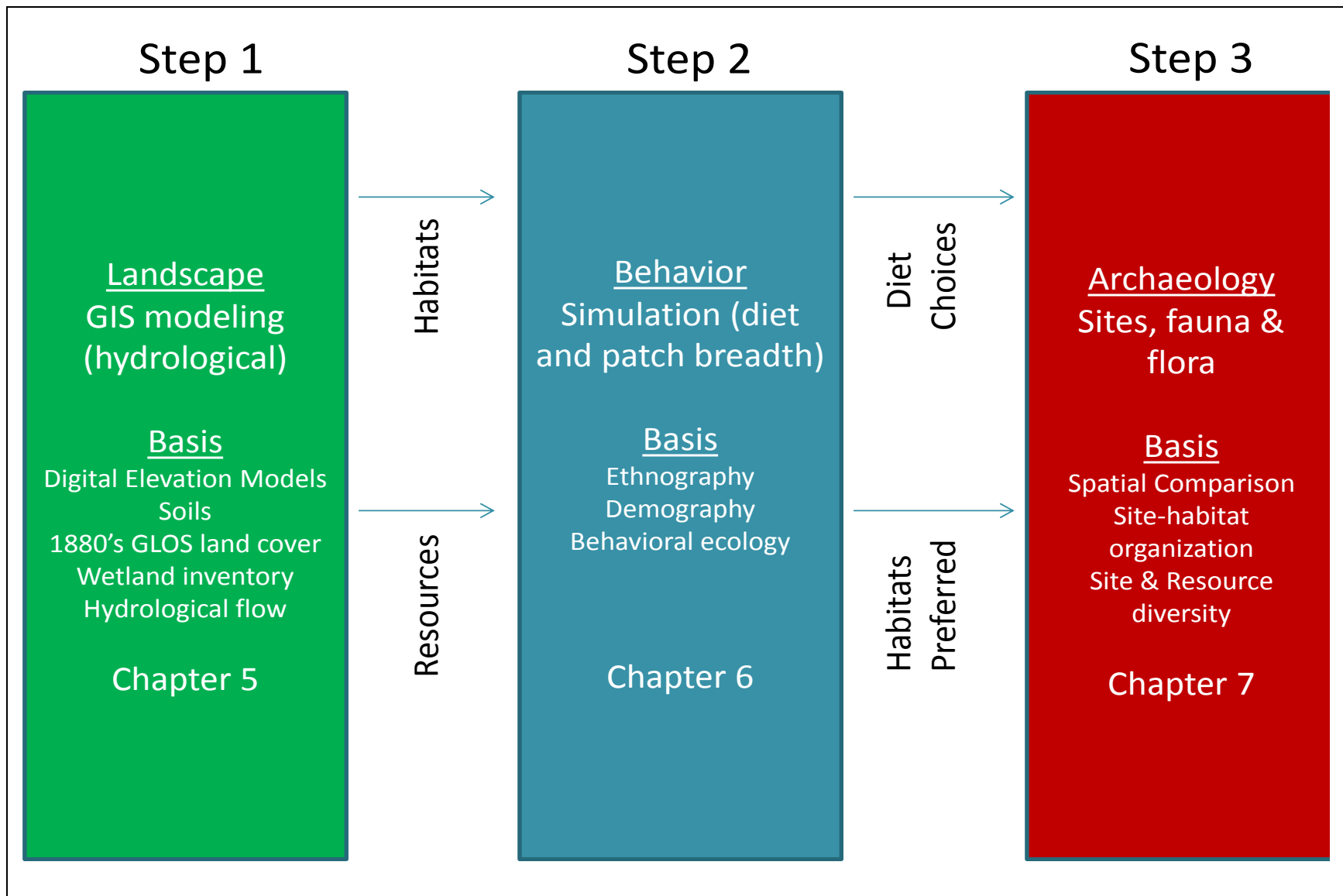


Figure 2. Project design

In an effort to resolve these shortcomings, alternative approaches focus on deductive models constructed from contemporary foraging analogies (Fitzhugh 1972; Thomas 1973; Winterhalder 1981a)

The contextual basis is provided by the natural environment where social and economic behavior takes place. The environment, then, provides the basis of subsistence choices and serves to fulfill biological and social requirements of groups. Economic decision-making strategies are then solutions to a number of basic problems: 1) securing sufficient energy (caloric) intake, 2) ensuring sufficient nutritional intake, 3) ensuring sufficient regularity of these intakes for survival and assuring satisfaction of other non-biological needs and goals (e.g., hides, antlers, taste, prestige, security). Solutions, therefore, require decisions about: 1) which resources to use, 2) how much of each resource to use, and 3) how and when to exploit resources (Jochim 1981). These solutions can be interpreted here using models of optimal behavior. Optimal behavior models allow us to visualize how people would behave given the specific conditions were the only factors affecting their behavior and should be considered only as a baseline of expectations, not as a description of real behavior. These heuristics generate predictions that can be compared to empirical data to expand our understanding of HG economy and society.

The most critical challenge to economic security is the presence of variability in the decision-making environment. Few studies have explicitly used risk and uncertainty as an explicit analytic variable in the study of HG economy (but see (Bates 2007; Clark 1990; Halstead and O'Shea 1989a)). Human understanding of variability can be thought of as two interrelated concepts of risk and uncertainty. Uncertainty is the state of having limited knowledge such that

a future state or outcome is difficult to describe due to the possibility of multiple outcomes (Cashdan 1990a; Clark 1990; Knight 1921). Risk is a state of uncertainty where possible outcomes have an undesired effect or a loss (Stephens 1981; Wiessner 1982b; Winterhalder 1986, 2007). The concepts can be observed as predictable and unpredictable variations in an ecological or social environment over time. This variation has implications for both the foraging economy, diet choice and land use in the SBD. For example, food quest outcomes that fall short of basic caloric needs are the result of risks attributed to the resource environment. An individual hunter's poor hunting ability or poor choices (i.e., skill and knowledge) are social factors that contribute to uncertainty and risk. Further, HG economies can be conceptualized as both an organization around resources as well as around other persons in the social relations of production. Social strategies for reducing risk and uncertainty expand explanatory foci in social and natural resources.

In order to use uncertainty and risk as an analytic framework, the cognitive and behavioral realm needs to connect. This connection is made by examining and employing empirical and theoretical analogs of nonhuman foragers and their feeding strategies (Charnov 1976; MacArthur and Pianka 1966). These animal behavior and ecological studies provide data about the nature of foraging, data that are applicable to humans as well. Ecological models are then an analytical tool, not a mirror of reality, and they do not deny a role for individual agency, as long as it is examined within its social and ecological context. Most ecological approaches in the study of HGs have a very narrow focus on subsistence, demography and settlement, for which direct relationships with the natural environment are most clear. The archaeological record is an ideal context for modeling due to the variability in strategies not found in the

ethnographic record that reflect the changing cultural response to the environment, and diachronic perspective on human behavior. Further, studies have increased our understanding of the relationship between behavior and patterns in material remains, largely through ethnoarchaeological studies of living groups (Binford 1978b; Kroll, et al. 1991; Yellen 1976). Ecologically derived human behavioral studies are based upon and guided by the Principle of Least Effort (i.e., people tend to work no harder than necessary in order to satisfy biological subsistence needs and cultural goals, and assume the minimization of cost is the central objective of HG peoples to economic decision making (Hewitt 1983; Keene 1981b, 1983; Reidhead 1980; Smith 1983; Winterhalder 1981a; Zipf 1949). These models assume that humans have rationality in goal formation and knowledge of the availability, costs and benefits of resources. The foremost approach in the use of principle of least effort is OFT.

Optimal Foraging Models

OFT is a decision-making approach derived from cognitive and ecological theories, which explains base human motivations (i.e., diet, nutrients) as choices. OFT has been typically applied to non-human animal behavior, highlighted by three main assumptions: 1) selection operates consistently and intensively over long periods of time, 2) optimal behavior is attainable, and 3) selection favors energy efficiency (Keene 1983; Smith 1983). These models are based on the neo-Darwinian assumption that natural selection and competition are an inevitable outgrowth of reproduction in a finite environment (Pianka 1974). Natural selection will favor foraging behaviors that result in maximum fitness with regard to the operating constraints. There will be differential survival of those behaviors, which allow for an individual or population to achieve goals in a specific environment. Given a set of resources with specified

characteristics, OFT models propose how these resources will be used. In sum, OFT states that foragers maximize their net return rates of energy intake while foraging, thus are optimizing their return. Assessment of behavior within an optimization framework requires a currency or cost-benefit metric that is significant to the adaptive goal (Schoener 1971). The currency that has been consistently used is the net rate of energy intake (Pyke, et al. 1977; Smith 1979; Thomas, et al. 1979). OFT approaches include Optimal Patch Use, Foraging time, diet, and foraging group size address a number of archaeological questions including site location, group organization, dietary composition and prey depletion (Winterhalder 1981b).

OFT is used to generate testable hypotheses about the 'best' strategies for particular circumstances. This ecologically based approach has the flexibility to address both the ecological and social components of decision-making. OFT explains adaptation strategies that are optimal intended to maximize the fitness of a population (Krebs and Davies 1997; Maynard Smith 1978; Pyke, et al. 1977). OFT makes a number of useful predictions about human responses to spatiotemporal variability or the decrease in high-ranked resources resulting from resource depression (see Chapter 3 to read a full coverage of relevant Optimal Foraging approaches used in the study). If the goal is to increase utility or reduce risk, HG should: 1) broaden diet to include lower rank species or specialize in few sustainable resources, 2) include wider patches, including lower rank patches, 3) intensify production, create suitable habitats for high ranked dependable resources, 4) form larger groups that that create efficiencies through group foraging – pool resources, information, networks therefore reducing variability through sharing and 5) invest in physical and social storage. These behaviors contribute to security: forager group size, exploitative pressure, habitat enhancement, resource flexibility,

suppression of competitive predators, and social institutions and beliefs. OFT, then can be used as the underlying operational model for HG decision-making based on underlying goal.

Decision-Making Rationale

Scholarly attention to principles underlying decision-making has focused on adaptive strategies concentrating on meeting biological needs and wants. Basic biological factors proximate to the individual include energy and nutritional requirements. At an intermediate level, applicable to the totality of economy, are factors of efficiency and economic security.

Last, underlying social dimensions include division of labor and ideational factors including taste and prestige. Although treated separately, these factors are interconnected and dependent on the topic of inquiry. The research undertaken in this dissertation reframes risk and uncertainty as a core underlying framework that contributes to social (i.e., prestige, division of labor), economic (i.e., security, efficiency of labor) and biological factors (i.e., nutrients and energy).

Risk minimization or reliability and efficiency or ease is suggested as the most important in forager decision-making. Both factors are ultimately related to individual reproductive fitness and are time dependent and interconnected. Foraging efficiency is an immediate goal, while risk minimization is a longer-term strategy. This research treats these goals as both short and long term, complementing one another, and will be treated as variables dependent on the scale of time.

Efficiency goal has been the basis of a number of studies that seek least-cost solutions to foraging problems; including studies of maximizing net acquisition efficiency (Jochim 1976b;

Winterhalder 1981b), for hunting decision models (Mithen 1990), and linear programming solutions (Keene 1981b; Reidhead 1979). Depending on the situation, other measures may be better indicators of choices. Other measures of labor efficiency include output per unit time or land (Jochim 1981; Torrence 1983). Labor efficiency per unit of time may guide choice and at the same time also varies greatly between cultures (Kelly 1995a). Costs associated with unit time are important because they preclude other activities. For example, scheduling conflicts may arise for resource seasonality and other competing cultural demands for the use of time. Time efficiency is likely the most important to cultures at northern latitudes, with greater seasonality in resource availability. If neither land nor time is constrained, then labor efficiency may be the best guide to decision-making. Labor-related ease of collection, or net yields for labor input, may be the alternative criteria for resource selection (Jochim 1981).

Another determinant factor of decision making is the energy budget. HGs differ vastly in their energy budget, as multiple factors affect labor efficiency including search, pursuit, capture, and processing costs, all of which are affected by resource productivity. Additionally, the technological and organizational characteristics of a culture can influence efficiency and the relationships of measures of efficiency (Jochim 1981). For example, the introduction of gill nets during Late Woodland times in the Great Lakes dramatically increased the efficiency of acquiring temporally limited resources (i.e., spawning fish) (Cleland 1982). Further, the ethnographies shows that prey and/or package size are strongly correlated with procurement efficiency: big game hunting can be tremendously efficient. Exploitative efficiency related to time and labor costs also makes larger animals more preferable. In addition to animal size, additional variables such as density, aggregation, wariness, mobility, and reliability may impact

food selection (Hewitt 1983; Jochim 1976b, 1981; Winterhalder 1977, 1981a, b; Winterhalder and Smith 1981).

Ethnographic studies of the classic Cree example consider variables of exploitative efficiency, choosing small mammals, birds or fish rather than alternative choices. Often, the killing of large and small animals is opportunistic within an exploitative round (Winterhalder 1977, 1981a). Regarding the high efficiency of fishing at certain seasons among the Cree, some forms of plant gathering by the Ache suggest the importance of prey aggregations and technology (nets and surrounds) that enhance efficiency (Hawkes, et al. 1982; Winterhalder 1981a). The package size, as defined by individuals or clusters, whether naturally or culturally created, may be a more important variable than prey size. Technology can lower search costs and pursuit costs, such as traps and dogs, which can account for cases for high efficiency in procuring small mammals such as hare (Winterhalder 1981a). Efficiency in food procurement or camp location can create free time for other activities (exchange, accumulation of surpluses) that may increase reproductive fitness and that can be used or manipulated to an individual's reproductive advantage (i.e., securing mates, attracting followers).

Observed subsistence patterns of human populations of similar makeup (size and environment) demonstrate that human decision-making can also be driven by goals other than labor efficiency (Bettinger 1991; Clarke 1972, 1977; Ellen 1982; Jochim 1976a, 1981). Efficiency is the ratio of resource output to the input of labor that is measured over a long time period. But, the ratio can be quite variable over a shorter interval period resulting in life threatening situations. Therefore, efficiency may not be the ideal rationale for decision-making.

Alternatively, risk minimization approach recognizes that food be obtained within each shorter, behaviorally significant period perhaps a day. Ethnographic evidence shows great variation in procurement success among resources and habitats; among seasons and years; among individuals and groups, since all environments and economies contain some variation and risk. Reliability, the expectation of finding a given resource is a conscious goal about food choice, habitat use, and camp location. Response to risk can take many forms including diet diversification, food storage, pooling and sharing and exchange (Agrawal 2001; Halstead and O'Shea 1989b; Kaplan and Hill 1985; O'Shea 1981; Wiessner 1982b; Winterhalder 1981a).

Economic security affects decisions. Security and the predictability of alternative options are critical to decision-making (Cashdan 1990b; Clark 1990; Cleland 1976; Jochim 1983; Tversky and Kahneman 1981). People pursue strategies that, given a set of alternative choices, best fit the least risk option(s) (Coombs 1980). For example, HGs are observed to respond to resource scarcity and variability at various temporal scales (i.e., seasonal, annual and long term) by a combination of strategies including mobility, diversification, storage, and exchange (Halstead and O'Shea 1989a). In general, economic security addresses future welfare even at the risk of immediate and occasional losses (Clark 1990; Halstead and O'Shea 1989b; Tversky and Kahneman 1981). The ideas of risk and risk tolerance are constructed from past experiences and contexts. From these experiences, people are able to implicitly form probability estimates over possible future events. Given a set of options, people will establish a hierarchy of preferences and rank those according to the schedule and value of the goals they seek to satisfy (Cashdan 1990b; Elster 1989; Jochim 1981).

A key factor that drives economic security is seasonality. Diet choices and hierarchy of diet preferences can vary throughout the year depending upon the seasonal availability, variation and characteristics of resources and cultural factors. For example, the effects of spatial variation on reliability and diversity are high when the variance of resource abundance is greater than the squared mean abundance. Therefore, mobility of HG should be high in poor environments with few resources, all maximally out of phase with each other, and should be low when resources show either little spatial variation or when they vary in phase (Harpending and Davis 1977). Additionally, HGs are suggested to behave in a manner to maximize subsistence security by different strategies based upon packing thresholds employing shifting combinations of sequentially scaled, risk pooling, and cooperative networks as well as expanding niche breadth and intensification (Binford 2001). Summarily, subsistence decisions are made through the evaluation of potential payoffs of various strategies, selecting the one that suits the environmental context and cultural goals/objectives that satisfy the perceived needs of the season.

The biological underpinning of security based decision-making includes nutrition and energy acquisition. Energy, the base requirement of living organisms, is an easily quantifiable variable through the transformation of food matter into energy and can be measured through kilocalories. Energy is the calculation of the ratio of time required for economic activities (locating, capturing, transporting, storage, maintenance, processing and consumption); a simple calculation that energy expended or output must not exceed input, food consumed (Kemp 1971; Rappaport 1984; Smith 1983).

Nutrition, the satisfaction of biological requirements for vitamins and minerals such that biological (metabolism, muscular and skeletal development) minimums are attained, is a critical biological requirement is observed not to direct decision-making about diet. Most resource environments, especially temperate climates, offer sufficient diversity of resources such that nutrition requirements are typically met (Jochim 1981).

A number of other social goals influence diet selection, including factors linked to taste, cost and prestige (Egan 1993; Messer 1984). The pursuit of prestige can be observed through the exploitation of prey size. In addition to efficiency provided by large meat packages, resulting from the increased net return rate, social prestige is also attained by the ability and skill of the hunter. Exceptional ability and skill is demonstrated by their food contribution can serve to enhance their relative value and prestige to other members of society. A number of examples also show that the capture of large game animals brings a hunter more prestige (Jochim 1976b:21; 1981:86-90; Winterhalder 1977, 1981b).

A number of non-food related goals are also sought as part of the food quest, such as game animal hides for clothing and shelter; bone and antler for tools; plants for medicinal, technological, ritual and symbolic value (Keene 1981b). On the whole, fulfillment of non-food values is also assumed to be embedded within the food choices (Binford 1978b). Social objectives such as information sharing, socialization, goods exchange, and values of resources affect resource decisions. Maple sugaring, a labor intensive activity, was pursued and provided a valuable source of food during times of scarcity and served as a valuable exchange item (Henry 1969:211; Holman and Egan 1985). Group efforts to gather maple sugar afforded people

a chance to socialize after a long winter season of isolation (Baird 1898; Densmore 1974). Group aggregation allowed the members of a community to exchange information about both the landscape wherein they dwelt and surrounding areas. Further, the gathering of moss, a plant that serves a whole host of purposes, is also important (Kimmerer 2003). In sum, utilitarian goals – explicit and implicit – acknowledge factors including energy, nutrition, efficiency, and taste; non-utilitarian goals, prestige and security affect economic decision-making and energy budgets (Bettinger 1991; Cashdan 1990b; Ellen and Fukui 1996; Jochim 1976b, 1981, 1983; Riches 1982a; Speth and Spielman 1983). These factors have to be compared and weighed against the composition, structure and productivity of the environment.

In order to understand the decision-making process, two key factors must be taken into consideration: context and behavior. The contextual basis is provided by the environment where social and economic behavior takes place. Economic behavior is the result of a cognitive rationale of decision-making given its context. In this way, these components of decision-making are linked and hierarchical. In decision-making context, the ecological environment can be studied through the spatiotemporal orientation of resources. The economic and social behavior can be studied through the analysis of diet and land-use decision-making. In order to do this, we must address 1) estimates of environmental and resource variations in the past, and 2) models that must embed individual short-term subsistence decisions within a broader temporal, spatial and social context. Risk can be understood in archaeology by the treatment of the structure of resource variability, creating models of risk mitigation, shifting seasonal resource ranks, and the implications of site redundancy and reoccupation (Jochim 1981; Mithen

1990). As social communities, HGs are able to transcend limitations in the ecological environment through social practices. Without the treatment of these variables, our understanding of decision-making is incomplete.

Social relations of decision-making

The HG economy characterized as simply the fulfillment of basic necessities of life – food, water, shelter – would be an oversimplification and reductionist. This framework results in an environmental deterministic endeavor and, therefore, does not provide a necessary understanding of the social and ideational dimensions of the culture. One important social analytic framework is division of labor. The division of labor in economic decision-making is observed through gender and age groups. Women and children are observed to exploit resources closer to residential sites by gathering plants; hunting and trapping small mammals and exploiting aggregated resources, such as anadromous spawning fish (Claassen 1991; Egan 1993; Jochim 1981, 1988; Nelson 2004). The gathered food is likely shared with all members of the group. The role of women in gathering resources is vital because their contribution is more likely to be a consistent, predictable and secure contribution to diet. Their contribution is shared throughout the group and ameliorates the variance in hunting returns and to risk incurred by men's activities. Further, the role of age and sex groups is important. Women's influence is important and can determine choices regarding settlement and critically, for this research, for land use and diet choices (Kelly 1995a:261).

Risk and uncertainty can play an important role in age and sex group influences diet and land use selection. Women and children are likely to recognize local level variance earlier and make decisions about when and where to move (Kelly 1995a; Zeanah 2004; Zihlman 1981). The

role of women in management of risk and uncertainty is also important through the information they hold. Women and men retain different types of knowledge about resources; women tend to have greater information about resource structure and variability based on the spatial predisposition of their purview and influence. For example, Yup'ik men hold information about landscapes at a larger scale (i.e., regionally, location of landscape features), and they also maintain information about their relationships in greater detail (Funk 2010). The storage of information creates a risk-minimizing strategy by specialization and the overlap of information across genders, where one gender holds the breadth and one stores the depth (interrelationship) of knowledge.

Analytic Review

The aforementioned social and biological goals play an important role in economic decision-making. The role of these goals in the context of environmental variability is incomplete and requires greater understanding. This research explores factors in diet choice and land use that address the spatiotemporal distribution of resources as well as biological and cultural needs within a context of a changing environment and economic security. These land use and diet choice strategies can have considerable implications in the understanding of overall HG culture, economic adaptation and continuity, and short term and long term trajectories.

Two analytic frameworks in the study area are presented: spatial and behavioral. Spatially, archaeological analysis often focuses on site or local level dynamics, not considering the regional environment. Conversely, regional analysis, when undertaken tends to overwhelm

local site level patterns. Typically, focus is placed on places with large and dense site distributions, rich material remains or places with monumental structures. Archaeological research is forced to use small areas because of limitations of available data, resulting in models of low gain (Ebert 2000). Better understanding requires a regional analysis of behaviors (Kowalewski 2008; Schroeder 2004). Spatiotemporal variability as an analytic basis is critical to understanding subsistence and settlement, as well as critical to understanding social dimensions to address this problem. Further, repeated studies have addressed HG decision-making with a focus on a key adaptive strategy, ignoring the influence of alternative options. In order to explicate the archaeological pattern, a model that incorporates multiple strategies is required. We must investigate variability-related human behavior by incorporating multiple coping/buffering strategies from a cultural framework. By framing social relations and organization as mechanisms for adaptation, we create a decision-making model that takes into consideration subsistence strategies that incorporate a variety of adaptation practices.

In the study area, economic decision-making approaches have been and continue to be critical to understanding adaptation and the processes for cultural change. The combination of spatiotemporal variability, habitat shifts and expansion and contraction of wetland environments led to the intensification of a wide range of resources, especially increased focus on plant foods during the Late Archaic; therefore setting a stage for depopulation of Saginaw Valley in the Early Woodland, then followed by subsequent Middle Woodland expansion during high water phases. Within this context, the HG decision-making is observed to be continually evolving to satisfy cultural and environmental demands in order to meet a number of social and

biological goals and opportune area for inquiry into processes and factors of adaptation and cultural change.

The archaeological record provides a spatiotemporal perspective on behavior in variable contexts that expands our ethnographic knowledge. Archaeological interpretations are often constrained by localized research efforts, with limited understanding of regional patterns as well as the complexities of coupled interactions between HGs and variable environments. Questions remain about decision-making with respect to environmental variation and linked spatiotemporal resource structure. Given that forager groups relied upon particular plant and animal resources, an understanding of their availability in changing environmental contexts is important to decision-making. To understand the role of variability, we must explicitly frame decision-making in terms of spatiotemporal resources and cultural responses to uncertainty. These models will help us to better understand past environmental dynamics and human behavior, providing valuable data and models of prehistoric HG adaptations.

Previous modeling efforts in the study area have sought to reconstruct resource landscapes in order to answer economic decision-making (Egan 1993; Keene 1981b). A first of its kind at the time, a deductive model simulation using ecologically-based OFT, a linear programming model using average costs measures for energy, and nutrients and hides for resource utility (Keene 1981b). This linear programming model is employed in a non-marginal environment with presettlement forest distributions, using fish and wildlife data based upon species richness and seasonal cycles in a given Saginaw River valley habitat. Key factors include the input-output ratio of kilocalories and essential nutrients, and raw material requirements quantified through net optimal energy capture. Lowest costs choices were rank-ordered in

preference, with the resulting satisfaction through low-cost choice considering resource processing and storage costs and incorporating non-food costs (e.g., clothing).

This endeavor develops a suite of seasonal resources and economic seasons, and specifically stresses the importance of plant resources contributing to Late Archaic diets (Keene 1981b). The study derives the monthly suite of primary, secondary and marginal resources that is constrained by various factors during winter. He suggests four economic seasons, two narrow spectrum and two broad spectrum. Broad spectrum activities for winter are fishing in the winter; broad spectrum foraging in summer, and intensive deer hunting in the fall. Plant foods hold a high value during certain seasons. Archaeological expectation for each of the seasons is also posited. Subsequent critiques of the model question the devalued role of nuts mast in the model.

Other related archaeology-based subsistence and settlement efforts also provide insight into economic decision-making. Another set of literature uses general subsistence models and suggest that Late Archaic groups chose an optimal solution from resources that would satisfy basic needs for the least amount of effort during four economic seasons. Therefore, fish would be exploited during spring at sites, broad spectrum collecting would take place during the summer, intensive deer hunting would occur during the fall, and broad spectrum hunting for small game such as beaver and raccoon and stored foods such as nuts and seeds would be gathered during the winter (Keene 1981a; Robertson, et al. 1999). However, these models have underestimated the diversity of forager resources choices and strategies. For example, nut exploitation during the fall, deer and wapiti during summer, and the importance of mobility and exploitation of resources in the interior of the SBD (regional exploitation) are choices and

strategies that are not addressed by these studies (Robertson, et al. 1999; Smith and Egan 1990).

Next, to explain food procurement strategies, a decision-making model based on multiple goals of taste, efficiency, prestige and a combination of these variables is used within the context of the division of labor. This simulation of resource selectivity suggests that highly productive resources such as fish, waterfowl, wetland tubers, and choices based upon task groups (female/juvenile) formed to exploit these aggregated resources were important, especially during the fall and spring. The Weber I site shows a preference for fatty nuts over acorns for their taste, while the Schmidt site suggests that variation in the availability of specific resources or efficiency is the primary goal. In summary, the flexibility of subsistence choices and their relationship to social and cultural goals is an important diet strategy (Egan 1993).

Other noteworthy archaeological approach uses ecological productivity and land-use patterns to understand Late Archaic subsistence by arguing for resource habitats, including uplands, upland margins, and lowlands exploitation for coping with resource variability and change (Lovis 1984, 1986, 1990b; Lovis and Robertson 1989). HG decision-making is focused toward exploiting productive niches rather than specific individual species resulting from temporal or periodic (predictability) and resource productivity (abundance and reliability) variation. An economic model has suggested that the radial configuration of river networks aided in maintaining and reinforcing this adaptation by information gathering and maximizing access to all regions (Lovis 1990a; Robertson 1987).

These modeling and archaeological efforts emphasize a comprehensive set of environmental and ecological variables (seasonality, resource distribution, nutrient values,

nutritional requirements, food-related labor costs, pursuit and processing costs, non-food requirements, prey characteristics [size, density, mobility, and aggregation size and assumptions about technology], seeking to reconstruct environments and vegetation, resource structure, and seasonality in order to predict subsistence choice strategies. HGs operate within these static environmental variables in these studies. They are treated as passive entities who behave to consume resources. However, our understanding of their behavior suggests that people interact with the environment dynamically, modifying their surroundings to suit their short- and long-term needs. Therefore, the environment must be viewed as a dynamic system, with coupled interactions and feedbacks between the HG and the environment being given priority for determining behaviors.

Questions and Expectations

The proposition employed herein states that a foraging adaptation is explained by the social relations or structure of their coping and buffering strategies, rather than simply by the abundance and scarcity of the resource environment. The organization of the research is organized through questions that contribute to the overall goals. These questions take into account both a landscape and behavioral perspective understood through spatiotemporal and scalar (i.e., short term, long term, local and regional) context of human interaction in the Saginaw Bay Drainage. The results will provide a better understanding of SBD Late Archaic, Early Woodland and Middle Woodland economy and adaptation through land use and diet choices.

In order to understand how HGs copes and buffer against uncertainty in the environment, three analytic chapters are presented: 1) predictive landscape, 2) behavioral simulation and 3) archaeological analysis. These chapters are intended to answer questions that build on each

other to explain the context, process and cultural signatures of buffering/coping strategies to uncertainty. First, the landscape model chapter seeks to understand the landscape level changes of the study area driven by hydrological dynamics.

1. What is the makeup of the regional and local environments framed through wetland distribution and densities?
 - a. What are the resource communities or habitats present in these wetland environments?
 - b. What are the seasonal or short-term changes in wetland environments (density and distribution) and implications for habitats and resource structure?
2. What are the long-term changes in wetland environments throughout the Late Archaic, Early and Middle Woodland periods?
 - a. Based on the given models, what challenges (spatial, seasonal & temporal) do wetland environments pose for economic adaptation?

Second, the behavioral simulation chapter seeks to understand diet and land use choices using diet and patch breadth optimal foraging in uncertain contexts informed by wetland density, distributions and heterogeneity.

1. What are the implications of patch variability on land use?
 - a. How do seasonal changes in landscape, wetland habitats and linked resource communities affect land use patterns?
2. What are the implications of resource variability on diet?

- a. How do these diet choices change in a habitat or patch (seasonally, longer term), given changes in the wetland environment?
- 3. What are the implications of the variability on the social relations of the economy (i.e., sexual division of labor, group to group interaction)
 - a. What are the differential contributions of division of labor given the variability of resource environment?
- 4. Given results of simulation - what strategies can HG employ to cope and buffer variable wetland resources and landscapes?

Last, the archaeological analysis seeks to understand broad patterns of diet and land-use patterns through sites, plant and animal remains. These patterns are used to evaluate both predictive landscape and behavioral simulations.

- 1. What are the patterns of diet choices and settlement from excavated material?
 - a. What patterns (settlement and diet use) are present in each time period
 - i. How do these patterns change over time?
- 2. What is the relationship between archaeological patterns and the landscape and behavioral models?
 - a. Given a relationship, what are the likely adaptive practices, social coping/buffering mechanisms employed by SBD foraging communities?

Dissertation Organization

This dissertation is organized into sequential chapters that build upon one another. The first four chapters establish the theoretical (i.e., risk and uncertainty) and methodological (i.e.,

landscape and behavioral simulation modeling) framework. Chapters 5 through 7 are analytical chapters pursuing original and new efforts at exploring the research questions. These chapters are structured as a scientific paper format with a quick introduction, background, method, results, discussion and conclusion. Chapter 8 is the concluding chapter intended to bring all chapters together.

Chapter 2: Risk and Uncertainty

Introduction

Hunter-gatherer (HG) choices can be better understood by addressing the roles that uncertainty and risk play in their decision-making. Choices made in spatiotemporal variable resource contexts are important to the study of behavior, especially since their economic mode of production relies on the products of the ecological environment. Further, these concepts play an important role in their cultural evolution and adaptation in the temperate environments of the Saginaw Bay Drainage of Michigan. Understanding these characteristics is important to the development of appropriate models of diet and land use. Therefore, risk and uncertainty are critical to the understanding of HG adaptation and linked social evolution and cultural change.

Typically, subsistence studies treat environment in a static context and assume change or variability in ecological environment does not play an important role in human choices. Further, social scientists focus on average conditions or normative concepts of human existence. To the contrary, environmental variability and interrelated concepts of risk and uncertainty have heuristic value for the understanding or investigation of processes of economic and social change (Cashdan 1990b; Halstead and O'Shea 1989a; Winterhalder 2007). In this research, temporal and spatial instability in food supply is assumed to cause problems for survival. Decision-making aimed at securing this food supply frames our understanding through the baseline social and biological goals embedded in cultural and social milieus of a society. These decisions must match the resource problem at hand in both capacity and scale (Cashdan 1990b). Further, linked effects of resource variability on society, polity and non-

subsistence economy are important as a means for indicating causal interconnections and evolutionary processes.

The acquisition of food requires effective and efficient decision-making and the success of a given strategy is linked to the evolution of foraging adaptation. Economic security requires an understanding of the types of risk and uncertainty as well as the ways people cope and buffer against them. Uncertainty and risk in the resource environment can be conceptualized as variation of food supply in time and space. The variability is the actual pattern of variation in the food supply resulting from the actions of actors (climate, humans) that influence the availability of food resources. Beyond just a heuristic exercise in decision-making, these concepts have implications for cultural change. The balance between structure of adaptation and structure of resource variability can have implications for shaping societal organization and providing conditions for social transformation and change. The ways in which cultures cope and buffer these variations can be the causal factors in economic change. Social relations of adaptation are embedded in marriage rules, kin relationship, social structure (e.g., households, community relationships), task groups (e.g., gender, age groups), and social identity and can even result in incipient social complexity, political hierarchy, and inequality.

Social institutions that are employed to buffer variability may have other functions within society during good years. These institutions may not be recognizable unless they are activated under required conditions of scarcity. For example, during times of scarcity, social institutions will likely sacrifice efficiency for risk-minimizing behavior. Over time, larger and stronger variability may require the embedding of coping and buffering practices within regular cultural practices and in effect may have widespread and systematic ramifications. The increase

and expansion of social roles in buffering may also serve to promote social institutions within which coping mechanisms are embedded. This often creates layered social mechanisms as a means for adaptation and concomitantly as a means for social change. For example, the appropriating and control of surpluses for the maintenance of elite may result in new sources of risk, which may lead to another set of coping mechanisms. These new coping mechanisms can lead to transformational or even catastrophic change.

Conversely, cultural change does not need to take place in contexts of consequential variability or scarcity, but can occur in abundant or stable and homogenous resource environments. In contrast, social changes and complexity can be responses to the social control of abundant resources (Ames 1994; Price and Brown 1985). Responses to variability are embedded in social life and the broader culture of a group and are likely to be already embedded in the normal operations of a culture. Decision-making approaches, and interrelated well-established foundations, set the framework for the development of predictive models of diet and land use in the study area. For example, Optimal Foraging modeling of human groups shows that energy maximization diets can be also risk minimization (Winterhalder 1986). Depending on the conditions, foragers seek to minimize the time spent foraging, to maximize net returns from a day or reduce the risk of complete failure and to the contrary, engage in risky behavior. Having demonstrated the importance of these concepts to adaptation, social evolution and change, a description of the characteristics and analytical power is undertaken.

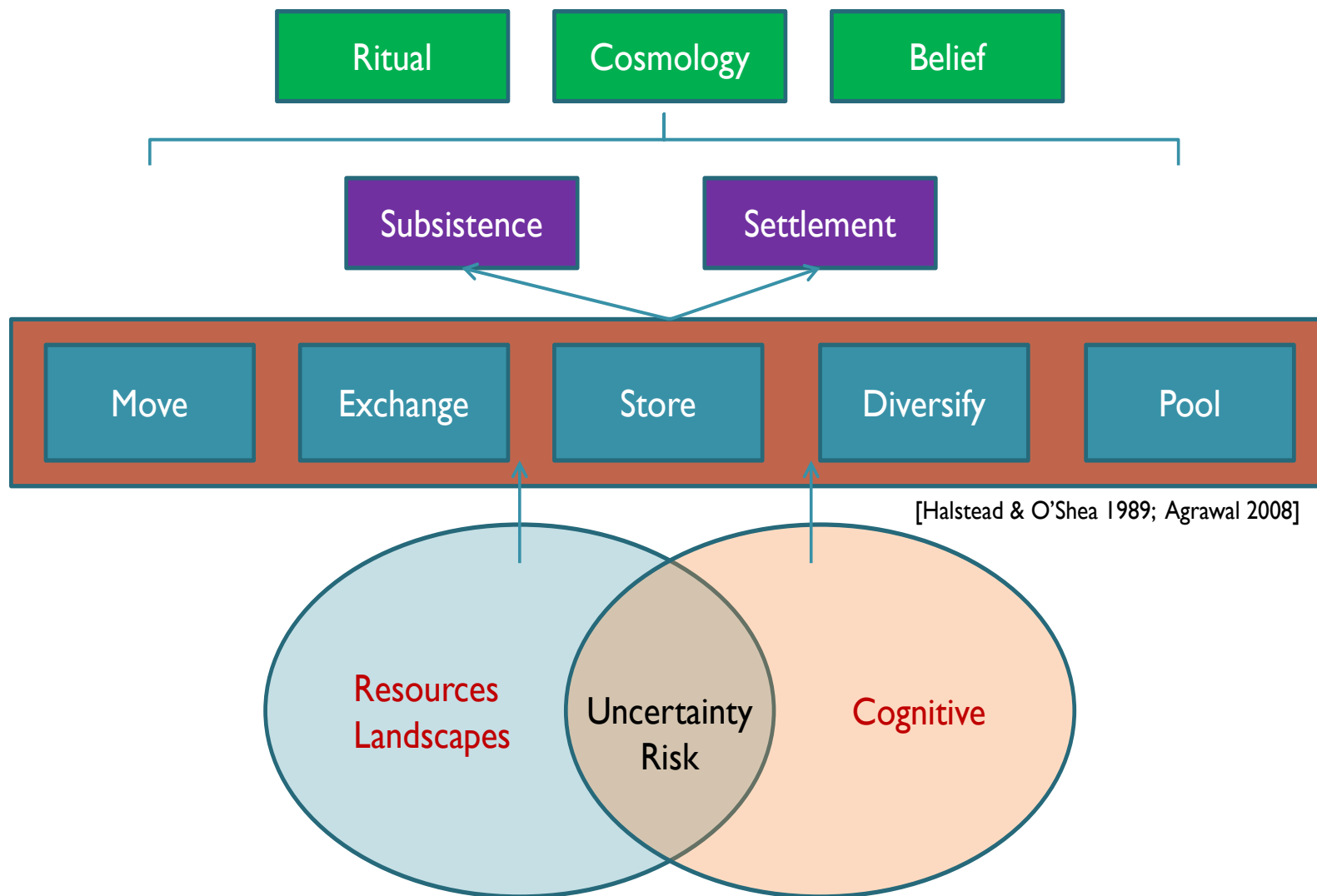


Figure 3. Uncertainty and risk relationship to culture

Dimensions of Variability

An understanding of the structure of variability is required for the development of appropriate models. Variability exhibits three scalar characteristics: temporal, spatial and intensity, which determine the scope of variability. Temporally, variability can be short and long term, whereas spatially, it may be localized or regional. Intensity is the scale at which both spatial and temporal variance takes place. Within these characteristics, a number of complex dimensions arise. These dimensions of environmental variability are two interrelated concepts: 1) duration and frequency and 2) magnitude and spatial scale.

First, duration and frequency of scarcity can be thought of as uncertainty over time. This type of variation is characterized as expected and unexpected short term (i.e., days), seasonal (i.e., within an economic season – autumn, winter, spring and summer) and multi-seasonal (i.e., spanning multiple economic seasons), annual (i.e., all four seasons) and inter-annual (i.e., multiple years). In the short term, this can be manifested in the change of seasons, where resources are different from winter to spring. People have cyclic expectations about what happens at a specific time of year. These changes are often predictable; seasonal variation can be repeatedly experienced, thus culture is likely to take this variation into consideration and is part of, and integral to normal existence. Next, inter-annual variation is the change from one year to another, where winters are mild one year and severe the next and summers are dry one year and wet another. Longer-term changes can be viewed as trajectories where there is decline or increase in temperature, precipitation, food resources or other relevant environmental variables. Unpredictable variation result from the external environmental and ecological factors (i.e., climate, pests).

Environmental variability may actually be cyclical variation on an unrecognized, long-term time scales. Further, this variability can unexpectedly last for an unpredictable duration and cause further problems for diet and land use. For example, a delay in the arrival of anadromous fish, plant growth can change the expectation of a resource at a place and time. This can be exacerbated by the spatial extent or spatial homogeneity. HGs in the Saginaw Bay Drainage (SBD) predictably suffered periodic food shortages in all seasons. Archaeological analysis typically addresses a few types of variability. Archaeological analysis attempts to assign material remains and sites to specific seasons in order to identify patterns of resource selection and overall movement on a landscape. Unpredictability in this case results from the deviations from the norms in a given season or longer time periods for a given dimension and becomes a context for change.

The magnitude and spatiotemporal extent relates to the size of the affected area, the intensity and length of scarcity; and can be thought of as uncertainty over space. Spatial structure concerns the relative homogeneity of the variability or how evenly or patchily the scarcity is manifested. This variability is further exacerbated by the intensity of variability over space. Intensity relates to the severity of the shortages and the degree of severity that can occur, and is a measure of variation that fluctuates above or below a given mean level over space-time (Harpending and Davis 1977). Unpredictable variation occurring as a result of external factors (e.g., climate, pests) may delay or intensify the cyclical variation on an unrecognized, long-term timescale. These dimensions provide a way to characterize the different dimensions of spatiotemporal variability. These natural resource dimensions alone are insufficient for study of uncertainty and risk, therefore a cultural is required.

Cultural and Economic Perception

In order to link the analytic dimensions of uncertainty and risk and society, understanding the cultural-based cognitive domain of risk and uncertainty is valuable. Studies of HGs are fraught with assumptions of time and space that reinforce normative understanding of risk philosophies derived from contemporary economic and cognitive studies. For example, contemporary linear understanding of time and place-based understanding of space has created a framework of an open, long-term future where prediction, or forecasting, has importance. Ethnographic and ethnohistoric studies of HGs present an alternative scenario where their ideas of risk and uncertainty are different. The HGs do not conceive time linearly; the past and future are said to circle around the present rather than define it (Adam 2002:504; Brody 2001:139; Ingold 2000:336). They are aware of the future and its relationship to the present but are unconcerned with what may or may not happen. This project assumes that prehistoric HGs also had similar belief systems.

HGs do not concern themselves with the future; this understanding is judged as problematic to their success (Ingold 2000:336; Sahlins 1972:30-32). For them, the perspective that the future cannot be known characterizes an alternative understanding where the appropriate response to uncertainty and risk is to focus on the present. For foraging communities, environmental change is likely to be part of a pattern of expected variability. Groups and individuals may or may not have realized that any climate change is taking place. The pattern of change is cyclical and repetitive, not necessarily aberrant. This perspective requires that a HG focus on the present and on strategies that contribute to effective decision-making in the present. Therefore, they need to acquire the wealth of information about the

present opportunities and conditions by maintaining contact with kin and the landscape and incorporating knowledge on travels (Bates 2007; Whallon 2005).

HGs do not simply rely on current information but are highly flexible and opportunistic when plans made with current information may not be fruitful (Bates 2007; Brody 1982). For them, planning, predicting and forecasting can be impractical, foolhardy and even arrogant. Flexibility in behavior may be the most effective strategy. To make predictions would be to make the knowledge sacred, not allowing the individual to be flexible. The vitality of this approach lies in the freedom allowed for improvisation and flexibility. The preference for freedom is complemented by the diversity of coping responses employed and, therefore, the approach employed in this project. This cultural perspective can be expanded with an understanding of how decision-making is practiced by individuals or agents.

Unlike the cultural perspective, economic analysis of risk behavior presents people as 'risk sensitive', 'risk averse' or 'risk prone'. This concept has been incorporated into Optimal Foraging models of prey choice, patch use, group size and time allocation (Caraco 1979; Green 1980; McNamara 1982; Smith 1983; Stephens 1981). Risk sensitive strategies can be predicted from the relationship between the expected benefits from alternative subsistence strategies and meeting minimum dietary needs (Smith 1983). A failure to obtain sufficient resources can be a real danger given stochastic or unexpected variation. Stochasticity is often due to imperfect information (lack of knowledge) or uncertainty and unexpected actual resource variation (lack of resources due to variation) (Christenson 1982; Smith 1983; Winterhalder 1986; Winterhalder, et al. 1999). HGs can respond to stochasticity in a number of ways. For example, the expression of the so-called 'extreme variance rule' states that foragers seeking to

minimize (to gather minimum required resources) should choose a strategy that yields more than minimum resources and with the least variance. However, if the expected mean returns for all strategies fall below basic requirements, then foragers choose the strategy with most variance (Stephens 1981).

Under conditions of scarcity, foragers need to take greater risks to meet requirements. Therefore, a forager's investment in risk reduction strategies depends on the cost of losing the resource (Cashdan 1985). In order to optimize returns of foraging activities, HGs must employ risk reduction strategies. Actual variation regardless of type results in people using coping mechanisms to minimize variance. Stochastic risk can result in variation such as frequency, predictability or duration of resource availability (intense resource depression and climatic variability), or the spatial extent or spatial homogeneity of resources (Halstead and O'Shea 1989b). A common thread in the different perceptions to uncertainty and risk is based on the information forager holds. The information and how foragers use their knowledge has implications for model characteristics.

Role of Information

Human behavioral models typically treat people as all-knowing, computationally perfect decision-makers (Moore 1981). In Optimal Foraging models, HGs are assumed to have knowledge of their environment and are able to assess the variability of anticipated resources. Counter to the implications of these models, HGs are likely not to have complete and accurate information. Access, contextualization and maintenance of information are key behavioral attributes in subsistence decision-making and have important implications for strategies that

are employed to cope with variability. In fact, the information – knowledge of the ecological and social environment – has implications for diet and land use choices (Whallon, et al. 2010).

The key variable in a HG's ability to cope and buffer is information, the knowledge of their surroundings – how knowledge is gathered, contextualized and shared (Whallon, et al. 2010). For example, mobility allows the opportunity for HGs to gather information regarding their environment and social relationships. This is reinforced by information storage and exchange (Agrawal 2001; Whallon, et al. 2010). This information is then used to understand environmental variability over a large area beyond their normal annual range (Halstead and O'Shea 1989a). The amount of information in the environment is voluminous and likely unmanageable. In fact, the vast amount of information is stored and structured through gendered patterns of information storage as exhibited by Yup'ik Eskimos groups (Funk 2010). Even though HGs do not have complete knowledge regarding adverse weather conditions or natural calamities that affect their resources or personal wellbeing, they make decisions based on the available knowledge of their total environment. Therefore, risk becomes implicit in their decisions. For example, if an anticipated resource is not a certain one, the cost of moving camp to a new location will in effect be higher and as a result we could expect HGs to stay longer in their current camp (Kelly 1995a).

A successful forager depends on the continuous monitoring and gathering of information regarding the environment. This knowledge is transformed to suit the existing conditions so that the returns from efforts match or exceed the costs expended. HGs are able to cope with changes in the environment by employing alternative strategies so that they modify the efficiency (e.g., locate, capture, process) through increasing the information and

incorporating technological and strategic (group organizational) changes. These optimizing actions can be understood using theories proven and dedicated to interactions of humans with the landscape. Foraging success is linked to the amount of information, with their own expertise of local conditions combined with knowledge of others. An individual forager's decision-making in a given day can be based on a number of factors, including how much food has already been acquired, whether there is enough time to acquire more without consequences to energy and probability for success, and whether there the desire for a minimal amount of food in a day. Therefore, a forager's goal can change due to success earlier in the day.

With the information in hand, HGs use coping and buffering mechanisms to minimize the effect of expected and unexpected resource variation. The response to variability is based on a HG's ability to incorporate knowledge about their situational context, therefore employing appropriate coping responses to address the problem at hand. These responses must match the problem at hand in capacity and scale. The unpredictability of hazards can also be a problem as this increases risk from environmental perturbations. Buffering and coping with environmental risks can be classified into five categories of adaptation responses or buffering mechanisms: mobility, storage, intensification, diversification, exchange and group pooling of resources (Agrawal and Gupta 2005; Halstead and O'Shea 1989b). These strategies can pool uncorrelated risk and minimize the effects of variability. The actual strategy employed is coupled intricately with the social relations of a community. These activities are manifested through cultural activities, inclusive of storytelling, cosmology, and even harvesting or cultivation rules. The effectiveness of a specific strategy is attached to the match between the structure and

organization of a society and the resource problem. Some strategies are better suited to local and regional conditions than others, where systemic economic change can result from localized changes in strategies of resource use, not necessarily linked to resource abundance but simply the strategy to expand or relax rules for coping and buffering against uncertainty and risk.

Coping and Buffering

Repeated studies of HG emphasize systemic flexibility to cope with environmental uncertainty and variability in food and land productivity (Braun and Plog 1982; Colson 1979; Robertson 1987; Spielmann 1986). Coping with environmental risks can be classified into categories of five adaptation responses or buffering mechanisms: mobility, storage, intensification, diversification, and exchange and group pooling of resources (Agrawal and Gupta 2005; Halstead and O'Shea 1989b). These strategies can pool uncorrelated risk and minimize the effects of variability. The actual strategy employed is coupled intricately with the social relations of a community. These activities are manifested through cultural activities, inclusive of storytelling, cosmology, and even harvesting or cultivation rules. The effectiveness of a specific strategy is attached to the match between the structure and organization of a society and the resource problem. Some of these strategies are better suited to local and regional conditions than others. The Saginaw Valley groups of Michigan were least likely to experience these shortages, but were likely influenced by neighboring groups and their needs for hunting territories, and the use of neutral areas (Cleland 1992:100). In the most productive season, HG are likely aggregate at places where there was apt to be the greatest carrying capacity and reaffirmed economic and social relationships. These areas are typically places where material culture (e.g., lithics and ceramics) is most diverse, often representing different

groups. For example, the Butterfield site is one of late winter/early spring occupation during the Late Archaic period (Robertson 1987).

Mobility

Mobility is the simplest and most common response to risk. It pools risks across space. This strategy offsets abundance by spatially redistributing people and food by either moving people to food (i.e., residential mobility) or by moving food to people (i.e., logistical mobility)(Binford 1981; Cashdan 1985; Sobel and Bettles 2000). The movement is one way to alleviate food scarcity (Binford 1982:8-11; Halstead and O'Shea 1989a:3). Foragers are often observed to move to familiar places in seasons of abundance (Cleland 1992:98). In fact, mobility is an important explanatory factor for the organization of sites in HG societies (Binford 1981; Wiessner 1982a). A group members positions themselves on a landscape to best acquire food and other necessary resources as a means for balancing foraging success against natural risks with a minimum of cost (Binford, et al. 1983; Jochim 1981). Patchiness in the resource environment has an important effect on foraging and land use patterns. If patches of different resources are uncorrelated or out of phase (existing at the same time), moving closer to one would move you farther from another.

A forager uses logistic mobility to gather resources, where exploitation is undertaken far from residential base. Here, mobility is used as way to average over spatial variation (Binford 1981). Flexible locales for settlement reduce stochastic environmental risks and resource unpredictability (Binford 1981, 1982). Changing mobility strategies in situations of high resource variance reduces risk by increasing the encounter rates within and between patches. Mobility ranges will be smaller where resources are in phase (different resources occurring at

the same time or at the same place), where people can remain near sites. Ranges are also smaller where there is little spatial variation. Increasing range size in these cases will have little effect on food supply diversity. Larger ranges are expected if resources are patchy but the patches are out of phase (Harpending and Davis 1977).

Further, the effectiveness of this strategy is directly related to the information about the spatial and temporal distribution of resources. HGs take advantage of the spatial and temporal structure of resources by moving away from scarcity. They employ a system of flexible territorial boundaries and extensive kin networks that permit bands to move as they see fit. Information gathering to monitor environmental variability over large areas beyond their annual round is a key positive consequence of mobility. Moving to new places provides information regarding uncertainty through their daily activities and their choices in gathering resources. The information is then used to understand environmental variability over a large area beyond their normal annual range (Halstead and O'Shea 1989b). Though HGs do not have complete knowledge regarding adverse weather conditions or natural calamities that affect their resources or personal well-being, they make decisions based on the available knowledge of their total environment. For example, if an anticipated resource is not a certain one, the cost of moving camp to a new location will in effect be higher and as a result we could expect HGs to stay longer in their current camp. For example, Agta women who gather the most, have the final say in mobility (Kelly 1995b). Women use their preferred resource type and potential distance traveled to procure those resources as a factor in deciding movement of the whole group.

Mobility often serves as a foundation for risk aversion and requires knowledge of spatial and temporal variability. Conversely, mobility can be curtailed when residential moves are deferred due to increasing time spent on exploitative activities. Curtailing residential mobility may result in logistical exploitation with a residential base and may also result in innovation in storage and food preservation techniques.

Storage

Storage pools and reduces risk over time and averages variation over time and space. HGs store to buffer against variation is common among highly seasonal environment (Densmore 1974; Henry 1969). This counters periodic shortages by setting aside surpluses. Storage provides alternatives to available resources on the landscape (Halstead and O'Shea 1989b; Ingold 1983). Storage balances the abundance of a specific season or resource structure against lean seasons and bad years and distributed resources. The pragmatic activity of setting aside harvested produce can be seen as a response to the temporal scheduling or resource extraction, transport, preparation and consumption (Ingold 1983). These are often the result of activity scheduling where mutually exclusive, non-concurrent activities take place. For example, if one activity has to be stopped for another to be performed (i.e., rituals), then consumables should be stored (Ingold 1983). The extent of storage is then determined by more than simply the available resource, and is linked to social and environmental rationale, including exchange and mobility.

The product of one activity is stored while pursuing another activity or resource. This strategy requires a large investment of labor and time. Investment in storage is an effective strategy if resource abundance fluctuates severely and production remains above minimum

requirements after transport, preparation (processing) and the building of storage facilities are considered. The practice of storage and mobility may be contradictory. Some of the costs related to storage (transport) decrease as mobility decreases, therefore they should be more common among sedentary groups (Cashdan 1985).

Storage is difficult in areas where spoilage is high, especially in hot and humid conditions; therefore requiring a need to look for other strategies to mitigate variance. Storage requires the understanding of the seasonal round and the expectation that one will return to the same locale or be willing to incur the costs of transporting foodstuffs. Storage also likely involves the coordination across households and social groups; this is an effective insurance against complete livelihood failure at a given point in time (Rowley-Conwy and Zvelebil 1989). Contrary to the belief that storage tethers people to one area, storage can be seen as a mechanism to ease risks associated with specific resource availability. Storage may be a way of coping with resource seasonality and food storage does not necessarily reduce residential mobility. If resource variability increases over time, HGs are more likely to engage in storage.

For example, Northwest HGs groups move their stored goods from one residential location to another demonstrating that storage is not a cessation of mobility. This movement of stored resources to another location also depends on the net return rate of travel because some of these stored foods will be consumed during travel. Overall, storage can mitigate risk and does not necessarily limit mobility. Storage has considerable implications for social complexity – transition from mobile to sedentism, foraging to agriculture, population growth and a key precondition for external trade. Storage and surplus exploitation results in drastic changes in the coping mechanisms for already uncertain and environments.

Further, storage has other consequences. The expansion of storage is also the intensification of specific harvests. The expansion of harvesting, processing and storage to increase the time spent on foraging to reduce variance. Intensification requires a greater investment of time and labor or a specialization of few highly ranked resources that yield high return under sustained exploitation. This strategy has critical consequences where the productivity of resources can be resistant to intensive exploitation or productivity can be enhanced by human agency, such as water control or regeneration of habitats (Bird, et al. 2005; Jones 1969; Larson, et al. 1996; Leonard 1989; Richerson, et al. 2001; Winterhalder 1986). This strategy reduces risk by increasing the productivity of land rather than increasing the amount of land (i.e., mobility).

Diversification

Diversification pools risk across the resources of multiple groups or individuals within a group by broadening the subsistence base. Individuals of the group may consume different types of foods, in more varied areas and by different task groups (i.e., gender and age). This strategy spreads risk across resources and to reduce overall vulnerability to the group. This is essentially increasing diet breadth. This strategy can also be employed to capturing and gathering lower-ranked resources whereby variance is reduced while meeting minimum requirements. The sexual division of labor in HG groups is seen as a diversification mechanism whereby subsistence diversification employs both risk-prone (males hunting) and risk-averse (women gathering) strategies (Halperin 1980; Zihlman 1981).

Communal Pooling/Group Foraging

The joint ownership of resources involves sharing of foodstuffs, labor, and information across households and groups. This strategy is most effective when household resources are not directly linked spatially to each other. Resource pooling responds to both homogenous spatial variation and temporal shortfall of resources. Households that are likely to exploit different resources or resource communities would likely benefit most when resources are pooled. This strategy takes place during the grouping of distributed bands during abundant season serves multiple functions including intra and intergroup communication of subsistence resource availability (Binford 1982; Riches 1982a), planning the seasonal round (Wiessner 1982a:63), and allocating seasonal ranges (Silberbauer 1982:30). This communication and transmission of knowledge allows the group to effectively exploit the regional landscape.

Pooling is likely used in conjunction with other strategies, the characteristic action results in the pooling of risk. This strategy requires the buildup of social networks and building a resilient resource structure. Cooperation can enhance efficiency through division of labor to reduce uncertainty, increasing chances of locating prey and reducing foraging overlap. Group strategy reduces variance in resource capture rates if yields are shared among group members. Sharing rules can provide different prediction about optimal group size base if the resources are shared among the hunting party and dependents or pooled centrally such that resources and redistributed to the larger group. Additionally, information from older, experienced hunters can mitigate temporal variation (Sobel and Bettles 2000).

Exchange

Exchange is the most versatile of adaptation responses; exchange plays off temporal variability with spatial variability. Sharing and regional exchange are effective responses to unpredictable day-to-day success in the food quest. Sharing and exchange of food and land among groups is a mechanism to alleviate relative success and shortfalls. Food exchange can take place through different forms, including accidental meetings, kin visitation, marriage, and the establishment and maintenance of regular exchange relationships. For food, trade and exchange networks replace mobility as a way of averaging spatial variation, especially in contexts of increased competition through growing population density, requiring greater productivity and consequently increased land use specialization. Exchange combines the efficiency of specialized producers with the dietary breadth of generalized consumers (Cashdan 1987). Reciprocity and exchange of food stuffs are hallmarks of egalitarian nature of HG social system (Isaac 1978; Kaplan and Hill 1985; Lee and DeVore 1968a; Polanyi 1959; Sahlins 1976; Service 1971). Sharing of food within a group maintains bonds and contributes to fitness of the individual by balancing variance in individual successes (Cashdan 1990b; Halstead and O'Shea 1989b; Lee and DeVore 1968a; Wiessner 1982a).

For land, at the regional scale, societal interaction and exchange is one key strategy to mitigate uncertainty in the environment through differential usufruct land use (Helm 1968; Leacock and Lee 1982a, b; Riches 1982a:121; Silberbauer 1982). At an interregional scale, shared use of territories or mutualism can be way to buffer against scarcity (Holman and Kingsley 1996). For example, groups can disperse and exploit more productive territory and also by exchanging with groups with better harvests. Ethnographic analogues show dispersal and

direct acquisition is common, especially in productive environments (Spielmann 1986). The territories exploited overlap at the peripheries and may even be neutral zones present where both communities may exploit resources (Pilling 1968). Groups who are familiar with territories often give permission for the use of, are aware of who uses, and avoid the use of a given territory at the same time (Riches 1982b:120). Cooperative buffering against variance is characterized by sharing of common resources, fostering long term, amiable relationships among groups through kinship and/or through social or political alliances. This strategy can result in a network of loosely coupled resource systems that averages out variation.

These buffering mechanisms are activated during increased variability in harvests. Beyond sharing, competitive strategies can also be employed, often a desperate measure when cooperation fails (Spielmann 1986:283-284). Wide-scale resource shortages can also trigger competitive exploitation where resource sharing, cooperation or scheduling of territory use is untenable (Hickerson 1970). Alternatively, historical and social factor of past interactions may also influence action to pursue competitive action (cf. Ford 1972; Spielmann 1986:284). Ethnographic analogues of Ojibwa and Ottawa show these groups occupy separate territories while sharing the headwaters of regions in between (Cornell 1986:23; McClurken 1986).

Researchers have identified a number of benefits for sharing or giving away food (Bird and Bird 1997; Blurton-Jones 1987; Cashdan 1989; Gurven, et al. 2000; Hawkes 1993; Hill and Kaplan 1993; Peterson 1993; Winterhalder and Lu 1997; Woodburn 1982). Exchange can take many forms including the transfer of food, cooperation, reciprocal altruism and reciprocity (Cashdan 1985; Lee and Devore 1968b; Wiessner 1982b). As an example, social storage, social networking or delayed reciprocity (social obligation to give) store resources over time in other

people. Social storage is the convergence of rights to specific resources on an individual or group. The exchange of resources or relationships (social exchange - marriages) builds formal long-term social relationships that likely required regular affirmation to provide assistance in times of shortage (Wiessner 1982b).

Exchange can take the form of balanced reciprocity and converts present abundance through social transmission to future obligation. In HG societies, food is often given freely without obligation, but, in more complex circumstances, obligations may be reinforced by exchanges of tokens that denote future obligations back to the giver. Exchange requires the transformation of surpluses into non-perishable goods that can be exchanged during difficult times (Sobel and Bettles 2000). Reciprocity can also take the form of generalized exchange, where extensive networks of partners aid each other in times of shortage (Cashdan 1985; Wiessner 1982b). Due to the larger spatial scale employed by exchange networks, risk is pooled, thereby minimizing variance by spreading risk or loss over units larger than a local group over much larger areas. These exchange systems operate as embedded social relationships that make small, regular and predictable losses or contributions in return for larger, uncertain return. Non-reciprocal or negative reciprocity of theft or raiding are also employed by risk prone individuals. This strategy is effective when no other options are present and returns are large but with high costs and consequences.

For example, the Basarwa of Northern Botswana uses reciprocity in buffering resource fluctuation. A horticultural group, Basarwa use reciprocal relationships with non HG groups. Their mobile lifestyle does not allow for the accumulation of goods. Reciprocity, therefore, serves as insurance against risk. For other HG groups, kinship relationships and alliances are

used establish this social insurance, which results in social storage. For them, sharing and cooperation with available resources in a given year is a risk management strategy (Cashdan 1985).

A study of stochastic foraging with costs and benefits of sharing versus diversification shows that sharing between two foragers with same diet breadth can maintain high foraging efficiency while reducing their pooled variation in the range of food intake by 58 percent, whereas expanding diet breadth alone results in only an 8 percent reduction in the standard deviation of the net rate of food intake, a small reduction in the risk of going hungry, and a 6 percent reduction in foraging efficiency (Winterhalder 1986). In this case, there are no alternatives in a given place. The only strategy to cope with this type of variation is to average losses over a large number of areas through network of kin ties. The !Kung San use a social institution called Hxaro, involving exchange of gifts between particular partners. These partners can be counted on to reciprocate in times of need and these relationships are reinforced through regular family visits. !Kung San choose partners by their geographic location and personal abilities so they are protected against risks (Wiessner 1982b).

The best solutions are likely to be strategies that employ a suite of coping and buffering strategies that is best matched to the structure of variability. For example, Optimal Foraging Theories make a number of useful predictions about human responses to spatiotemporal variability or the decrease in high ranked resources resulting from resource depression. If the goal is to increase utility or reduce risk: 1) HGs should broaden diet to include lower-rank species or specialize in few sustainable resources, 2) include wider patches, including lower rank patches, 3) intensify production, create suitable habitats for high ranked dependable

resources (cultivation, horticulture), 4) form larger groups that create efficiencies through group foraging – pool resources, information, networks therefore reducing variability through sharing and 5) invest in physical and social storage. Using the Late Woodland strategies as an example, the conditions present in the SBD during the LA to EW cultural periods required the establishment and maintenance of cooperative buffering mechanisms. Settlement patterns and diet choices are then indicators of an effort to ameliorate these effects (Holman and Kingsley 1996).

Coping Hierarchy and Scale

The aforementioned behaviors are not simply alternatives that HGs select but are often linked such that they can be hierarchical and scalar. These scales can operate as low and high level mechanisms. Low-level mechanisms are efficient and reliable and are limited in scope, whereas, high-level mechanisms are powerful, large, relatively rarely activated and can mitigate larger scarcities (Halstead and O'Shea 1989b). High-level mechanisms only function if reinforced regularly, even if rarely used. These emergency mechanisms are likely embedded in the day-to-day cultural repertoire (Garnsey and Morris 1989). For example, the regular practices of ritual and feasting are likely mechanisms that aid the production of surpluses on a yearly basis.

At greater severity, where shortfalls are beyond the local coping capacity, high-level strategies may be employed, such as inter-regional exchange and intensification, which could possibly result in subsistence changes (Hawkes and O'Connell 1992; Larson, et al. 1996; Leonard 1989). Buffering strategies are additive such that larger and more complex societies incorporate larger and more complex mechanisms. Coping with variability is a hierarchical process, where

strategies that are employed are broadly or selectively used based upon the structure and scale of the uncertainty.

The actual choice of adaptation(s) practices is dependent on a number of contextual factors including social and economic practices of the community, ecological environment, social relationship networks and access to resource zones. Societies are likely to employ an array of strategies in a hierarchy of responses and differ based on the individual, band and community. They may also employ age-sex task groups to focus on different types of mechanisms, therefore diversifying the strategies that are employed. The treatment of uncertainty and risk can be a fruitful domain for the exploration of social evolution and adaptation. The landscape and behavioral models created for this project incorporates risk and uncertainty as analytic dimensions that provide an alternative approach for diet and land use studies. The landscape model employs stochasticity, the random nature of variability in the effective environment. In the behavioral model, three key dimensions are represented: 1) information a forager holds, 2) the level of risk a forager is willing to take, and 3) the implications of levels of risk and uncertainty on coping and buffering strategies. The next chapter links the concepts presented here with two practical modeling approaches contextualized in uncertainty and risk-based decision-making.

The next chapter reviews the modeling methodology in terms of their strengths and weaknesses as well as its use in archaeology and ecology.

Chapter 3: Modeling Economic Decision-Making

Introduction

Understanding hunter-gatherer (HG) adaptation to uncertain and risky environments is undertaken by a modeling approach. This research constructs two coupled predictive models: a resource landscape and a behavioral simulation. In archaeology, predictive modeling is used to generate a hypotheses and expectations, and identify landscapes with a high potential for cultural preservation. While useful for conservation and heritage management, the procedures underpinning predictive modeling also provide a means for interpreting the known archaeological and ethnographic records, as they relate to current theories of human behavior. If modeled and observed behaviors differ, this provides an opportunity to explore the nature of such variation (Reidhead 1979; Winterhalder 1977). In the first of these two models, a series of resource landscapes are constructed. This approach provides information about the prehistoric contexts, thereby filling in gaps in our understanding that are unavailable due to the limited and narrow archaeological record. Next, a behavioral model is developed using a simulation approach, using Optimal Foraging Theory (OFT) to understand diet and land-use choice, predicated on the effort to cope and buffer risk and uncertainty in the environment.

These choices are explored in the terms of criteria employed by past and present HGs based upon a given decision logic: which resources will be exploited at what season, in what quantities, and in what localities (Jochim 1976b). Next, both models are evaluated with archaeological site, zooarchaeological, and archaeobotanical datasets from the Late Archaic to the Middle Woodland periods in the Saginaw Bay Drainage (SBD) of Michigan. This chapter

presents a review of the methods employed to develop these models, as well as model characteristics and attributes.

Models

Models are typically abstract descriptions of the HG economic system (a set of components that interact) that allow for the assessment of human choices, understood as alternative options and competing demands (Jochim 1976b). Modeling allows for the identification of system components and constraints, and defines expectations regarding the structure and dynamics of interacting components. They seek to understand correlative and explanatory reasoning of phenomena through the explicit identification of relevant objects. In archaeology, modeling effort is intended to create predictions, as with this project, specifically about contexts (site locations) and behaviors (what people do). Models allow for understanding the implications of goal-oriented choices and related archaeological and cultural patterns (Binford and Binford 1966; Clarke 1977). These models are deductive and built upon theories of human behavior and ethnography. These predictions can be used to test interpretations through empirical data.

Models can generate counter-intuitive hypotheses, thus securing against the fallacy of affirming the consequence (Bettinger 1980; Binford and Bertram 1977). Archaeology is replete with modeling approaches focused on subsistence and settlement practices (Clarke 1972; Thomas 1972; Wobst 1973). Other successful efforts employ evolutionary and behavioral ecology models framed in OFT (Bettinger 1991; Broughton 2003; Winterhalder and Smith 1981, 2000). Michigan archaeology has also successfully employed deductive approaches (Arnold

1977; Egan 1993; Keene 1981b; Krist 2001). These formal models exemplify archaeologists' far-reaching efforts to understand causes of behavioral and material patterning.

Model-building requires the explicit identification of its purpose (goals), definition of the system (i.e., assumptions, what is inside and outside the system), key variables, and the behavior of key variables and interrelationships between variables. This endeavor is an exercise in placing priority on aspects of the problem that are important to the researcher. Priority in this project is placed on behavioral strategies (i.e., mobility, diversification, exchange, pooling and storage) aimed at fulfilling basic dietary needs. The variability present and boundaries of these strategies are derived from HG ethnographic records aimed at adapting to environmental uncertainty and risk. For the best results, a proper match is required between the research problems, theory, and the methods that are employed. Decision-making models require logical consistency achieved through a transparency of model characteristics with explicit goals, assumptions, currency, and constraints.

HG subsistence decision-making goals are to procure necessary or minimum diet resources for biological needs. These goals are underpinned by the primary goal to cope and buffer against uncertainty and risk in the environment by behavioral rules based on how people may have behaved in the past. In order to adapt to these conditions, HGs select food and use their land in strategic ways. These choices result in cultural patterns, in turn manifesting in archaeological material patterning on a landscape.

Assumptions are the baseline criteria employed in decision-making. These criteria create boundaries for the choices of individuals, where considerations outside these assumptions do not play a role in human economic and social behaviors. These boundaries limit factors of the

decision logic and alternatives that could explain diet and land use choices by the following:

Economic activities directed toward providing the basic nutritive and other raw materials necessary for the survival of a group through conscious choice; deliberation is rational, based on preferences among consequences.

Efficiency is a baseline property of decision-making (Hewitt 1983; Keene 1981a, 1983; Smith 1983; Winterhalder 1981b). When faced with a choice between two equal resources, the one of lower cost will be exploited. Efficiency can therefore be considered an “in the moment” decision between two alternatives. Scheduling of economic activities is the allotment of time and energy for food and depends on choices among competing or mutually exclusive activities with goals of achieving economic security. Efforts to ameliorate risks and uncertainty in the environment are long-term strategies and can be identified through diet and land use against a background of opportunistic exploitation.

Risk and uncertainty in resources can be represented as both proximate to the individual (information held) and present in the natural environment through spatiotemporal variance. The effect of perturbations in the subsistence system, either internal or external, can be modeled in terms of changes in costs and/or limits of resources and information that is available to a person. This model assumes an open system, where external inputs are used to demonstrate variation for interpretation. Decision-making in the resource environment can originate from motivations and external factors, such as food items or goods outside the study area, through exchange and the transmission of information from persons outside the study area.

Traditional ecology deals in three currencies: energy, matter, and information. OFT uses kilocalories, a quantifiable value as the net energy acquisition rates associated with different resources, patches, and group sizes (Winterhalder and Smith 1981). Energy exchanges are recorded in terms of input and output ratios. Input is calculated as the ration of time expended for locating, capturing, transporting, maintaining/storing, and consuming food resources. Output is calculated as terms of energy returned from these activities as a result of resources being consumed (Kemp 1971; Rappaport 1984; Smith and Winterhalder 1992; Winterhalder 1981b).

A person's fitness is associated by the net remaining calories after input and output activities. Other approaches in OFT include food nutrients (matter), due to the recognition that caloric efficiency is insufficient to explain the special role that meat plays in HG diets, since the satisfaction of nutritional requirements is also essential to human subsistence (Egan 1993; Keene 1981a). Dietary diversity and task group-based resource preferences contribute to dietary and nutritional requirements. Therefore, nutritional adequacy is embedded within food choices based on other criteria (Egan 1993; Jochim 1988). Finally, the use of information as a currency is relatively new. Information is the knowledge an individual holds of his surroundings and the resource distribution and density at a given locale (Whallon, et al. 2010). This project uses a mixed currency based upon the scale of analysis. Kilocalories are used as currency in resource choices; whereas information is used in the knowledge of landscapes and decisions about where to move.

The model is intended only to address HG diet and land use in the SBD area aimed at meeting minimum requirements for survival. The study area provides a constrained landscape

where HGs are reliant primarily upon the resources contained therein based upon spatiotemporal variability. This project is a regional study and limits the connectivity with larger interregional networks of interaction.

Data Needed for the Models

HG diet and land use requires information about both the natural and social environment. The relevant natural and social environment is explicitly identified by their constituent variables. First, the dietary needs of a group are determined by HG demographic and organizational information, including group size, individual caloric needs, and sex/age group contributions to diet. Next, the ecological environment provides the resource context through land cover, and biogeography. These variables are organized from a spatiotemporal perspective; providing where, when, and how much of these resources are available.

Choices of resources and habitats are dependent on the effective environment of the study area. An inventory of biophysical (climate, soils, lake levels, hydrology, landscape features) information that contributes to prehistoric diet and land use is based upon a synthesis of contemporary land cover, hydrological, geoarchaeological, ethnographic and historical data. The characteristics of these variables are taken into consideration to determine the resource landscape. These features are further complicated by spatiotemporal changes requiring the understanding of changes across seasons within each study time periods. These characteristics and behavior of the landscape directly affect HG decision-making about resources and habitats (see Chapter 5 for detailed information).

The inventory of plant (phytogeography) and animal (zoogeography) resources available to HGs is based on the environmental reconstruction of the region, based on the contemporary

knowledge of resources in the study area. The relevant economic resources are derived from ethnographic and ethnohistoric documents (Chomko and Crawford 1978; Cleland 1966; Densmore 1927, 1974; Erichsen-Brown 1979; Gremillion 1997; Henry 1969; Kimmerer 2003; Krech 1981; Smith 1979; Yarnell 1964). The ecology of individual species and their habitats are important to diet and land use studies.

The spatiotemporal characteristics of a resource includes its timing; productivity (weight multiplied by density) per unit area of habitat; and the spatial variability of a given resource. Productivity can be associated with the size and caloric value of the resource. The life history of a specific resource provides information about their preferred habitats, seasonal behavior (e.g., hibernation, dormancy), relative abundance (seasonal aggregation), predictability (when species are available), and reliability (how likely a HG can expect this species to be at this place). Resources vary and may be unavailable to HGs or may not be preferred (e.g., low fat). The structure of resources has implications for diet and land use decision-making, the biogeographical data is critical to an effective model.

Productivity for a given habitat is derived from contemporary data and based on prior reconstructed environments. The probable composition of a given animal, fish, and plant resource is based on contemporary values for a given habitat. These values are borrowed from fish and wildlife literature represented in grams and kilograms. This model focuses on general caloric yields of each species, since meat yield is a good measure of utility (Cleland 1966; White 1953). Prey size is a good proxy for prey rank; generally the larger the animal, the higher the return rate. The productivity of these resources varies seasonally, inter-annually, and within

each of the study cultural periods due to the variability in the habitats present due to changes in the natural environment.

Finally, seasonal abundance of a specific resource also plays an important role in choices amongst alternatives. For example, a fish run or abundance of nuts at a given place can also dictate resources gathered. Nuts or fish become an aggregate product where their cumulative productivity is assessed and exploited.

The size of a HG household in proximity to the study area varies over the course of a year and ranges from one to nine people in a group (Howell 2000; Murdock 1967; Schoolcraft 1839). These households live and move together and cooperate in activities for obtaining food. They also practice alternative non-overlapping strategies for food exploitation based upon age/sex groups (Binford 1978b; Hallowell 1992; Henry 1969; Woodburn 1968). They come together for labor intensive activities that require the whole group (Cleland 1982; Henry 1969; Landes 1969; Steward 1938). This number is a mean value derived from studies among the Ottawa and Ojibwa bands living in Wisconsin and Michigan during the 1830s. The households ranged from a single individual to sixteen people, with a mean value of 4.9 (Cleland 1992). Alternatively, the mean number of individuals marginal Southern African !Kung San households is 2.6 (Howell 2000). There is considerable variability depending on the environmental factors. This study uses a household size comprised of a nuclear family with five individuals: two females, two males, and a child. Further, there can be possibly multiple household units operating in the SBD.

Minimum nutrition is the nutrition required for five individuals of varying sizes depending on age, gender, and energy (Ellen 1982; Haas 1944; Messer 1984; Wing and Brown

1979). Using the Department of Agriculture requirements, minimum nutrition for an individual is based on a 2,000 Kilocalorie diet (NRC 1989). This study does not concern itself with minimum vitamin and mineral requirements for survival. HG preference at acquiring a variety of foods, selecting for taste and fat is assumed to address nutrient requirements (Egan 1993). For this study, the average dietary requirement for a household is 2,000 Kilocalories for each individual. This value averages differential requirements based on age and sex, and simplifies calculations.

Individual contribution to diet is based on group member's role in gathering plants, hunting and trapping small and large mammals, birding, and fishing. The average resource contributions in temperate environments are 31% based on gathering, 35% based on hunting, and 34% based on fishing (Kelly 1995a; Lee and DeVore 1968a; Murdock and Wilson 1972). Contribution to diet is also based on the level of risk tolerance by group members. Men are likely to take on higher risks, whereas women and children accept lower risk. This has no direct impact on the relative contribution to diet but does have implications for the individual preference for resources (Waguespack 2005; Winterhalder, et al. 1999).

The quantitative determination of land use and resource choices in a decision making model are based on values assigned to alternatives based upon a utility function that is dependent upon both the net yield of kilocalories and the composite factor of risk and uncertainty. The uncertainty and risk in a habitat or resources can be determined by the habitat and resource's relative predictability, reliability and abundance. The risk and uncertainty can be order according to rank and incorporated into HG choices.

Techniques

This study uses decision-making logic using classic, proven OFT models using computer aided programming and analysis. The contextual landscape and behavioral models are created by the use of Geographical Information Sciences (GIS) and simulation (SIM). The resource environment is reconstructed through mapping and visualization techniques with the creation of composite landscapes based on key variables. The landscape model entails the aggregation and synthesis of geospatial data. GIS provides a framework and platform for the representation of both ecological and cultural information (Goodchild and Janelle 2004). A computer's ability to store, provide representation, processing, integration, and analysis of spatial data results in a hierarchy of nested data. This approach allows for better visualization of variables (e.g., vegetation, drainage, river networks, and elevation) that comprise the resource landscape (See Chapter 5). The model is constructed by the use of GIS map overlay techniques. GIS manipulation functions (buffer, overlay, clip, and so forth) of land cover variables are used to create precontact landscapes (Brondízio 2005, 2006; Brondízio and Chowdhury 2010). The landscape is used as the contextual basis for the simulation of diet and land use behaviors.

The simulation of human behavior is aided by programming software. This approach simulates the outcome of interactions among a population of individuals. The individual acts upon set decision logic in a particular environmental context and resources. These simulations “emphasize dynamics rather than equilibria, distributed processes rather than systems-level phenomena, and patterns of relationships among agents rather than relationships among variables” (Kohler 1999). Simulation approaches have been used effectively in a number of archaeological studies during the past decade (Kohler and Leeuw 2007; Kohler 1999; Reynolds

1985; Sabloff 1981; Thomas 1972; Winterhalder 1986; Wobst 1973). The landscape becomes the baseline model in an agent-based environment, where a simulation using explicit decision-making logic is run. Within a simulation program, each patch, or cell – the minimum scale of analysis, stores information about a number of relevant data variables including the landscape substrate (e.g., soil and land cover), resources (e.g., biogeography), and agents (e.g., foragers), who make choices about diet and land use (See Chapter 6).

In the simulation, humans interact with their resource landscapes making choices about habitats to exploit, and the animal and plant resources in the habitats. The HG becomes an active decision maker, modifying his behavior based upon the dynamic resource environment and decision logic. The SIM program iterates these actions for each time step (in terms of a day) for seasonal and annual bases while the resource contexts are modified to reflect seasonal and random (stochastic) changes. This simulation is rerun for each study cultural period with its unique landscapes. After a simulation run, a set of resources that were selected, caloric intake levels of a group, types of habitats that were selected, and other attributes relevant to the satisfaction of basic biological needs are recorded. Further, a movement map is also recorded daily, seasonally, and annually. The resource and habitats selected are nested hierarchically, where choice of a habitat influences the resources chosen in a given simulation iteration. Both of these coupled approaches provide an alternative perspective on development of predictive models of HG diet and land use.

Resource and Habitat Selection Logic

The exploitation of a specific resource and habitat is dependent upon the costs and benefits associated with the effort. For the exploitation of resources, benefits can simply be

defined in terms of the caloric return from the hunted or gathered resource. The cost of a resource requires a detailed analysis of the activity that was pursued. A cost-benefit approach is often difficult to quantify since the analysis of contemporary HGs is context specific (Kemp 1971; Lee 1968; Lee and DeVore 1968a, b; Rappaport 1984). The costs may not have analogs to differential climatic regimes, or spatial and temporal settings (Hewitt 1983; Keene 1981a). An alternative approach includes an analysis of proxy variables such as resource density, mobility, aggregation, and predictability (Cowan 1985; Egan 1993; Jochim 1976b; Keene 1981b). In this way the environment and temporal contexts are considered.

The effectiveness of a particular diet or habitat choice is measured by the cost incurred and benefits derived from the procurement activity. Costs may include the energy expended to procure a resource through three separate acts: search, pursuit, and processing activity. First, searching is the decision to select a resource or patch, based upon shared information, and it is an intentional action on their part (Hewitt 1983:232; Keene 1981b). Opportunistic exploitation is often the response when an intended resource foray was unsuccessful (Brody 1982; Ingold 2000). HGs seek resources where there is the highest density (measure of resources per unit area) of resource, therefore likely the highest probability of return, partly due to a lower search time. Therefore, search time can be an inverse function of food density (Egan 1993; Hewitt 1983; Keene 1981b; Smith 1983). Second, the pursuit costs are a function of the mobility of a given resource. Hunting highly mobile animals such as elk and deer requires cost effective strategies including trapping, sitting and waiting, or a communal effort to flush and trap. Further, the costs of pursuits are reduced through mapping onto the behavior of resources, whereby the foragers place themselves in the opportune places to reduce effort. Pursuits cost

can be summarized as inversely proportional to the level of prey aggregation and proportional to the distance of prey from the hunter. Third, the most complex of the procurement activities to quantify is handling or processing costs since the act is dependent on a complex set of variables including technological efficiencies and resource weights. In an effort to simplify the procurement costs, this project does not consider the level of technology as a basis for procurement costs but relies on resource density and weight as a measure of these costs. A given cost of processing is directly correlated with the size of the resource multiplied by the density of the resource. For example, processing 100 pounds of elk is equal to processing 10 pounds of fish where there are 10 fish caught.

Further, the risk and uncertainty of each must be included in the cost and benefit calculations. Uncertainty and risk can be demonstrated as the distribution of resource productivity keyed to environmental conditions. HGs are likely to have knowledge of the reliability and security of a resource, predicted from past experiences (see Chapter 1 for more information). The greater productivity of a given resource is a proxy for its predictability and security. Uncertainty and risk can also be conceptualized as stochastic, the randomness of resource availability or procurement success, where a given patch can have differential productivity in a given day and season. The reliability and security of a resource is a spatiotemporal variable where resources vary seasonally and inter-annually. They may vary in their predictability, abundance, and biophysical characteristics including weight and density. The reliability and security of resources varies according to a species wariness and mobility, which can vary seasonally. For example, deer are gregarious and tend to aggregate during rutting season; anadromous fish are highly mobile and aggregate during spawning.

At the habitat scale, uncertainty is represented by the knowledge of alternative patches held by foragers, whereas risk is represented by the choice of a forager—to choose patches that are more predictable from previous experiences. To simplify the challenges of calculating procurement costs, this study creates a composite cost of search, pursuit, and processing as the relative efficiency in term of productivity (weight [kg] multiplied by density of resource per unit area [km²]) and a composite factor for uncertainty and risk associated with a resource or habitat. The composite factor is based on a rank order of risky and uncertain habitats and resources. The composite factor is based on the predictability, reliability and abundance of a food resource and a habitat. Uncertainty can be determined by the mobility of a resource; mobile resources are less certain. Habitats closest to a group's current location are more certain; one that are farther away are uncertain. Therefore, the logic employed to make choices about resources and habitats are based on the combined costs and benefits taking into consideration basic resource and habitat utility and risks and uncertainties in each.

Decision Logic

Given the composite costs and benefits of alternative choices, HGs are assumed to use OFT decision logic. The initial simulation starting conditions observe a HG group located on the most productive patch in the study area. They select what to consume, where to move, when to leave in order to reduce the uncertainty and risk in the environment and based on the costs and benefits of alternatives. An individual stays in a locale and procures resources based on the rank order of resource alternatives (see Diet Breadth Model). They stay in a place (see When to Move section) until the productivity of a nearby patch is greater within range of patches of which the forager has knowledge (see Patch Choice and Ideal Free Distribution Models). The

forager moves to new patch and begins a new procurement activity. The choice of where to move is complicated by the information held by a forager. These choices are contingent on the constellation of cost and benefits of the action that must be estimated or measured in order to predict HG diet choice and land use.

Encounter Contingent Model

In an encounter contingent model, a forager randomly comes upon edible resources. These encounters initiate a choice: to harvest or continue searching. Each of the resource items is measured for its desirability by the net acquisition rate of energy. The rate is the cost incurred subtracted by benefits yielded. This cost can be used to explain the benefit in pursuing and handling or precluding the resource for another resource. This model is designed to predict food that foragers should attempt to procure (pursue, capture, process, and consume) or ignore in order to continue searching for greater returns (Hawkes and O'Connell 1992; Kaplan and Hill 1992; MacArthur and Pianka 1966; Stephens and Krebs 1986). The model states that once resources are ranked in terms of their returns or profitability, after search and handling time are factored in, foragers should choose to pursue resources that yield the highest rate of return upon encounter, irrespective of the encounter rate for each prey item. Lower ranked resources will be pursued when higher ranked resources are unavailable, in order of diminishing return rates (Gremillion 2002). A reduction in the density of higher ranked prey will result in foragers increasing their diet breadth to include lower ranked items. These models are used to predict changes in diet choice as a function of changes in the environment or in the forager's abilities or capacities.

Resource depression, environmental change, and increased focus on a specific resource may decrease encounter rates with highly ranked resources, which in turn will increase search costs and lower overall foraging efficiency (Stephens and Krebs 1986). This will cause resource selection to expand to lower ranked items. Conversely, increasing encounter rates with highly ranked resources progressively will narrow the range of resources selected, displacing previously consumed resource items (Broughton 1997; Pyke, et al. 1977; Schoener 1971). For example, the introduction of snowmobiles increased prey encounter rates among Cree foragers (Winterhalder 1983).

The diet breadth model suggests the most efficient strategy in an abundant environment is a focus on the most productive resource (shrinking the breadth), whereas, in distributed or patchy habitats, we will observe a diet breadth that is diverse to meet minimal requirements for sufficient resources. The diet breadth model, an efficient strategy, therefore an adaptive and evolutionary one, is to select the highest ranked resources when encountered, and to shift to lower-ranked resources only when the density of highly ranked prey is reduced. Resources outside those that are highly ranked will be ignored and with no partial preferences. The decision to include a lower ranked item is not biased on its abundance, but is based on the abundance of the higher ranked item.

When to move

A HG must make a choice regarding when to leave an area, where to move, or which new patch to exploit due to declining resources in the current locale. The knowledge of available patches determines the choice of next move. Given the knowledge of the available patches, the rationale used by HGs follows two OFT approaches, including Patch Choice and

Ideal Free Distribution (IFD). Patch choice provides logic for choosing how long to wait, when to leave the current patch, and the decision between groups of patches. Ideal Free Distribution provides the logic for choice among all known patches and interaction with other foragers.

The IFD explains why a specific patch instead of any other is selected. Patch choice determines a locale that a forager should exploit next. The choice to move to a new locale is contingent on the information that a forager holds about the productivity of a new patch. The patch choice model specifies which areas a forager should choose to search in order to obtain the maximum return when resources are unequally distributed (Pyke, et al. 1977). Foragers should search higher ranked patches first (those yielding the highest returns after search and handling time are factored in), and should search lower ranked patches as higher ranked ones become depleted (Smith 1983). By moving, the group will incur the cost of moving and finding a new patch. But, upon locating a new patch, the group will be rewarded with a higher rate of return. The patch choice model follows the same logic as the diet breadth model.

Unlike diet breadth, decisions regarding patch choice are interdependent with decisions about patch residence time. Within a patch, the rate at which food can be harvested declines as a function of the time spent there by foragers. For example, the most accessible nuts are harvested before moving to more difficult and less attractive ones. Marginal Value Theorem (MVT) states that the optimal forager abandons a patch when its declining marginal rate of return equals the Net Acquisition Rate, or the average foraging rate, averaged over visits to many patches (both for resource value and travel time) (Charnov 1976; Stephens and Krebs 1986). The marginal value of the current patch is compared to the average value of moving on.

Moving to a new patch increases the encounter rates, raising foraging efficiency and reducing patch residence time in the depleted patch.

A forager moves more quickly through an environment that is dense with rich patches, taking less from each one that is encountered. A forager will leave a patch before it has been fully depleted, incidentally leaving stock behind for the patch to recover. Summarily, patch decisions are synchronously-based decisions where the decision to leave and the travel distance to the next patch are both considered with imbedded knowledge of forager environment. Therefore, predictions about patch residence time depend on patch choice; conversely, predictions about patch choice depend on residence time. The amount of time spent in a patch is dependent on the rate of patch depression. Patch depression results from over-exploitation, prey relocation, changes in prey behavior that make capture more difficult, and microhabitat change through environmental change or human land use (Broughton 2003; Broughton and O'Connell 1999; Charnov 1976; Nagooka 2002).

As an alternative to moving from patch to patch, HGs can reside at a central location and exploit patches surrounding this central location for foraging and field processing effort. This model attempts to solve problems stemming from situations in which resources are located in a different place from where they will be consumed (Orians and Pearson 1979). This model predicts that patches that are farther from a central place or residential base will begin to be depleted after closer patches are depressed. This is because more distant and previously under-used patches should contain higher densities of high-ranked prey, thus making longer-distance travel more worthwhile so long as the return rate is above that of nearer patches once travel costs are factored in (Broughton 2003). Foragers should relocate their central place when

foraging returns fall below those that can be obtained elsewhere once relocation costs are factored in (Hayden 1981; Kelly 1989; Sahlins 1972). This model examines the cost of bringing people and resources together once round-trip time from the patch to the place of resource consumption is factored in. The general rule is that larger load sizes and greater pre-processing will be more profitable the farther one must transport the resource (Beck, et al. 2002; Bettinger, et al. 1997; Jones and Madsen 1989; Metcalf and Barlow 1992; Rhode 1990).

Ideal Free Distribution

The ideal free distribution (IFD) represents the logic of habitat selection and migration (Fretwell and Lucas 1970). An IFD describes the way in which animals distribute themselves between several resource patches. The theory states that individual animals will aggregate in various patches proportionately to the amount of resources available in each patch. For example, if patch A contains twice as much food as patch B, there will be twice as many individuals foraging in patch A as in patch B. The term "ideal" means that animals are "ideal" in their assessment of patch quality; they know how profitable each available patch is. For this project, this ideal constrains the patches to those of which they have knowledge. The term "free" means that animals are capable of moving unhindered from one patch to another. Both assumptions are often violated, for example if the animals stop in the first patch they get to do that without looking for others, or if there are dominant individuals preventing others from foraging optimally.

The quality of the habitat depends on both resource abundance and the density of the population inhabiting and using it. The IFD assumes that habitat quality is a function of population density. The initial settlers exploit the best habitat more intensively. Further

immigration and population growth reduce the availability of resources and the quality of the habitat decreases. Crowding, depletion, and competition are possible reasons for habitat quality decline. Conversely, habitat quality determines the equilibrium distribution of foragers. The marginal quality of a highly valued habitat will eventually drop to that of second rank, as yet unsettled habitat. If each group seeks to occupy the best habitat, further growth or immigration will be apportioned between habitats A and B such that their marginal value to residents is equalized. This model suggests that habitats will be filled on rank order, that human densities at equilibrium will be proportional to the resource quality and that the suitability of all occupied habitats will be the same at equilibrium. Likewise, small habitats will be quickly affected by settlement, generating a sharply declining curve of suitability as population densities increase. If immigrants were to defend their territories, then newly arriving individuals would be displaced more quickly to lower ranked habitats, defined as the ideal despotic distribution (Sutherland 1996).

For example, one study explores the seasonal and relative shifts in values and availability of local and distant resource opportunities. A foraging group whose two most important resources, margins of lakes and lacustrine species versus mountain sheep and pinyon nuts, are found in geographically separated habitats. Their relative importance changes during the seasons. We expect foragers to camp near the more dominant of the food sources (fish) and use logistic mobility to acquire easily transported less dominant pinyon nuts. The shifts in costs (transport) and benefits (yield) will lead to the decision to switch the pattern of settlement and logistic procurement, thereby residing adjacent to pinyon nuts while harvesting fish logistically (Zeanah 2000).

Implementing the model

The coupling of the landscape model and behavioral simulation provides framework for understanding of economic decision making in heterogeneous environments. Further, the use of classic OFT models allows for consistency and methodological rigor. Next, both the models require understanding of the SBD social and natural environment. The next chapter presents this relevant data, focusing on the role of uncertainty and risk on these variables in the SBD of Michigan.

Chapter 4: Social and Natural Environment

Social and Natural Environment

The two built models of landscape and behavior employed in this research are based upon the understanding of hunter-gatherer (HG) cultural and natural environments in the Saginaw Bay drainage (SBD) of Michigan. These models are dependent upon the explicit identification of factors determining the resources, habitats, and characteristics of the societies that are present. Further, these factors need to be conceptualized through an understanding of variability, highlighting the implications of change. Basin-wide variation is important for the structure and distribution of resources and habitats in the study area (Larsen 1973). Variability in the natural environment is credited to regional change in climate and linked changes in land cover. Specifically, variability in the productivity of resources and habitats, and linked social change, is understood through the changing economic role of wetland habitats and resources (Dustin 1968; Fitting and Allison 1972; Keene 1972; Lovis 1985; Lovis, et al. 2001).

SBD wetlands provided an excellent resource base, offering typically reliable, predictable, and abundant resources. Further, wetland environments have important implications for societal development and complexity (Brown and Vierra 1983; Lovis, et al. 2001). This chapter presents relevant information directed at the coupling of social and natural environments, which play a role in the economic decision-making of the HG. This is accomplished through a presentation of an analytic framework linking both the social and natural environments; with a review of relevant climate, geography, geology, hydrology, and biogeography—highlighting the relevance, ecology, and inventories of each.

Landscapes

One way to understand HG society and economy is through the ways they map the natural environment through their experiences by making a locale, feature, or a place important. The cumulative natural and cultural place can be considered as a landscape, the totality of a natural environment understood through a cultural lens. Landscape or "place-based" research provides a way to integrate environmental context in the analysis of prehistoric land use and diet choice (Ashmore and Knapp 1999; Basso 1996; Tilley 1994). For this research, the connection between a place and meaning is grounded in the intersection of environmental uncertainty and human actions. Landscapes are created by incorporating archeological, paleoecological, and geomorphological information, providing the basis for understanding continuity and change in the development of culture (Basso 1996; Erikson, et al. 1980; Menzies 2006). The combination of landscape features and cultural use and markers provides insight into the use of land and, by extension, its cultural perception. This perception includes an understanding, often accomplished through language, of what places are important, sacred, and dangerous (Basso 1988).

Taken together, landscapes are then the cognitive map of a natural resource environment that is critical for human adaptation to uncertainty and risk (Golledge 1999). Humans are said to acquire, code, store, decode, and use cognitive information as part of their daily activities. Specifically, heterogeneous environments are easier to conceptualize, and provide criteria for cognitive segmentation (Allen 1981). For example, a place where people live (i.e., a village, residential base) and its surrounding territory were important elements of personal and collective identity (Merrell 1989). For example, Anishinaabe perceive landscape as

occurring along two axes, spatial and temporal (Davidson-Hunt and Berkes 2003). Spatial perception relates to how patterns of things, such as resources, are distributed. Knowledge of such distribution, interrelationships, and properties occurs along a temporal axis. Knowledge, for example, of where a plant is growing allows you to harvest the resource as long as the plant community does not change. What do you do if fire destroys that particular location? You must have an understanding of both resources and cultural landscapes to cope with this event. This understanding is accomplished through language. Words are used to link specific plant species with the locations of those species.

Additionally, place names are also used to provide a mental image of how a place within the landscape looks, how it is related to other places, what occurred at the place, and/or what might be found in that place. Place names are fixed nodes, reference points, upon which the creation of spatial patterning of the landscape is built. Place names did not just mark places but brought together places in relation to each other by paths of travel and sacred and revered settings. Landscape, in this perspective, becomes a network of nodes and trails that orient a person in physical, social, and cultural spaces (Berkes, et al. 1994).

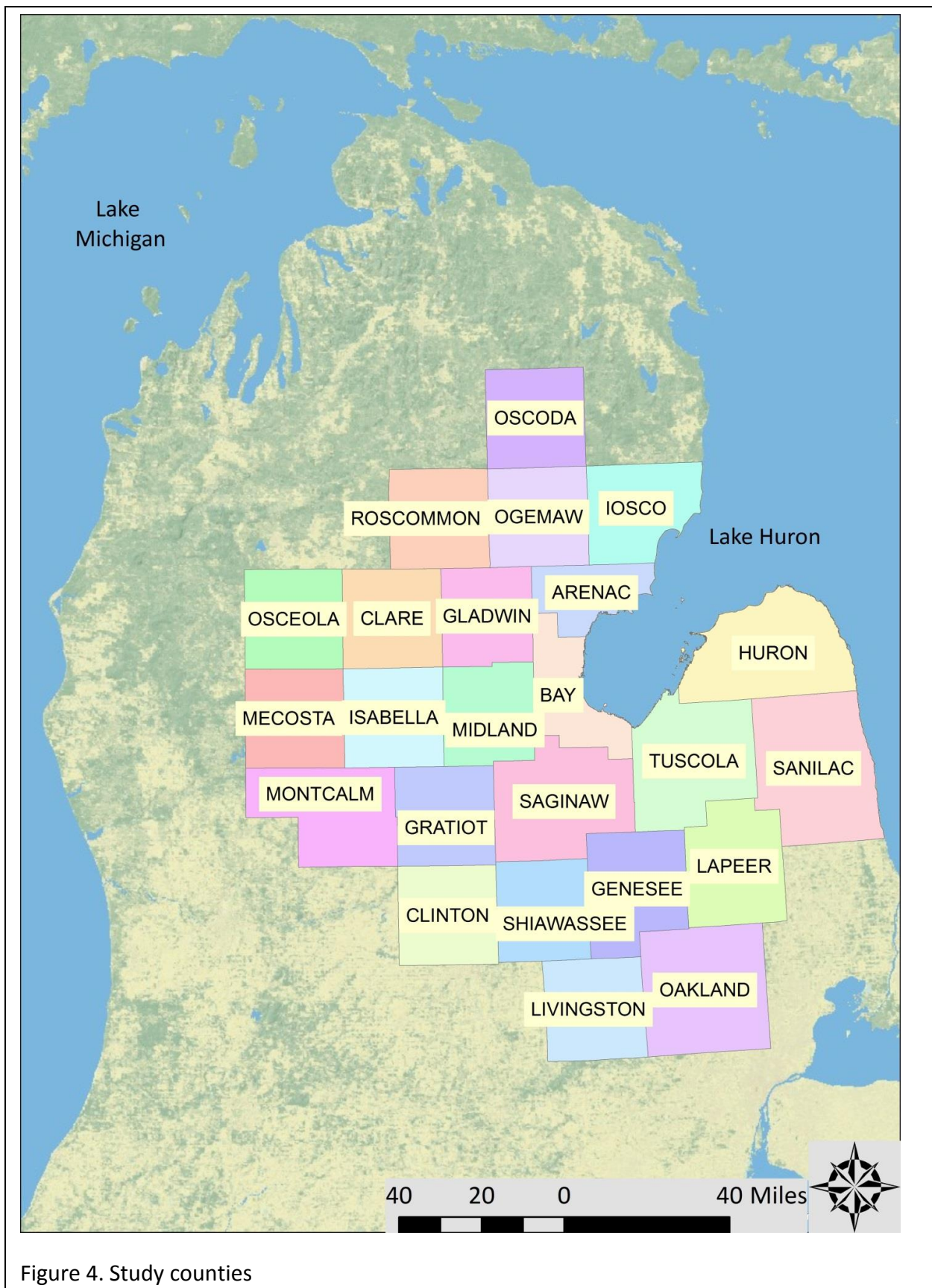


Figure 4. Study counties

Over time, a landscape can develop unique meaning. For example, places that are occupied or relevant for economic and social reasons are considered as persistent places (Lovis 2009; Schlanger 1990). Persistent places are unique locales that play important roles in the cultural development of an area. Beyond a single locale, these places can be larger-scale features, including key rivers, wetlands, and landforms (i.e., dunes, beach ridges, moraines, kettle lakes, and so forth). These places have greater archaeological importance as exhibited through extensive material inventories spanning time. Landscapes, in this way, link the social to the natural world and can be analytic approaches to risk and uncertainty in SBD. In summary, the landscape perspective provides a framework for linking the world of nature to society and, therefore, the approach used for this project.

Biophysical Environment

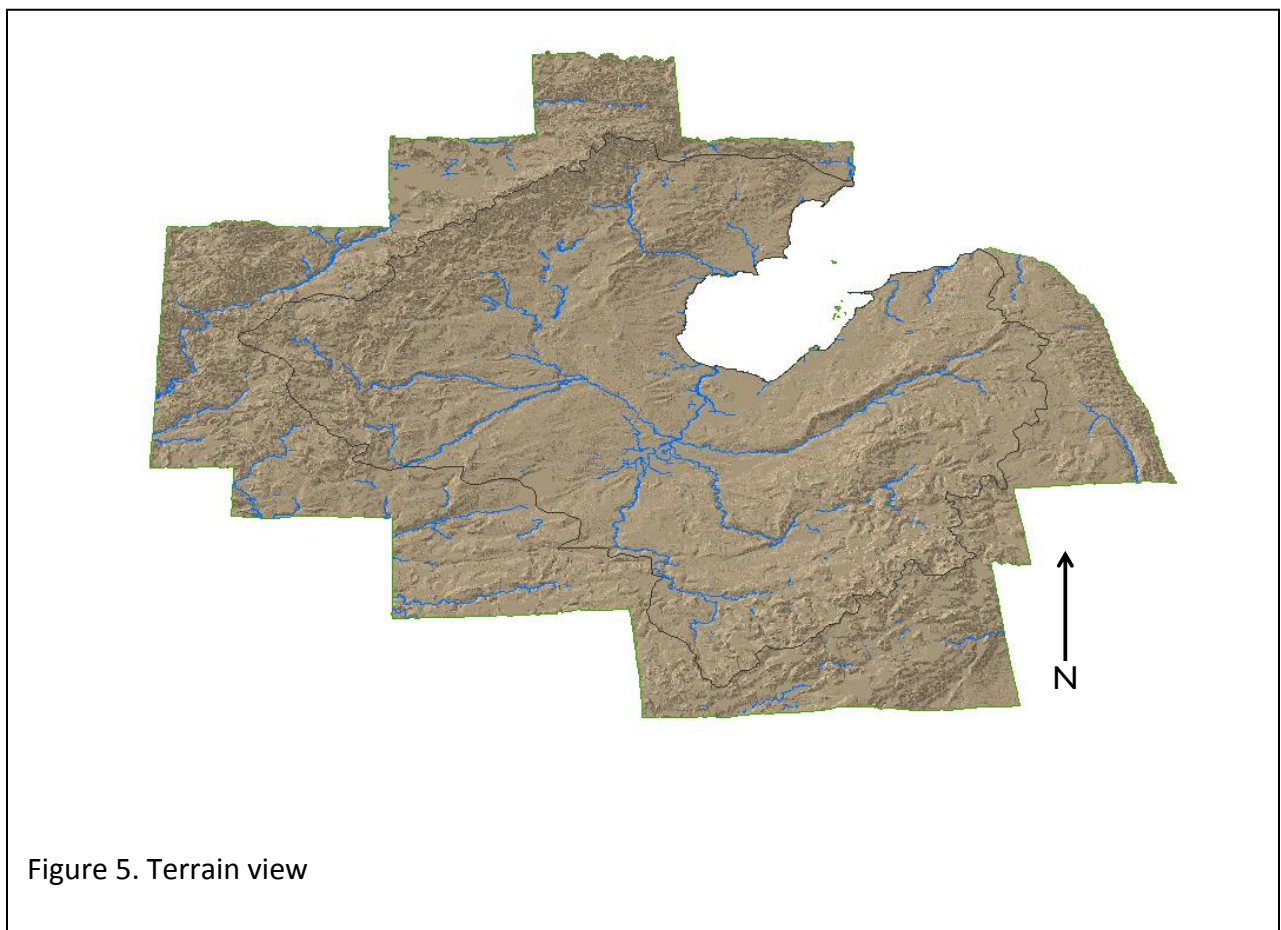
The SBD natural environment is comprised of a number of key drivers from its ecological past, including physiography, climate, and biogeography—culminating in the effective socio-natural environment. One key factor in HG cultural development in the core Saginaw Valley Basin is extensive wetlands. A focus and priority are placed on the development of habitats and resources, the effective subsistence environment that is primarily derived from wetland dynamics in the area. This focus is relevant since hydrology is an overriding influence and determinant factor of land cover and resources that are present. Therefore, this project places priority in the reconstruction of landscapes based on changing wetland dynamics over time (see chapter 5).

The physiography (geographic features) of the area is determined by glacial and post-glacial geomorphologic processes (e.g., isostatic rebound, inundation, the drainage of lakes, and incision of drainage outlets), from the Wisconsin glacial advance and retreat, which occurred from approximately 14,000 to 13,800 B.P. (Dorr and Eschman 1970). The advance and retreat of glaciers created natural features, including the Port Huron and Bay City Moraines. Glacial processes also result in the development of study-period drainage systems, river networks, and beach terraces created by Lake Saginaw and Lake Chicago during the Lake Algonquin stage (Butterfield 1986). The terraces and moraines that were left behind, which run parallel to the bay, provide the low relief and a substrate through which major tributaries such as the Cass, Shiawassee and Tittabawassee, and Saginaw rivers flow and drain into Saginaw Bay.

These rivers form a centripetal drainage network with numerous stream inputs, and they support extensive habitats and resources in the area. The core basin is unique with extensive wetlands derived from limited topographic relief and poorly drained glacial and lacustrine soil substrates. This environment is patchy with a seasonal diversity of plants and animals that make the core wetland area a highly productive but uncertain environment. The environment is balanced by abundance and scarcity due to localized seasonal variation and landscape-wide changes resulting from a number of factors, including climate and hydrology—resulting in complex land cover and biogeography.

Today, the Saginaw Bay Drainage (SBD) encompasses an 8,700 square-mile area within twenty-two Michigan counties (Figure 4. Study counties). The drainage is America's largest contiguous freshwater coastal wetland system with 175 inland lakes and 7,000 miles of rivers

and streams. Extensive riverine, coastal, and interior lacustrine wetlands provide habitat for a multitude of floral and faunal species and serve as a vital migration route for waterfowl and birds on the Mississippi flyway. The contemporary environment is unlike the prehistoric past, due to large-scale changes that include wetland drainage and agricultural and industrial land use. A number of key variables are important to the understanding prehistoric past including climate, geomorphology, and ecology.



Climate

The present SBD climate is mild, ameliorated by the effects of Lake Huron and protection afforded by Saginaw Bay. The annual rainfall ranges from 70-80cm, the average

annual snowfall is 1 m, with an average growing season of 153 days (Albert, et al. 1986; Seeley 1918). First frost takes place between September 30th and October 15th and heavy frost (< 0 degrees Celsius) occurs between May 2nd and May 15th. These conditions make SBD capable of supporting extensive plant growth. The Late Archaic (LA) and Middle Woodland (MW) Period had a climate similar to modern climate, based on vertebrate and pollen data (see (Bernabo 1981) for detailed climatic coverage of the area), whereas, the Early Woodland (EW) is suggested to be colder and drier (Halsey 1999). This generalization is misleading; much of the past environment is based on multiple factors including temperature, moisture inputs, lake levels, fluvial dynamics, plant cover, and other criteria.

The SBD is situated along the transitional zone between the Canadian and Carolinian Biotic Provinces (Cleland 1966; Potzger 1947). The transition zone, a mosaic of heterogeneous environments, is an area whose total carrying capacity was intermediate to both the Carolinian and Canadian Biotic Provinces. The location along the near northern extremes of the Carolinian Biotic Province results in phytogeographical patchiness, lacking in expansive homogenous vegetation (Albert, et al. 1986). The area is also at the upper limits for a 150-day growing season, which is a requirement for reliable plant productivity (Yarnell 1964).

The transition zone has implications for the resource landscape. In both biotic provinces, winter is the most critical season. The SBD warm season, with a system of radial river systems and high stream density and elevation profile, results in extensive wetlands and is a source of abundant and diverse plant, mammal, bird, and fish resources (Lovis 1985). The available

resources are diverse due to a mixture of species and higher density of resources, because of wetland productivity in both biotic provinces (Hambacher 1992).

The phytogeography of the Canadian Biotic Province is typically characterized by mixed beech-maple hardwood and coniferous forests, with a relatively lower game animal (i.e., moose, elk, and deer) density than in the Carolinian Provinces to the south. Plants and migratory birds are also in lower densities and likely unavailable during colder months. Typically long seasons of cold weather make Canadian biotic provinces harder places in which to live (Cleland 1992). Ethnohistoric and contemporary groups living in the Canadian Biotic Province are required to have a flexible subsistence system to cope with winter shortages. Among proto historic groups in Michigan, the Ottawa fished, processed, and stored inland shore fisheries of fall-spawning fish and lake trout. Fall fishing sites were likely places where groups aggregated then dispersed for winter hunting (Cleland 1982): 772-768. Additionally, people lived on interior lakes adjacent to resource-rich habitats, which was another way to enhance their chances of obtaining food (Holman 1978).

Substrates

A key variable in the productivity of a landscape is the substrate of the study area. Soils and water are substrates that are relevant to the study area. A given substrate determines the density and distribution of plant and animal species (Soil substrates are the upper part of the ground, and are affected by organisms, water, wind, and climate; therefore, they change regularly. Soils are used by plant roots and constitute the basis for plant growth). SBD soils originate from post-glacial deposits transformed by natural processes (i.e., chemical,

precipitation and water percolation, organic material accumulation and percolation, and animal and cultural modification). The core basin is flat, interrupted by low ridges, sand dunes, and moraines. Old beach ridges are present near the bay; sand dunes are present downwind of drainages, and crescent-shape end moraines run parallel to Saginaw Bay (Albert, et al. 1986). These drainages are poorly emptied and cross cut by excessively drained beach ridges. The quality of the overall soil is poor with much of the interior being a clay lake plain with dissecting drainages (Egan 1993):61.

Contrary to those described above, productive soils are present along extensive river meanders and confluences. The core basin soils are represented by categories based on their elevation, drainage, and productivity, which are categorized according to United States Department of Agriculture classification scheme (see Appendix A). Soils are characterized using a classification system based on presumed soil genesis through historical and geomorphic processes (Schoeneberger, et al. 1998).

Next, hydrology can be a more important substrate since the presence or absence of water overrides any influence of soils. Both the permanent and temporary presence of water is important to wetland environments. Hydrology is dependent on both the overland and the underground presence and flow of water. Ground water levels are dependent on topography, soil types, the presence of lakes, and generally follows the slope of soil surfaces. The deeper the ground water level, the weaker the relationship with soil topography (See Appendix A – Soil Classification).

Lake Levels

Long-term variations and short-term fluctuations in lake levels modify the geography of lake shores as well as the plant and animal communities associated with the Great Lakes and inland aquatic and terrestrial landscapes. Lake level fluctuations may have spurred settlement and mobility in the Saginaw Valley (Butterfield 1986; Larsen 1973; Lovis 1986). The lake level phases for the study periods are the Lake Nipissing stage (184 m [605 ft] amsl) from 4700 to 4500 B.P. (2750 B.C. to 2550 B.C.) and the Algoma stage (181 m [595 ft] amsl) from 3200 B.P. (1200 B.C.) During the Lake Nipissing stage, the Saginaw drainage system began to stabilize to its current configuration (Monaghan, et al. 1994). Later, closure of a northern drainage outlet shifted outflow to the south during the shorter high water Nipissing II. The outflow of high water stabilized during the later post Nipissing recession. The Algoma stage (181m [595ft] amsl) occurs around 3200 B.P. (1250 B.C.); waters continued to drain until modern levels were established at 2600 to 2500 B.P. (650 to 550 B.C.)

The post-Algoma drainage played an important role in landscape characteristics during this period. The decrease in water levels, from a high of 181 meters (594 ft) to 177 meters (581 ft), resulted in pooling and ponding of water between glacial moraines, producing extensive marshes and swamps. The slow drainage of these high water levels conversely also created vast heterogeneous terrestrial habitats. These new habitats provided for increased resource productivity and opportunities for HGs.

Modern lake elevations (177m [580 ft] amsl) were established from 2600 to 2500 B.P. (Lovis 1986; Speth 1972). The Nipissing and Algoma levels correspond broadly to the Late Archaic, whereas modern lake levels are present during the Woodland Periods. These modern levels were interrupted by short periods of high-water levels in both the Huron Basin and Bay

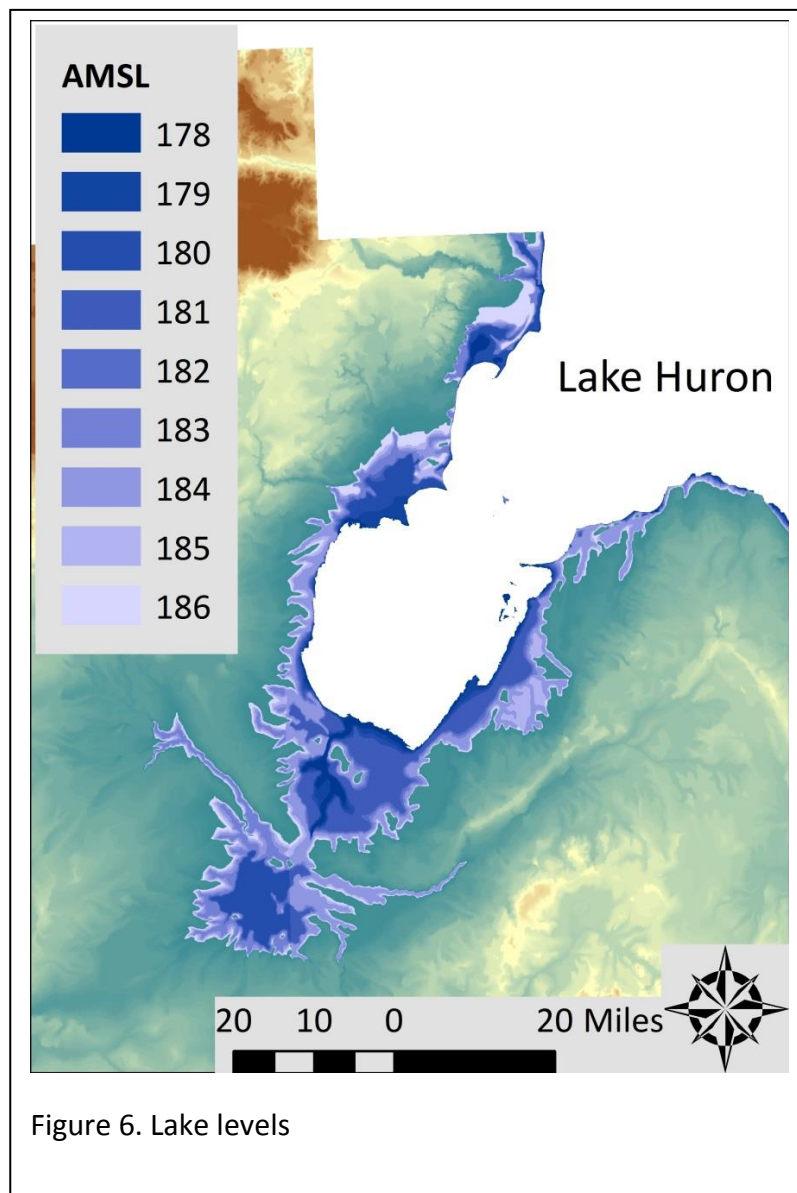


Figure 6. Lake levels

City areas (Farrand and Bell 1984; Larsen 1973; Lovis and Cleland 1993; Speth 1972). One such short-lived high-water phase in the Middle Woodland period is present at the Schultz site (20SA2), at the confluence of the Saginaw and Tittabawassee rivers. These fluctuations in lake levels are present with high water phases attributed to climate (temperature and precipitation) (Farrand and Bell 1984; Larsen 1973; Lovis and Cleland 1993; Speth 1972). High water phases,

both during the Late Archaic and Middle Woodland, are proposed as key drivers of general landscape characteristics and wetland habitats for this project (Figure 3 – Lake Levels).

The Late Archaic in the Saginaw River Basin is a period with modern vegetation communities, high water levels, and fluctuating lake levels (Ahearn and Bailey 1980; Cleland 1966; Cleland 1989; Cowan and Smart 1979; Egan 1988; Keene 1981b; Lovis, et al. 1994; McMurray, et al. 1978; Monaghan, et al. 1994; Smith 1989; Yarnell 1964). The long-term variations and short-term fluctuations in lake levels changed the geography of lakeshores and the biogeography associated with the Great Lakes and inland aquatic and terrestrial resources (Butterfield 1986; Larsen 1973). For example, a large number of Late Archaic sites likely were found within a seasonally inundated landscape, evidenced by site locations at specific elevations above local base levels; over time, sites do move lower to the base levels (Lovis 2009)

The Early Woodland Period is a relatively drier period, with lower water levels and less periodicity of flooding. Others suggest that the Early Woodland economy was similar to the Late Archaic, characterized by large mammal hunting, particularly white tailed deer (*Odocoileus virginianus*) and elk (*Cervus Canadensis*), nut and wild plant harvesting, and fishing (Smith and Egan 1990). Early domesticates were also introduced into the area. Squash (*Cucurbita pepo*) was present, evidently coincident with the introduction of ceramics in that region (Arnold 1977; Martin 1985; Monaghan, et al. 2006; Ozker 1982; Wright 1964).

The Middle Woodland Period is observed when lake levels in Lakes Michigan and Huron rose to 180m amsl, which is 3 meters higher than modern levels (177m). The rise in lake levels along the Huron basin likely resulted in periodic and extensive flooding (Kingsley, et al. 1999; Lovis, et al. 2012; Lovis, et al. 2005; Lovis, et al. 2001; Monaghan, et al. 1994). Exploitation of cultigens increases during the Middle Woodland. Squash is present at Bridgeport Township site

(Egan 1990) and Schultz site (Egan 1993). Nut use decrease markedly during this time period as well and may result from scheduling conflicts with the autumn harvest of domestic crops (Allison 1972). Other interpretations include a shift in the exploitation of other wild plant species (Lovis 1985) and concentrated or intensive hunting of large Cervids (deer) during rutting season (Keene 1981b). Faunal assemblages suggest a limited range of productive large mammals and fish exploitation (Cleland 1966; Luxenburg 1972).

A study on the adjacent Muskegon River highlights the fluvial dynamics of aggregation and down-cutting following periods of equilibrium, suggesting variable discharges from the uplands into the Saginaw basin played a role in wetland communities (Arbogast, et al. 2008). Wetter climates of both Late Archaic and Middle Woodland Periods likely increased discharge into the basin, renewing and sustaining wetland resource communities along drainage base levels from the uplands to the Saginaw river outlet.

Biogeography

Biophysical variables, climate, soils, and lake level changes are the basis for the ecological environment and biogeography that are present. Both the phytogeography and zoogeography are the basis for habitats and diet choices and are affected by changes in the landscape. Phytogeographical changes can be observed through pollen studies (see Appendix A for more details). Pollen studies provide plant cover, density and distribution and can also serve as proxies for temperature and precipitation. Five pollen studies, located in and adjacent to SBD, are used to determine the plant cover.

Table 1. Pollen sites			
Lake/Bog	Location	Altitude	Author
Chippewa Bog	43.12389N -83.24111W	270 m a.s.l	(Ahearn and Bailey 1980)
Demont Lake	43.5N 85.0W	248 m a.s.l	(Kapp 1999)
Vestaburg Bog	43.41667N -84.88333W	255 m	(Gilliam, et al. 1967)
Wintergreen Lake	42.4N -85.38333, NE of Kalamazoo, NW of Battle Creek	271 m	(Bailey 1977)
Cowden Lake	NW, Bordering SBD	Unknown	(Hupy and Yansa 2009)
Hicks Lake	West, Bordering SBD	Unknown	(Hupy and Yansa 2009)
Morrison Lake	SW, Bordering SBD	Unknown	(Hupy and Yansa 2009)
Frain Lake	42.33N, -83.63S	271 m	(Kerfoot 1972)

The Vestaburg Bog (Gilliam, et al. 1967) and Chippewa Bog (Ahearn and Bailey 1980) areas were forested by a diversity of hardwoods by the onset of the Late Archaic (5550 B.C.), with a mixture of oak-hickory (Carolinian) and pine (Canadian) dominated biotic communities. A warming period was present during the Hypsithermal from 4050 and 3050 B.C. (during the Nipissing and Algoma Lake level Phases). Modern forest communities are suggested to be present thereafter (Ahearn and Bailey 1980; Gilliam, et al. 1967; Kapp, et al. 1977; McMurray, et al. 1978).

The study of cultural periods demonstrates similar patterns of pollen across the different sites with a mix of southern and northern taxa. The pollen data, from the General Land Office Survey (GLOS), archaeobotanical data, ethnohistory, and Curtis' 1971 (Curtis 1959) study of similar forests in Wisconsin provide a classification of forest communities. The communities include 1) northern and southern mesic hardwood forests; 2) a northern and southern wet-mesic, hemlock, and hardwood forest; 3) a northern and southern, mesic, beech-

hardwood-pine forest; 4) a southern mesic, beech-maple forest; 5) a northern and southern dry-mesic, hardwood forest; 6) a northern mesic to wet-mesic, lowland swamp forest; and 7) a northern and southern wet-mesic, hardwood forest.

Past reconstructions of botanical communities and pollen data show much concordance. These sequences suggest a mixed hardwood forest, very similar to the pre-settlement forest, which was established by 3850 B.C. with changes in the specific wood genera (Ahearn and Bailey 1980; Gilliam, et al. 1967; McMurray, et al. 1978). No major changes in the composition of forest communities are present. The terminal Late Archaic to the Early Woodland Period is characterized by expanding forest communities; specifically Oak/*Quercus* spp. dominated forests. The succession of plants and linked hydrologic and climatic changes, result in the contraction of wetland environments and the expansion of forested communities.

The Middle Woodland Period, Hicks Lake pollen core suggests a northern mesic forest of eastern hemlock/*Tsuga* spp., American beech/*Fagus* spp., and sugar maple/*Acer* spp. pointing to a return to wetland-influenced landscape. Further, spruce/*Picea-Abies* spp. communities are present in lowlands. Pine/*Pinus strobes* spp. and oak/*Quercus* spp. are also present, most likely on sandy uplands. At Cowden Lake, dry oak/*Quercus* spp. and mixed forest oak/*Quercus* spp. dominated with sugar maple/*Acer* spp., American beech/*Fagus* spp., elm/*Ulmus* spp., and communities of *Pinus* and *Quercus* are also present. Oak/*Quercus* spp. begins to decline at 1850 B.P. At Morrison Lake, mixed oak/*Quercus* spp. and beech/*Fagus* spp. forest and oak/*Quercus* spp. dominated forests with hickory/*Carya* spp., hop hornbeam/*Ostrya* spp., and poplar/*Populus* spp. Beech/*Fagus* spp. and sugar maple/*Acer* spp. forests are also present but are less dominant.

Cowden, Hicks, and Morrison's palynological data also demonstrates a different perspective on plant cover and climate (Hupy and Yansa 2009). This analysis suggests that climate change from the early to Middle Woodland Period results in the shifting on the tension zone, and coupled the density and distribution of plant and animal species. Vegetative environments changed from 2000 B.P. (Late Middle Woodland), from dry conditions to wet conditions, resulting in increases in mesic forests—*Fagus*, *Acer*, and elm/*Ulmus* spp., concurrent with a decline in oak/*Quercus* spp. abundance.

Taken together, the palynological data presents a static picture of plant communities over time. But, these same data highlight the importance of local habitat changes. A shift toward wet environments with ameliorating climate is observed during both the Late Archaic and Middle Woodland Periods. Marshes along bay and river margins are present with water-loving species, including cattail/*Typha* spp., arrowhead/*Sagittaria latifolia*; sedge/*Carex* spp.; and bulrush/*Scirpus* spp. (Curtis 1959). Pollen data further suggests an increase in aquatic taxa at Vestaburg Bog at 1200 B.C. with the establishment of wetlands, with rising lake levels and post-Hypsithermal moisture increase. These changes resulted in the contraction of overall forested areas and an increase in cattail marshes. These phytogeographical changes are used to link the types of habitats that are present to economically relevant animals (Albert, et al. 1986).

Zoogeography of the area is a mix of species found in both the Carolinian and Canadian Biotic Provinces. Since zoogeography is directly connected to the habitats that are present, birds (e.g., geese, ducks), reptiles (turtles), mammals, and fish represent SBD diversity (Baker 1983; Cleland 1966). Over time, the changes in phytogeography and habitats result in concomitant changes in density and the distribution of all species. In the terrestrial

environment, changing plant communities through secondary succession provided an area where a diverse set of small and large mammals is present.

Wetlands and other aquatic environments are observed to support a diverse set of animal resources. A wide range of species are present in lakes, fast rivers, as well as shallow, and slow-moving waters (Cleland 1966; Keene 1981a). For example, riverine anadromous fish species (lake sturgeon and sucker) are present and seasonally abundant. Wetlands serve as areas of dependable food sources for many bird and terrestrial animals. The SBD served as a vital link along a minor flyway for migratory waterfowl (Keene 1981b). Both terrestrial and aquatic resources are taken into consideration for the landscape model; these variables are modified, based on the habitats that were present at different study periods.

Role of Wetlands (Palustrine Systems)

Wetlands are among the Earth's most productive ecosystems. They provide food, water, raw materials, landscape stability in the form of flood control, and other ecosystem functions. They are sources for biodiversity and have high resource density. Wetlands are areas of transition, formed by both aquatic and terrestrial factors, and the borders between them are hard to define. They can be classified according to their ecology, their natural and societal function, or their hydrology. An understanding of a wetland ecosystem is important for the understanding of the adaptive process of the Saginaw Bay Drainage. An attribute of wetlands is a diversity of wildlife habitats, providing economically important animal and plant species diversity. Hydrology is the driving and unique force in wetlands; the presence and duration of water in the soil column and on the surface influences the soil productivity and plant growth.

Temperate wetlands, like the study area, are categorized into three common types; marshes, swamps, and bogs. First, marshes are the most biologically productive ecosystem in temperate regions, especially in Michigan. Marshes are characterized by the broad array of wetlands that are dominated by grass-like vegetation. Typical marsh plants include rushes, reeds, sedges, cattails, and grasses. These areas are periodically covered by standing or slow moving water and are usually associated with ponds, rivers, streams, inland lakes, and the area's Great Lake – Lake Huron. Sandy soils and finer textured, nutrient rich soils with large amounts of organic matter are key to Marsh substrates (Comer 1995, 1996).

Marsh-like wetlands can include interdunal swales (wet areas between beach ridges) and wet meadows (saturated soils, grass-like vegetation, also referred to as wet prairies). The lush vegetation and rich invertebrates and insect life provide excellent habitat for water birds, furbearing animals, and are important spawning grounds for many fish species. Second, on the other hand, swamps are wooded wetlands (e.g., conifer, hardwood, and shrub). These areas are also inundated or saturated periodically during the growing season. Many swamps are also associated with lakes, rivers, or streams or with the presence of ground water near the surface. The soils are typically nutrient high, with organic matter deposited by flood events and the interannual accumulation of organic matter. Dense vegetation and proximity to the surface allows for a high nutrient exchange between land and water ecosystems. Third, Fens (connected to ground water) and bogs (water from rains) are wetlands that are covered with thick peat deposits.

These places serve as habitat for deer, bear, raccoons, and small animals; they are a resource attraction for wild animals. Fish and bird species are dependent on wetlands for food

and nurseries, and wetlands are a preferred habitat for furbearing animals such as muskrat, beaver, otter, mink, and raccoon. Cedar swamps are critical for winter browsing for white tailed deer and for thermal cover. For plant growth, wetlands are areas that are unique to the secondary succession of plants.

Ancient peoples were attracted to wetland environments due to the wealth of resources, plants and animals, and the ease of travel and transport. People rarely settled in wetlands, but chose to map onto these resources along the edges of wetlands, harvesting the resources therein. Wetlands have high values of resource diversity, productivity, and reliability (Nicholas 1991; Williams 1991). Larger wetlands, like SBD, may support a wider range of biotic communities and may have been important hunting and collecting areas that were used intensively. SBD may not have had any modern analogues at specific times, such as when this area was likely a wetland mosaic of terrestrial and wetland components that formed within former glacial lake basins. A wide variety of habitats and features can be associated with these settings, including shallow lakes and ponds, emergent riverine systems, adjacent uplands, and mixed deciduous-coniferous forests, each with a unique biotic community. These landscapes were higher in diversity and productivity than those in surrounding upland and coastal zones. These patterns may have served this area as a core area for settlement, where uplands and coastal areas are secondary or seasonal procurement areas associated with smaller cluster sites. Resource abundance in the context of regional scarcity may have encouraged some degree of sedentism (Kelly 1995a). Clustering associated with the change in productivity of wetlands and other landscape components may be present.

In the long term, wetlands can be used in different ways. The different land-use pattern can be an indicator of a differential resource-use structure. Possibly, there could be a shift in the importance of wetland adaptation from a core area to a peripheral one for seasonal or resource-specific harvesting episodes. The presence of cultural features and material culture may reflect these patterns. The relative ratio of resources to other resources can be an indicator of this change. The decrease in size of the wetlands played a role in subsistence and technologies used in the exploitation of resources. Land-use changes are also likely. Environmental fluctuations can result in changes in land use where the appearance of longer-term housing structures, associated with wetland areas like marshes, could be indicative of increasing and decreasing focus on wetland resources. First, a continual use of an area or wetland resource is indicative of long-term stability, reliability, and importance. This intensive and extensive and long-term focus could also be a trigger for the exploitation of the efficiency of lowland forests and plant harvesting (Smith 1995; Struever and Vickery 1973; Usner 1983). Contemporary indigenous groups continue to depend heavily on wetland resources. Many still collect plants such as cattail, tule, wapato, water parsnips, Canada mint, sphagnum moss, bog cranberry, creeping snowberry, and other plants (Fowler 1990).

Wetland environments played an important role in human adaptation in SBD. An increase in underground and overland water flow occurs during every spring thaw. Broad low slope riverine environments likely result in flooded environments, especially in areas with wide stream meanders. Extensive wetlands were almost continuous in the drainage basin during the early nineteenth century (Houghton 1837; Macomb, et al. 1856). Swamps, marshes, bogs, estuaries, and seasonally inundated lands are components of the regional SBD landscape. The

importance of these settings is demonstrated by the incorporation of wetland flora and fauna into economic and subsistence practices. Further, these areas may have also fulfilled economic buffer zone requirements of defensive refugia and spiritual/sacred places. Clustered wetlands have been shown to be the foci of frequent seasonal resource exploitation in the past. They may have been used restrictively as temporary food shortage resource zones due to drought elsewhere. Last, the geoarchaeological studies of the core of Saginaw Valley suggest likely impacts to a majority of the sites located along riverine environments, due to erosion through fluvial geomorphologic processes (Arbogast, et al. 2008; Lovis, et al. 1996).

Extensive wetland environments have a higher biomass and can support higher population densities. The intensive use of wetlands may have allowed for a decrease in minimum territory size for groups. Territoriality and increased sedentism may also be established in this intensive use of wetlands through the association of cemeteries linked to wetlands. Recurring use of these cemeteries may identify them as special places on the cultural landscape, which were maintained or revisited as part of recognized territories or cultural landscapes (Doran and Dickel 1988; Jefferies 1987). Schultz/Green Point sites highlight this practice (Fitting and Allison 1972; Kingsley, et al. 1999; Lovis, et al. 2001). Conversely, wetlands can be a limiting factor in HG land use. Specific types of wetlands, such as muskeg and hardwoods, may restrict the exploitation of resources and may limit travel as well as unknown or dangerous places. These areas can also be places that are unappealing for settlement due to excessive moisture and possibly nuisance bugs that may be present.

In summary, the features of the landscape and human responses are transformed due to increasing and decreasing wetland environments, and to resource distributions in the area.

High water stages in these areas likely caused a number of short-term problems but also allowed for new opportunities with the expansion of the diversity of productive wetland resource communities while sustaining existing resource structures further afield (Lovis 1986; Lovis, et al. 2001). Primarily, the broad landscape variability can be viewed as an asset for HG subsistence. Throughout the study periods, the Saginaw basin is annually renewed by variable moisture inputs associated with both lake levels and fluvial drainage networks. Geomorphologic processes such as centripetal drainage into the core basin sustained and renewed cyclic wetland environs to encourage the development of microenvironments, which supported productive resource communities.

Modeling Risk and Uncertainty

Incorporating the diversity of information presented in this chapter is almost impossible and ineffective for a modeling effort, especially since models are intended to be the simplification of reality. Ethnographic and ethnohistoric information shows that hunter-gatherers are selective regarding the places and foods they choose to exploit. Therefore, only relevant habitats and foods are used for the modeling effort. Further, these built models are dependent upon the risk and uncertainty of these habitats and resources.

Habitats are dependent upon the overall environment of a given season and time period. Late Archaic and Middle Woodland habitats are heavily influenced by changing lake levels and fluvial dynamics. Conversely, Early Woodland habitats are similar to late prehistoric landscapes. Habitats (also called resource communities) are assemblages of interacting plants, animals, and other organisms that repeatedly recur under similar environmental conditions and are predominantly structured by natural processes (Kost, et al. 2007). The productivity of a

given habitat type is determined by its ecological makeup and varies according to biophysical characteristics.

Resources within a habitat are classified according to social and economic importance, based on kilocalorie yield and life history. A resource's life history explains the availability and productivity in a given habitat in a given month. These resources are based on published sources (Baker 1983; Barnes and W.H. Wagner 1981; Keene 1981b; Yarnell 1964). They are classified in broad categories, including plants (nuts, fruits, seeds, greens, roots/tubers/corms, saps); and animals (small and large mammals, fish, bird, reptiles, shellfish). Availability is determined by their presence in a given habitat and based on cultural preference for exploiting a given resource. For example, bears are usually hunted and taken in late fall and winter months when they are fat and hibernating, which makes them less dangerous to hunt (Carver 1956; Henry 1969). Birds are available year round, whereas migrating waterfowl are present in high density during key months. All resources are available to each member of the group given that each member type has higher or lower probabilities of capture of each resource (see Chapter 6). For the purposes of this study and to maintain reasonable simplicity, resources are categorized into separate classes: large and small mammals; large and small fishes; migratory birds, etc.

Productivity of the resource is based on a simple estimate of mean density versus mean weight (yield). These values are based on established scholarship within Michigan and the Great Lakes (Baker 1983; Keene 1981b; Lovis 1989). Average densities per 3 km² (1 mi²) are multiplied by average weights to calculate productivity in each habitat during a study period. For animals, productivity also varies based upon the community level behaviors, including

aggregation and dispersion. For example, anadromous fish can be highly aggregated during spawning. These factors are taken into consideration with varying seasonal values for each.

Plant densities and yields are based on a given habitat and season (Cowan 1985; Hewitt 1983; Keene 1981b; Reidhead 1979). These mean densities are based on GLOS information and comparative information from Wisconsin (Curtis 1959). Mean yields are based on the values determined by taking into consideration the capability of a plant to bear fruit, and the net edible biomass that is available. The productivity of each plant is calculated for a given area or the basic spatial unit of analysis (3km²).

Both plants and animals are exploited by all members of the group. These resources have inherent risk and uncertainty dependent upon the biophysical environment. Resource uncertainty is the lack of knowledge about the presence or absence of a resource. Risk is the chance that you may fail to procure a known resource. Plants have low uncertainty and risk because they are fixed in place and can be exploited easily. They are more apt to be gathered by women and children. Further, small and less dangerous animals (i.e., rabbits, squirrels) have greater uncertainty and greater risk due to their mobility. Highly mobile and distributed resources having greatest uncertainty and risk (least probability of success) are apt to be exploited by men. The relative success of resource exploitation is determined by a composite factor intended to quantify resource risk and uncertainty. For example, a male aims to exploit resources that are higher in risk and uncertainty, whereas women and children exploit more reliable resources. Therefore, men and women exploit resources based on their risk and uncertainty preferences by creating a differential rank order of resources. Based on this rank order, a HG exploits resources that are present in a habitat. Finally, this composite value is

multiplied by the relative contribution to diet by men, women, and children. Women and children provide kilograms of food per .004 km² (1 acre); resources exploited by men are calculated as contributing .10 km² (25 acres) area; collective resources areas provide .08 km² (20 acres). Maple sap varies as collected from a .008 km² (2 acres) area.

The last several and the current chapters present the background required for the development of both landscape and behavioral models. The combination of uncertainty and risk-based theories provide the framework for understanding the roles of landscape and behavior on diet and land use, with the identification of relevant variables. The chapters that follow provide the analytic and interpretive component of this research effort. The next chapter creates the resource landscape model present during the study periods. The subsequent chapters explain HG land use and diet behavior. The last analytic chapter describes archaeological implications and an evaluation of models and the material culture that is present.

Chapter 5: Predictive Resource Landscape

Introduction and Approach

This chapter recreates a prehistoric resource landscape. The landscape can be used as the environmental and spatial context, where hunter-gatherer (HG) land use and resource choices can be explored (see chapters 6 and 7). Further, this landscape can be used to predict resource intensive and depleted zones at a given cultural period. Prior studies have addressed landscape – habitat – resource relationships by a focus on terrestrial features including geomorphologic and biogeographic factors (Arnold 1977; Jochim 1976b; Krist 2001). This work leverages these studies and refines them by placing priority on underexplored hydrological drivers. The predictive resource landscape model is based upon the aggregation, synthesis and manipulation of historical and contemporary ecological datasets. The model is developed by the creation of terrestrial and palustrine (wetland) land cover and resource communities (see Figure 7. Landscape data model). These resource communities are habitats and patches with differential biogeography present. As is well known, habitats comprised of animals and plants contribute to hunter-gatherer (HG) diet and land use choices, often framing the social relations of these prehistoric groups. Two key types of landscape are constructed: palustrine and terrestrial. A priority is placed on palustrine landscapes due to the extensive influence of hydrology on past terrestrial environments of the Saginaw Bay Drainage (SBD) (See Chapter 4 for background). Distinct models based on Late Archaic (LA), Early Woodland (EW) and Middle Woodland (MW) study period land covers are created.

The analytic landscapes are presented as composite models. A composite view is the integration of multiple events as part of a map, comparable to a snapshot in time. Composite information presents events in multiple states at adjacent points in time creating a time trend or series of maps allowing for better understanding through visualization and documenting the chronology of changes to land cover in the study region by considering different states as bounded by temporal events. The composite maps are generated by using Geographic Information Science (GIS)-based visualization methods. GIS software, ESRI ArcMap v.10, allows for both the visualization of and interaction with large amounts of information, permitting the alteration of the displays. This approach creates multiple perspectives (i.e., spatial and temporal) and enhances the understanding of varied phenomenon.

The geographic datasets used in this effort were acquired from the State of Michigan Digital Libraries, maintained by the Center for Geographic Information (Department of Information Technology). The Michigan geographic framework uses a single zone system named the Michigan GeoRef projection system, using the Oblique Mercator based North American Datum 83 (NAD83) (CGI 2009; MDNR 2001). The visualization of the study area includes multiple dimensions and spatial variables such as geology, groundwater, hydrography (drainages, wetlands, shorelines, and fluvial systems [rivers and streams]), historical and contemporary land cover/use, soils, topography (digital elevations, land forms). These digital vector and raster datasets are clipped from original statewide regions to study area Counties and further modified by relevant geomorphic variables using established geoprocessing techniques (e.g., buffer, overlay, map algebra etc.).

Terrestrial and Palustrine Landscapes

Palustrine and terrestrial environments are created through the synthesis of historical and contemporary proxies (see Figure 8. Wetland data manipulation). The palustrine environment can be further subdivided and categorized into coastal and interior areas. Both environments are determined by numerous variables: moisture (precipitation, snow melt), subsurface hydrography (water table and wetland recharge), Lake Huron levels and fluvial dynamics (river confluences, stream meanders boundaries), climate (temperature), and topographical landforms (terrain, local base levels, moraines, ridges). Precipitation and snow melt contribute variable amounts of moisture over the different study periods of interest by distribution through river and stream networks to Saginaw Bay, or absorbed into the soil substrate. The input volume varies according to the season, resulting from spring thaw and snow melt. Such seasonal hydrodynamics create shorter- and longer-lived wetlands and wetland-influenced terrestrial environments. Additionally, these processes can create alternating wet and dry areas whereby different types of perennial, annual, or seasonal wetlands are created. Stability in wetland environment, coupled with complimentary soils can create unique and highly productive resource environments. It is these stable wetland landscapes that support a high density and diversity of resources (see Chapter 4 for discussion of wetland types and resources).

First, the extent, configuration and composition of coastal wetlands are driven by Lake Huron water levels, the coastal hydrography, and soil composition. Specifically, coastal wet areas are determined by the interplay between low coastal gradients elevation, water table proximity to the surface, and poorly drained soils. Areas with poor soil permeability, drainage,

and recharge play a role in water remaining above ground (i.e., surface storage). The greater the permeability, the quicker the ground surface becomes dry—all other things being equal. Second, the interior wetlands are conditioned by similar factors, with significant addition of topography. The interior wetlands are influential in areas that are likely to trap excess moisture, such as local base levels, which are flat areas (zero slope) and topographical buffers (i.e., moraines, ridges) that retain water longer. These moisture-influenced terrestrial environments are places where one can observe rapid primary succession of wetland tolerant plant species and secondary succession of non-wetland tolerant plant species. Coastal and inland wetlands each create unique environments. The climate of the study area in turn results in short-term or long-term reactivated wetlands, where there are unique locales for productive habitats through the seasonal succession of plants and the associated habitats for a variety of animals.

The terrestrial environment is analytically created by the synthesis of topographical landforms and the lack of wetlands. Such areas are compositionally driven primarily by the absence of water, this due to the lack of retention of moisture inputs, drainage, and are linked to higher groundwater recharge (higher absorption and saturation). The drainage and recharge factors also help in determining the type of plant cover present in a given area. This combination of terrestrial and palustrine land cover, which can then be associated with pertinent palynological data, results in the probable resource communities. This project simplifies the diversity of resource communities by limiting them to established communities (Kost, et al. 2007). From the seventy-six different communities, this research reduces the diversity by focusing on a subset of fifteen key resource communities (see Appendix A for resource community's description). Among these, fifteen are wetlands (emergent marshes,

hardwood and conifer swamps), lakes, rivers, forested upland (e.g., beech sugar-maple forests, mixed oak forests, coastal wet prairies). Land cover classes are also aggregated in a number of ways to highlight wetlands and vegetative structures: (1) forests (coniferous, deciduous, mixed); (2) non-forest (range, barren); and (3) wetland (emergent and hardwood), and so forth.

The variables in aggregate define terrestrial and palustrine environments are aggregated in ways that reflect the probable environments present at a given time period (see Table 2Table 2. Variable manipulations).

Table 2. Variable manipulations			
Variable	Late Archaic	Early Woodland	Middle Woodland
Rivers and streams	Current + 300 meter buffer, lower slope/energy system	None higher slope/energy system	Current + 100 meter buffer lower slope/energy system
Terrestrial cover	Low	High	Medium
Lake levels	184 - 181 amsl	177 amsl	181 amsl
Water table	Contemporary	Contemporary	Contemporary
Local base levels wetlands	High	Low	Low
Pollen	See pollen diagram	See pollen diagram	See pollen diagram
Soils – Flooding	High – Annual	Low – Seasonal	High - Annual
Soils – Ponding	High	Low	High
Ground water recharge	Contemporary	Contemporary	Contemporary

Geoprocessing

Prehistoric landscapes are reconstructed by the manipulation of geographical representations of contemporary and prehistoric biophysical proxy data. The disparate types of data and the relevant contribution of biophysical variables to both the palustrine and terrestrial landscape models are organized into two categories of complexity: base models, augmented models (Table 3). Base models entail a simple modification of existing spatial data. Augmented

models are built upon multiple base models. Base models include the creation of: local base levels, historic wetlands, lake levels, water close to the surface, groundwater recharge, soils, fluvial geomorphology, and flooding. These manipulations involve simple selection and buffering procedures to create polygons for relevant time periods intended to be used in the augmented models. The combination of these base and augmented polygons creates unique resource landscapes for the three study periods (See Appendix A).

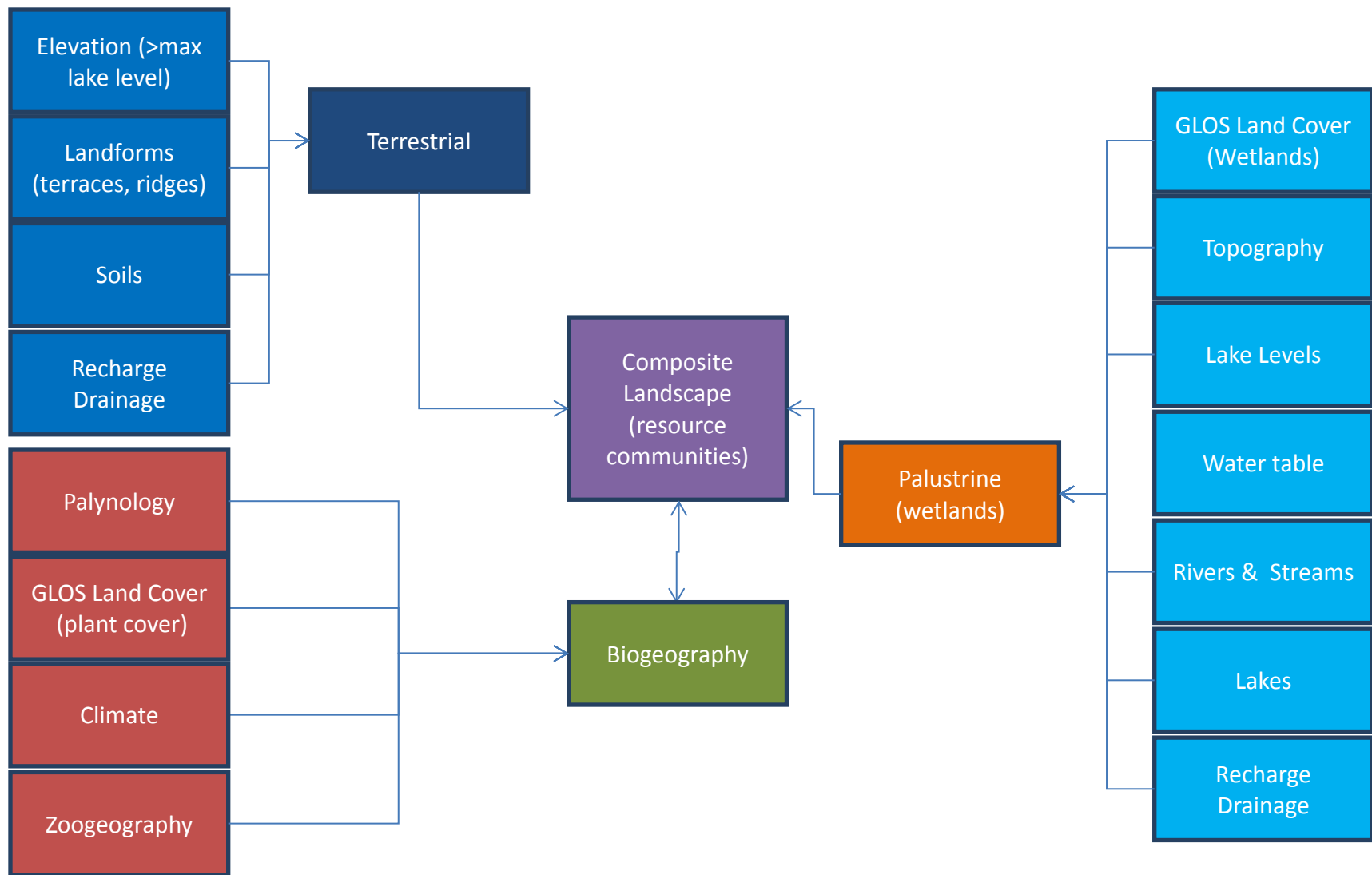


Figure 7. Landscape data model

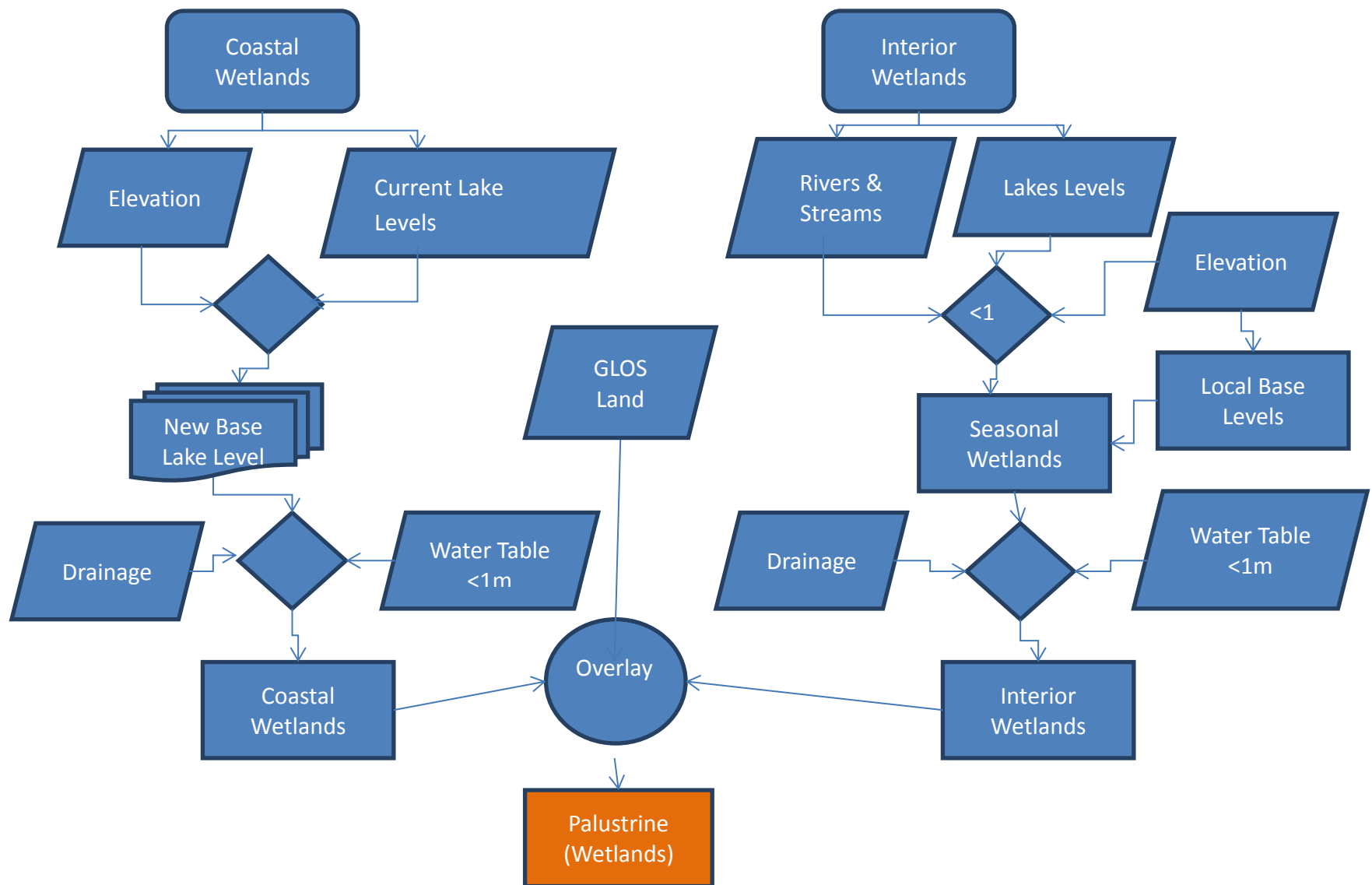


Figure 8. Wetland data manipulation

Table 3. Data manipulation – reclassify attributes					
New Dataset	Base or Augmented	Original Dataset	Vector Raster	Output	Attributes/Action
Local Base Levels	Base	Digital Elevation Model	Raster	Vector (Polygon)	Slope = 0 and area about 3,500 acres, reclassify attributes
Historic Wetlands	Base	GLOS 1800s	Vector (polygons)	Vector (Polygon)	Select by wetland land cover, rivers, and lakes. Buffer by 300 meters, reclassify attributes
Lake Levels	Base	Digital Elevation Model	Raster	Vector (Polygon)	Map Algebra select for historical elevations, and buffer 300 meters, reclassify attributes
Water close to surface	Base	Water table, Digital Elevation Model	Raster	Vector (Polygon)	Raster subtraction of Water Table from Digital Elevation Model. Select where they are separation within one meter. Seasonally inundated wetlands are riparian areas using vertical proximity (<1m) to a water table surface. Convert raster to vector. Shrink polygons to reflect, reclassify attributes
Groundwater Recharge	Base	Groundwater Recharge	Vector (polygons)	Vector (Polygon)	Select for low recharge. High recharge areas are used as the basis for climatic expansion of forest regimes based on transitional boundaries, reclassify attributes
Plant cover	Base	GLOS 1800s	Vector (polygons)	Vector (Polygon)	Select for all land cover excluding rivers, streams, and wetlands, reclassify attributes
Soils	Base	SSURGO	Vector (polygons)	Vector (Polygon)	Select hydric soils, flooded, and ponded classes during the winter to early spring, reclassify attributes
Rivers and Stream wetlands	Augmented	Hydrography , Digital elevation models	Vector and Raster	Vector (Polygon)	Buffer 300 meters along similar contour elevation for possible upstream wetland environments, reclassify attributes

Table 3. (cont'd)					
New Dataset	Base or Augmented	Original Dataset	Vector Raster	Output	Attributes/Action
Coastal Wetlands	Augmented	Multiple	Vector (polygon)	Vector (Polygon)	Overlay of coastal river and stream buffer, elevation, water close to surface, poorly drained soils, and historical wetlands, reclassify attributes
Inland Wetlands	Augmented	Multiple	Vector (polygon)	Vector (Polygon)	Overlay of river and stream wetlands, local base level, water close to surface, poorly drained soils, and historical wetlands, reclassify attributes
Terrestrial Landscape	Augmented	Multiple	Vector (polygon)	Vector (Polygon)	Overlay of Land form features, elevation, base plant cover, and climatic modifications based on climatic regimes, reclassify attributes

The Early Woodland resource landscape is assumed to be similar to GLOS 1800s land cover with modern lake levels and drier and colder climates. The earlier LA is a drastically different period, with warmer climates, extensive wetlands, and higher lake levels. MW is an intermediate period with expansive wetlands and moderate climate (See Chapter 3). The augmented models are created by the manipulation and combination of base models by a series of data manipulation operations (e.g., overlay, buffer). In general, the data manipulation is as follows:

The first step is the modification of The GLOS 1800s land cover, the land cover is used as a baseline landscape model for the creation of both the LA and MW high-water period landscapes. Both of these periods have variable moisture inputs, therefore resulting in variable wetland densities and distributions. The Michigan Natural Features Inventory (MNFI) digitized General Land Office Survey (GLOS) and 1990 United States Geological Survey (USGS) 100K DLG land cover data provides the basis of land cover and resource communities. The plant cover and wetland distributions in the GLOS set the framework for the environmental reconstructions (Comer, et al. 1995). The GLOS, which remains the most detailed pre-settlement vegetation data set for the study region, was originally conducted as part of the mapping of the area included within the Northwest Ordinance between 1821 and 1834. Surveyors took detailed notes on the location, species, and diameter of each tree used to mark section lines and section corners. They commented on the locations of rivers, lakes, wetlands, the agricultural potential of soils, and the general quality of timber along each section line as they were measured.

The second step involves the the inclusion of rivers and streams. The modified land cover is altered to include a buffer to account for stream meanders and overbank flow, while

retaining original river boundaries. These areas are classified as seasonal wetlands, and are prone to ponding and flooding with seasonal grasses and shrubs.

The third step includes the inclusion of lake levels. The modified land cover is overlaid with the lake levels for each of the several bounded study periods. Lake levels provide the minimum extent of inundated landscapes, both along the coastal and interior low-lying areas comprising the composite model. These high water levels also affect the fluvial dynamics of the larger regional system, with decreased slope, reducing the energy of the water flow, and resulting in pooled and flooded upstream locales. Lake levels for each period are determined by using a digital elevation model with a horizontal resolution of 1m and vertical resolution of 20 cm.

The fourth step involves local base levels. The land cover is further modified by local base levels. Local base levels are areas that are larger than 1200 hectares with flat or level areas (zero slope) and which are linked to large river and stream networks. These base levels trap moisture for short periods until they are drained, either to lower elevation or to be percolated into the soil. Such areas are places with high probabilities for seasonally activated wetlands (emergent marshes and shrub swamps). Whether they become marshes or annual wetlands is determined by the rate of moisture input and drainage, based on the relevant time period. Once drained, these areas are transformed into terrestrial habitats through succession where plant communities are present, rates and states being dependent upon soil composition and groundwater recharge potential.

The fifth step involves the inclusion of the water table. The land cover is modified through water table effects. A water table close to the surface is an area with higher moisture,

especially when external inputs (precipitation) result in ponded and flooded areas. These areas that are likely to have seasonal wetlands are likely to be persistent places that serve as resource draws. Therefore, land cover is overlaid with high water table areas as potential locales for seasonal inundation. Dry land areas are those with neither water input, nor proximity to a water table ($>1\text{m}$). These areas possibly are not always dry, but could be fed by runoff and have well-drained soils. This classification threshold results in groups with fairly distinct average soil and water conditions (Baker, et al. 2001). The water table digital elevation is subtracted from topographical elevation model to arrive at the water table influenced areas.

Note: steps 1 through 5 establish probable areas for the pooling of water. Within these areas, water tables close to surface, local base levels, and low-drainage soil classes determine areas of standing water.

The sixth step involves the inclusion of soils data. The land cover is modified by possible areas of flooding, pooling of water, and poor drainage using the Natural Resources Conservation Service (NRCS)-National Cartography and Geospatial Center (NCGC) archived and distributed the State Soil Geographic (STATSGO) and Soil Survey Geographic (SSURGO) databases.

The seventh steps include the groundwater recharge rates. The land cover is overlaid with areas of low to high groundwater recharge. Plant species and communities are dependent upon how quickly moisture percolates down into the soil and root systems. Groundwater recharge or deep drainage, or deep percolation, is a hydrologic process where water moves downward from surface water to groundwater. Groundwater is recharged naturally by rain and snow melt and, to a smaller extent, by surface water (rivers and lakes). Recharge estimation is

determined by principles of soil physics. The extent of ground water recharge by a wetland is dependent upon soil, vegetation, site, perimeter to volume ratio, and water table gradient (Carter and Novitzki 1988; Weller 1981)}. Groundwater recharge occurs through mineral soils found primarily around the edges of wetlands (Verry and Timmons 1982). Therefore, recharge levels can be an excellent basis of predicting resource communities (See Appendices 5 - drainage model).

Low levels of recharge and drainage result in moist environments that are slow to dry, especially after spring melt. These areas are likely places for mixed hardwood and conifer swamps. Coastal areas with similar attributes are wet prairies and shrub swamps. Higher elevation, low recharge areas are usually mixed conifer swamps. These areas are mixed environments due to gravity-based drainage over land. Medium to high recharge places are areas with beech-sugar maple-hemlock forests reflecting the Carolinian and Canadian biotic communities. The Carolinian biotic province is more likely to have beech-sugar maple forests whereas the Canadian biotic province is more likely to have hemlock-white pine forests, white and red pine-mixed hardwood forests, and a combination of beech-sugar maple-hemlock forests. The level of recharge provides information about where past wetlands could have been present given a sufficient input of moisture from streams and rivers and precipitation.

In the eighth step, the land cover is modified by reclassifying baseline resource communities with data derived from palynological studies. The pollen that is present from existing cores data tables to the periods of interests is used to modify baseline biotic communities that were present at the given time period by expanding or contracting resource communities. Palynological records indicate the presence or absence of species and, to some

extent, plant abundance; they can be misleading and they do not describe the spatial distribution of vegetation surrounding an area. Overall, a large variation in pollen communities can be indicative of systematic changes in climate.

Results

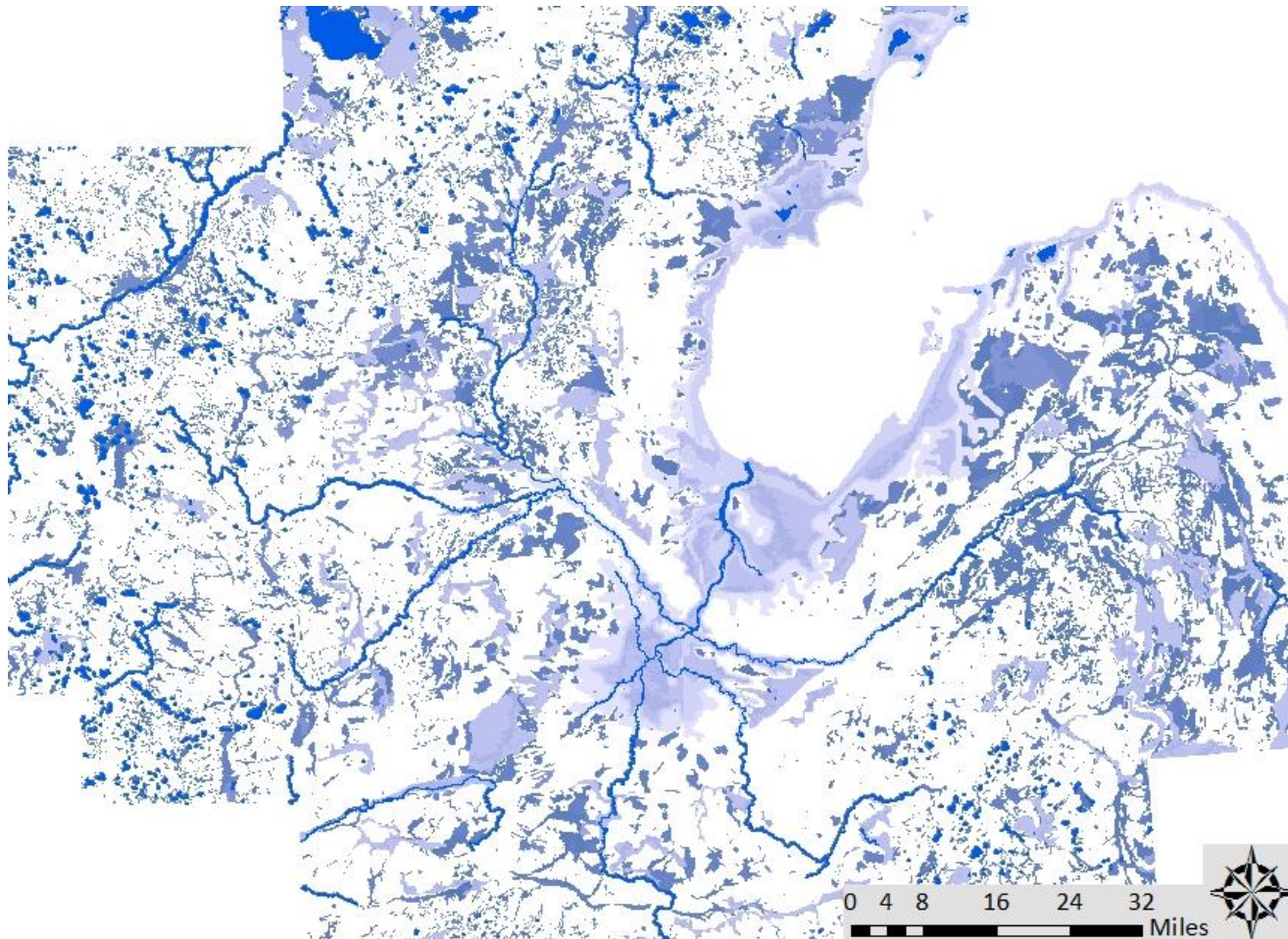


Figure 9. LA Composite wetlands by time period (in blue color)

LA wetlands are extensive along all major river systems in both interior uplands and lowland areas, and adjacent to Saginaw Bay. EW wetlands (large scale) are limited constrained to the core embayment. MW wetlands are extensive, but limited to the Saginaw Valley and core embayment. Note: see appendix A for EW and MW wetlands

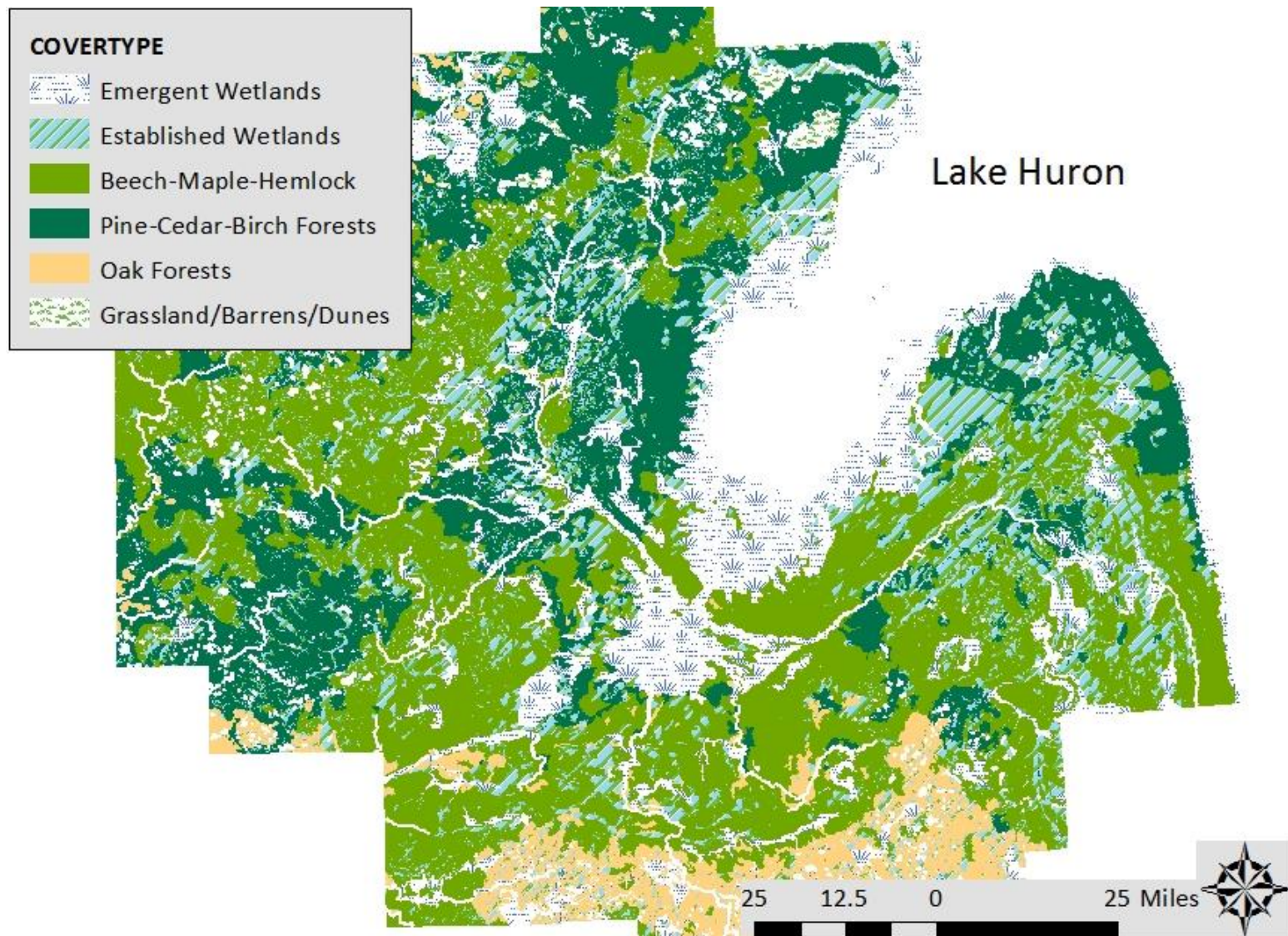


Figure 10. LA land cover and legend

Wetlands are present throughout the region during the Late Archaic.

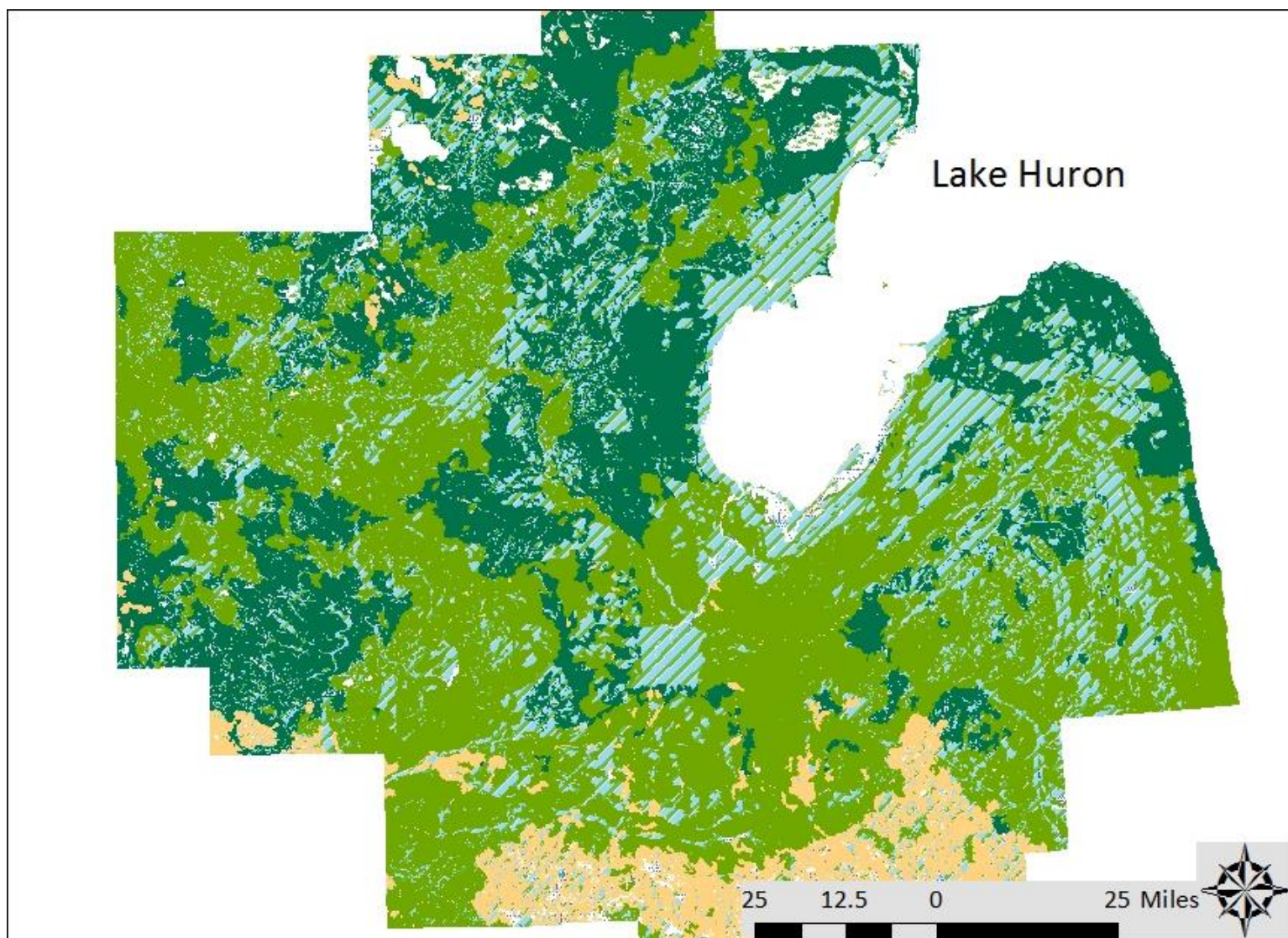


Figure 11. EW land cover and legend

Established wetlands are present throughout the Saginaw core. Note: see Figure 10 legend.

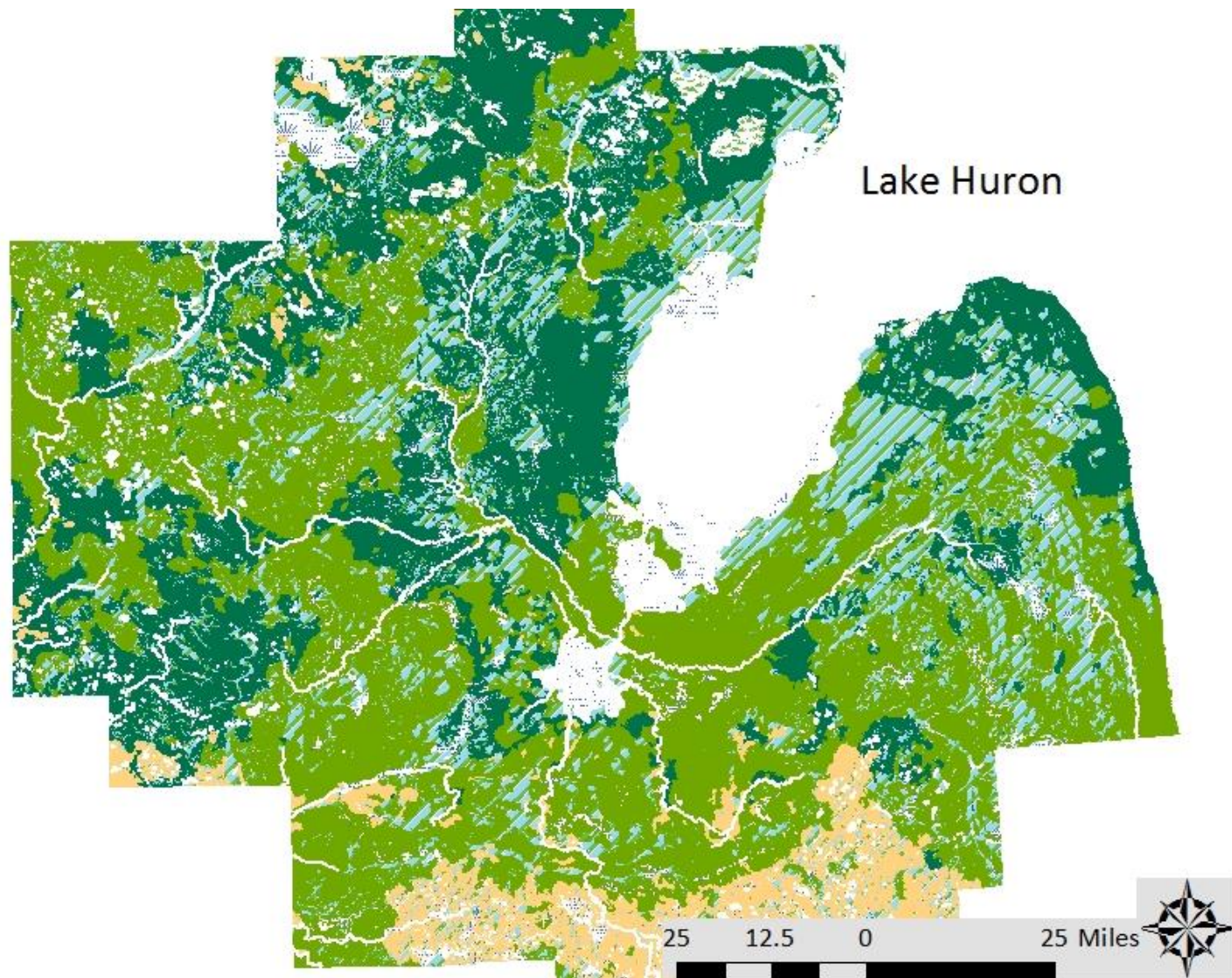


Figure 12. MW land cover and legend

Wetlands are constrained to core base levels. Note: see Figure 10 legend.

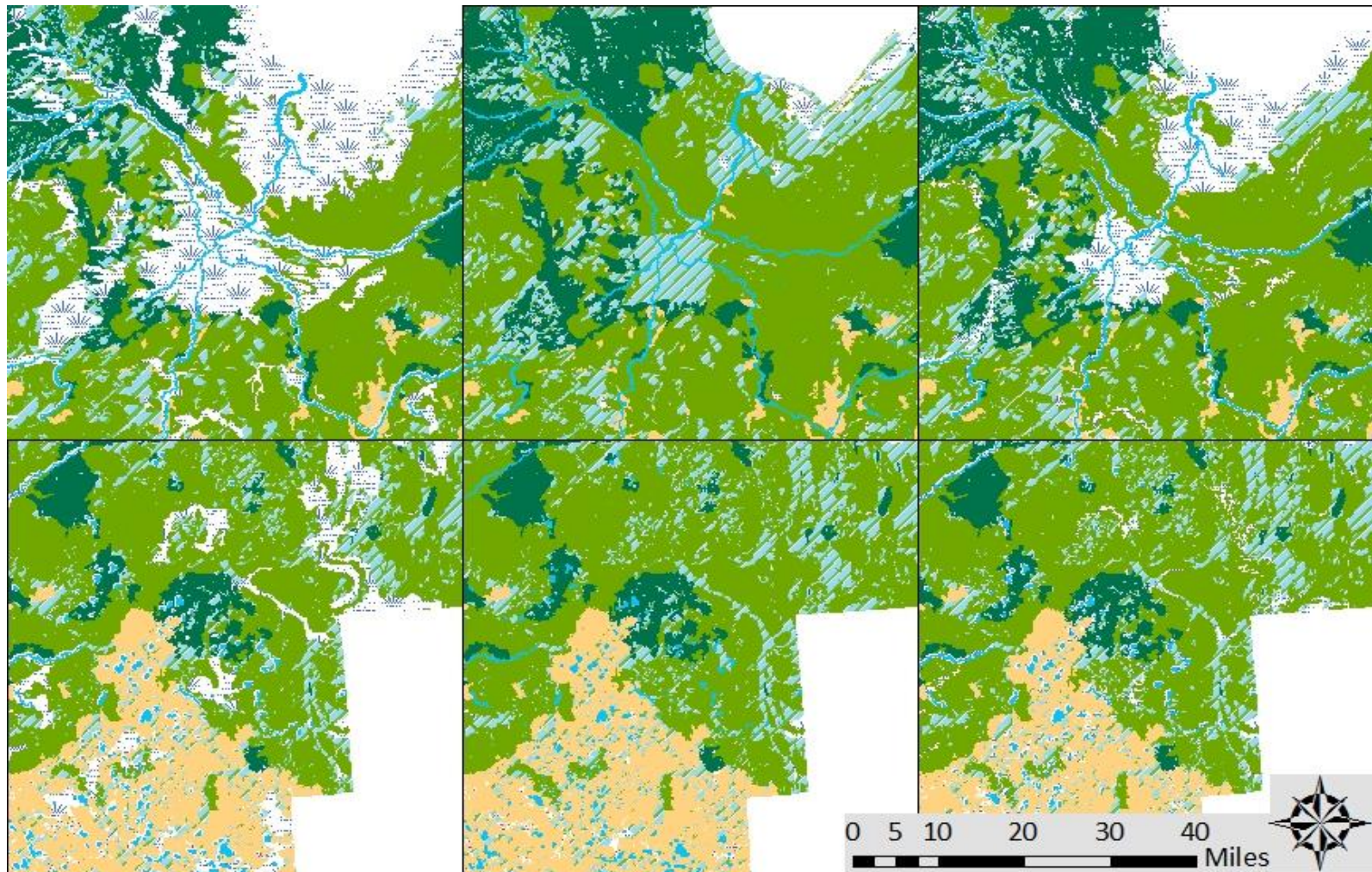


Figure 13. Saginaw (top) and Lapeer counties (bottom) composite landscapes

The distribution of ephemeral wetlands is highest during the LA located at confluence of river systems. The EW period, these wetlands stabilize and form cyclical emergent wetlands and shrub swamps. The MW land cover is a mixture of both transitional wetlands and stable emergent and shrub swamps. Note: see Figure 10 for legend. LA (left), EW (middle), MW (right)

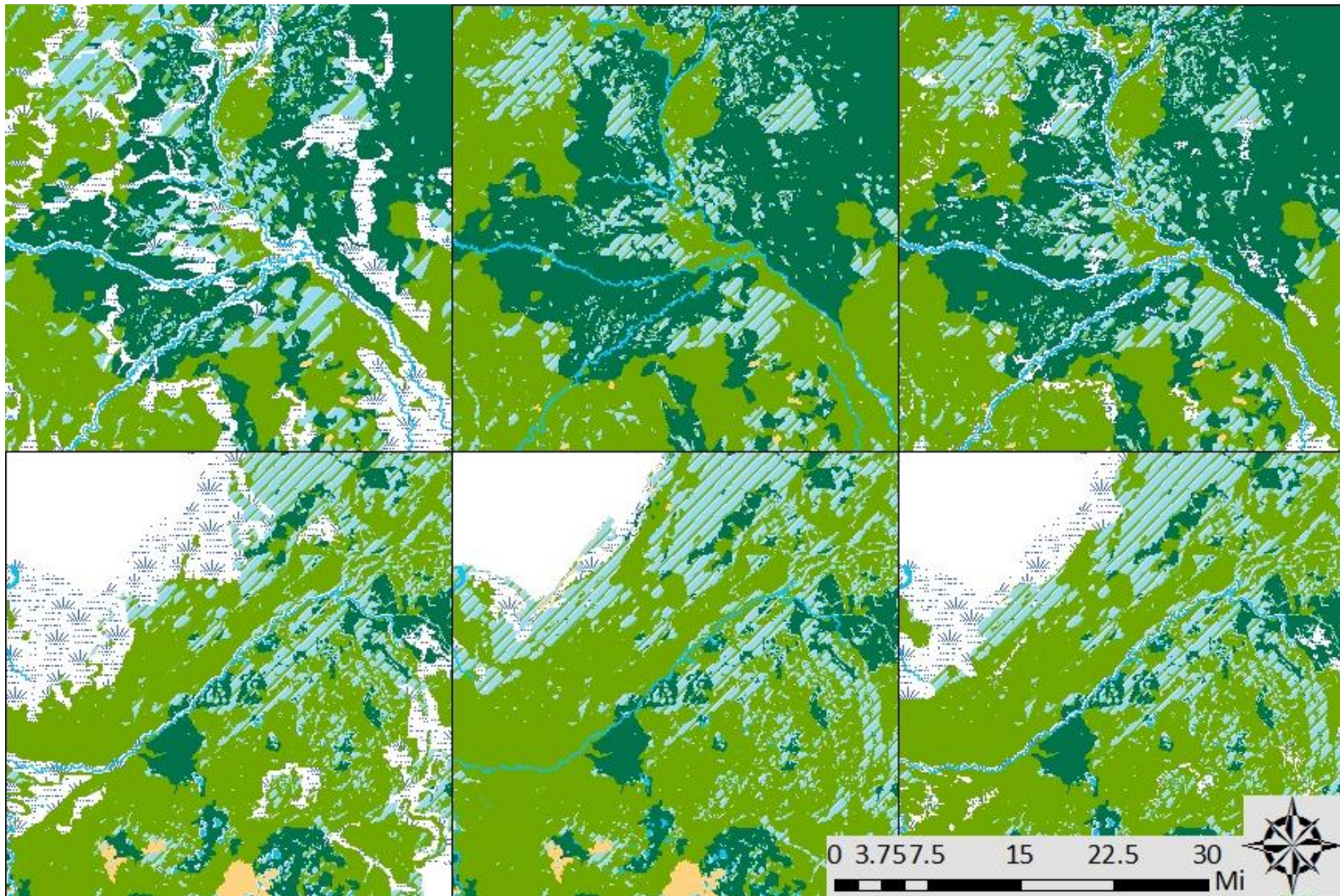


Figure 14. Midland (top) and Tuscola counties (bottom) composite landscapes

Midland County has heterogeneous wetlands that change in size over time. Tuscola coastal areas are wetland dominated with inland Beech-Maple forests. The Cass River flowing through Tuscola is bounded by river influenced by wetlands and bounded forests. Note: see Figure 10 for legend. LA (left), EW (middle), MW (right)

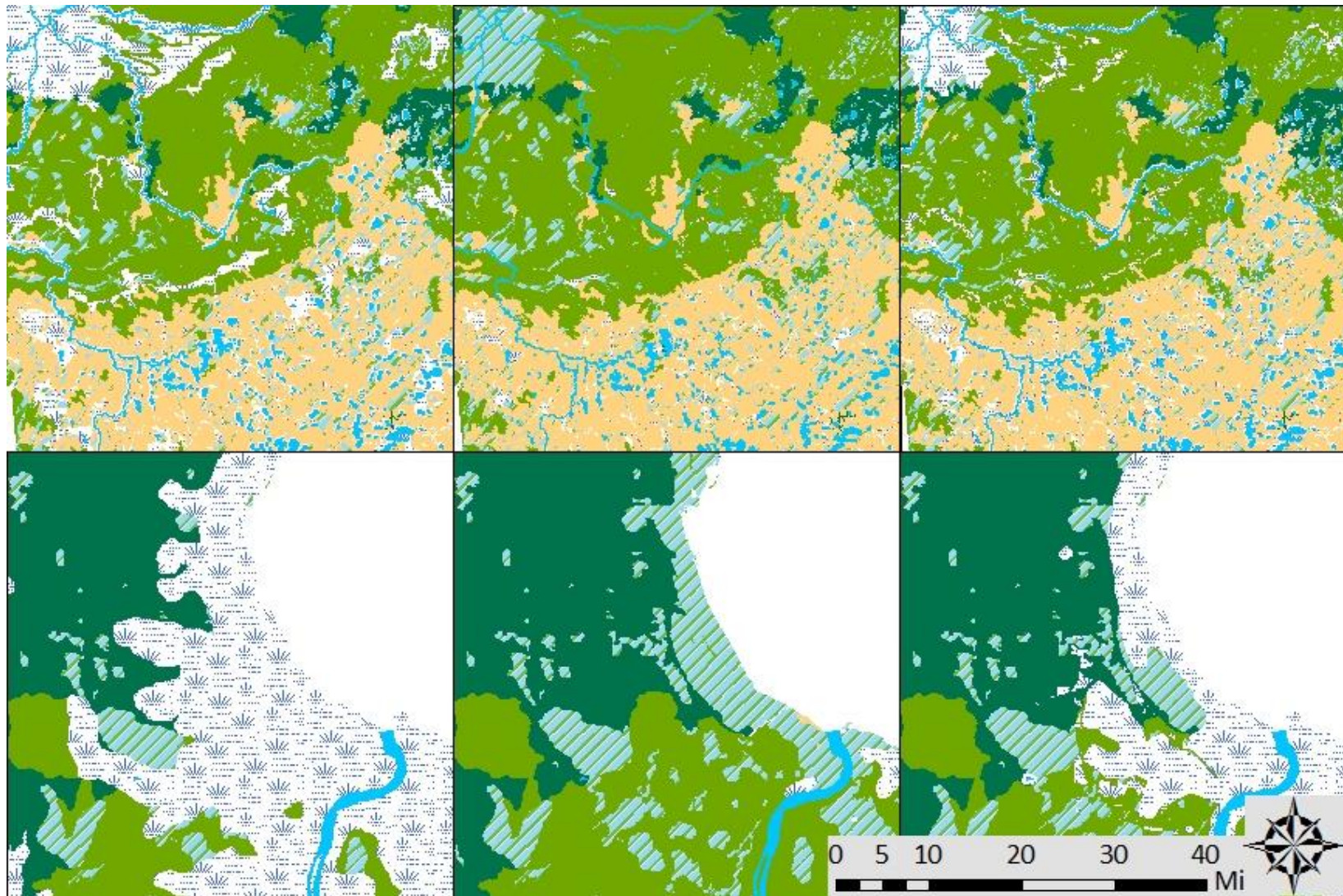


Figure 15. Genesee County (top) and Tobico Marsh area (bottom) composite landscape

Genesee County to southeast is observed to have a number of wetland dominated areas along river courses and along paleo-river meanders. Tobico Marsh area is highly wetland influenced. Note: see Figure 10 for legend. LA (left), EW (middle), MW (right)

Table 4. Results summary			
Characteristics	Late Archaic	Early Woodland	Middle Woodland
Heterogeneity (regional)	High	Low	Medium
Heterogeneity (local)	Low	Medium	High
Palustrine	Very High	Low	High
Terrestrial	Low	High	Medium

Regional level heterogeneity (spatial clustering of resource habitats) amongst the three periods is highest during the LA and MW periods. The local (within multiple square miles) heterogeneity is highest during the MW and EW periods. Wetland land cover is largest during the LA, followed by MW period. The converse is true for terrestrial land cover. Higher spatial heterogeneity means that overall criteria estimated for the entire landscape may not adequately describe the landscape at any given location.

Table 5. Cover type change by cultural period by square mile						
COVERTYPE	Late Archaic	%	Early Woodland	%	Middle Woodland	%
EPHERMERAL WETLANDS	2080.1	14%	0	0%	807.7	5%
SHRUB SWAMP/EMERGENT MARSH	83.6	1%	212.9	1%	105.5	1%
MIXED CONIFER SWAMP	1095.8	7%	1429.8	9%	1257.8	8%
MIXED HARDWOOD SWAMP	657.4	4%	903.7	6%	764.2	5%
RIVER	804.9	5%	203.5	1%	931.6	6%
WET PRAIRIE	105.5	1%	180.6	1%	121.7	1%
BLACK ASH SWAMP	174.9	1%	265.2	2%	227	2%
CEDAR SWAMP	314.9	2%	410.1	3%	349.1	2%
MUSKEG/BOG	8.6	0%	20	0%	15.9	0%
Total Wetlands	<u>5325.6</u>	<u>35%</u>	<u>3625.9</u>	<u>24%</u>	<u>4580.5</u>	<u>30%</u>
BEECH-SUGAR MAPLE FOREST	1843	12%	2028.2	13%	1908	13%
BEECH-SUGAR MAPLE-HEMLOCK	3003.1	20%	3583	24%	3325.1	22%
Total Beech Forests	<u>4846.1</u>	<u>32%</u>	<u>5611.1</u>	<u>37%</u>	<u>5233.1</u>	<u>35%</u>
HEMLOCK-WHITE PINE FOREST	1487.4	10%	1771.3	12%	1642.4	11%

Table 5. (cont'd)						
COVERTYPE	Late Archaic	%	Early Woodland	%	Middle Woodland	%
JACK PINE-RED PINE FOREST	578.8	4%	633.9	4%	594.2	4%
WHITE PINE-MIXED HARDWOOD	718.5	5%	839.5	6%	756.6	5%
WHITE PINE-RED PINE	411.1	3%	492.9	3%	442.2	3%
WHITE PINE-WHITE OAK	109.8	1%	126.9	1%	115.2	1%
MIXED PINE-OAK	28.4	0%	30	0%	28.6	0%
Total Pine Forests	4819	32%	5289.6	35%	3579.1	24%
OAK-HICKORY	614.3	4%	730.9	5%	655.5	4%
MIXED OAK	167.9	1%	201.8	1%	179.1	1%
MIXED OAK SAVANNA	169.3	1%	202.6	1%	177.9	1%
Total Oak Forests	951.4	6%	1135.3	8%	1012.4	7%
SPRUCE-FIR-CEDAR	0.7	0%	1	0%	0.7	0%
ASPEN-BIRCH	89.9	1%	103.1	1%	96.2	1%
Total Alternate Forests	90.6	1%	104.1	1%	96.9	1%
BLACK OAK BARREN	422.7	3%	526	3%	454.6	3%
OAK/PINE BARRENS	43.2	0%	46.5	0%	44.8	0%
PINE BARRENS	117.3	1%	135.3	1%	126.1	1%
EXPOSED BEDROCK	0	0%	0	0%	0	0%
SAND DUNE	0	0%	0.8	0%	0	0%
GRASSLAND	1.4	0%	1.5	0%	1.5	0%
Total Misc	584.7	4%	710.1	5%	627	4%
	15132.4		15081.1		15129.1	

Across the LA, EW, and MW cultural periods, substantial changes in the overall mix of land cover types occurs. During the LA period, an increased number of wetlands are present, both in terms of emergent and transitional wetlands. Beech-Maple forests are the dominant feature on the landscape in all study periods, with considerable decrease in both LA and MW. The drier EW period, LA wetlands are changed into forested swamps and Beech-Maple forests. The MW also exhibits a similar pattern of LA wetlands, but at lower levels focused on the core basin areas.

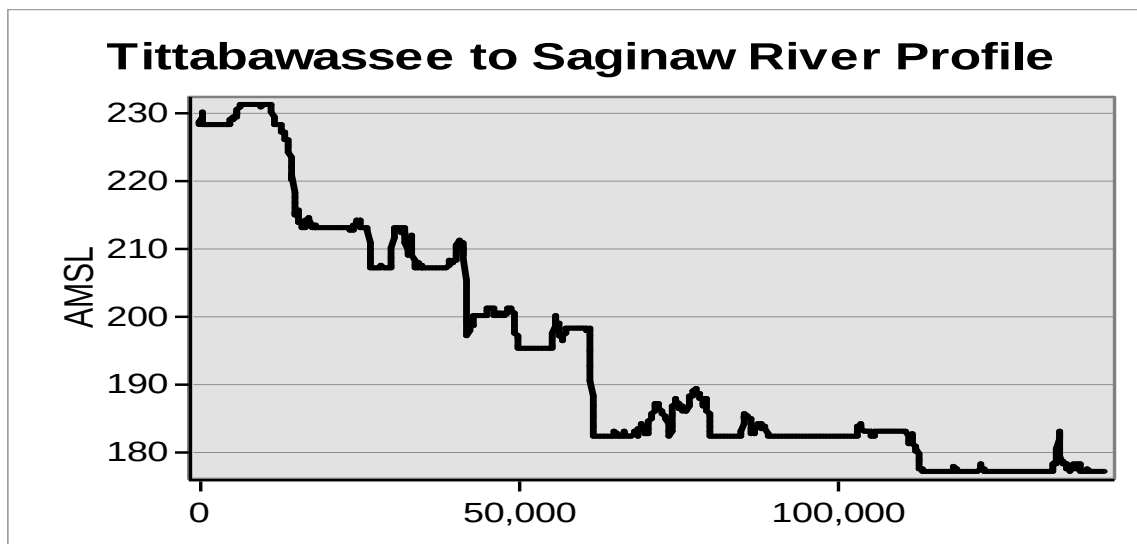


Figure 16. Tittabawassee to Saginaw river course profiles

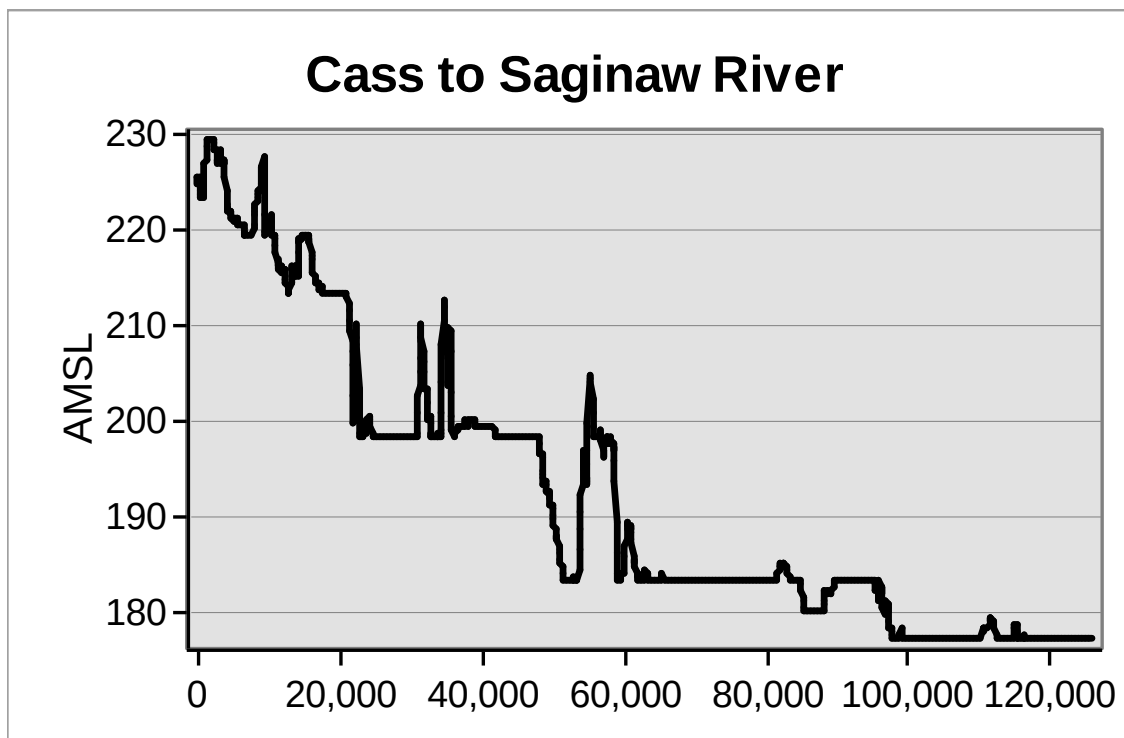


Figure 17. Cass to Saginaw river course profile

The river elevation profile shows probable areas where river courses and base levels influence the landscape. All large river systems with base levels (flat areas) are likely areas where water is retained forming ephemeral wetlands. Note: see appendix A for other river profiles.

Discussion

The reconstructed landscapes employed here have been derived and constructed from contemporary and historical proxies that place primacy on the change in wetlands over time. Other alternative models based strictly on ecological succession or complex hydrology may yield different results; this model provides a regional and local perspective on palustrine spatiotemporal variability and the effects on terrestrial landscapes. The resulting wetland distributions have considerable implications for habitats, resource structure and human choices for diet and land use (see Chapter 4).

Overall, the study presents a refinement to our understanding of changing prehistoric landscapes. A number of interpretations are made; all addressing spatiotemporal wetland distribution and densities. The model posits a predictive hydrological of three cultural periods in the SBD of Michigan. Wetlands, as previously stated are assumed to be a key driver of resource landscapes. These assumptions are well founded and based both on material inventories from sites and geoarchaeological studies. The model presented predicts the probable densities and distributions and possible implications of these wetlands and wetland influenced landscapes. The distribution and densities of wetlands are used for the understanding of spatial and temporal resource variability of the study area. Further, wetlands also provide the basis for analysis and prediction of terrestrial habitat density and distributions and the resources found therein. These models, with their palustrine and terrestrial landscapes changes, and long and short term land cover change have considerable implications for regional distribution and densities of cultural use of these areas.

First, the regional study area has considerable likelihood for varied wetland types over the three study periods. The model presented here suggests that the LA has wetlands that extend further upstream and play a role in the resource structure of the regional area. Two key types of wetlands are identified, transitional or ephemeral wetlands, and stable wetlands that includes emergent marshes, shrub and hardwood swamps. Both wetland types are driven by increased moisture input driven both from increases in lake levels and fluvial input changes through climatic activity. The resulting coastal wetlands are larger and more homogeneous during the LA and MW periods. The large size of these wetlands likely made them unappealing and inaccessible for daily resource exploitation due to lack of direct access and increased resource variability (i.e., unpredictable) . The transitional wetlands, on the other hand, are likely areas of high productivity with secondary succession taking place over time, repeatedly, dependent upon varying moisture inputs along the Core embayment and confluences of major river systems. Further, these transitional wetlands are also present upstream in a number of major river systems during the LA and to a lesser extent during the MW periods.

Second, terrestrial stability during the study periods varies with key locales playing an important role over time. The LA terrestrial habitat is least dependable, during the LA with considerable regional change over time. The greatest terrestrial stability likely takes places during the EW period which experiences the least amount of wetland activation. Finally, MW terrestrial stability in the Core embayment area is likely to be poor with considerable flooded and reactivated wetland environments, while upstream locales are more stable. Ecological studies show that changes in landscapes, from xeric to mesic to hydric environments and back results in short and long term changes in productivity with the introduction of new plant cover

and associated animals. These environments provide a boom and bust environment, potentially serving as a resource pull for foragers. Initially, the variable nature of these initially can be uncertain and risky; over time, however, landscape and resource stabilization of these areas results in highly productive areas for exploitation.

Third, there is considerable change in the overall pattern of land cover and related resource communities from the LA to the EW periods. Much of this variation is spatially focused on the core Saginaw Valley basin with increasing stability in upland areas over time. Both the palustrine and terrestrial environments are observed to change over time. The LA is a time period with considerable change both along the Saginaw Valley corridor and in upland areas with a diversity of wetland-influenced terrestrial areas. This can be attributed to the topography of the river valleys with numerous areas where water could be possibly trapped (e.g., beaver activity, soil accumulation or down cutting due to downstream flow). This situation is more complex as a result of seasonal retention of moisture in the form of flooding and pooling in numerous base levels. The MW period is characterized by localized change along the Core Saginaw and Shiawassee river subsystems.

Finally, the seasonal processes in all three study periods may cause regional problems (i.e., climate driven habitat succession) for the resource productivity. LA and EW landscape change is substantial given region-wide transformation from warmer and wetter to a drier and colder climate. The EW period, large-scale losses of wetland environments of all types are likely. We also see the transformation of stable emergent and shrub wetlands to hardwood and conifer swamps in interior areas, and the development of stable forested areas in amenable soils and recharge zones. The transition from EW to the MW is more moderate with most of the

wetland effects localized to the core embayment to Saginaw Bay and coastal areas. The coastal areas are substantially affected with inundated landscapes in both the LA and MW periods. These areas remain rather unattractive (due to complete inundation of large areas), resulting in seasonal wetlands during the EW period due to low topography, poor soils, and groundwater recharge (see Figure 6). The overall regional and local environment is significantly affected by the wetland change.

Revisiting the Initial Research Questions

What challenges do wetland environments pose for foraging adaptation (landscapes and diet choices)?

The resource landscape poses a number of challenges; seasonal and long term and local and regional variation. Two key factors are the wetlands distribution and density over time and the effect of seasonality on habitats and food items. The distribution and density of the terrestrial and palustrine landscapes vary over time with implications for resource communities. Regardless of the study period, the seasonality of the landscape likely poses problems to the resource distribution and densities. Emergent wet environments and successional drier environments change resource densities and community composition. The extent of flooded and pooling due to lake level and fluvial dynamics makes large areas of Saginaw and Bay Counties unappealing. At the same time, the late spring drainage of these wetlands creates diverse niches through the succession of shrub and grass growth resulting in environments that are highly productive in terms of both plant and animal resources.

What is the makeup of the regional and local environments understood through wetland distribution and densities?

Regionally, hydrology plays an important role in the core basin; Saginaw Valley and the Shiawassee embayment are heavily influenced, with a lesser influence on upland areas. A number of areas remain stable over time, as either dry or wet areas. Other areas, especially low lying base levels adjacent to major river systems go through short-term seasonal changes and long-term transformation to stable habitats between time periods. For example, a number of large spatial and temporal changes are observed in palustrine landscape. Wetland areas change over time from permanent to semi-permanent hydric areas of varied habitats and differential resource densities. Next, a number of the terrestrial landscapes remain dry, resulting from elevated topography likely providing important areas to access for respite from late winter and early spring wet environments. The LA is a period with a considerable number of resource habitats; wetland areas are present both in the core basin and all long large river systems. EW period, wetlands contract significantly; earlier transitory wetlands become stable hardwood and conifer swamps. MW changes are localized to the core basin; both embayments and river valleys are influenced by the rise in water levels and the reactivation of extant wetlands and habitats.

What are the long-term changes and implications of wetland environments throughout the study periods?

The LA to EW period predictive land cover shows a considerable change at both the local and regional scales. EW to MW change is less but significantly affects the amount of wetland areas close to the Shiawassee embayment and coastal areas. The key factor is the stability of

these environments. LA and MW periods have increased unpredictability and lower reliability, but with a greater abundance of wetland derived resources. The high water level introduces a number of species unavailable to them during the MW. For example, Lake Sturgeon and other productive fishes move further upstream toward the confluence of the Tittabawassee, Saginaw and Cass rivers (Lovis, et al. 2001).

What are the resource communities or habitats present in these wetland environments?

The key wetland environment likely goes through seasonal and successional changes over time. A number of wetland types are present including transitory wetlands as well as mature wetlands. Transitory or ephemeral wetlands are inundated for period of time, and then stabilize through plant succession. After the initial draw down of LA high water levels, emergent marshes and swamps are present. The continued drainage of waters causes wetlands in higher-elevation base levels to be transformed into hardwood and conifer swamps given the amount of soil recharge present. Base levels are likely to be stable for longer periods of time with annual cyclical activated wetlands creating a unique ecological environment. Stable, long-term wetlands, such as the one along the Shiawassee embayment, were likely unique locales for plants and animals. Since much of the effects of high water levels are localized to key areas, including coastal and low elevation inland areas, the inundation of the areas created a unique palustrine composition. Areas with high recharge likely were emergent wetland environments, whereas the areas with low recharge has conifer and hardwood swamps. Regionally, the LA is observed to be different with considerable inland variation along low-lying areas buffered by moraines and remnant beach ridges.

What are the seasonal or short-term changes in wetland environments (density and distribution) and implications for habitats and resource structure?

The seasonal change may be the most important factor of habitat and resource preference and choice. Seasonal wetlands varied in all periods and have considerable implications for the Early and MW periods along with lower wetland density and distribution. Seasonal wetlands are unique areas with productive secondary succession. Secondary succession requires the removal of existing organic matter through a predictable cyclical process. Areas that are cyclically inundated will lose existing plants. These types of wetlands are typically activated seasonally such that there is standing water at one or multiple times during a year. Standing or moving water does not allow tree growth, but encourages herbaceous and grass development. This type of succession likely took place on a regular interval, regionally during the LA period and locally (core Saginaw Valley) during the MW period. These are highly productive habitats for varied set of animals including reptiles, birds, and small mammals.

Conclusion

The predictive wetland derived landscape model presented here provides a refinement of the existing understanding of the prehistoric land cover of the Saginaw Bay Drainage of Michigan. Wetlands play a critical role in landscapes and habitats in this study area. Further, changes in wetland distribution and density between the cultural periods is considerable and also influences hunter gather land use and diet choices. Next, local and regional variability is a driving force in all study periods. LA landscapes are diverse with extensive wetlands. These areas are likely to be highly productive but with greater risks and uncertainties given the predictability of these areas. EW landscapes are the most stable but with net productivity

higher in key areas including the Saginaw core along large river confluences. Regionally, we observe a decrease over the LA in highly productive habitats. MW landscapes are variable along the Saginaw Core with stable areas further upstream. In all three periods, key locales are considered to be important due to their relatively stability and proximity to productive environments and can be considered as places of cultural importance. Taken together, the landscape models provide contexts for uncertainty and risk in the landscape and resource environment. The modeled prehistoric landscapes can be now employed to evaluate behavioral and archaeological expectation of hunter gatherer land use and diet choice.

Chapter 6: Simulation

Introduction

This chapter executes two linked simulations to assess the effects of uncertainty and risk on land use and diet choices. Simulations employed here are heuristic exercises that provide alternative ways of understanding the hunter-gatherer (HG) economy through the probabilistic study of decision-making practices. Past analyses of economic decision-making focused on concerns that are proximate to the individual, aimed to fulfill short-term requirements including nutrients, efficiency, taste, and fat (Egan 1993; Keene 1981b; Reynolds 1985). These analyses are deterministic models, where outcomes only develop one way and result from specific goals to increase efficiency or meet minimum biological requirements. They are intended to assess the effect of key determinant factors on diet choices. The simulation presented here explores the variability (spatiotemporal heterogeneity) in the key factors (diet and patch breadth). Both, risk and uncertainty are implicit in archaeological settlement and subsistence studies, often used in interpretive basis for cultural phenomena. No studies to date have used these factors to explicitly assess their effect. This study provides an alternative approach to understanding HG economic decision-making and addresses spatiotemporal variability in the resource environment.

Decision-making, therefore, is determined by both expected and unexpected (random or stochastic) variability in the resource environment. Specifically, the simulation developed is a dynamic (time-dependent) model using stochastic (one or more variables characterized by a distribution of individual values that are unpredictable) variation. Stochastic processes are

indeterminate, where a process may evolve in many different outcomes. These outcomes, when taken together, reflect the potential range of diversity of economic practices given a set of assumptions. Variance, both in terms of the natural environment and the foraging individual, becomes a critical part of analysis (see Chapter 3 for review).

Uncertainties and risks can be the result of a number of factors that can be attributed to the variability of the natural environment and the individual exploiting resources. Uncertainty is conceptualized as stochastic (random) variation. Next, risk is conceptualized as choice amongst known options, each with its own variability and rewards. Risk is proximate to the individual and external to the environment (see Chapter 3). Risks, then, can be attributed to information, skill and ability a HG holds. For example, men are ethnographically observed to undertake greater risks in resource exploitation. In this way, men may prefer to exploit resources that bring the highest amount of reward. Alternatively, women also engage in risky endeavors but usually only when absolutely necessary. They are likely to hunt small mammals, and pursue gathering and fishing activities. Both groups hold overlapping, but different types of information about the natural world (see Chapter 3 for overview) (Kelly 1995a).

Given these uncertainties and risks, a HG's goal is to efficiently and effectively gather resources from a variable resource environment. To mitigate the uncertainty and smooth out variance, HGs employ strategies that will mediate both expected and unexpected variation. For example, choosing the best productive patch at a given month is one way to reduce uncertainty. Thus, exploiting a specific patch or resource is determined by considering various

factors (e.g., probability for success, gender preference, net caloric yield, and HG skills), all intended to reduce uncertainty and risks.

This simulation contextualizes the roles of landscape, resources, and HG uncertainty and risk within the principles of Optimal Foraging Theories (hereafter OFT). Choices about resources and resource patches are based on a diet and a patch-breadth OFT approach modified by uncertainty and risk factors. Both diet and patch breadth models select from alternative sets of resources that are rank ordered for best returns. OFT models do not take into account variability in the natural environment and its effect on the patch or the individual. Unlike other OFT models, the simulation executed here incorporates this variability as underlying principles of OFT patch and diet-breadth decisions.

Approach

Land use and diet choice simulation is written in Visual Basic programming language using the Microsoft Visual Basic for Applications environment. Microsoft Excel and Access tables are used to store, retrieve, and modify variables. Three data sources are used for the simulation. First, patch density and distribution data is derived from the predictive hydrological models developed in Chapter 5. This land cover data serves as the basis for patch types that are present in a given time period. Second, animal biogeography is based on contemporary animal behavior studies. Plant resource characteristics (i.e., caloric content, size, weight) are derived from the United States Department of Agriculture, Agricultural Research Service, National Agriculture Library, National Nutrient Database for Standard Reference, Release 25 (USDA 2012). Plant behavior is derived from United States Department of Agriculture Plants Database (NRCS 2011). Native use of resources is identified through

ethnohistoric and ethnographic studies amongst Ojibwa and Ottawa communities of Michigan and Wisconsin (EthnobotanyDB 2011) and ethnographic analogs of varied hunter-gatherer groups.

The choices amongst competing patches and resources are based on the net yield of calories, based upon the productivity of patches derived from the biogeographic characteristics of plants and animals. Uncertainty and risks are conceptualized as the relative probabilities of events occurring along a continuum between zero and one hundred. The probabilities are randomly selected, emulating the established distribution. The choice of a resource in a patch is determined by the relative probability of the presence of that resource at a given patch and at a given time. The productivity of a patch is determined by the weighted cumulative probability of each resource present in a patch multiplied by the cumulative probability of resource present in a given month, multiplied by the caloric yield of that resource. This use of probability operationalizes the realities of stochastic events. For example, the stochasticity present in the resource environment can require that HGs exploit a greater number of resources, even low ranked ones, due to the uncertainty of higher-ranked alternatives.

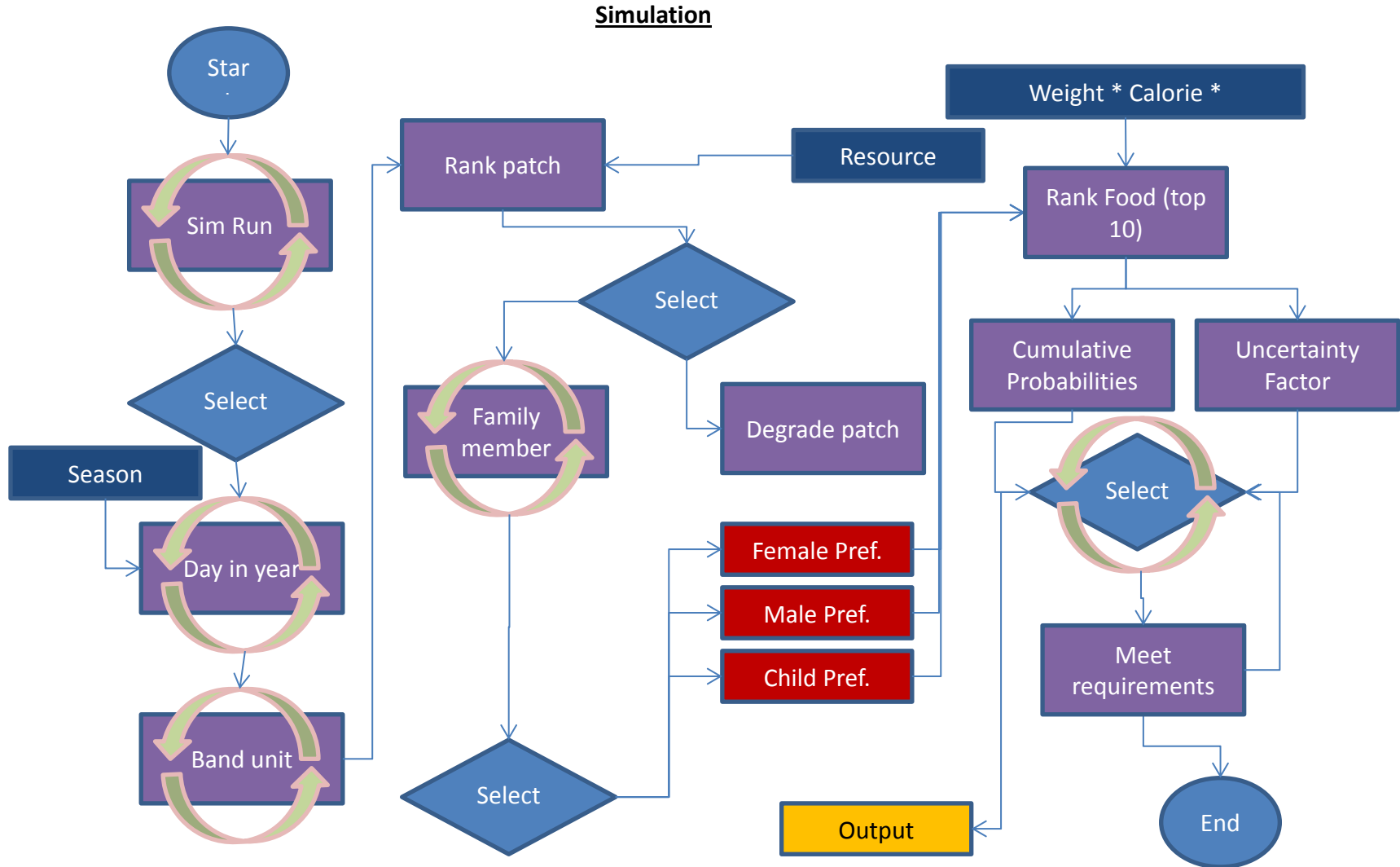


Figure 18. Simulation data model

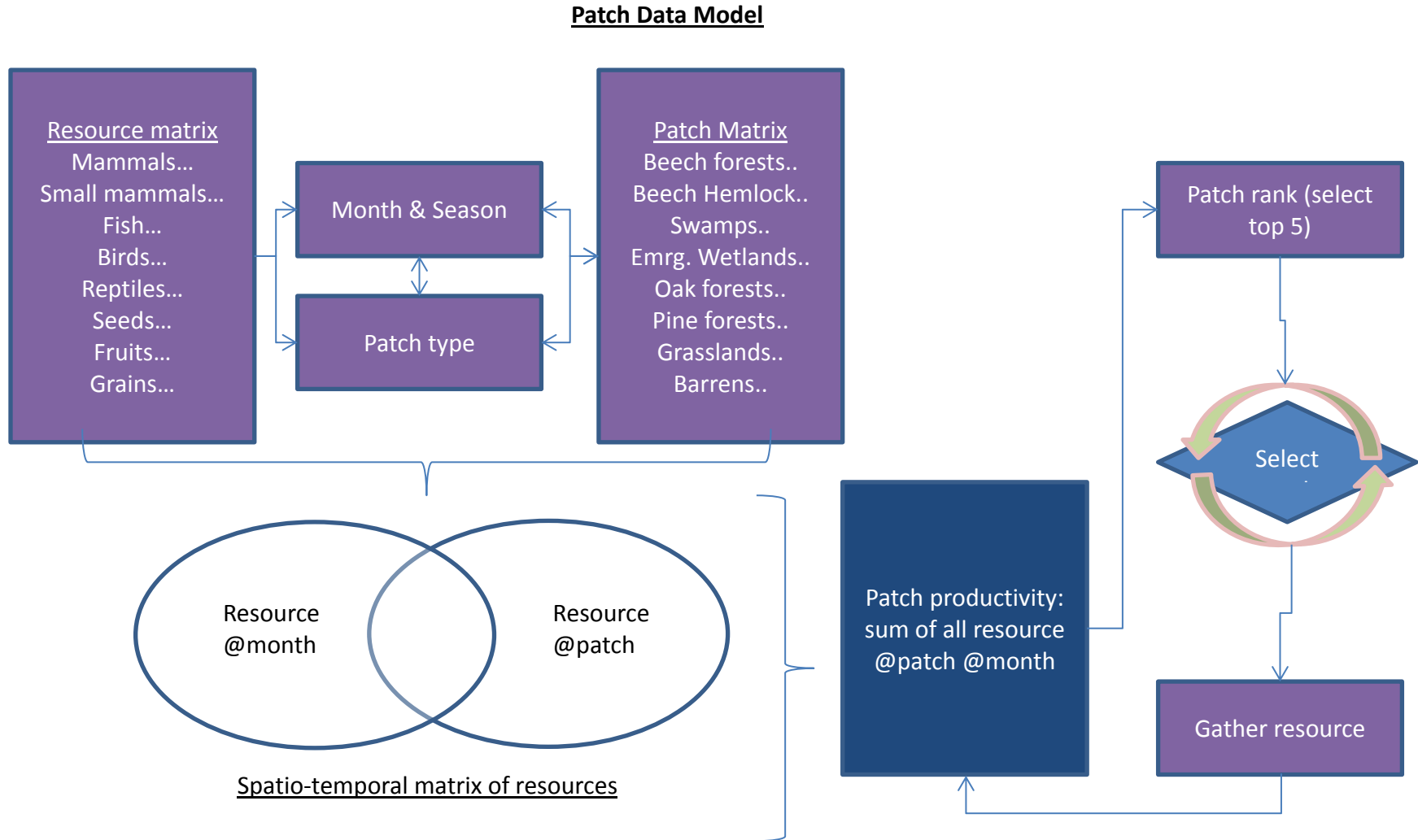


Figure 19. Patch selection data model

The choice of a patch is dependent on the most productive set of resources at a patch in a season. Seasonality and the effect of distribution and density are determined on a monthly basis.

Patch Choice (Habitat Selection)

A foraging band is purposeful about its actions and is knowledgeable regarding the risks in the resource environment. The band will move to a new area using their past knowledge of that area; from their firsthand knowledge through visiting the area during logistical forays, or gained through information exchange with others in the area. A typical foraging area is assumed to be three-mile radius of a given patch. The selection of a patch is independent of actual forager presence or exploitative success in the patch (Kelly 1995a). The selection and use of a patch (1 sq. mile) are determined by numerous factors including relative productivity and prior use of the same patch, or patch degradation.

First, productivity is dependent on the season and the collection of those resources available in that season (see Figure 19). The potential presence of a resource in a patch is determined by four continuous classification categories: very low (0 and .1), low (0 and .3), medium (.3 and .6), and high (.3 and 1). For example: a patch with mallard ducks and cattails would be calculated as the sum of caloric yield of both species in a given month or season. Then, the selection of a patch is determined by adding the probabilities of two events, providing the relative rank of all resources–patch, resource-month combinations.

Patch productivity = sum of the net yield of resources at a patch *

Sum of the net yield of resources in a month

Second, a patch quality is degraded when prior use of the same patch, resulting in a 20 percent (see Chapter 4 for assumption rationale) decrease in the net caloric yield. Patch degradation is a feedback process in OFT where a consumed patch is degraded by exploitation within an annual

round. This feedback affects the outcome of future choices, making patches assumed to be productive unappealing to groups (knowledge regarding a patch is assumed to be transmitted between groups). A given patch is assumed to regenerate after an annual cycle. Last, a HG selects among the top three patches (number is based on ease of programming to randomly select amongst top three choices) based on productivity, using a weighted cumulative probability distribution resulting in the random selection of a patch based on its relative proportions.

Diet Choice (Resource Selection)

Diet choice is a selection of resources from a given patch at a given month, based on the random weighted, cumulative probability of the total resources present (see Figure 2 and Figure 3). The net yield of gathered resources is limited to what an individual collects in a two-hour time period (number based on ease of programming). For example, the amount nuts gathered would be based on a probability function that returns a value that varies between probable highs and lows. This approach has the effect of equating the exploitation of varied resource types (i.e., deer versus cattails).

$$\text{Net yield of a resource (2 hours)} = \text{Caloric yield of a resource} *$$

$$\text{Ease of exploitation} * \text{Gender preference}$$

$$\text{Ease of exploitation} = \text{Predictability} * \text{Abundance}$$

$$\text{Caloric yield of a resource} = \text{weight} * \text{density} * \text{calories}.$$

A number of key factors determine resource selection, including the age/gender class of an individual. For example, highly mobile and non-aggregative species are harder to exploit. First, the HG gender role is represented along a probability continuum that ranks preference toward species based on the likelihood of actual exploitation. For example: men may prefer to exploit higher-yield larger mammals that are risky and dangerous (i.e., costly signaling), whereas women and children may exploit small mammals and plants foods. Children, specifically, will exploit resources similar to women but at lower success and productivity rates. Therefore, the net amount of caloric expenditure exploited for the same resources is lower. Second, a HG in a band unit is limited to four attempts at gathering resources in a given day. This requirement is based on the relative amount of time devoted to actual exploitation activities. Third, the probability of failure is a random variable based on the intrinsic uncertainty in the environment. HG who attempts to exploit white-tailed deer may fail based on random stochasticity.

Table 6. Probability classifications for resource types				
Category Type	Low	Medium	Medium High	High
Large Mammals	0 to .1	.1 to .5	.5 to .9	.9 to 1
Small Mammals	0 to .1	.1 to .9	N/A	.9 to 1
Birds	0 to .1	.1 to .9	N/A	.9 to 1
Fish	0 to .1	.1 to .9	N/A	.9 to 1
Reptiles	0 to .1	N/A	N/A	.1 to 1
Mollusks	0 to .1	.1 to .9	N/A	.9 to 1
Grass Herb	0 to .1	N/A	N/A	.1 to 1
Nuts	0 to .1	.1 to .5	.5 to .9	.9 to 1
Seed Grain	0 to .1	.1 to .5	.5 to .9	.9 to 1
Seed Fruit	0 to .1	.1 to .5	.5 to .9	.9 to 1
Tree Fruit	0 to .5	N/A	N/A	.5 to 1

Note. Table 6 probability classifications vary due to the ease or difficulty of capture. For example, a tree fruit is either present or absent, whereas, small mammals are mobile and opportunistic. Smaller mammals, therefore, require different probability classification based on seasonality, and habitat, when they are exploited.

Resource Selection Data Model

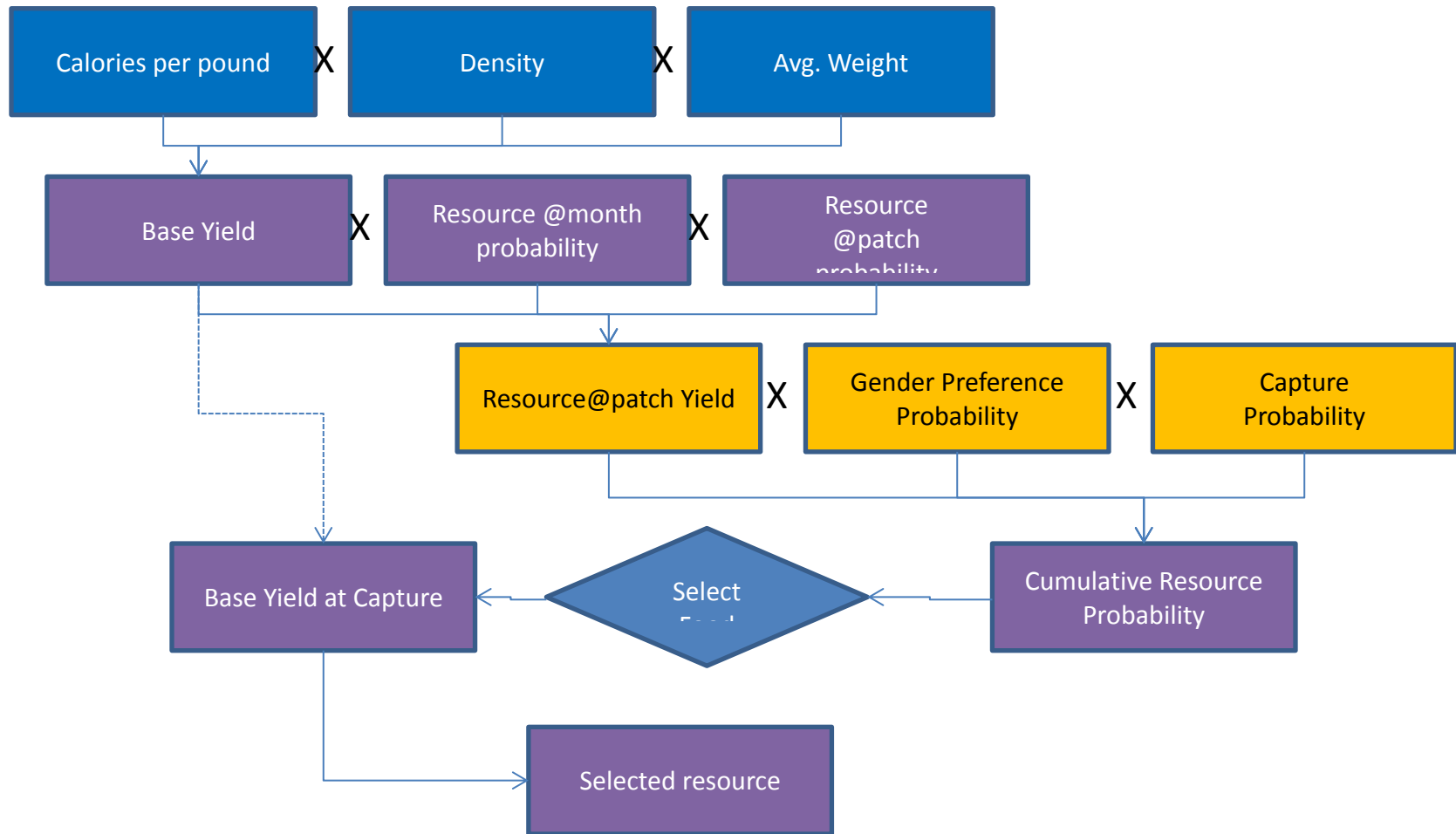


Figure 20. Resource selection logic model

Simulation Results

Simulations provide a series of alternative understandings of HG choices of patches and food items selected in an annual round. Results are divided into two categories, land use and diet selection:

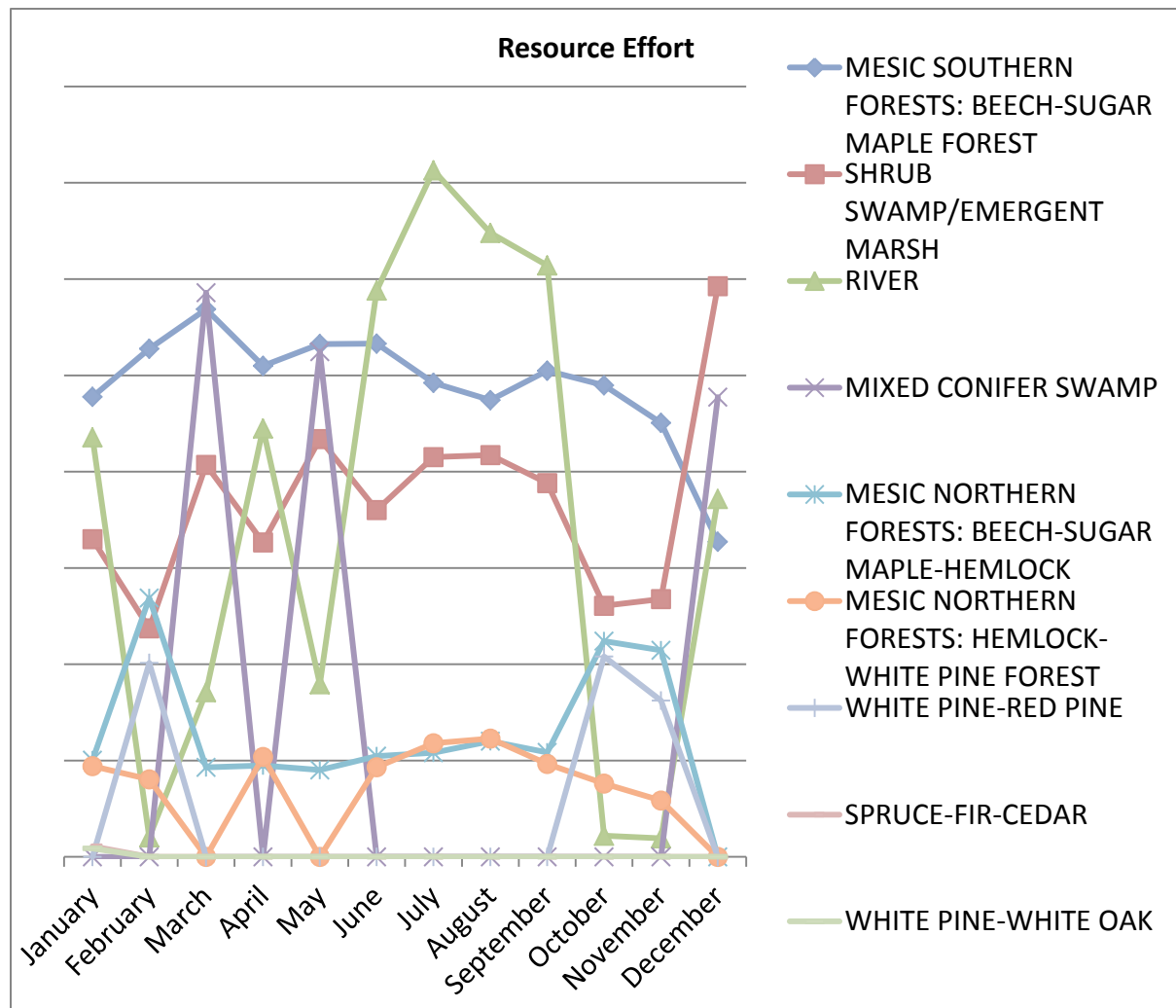


Figure 21. Resource choice effort in a patch

HGs use a number of key patches over the annual cycle. Riverine environments are the most productive during the summer. Mesic southern and northern forests are productive during the winter season. Mixed conifer swamps are highly variable, with boom and bust productivity. Other wetlands are highly productive during the early winter and continue to be moderately productive throughout the year.

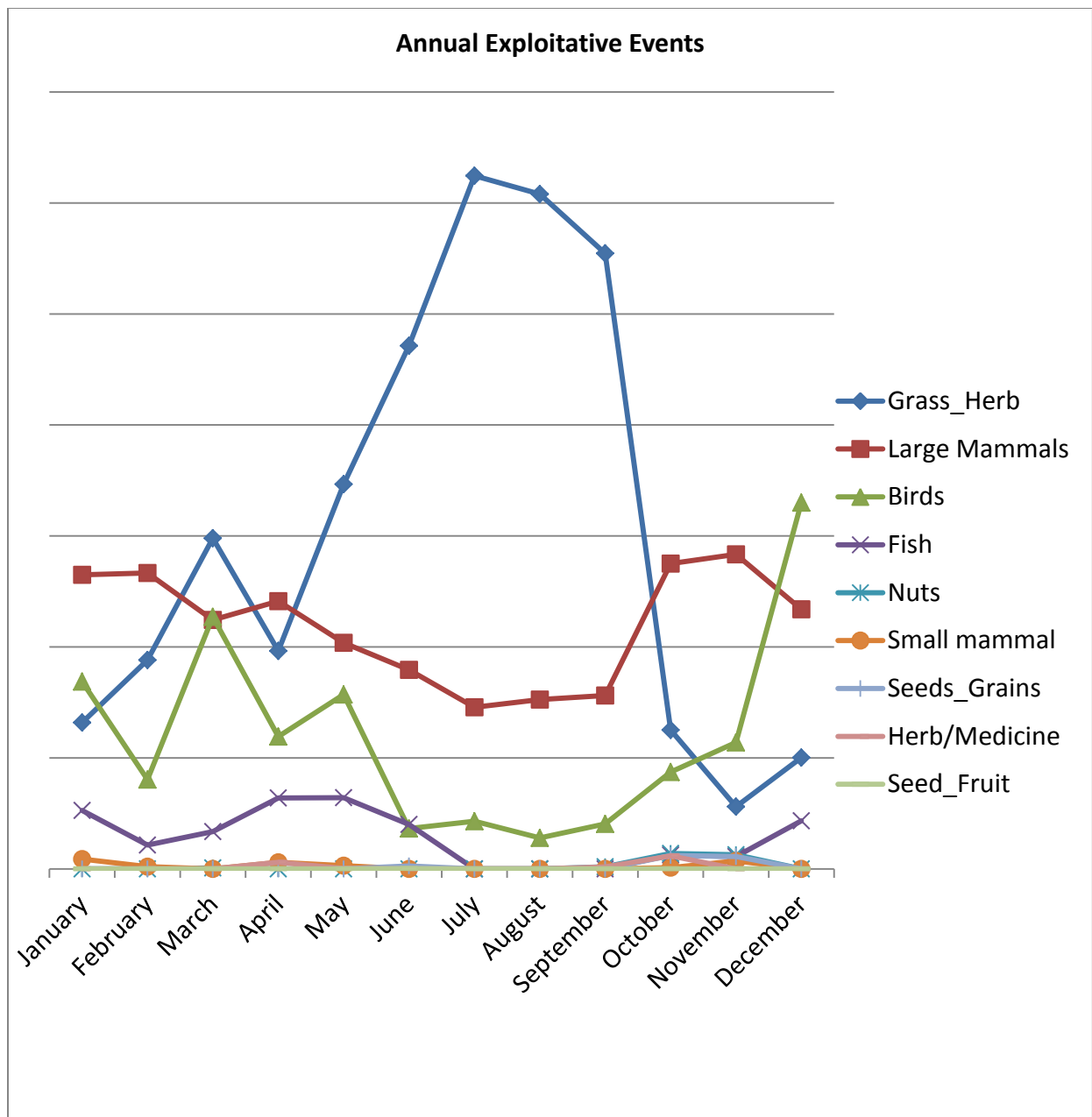


Figure 22. Annual exploitative events (combined male and female)

The cumulative attempted (not all are successful) exploitative events is due to efforts of five different family units with varied gender compositions. Given the net attempts, two classes of foods dominate; Grass_Herb (plants that are diet foods) and Large Mammals (deer, elk, moose). Birds and fish are the third and fourth ranked items exploited, respectively. This simulation suggests that HGs mitigate risk and uncertainty by exploiting resources that are both, abundant at a given time and place and can provide efficient yield relative to attempts to procure them. The varied monthly attempts highlight the importance of plant foods during the summer and alternatively large mammals and birds at other times of the year.

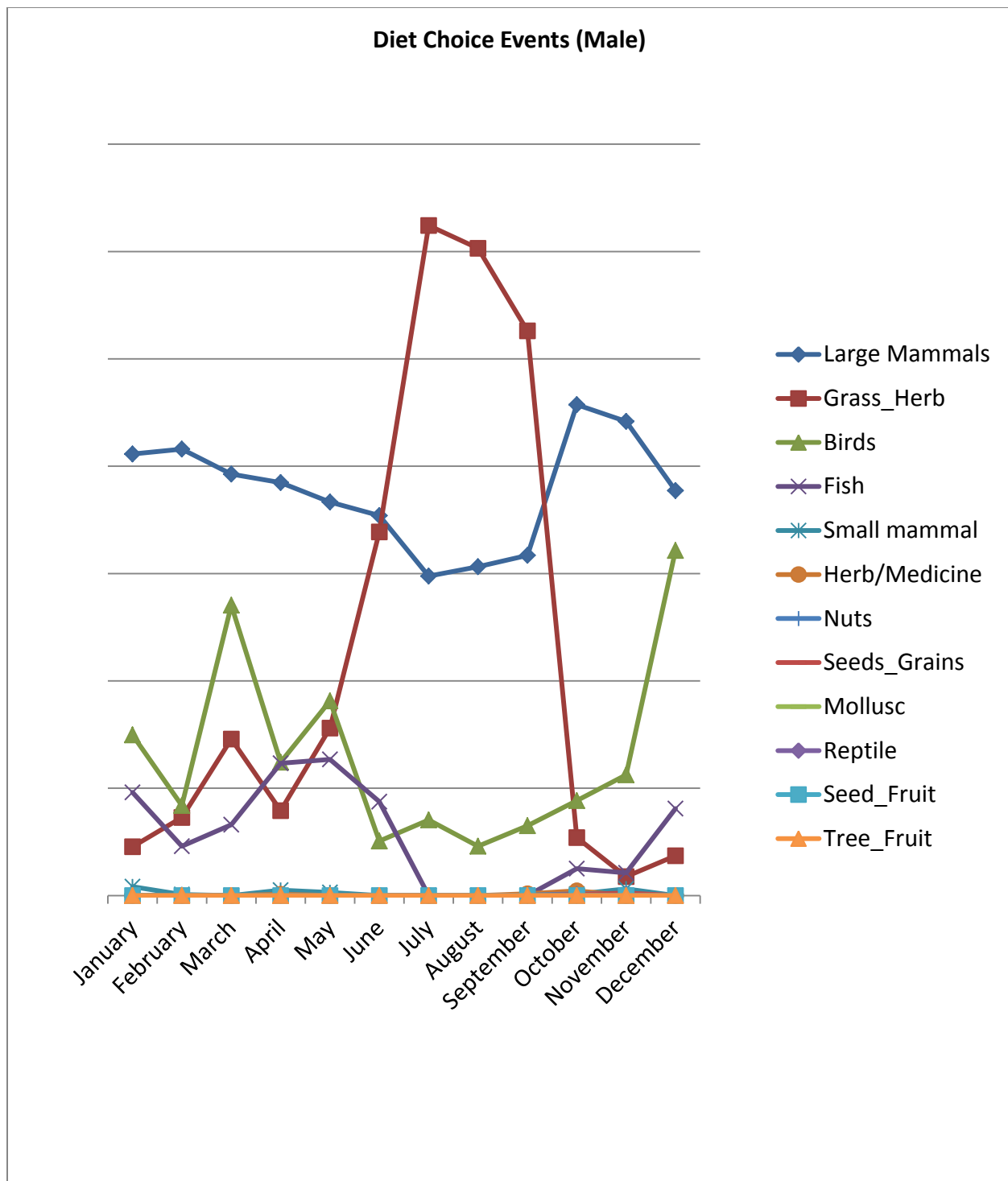


Figure 23. Diet choice events by gender (male)

Exploitative events based on gender highlights the cultural preferences for exploitative radius and risk aversion. Men exploit large mammals and highly productive plant foods. Birds and fish rank secondary and are important as well.

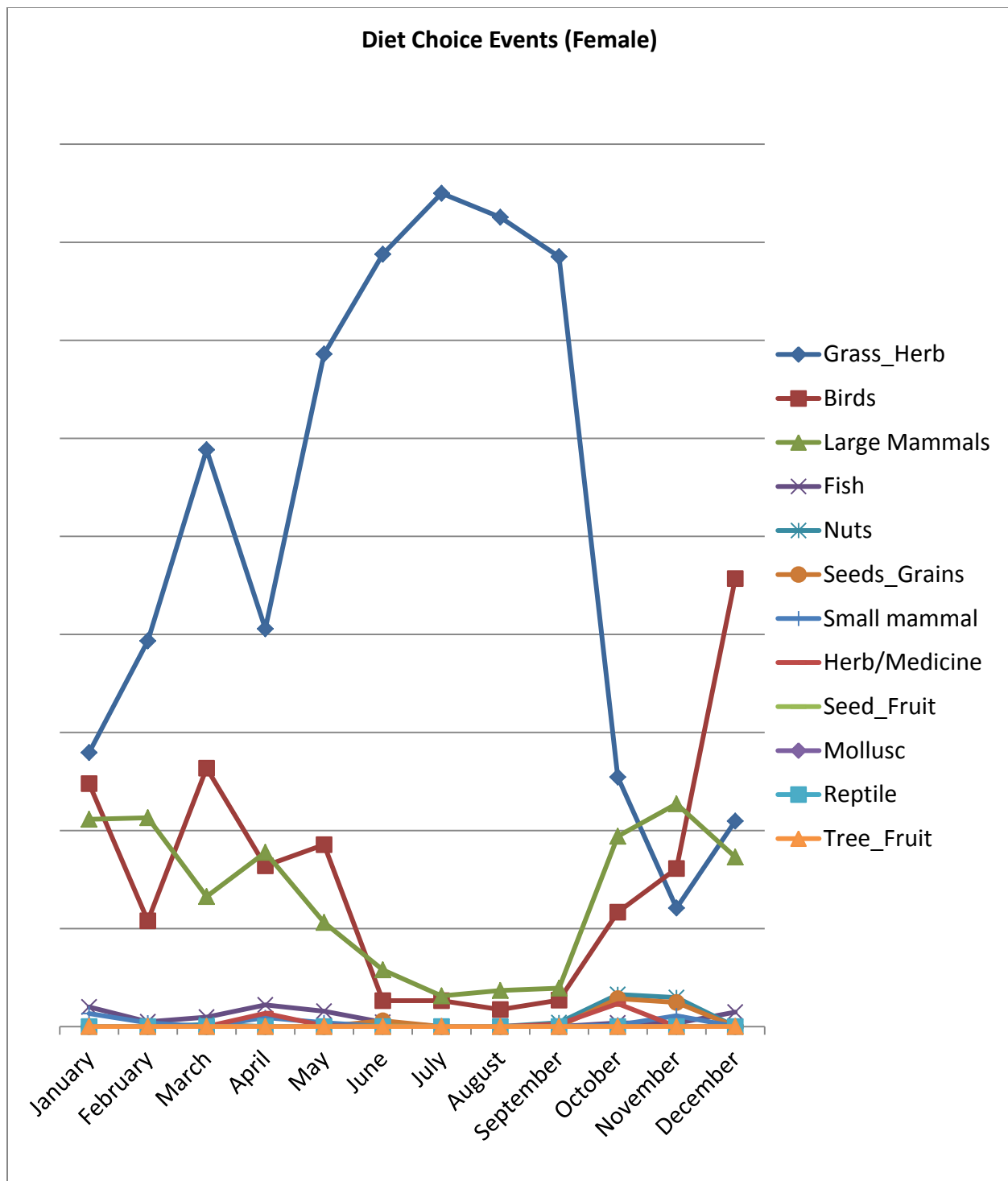


Figure 24. Diet choice events by gender (female)

Exploitative events based on gender highlights the cultural preferences for exploitative radius and risk aversion. Women make choices to exploit plant foods and birds and, to a lesser extent, small mammals. Interestingly, women would also be driven to exploit large mammals given alternative are not available.

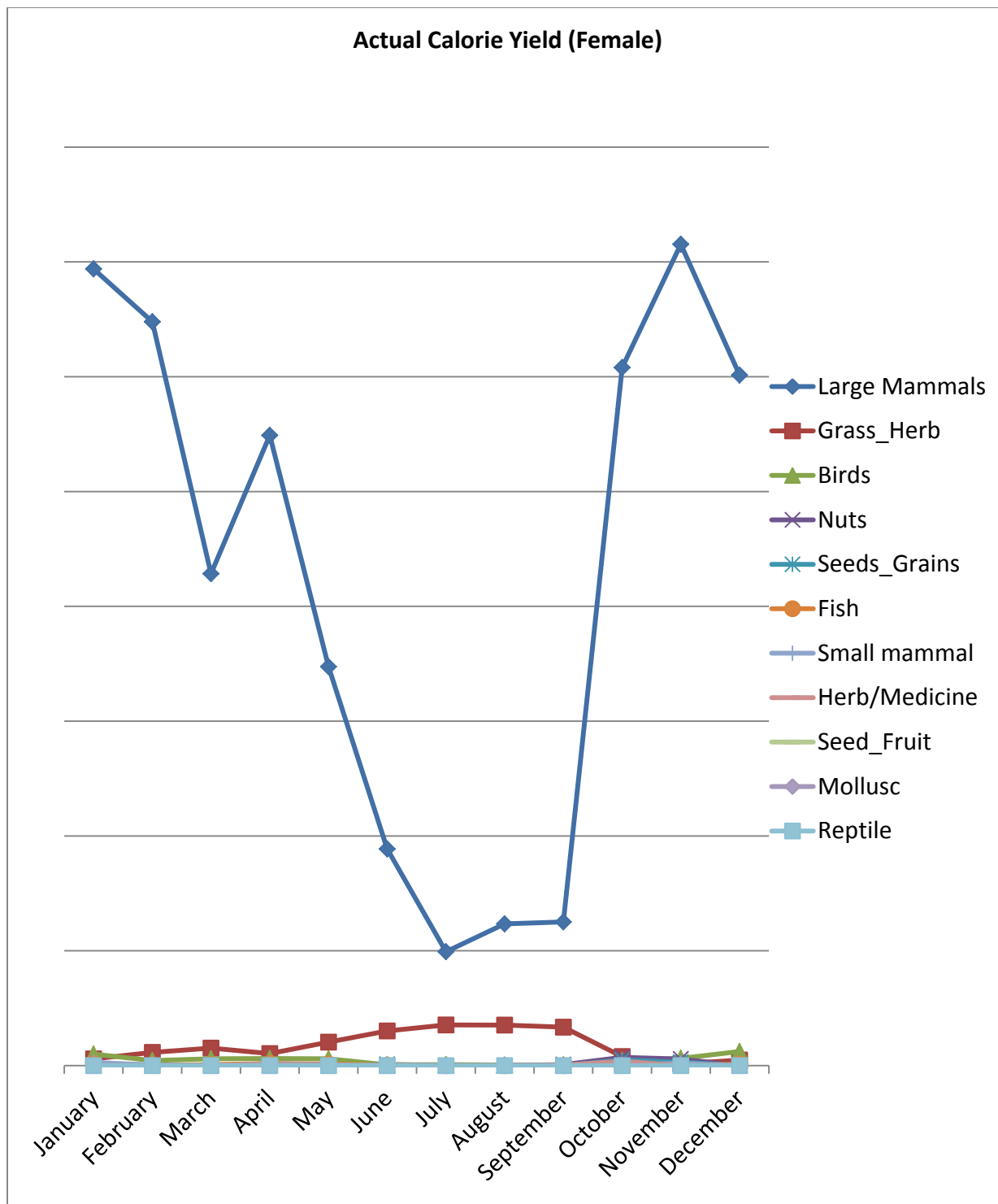


Figure 25. Actual caloric yield (female)

The actual yield is determined by both the relative uncertainties attribute to species behavior and patches exploited results in a modified set of caloric yields.

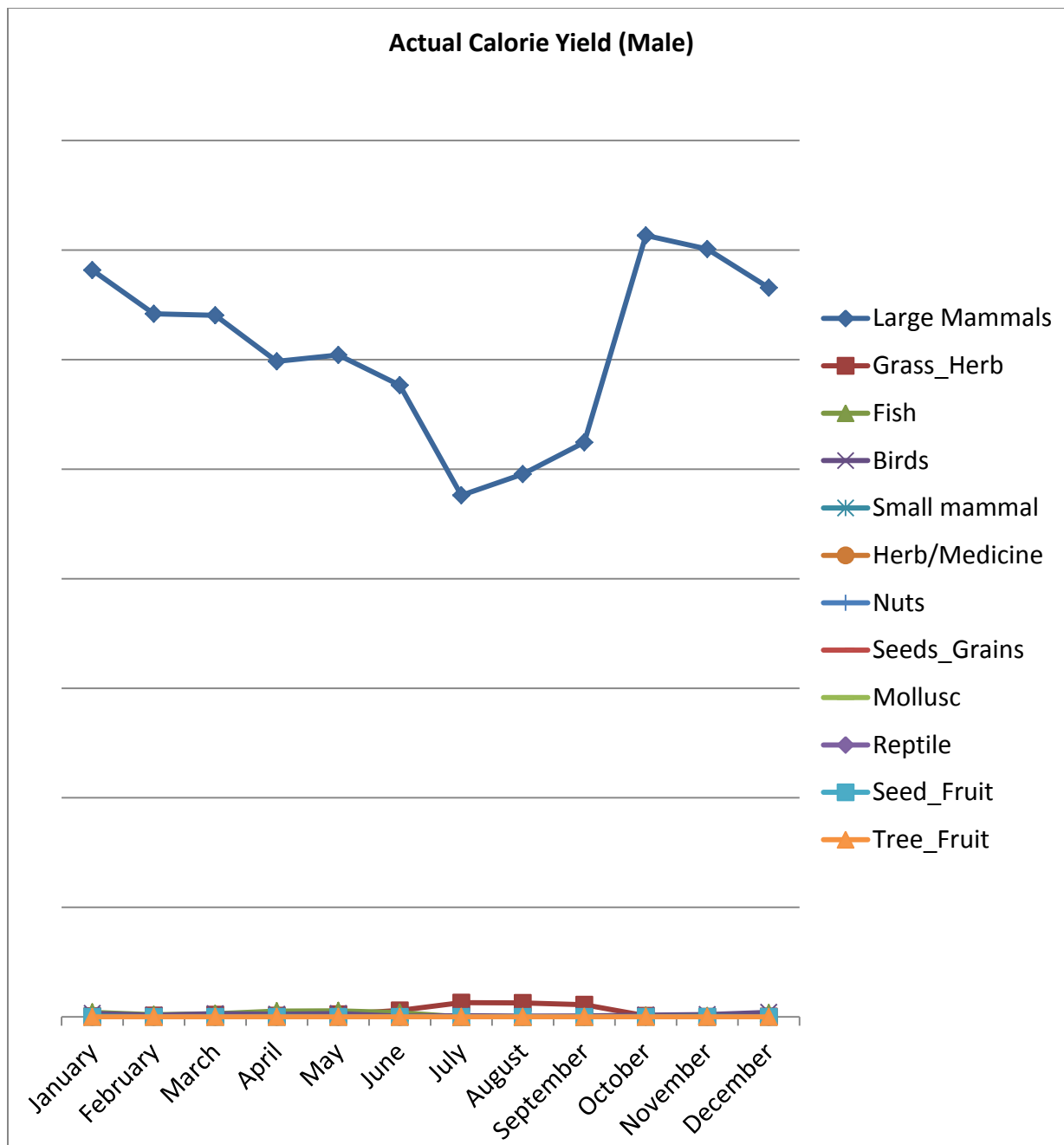


Figure 26. Actual caloric yield (and probability of success (with 10% uncertainty factor)

The actual yield is determined by both the relative uncertainties attribute to species behavior and patches exploited results in a modified set of caloric yields. The dominant exploited resources are large mammals, followed by a suite of other resources including fish, birds, and small mammals at different parts of the year. The net yield of large mammals considerable outweighs all other resource groups.

Discussion

The simulation outcomes present an alternative perspective of HG land use and diet choices. The outcomes of the models demonstrate that the role of uncertainty and risk is considerable, and critical to the decision-making process. Further, spatiotemporal variability likely plays an important role in uncertainty and risk and also linked economic and cultural practices. However, heuristic endeavors must be carefully interpreted. These outcomes are often the result of assumptions made initially in the model and may mask complex processes.

Regardless of issues posed by model assumptions, the simulation outcomes highlight some key social and ecological factors that influence land use and diet selection. The social factors that plays a key role is gendered risk preferences and division of labor. The variable risk preference of male and female is observed to play a complementary role in their overall success, given their net yield curves (see Figure 20). The male preference for high risk and high yield resources likely results in considerable variation in actual success given differential uncertainty factors, but the overall yields justify their exploitative strategy.

The simulation shows that given considerably larger uncertainty factors (actual was .10 percent) brings all other resources in more equal standing with large mammals. But, the shape of the yield curve is relatively linear throughout the year (see Figure 20). Overall, men should focus and alternate among large mammals regardless of the time of year. They should alternate between resource types when their success is limited (high uncertainty) especially during the summer when the net returns of alternate resource could possibly compete with large mammals. In actuality, their goal throughout the year should change little. The relative success

of exploiting these highly mobile and seasonally variable resources can be increased by group strategies (coordinated hunting), specialized hunters (highly skilled males), and significant interactions and communication amongst hunters, their families and affiliated groups.

The interesting outcome is that women should also prefer high yield large mammals, especially given their net caloric yields. An increase in uncertainty factor has very differential effect on their preferences (see Figure 20). Women yield curve is convex. They are likely to prefer very different resource at different times of the year. With increasing uncertainty, women will rank a whole suite of alternative resources rather than large mammals. Alternative resource, especially plants become more reliable and complementary as well. The social role of risk preference, in turn division of labor plays an important role in land use and diet decision making.

The ecological factors include that plays an important role include, both the varied influences of spatial orientation of landscape features and seasonal availability of key resources. Key patches on the landscape are variably productive based on a given season and cultural period. Abundance and dearth of resources in these patches also play an important role in decision-making

The patches selected throughout multiple simulation runs suggest that the effective way to address variability in the resource environment is to focus on key patches (given that they are accessible), including Mesic southern and northern forests, river settings, and intermittent wetlands to a lesser extent. Mesic southern forests are the best productive environment, with a balance of moisture, warmth, and resource potential. The river networks, both large and

medium, further provide productive habitats throughout the annual cycle. The forested uplands along river system headwaters have low variability and display a greater stability of resources. The core wetlands provide a highly contrasting view, with significant variability during the winter, and early spring, seasons. The core wetlands become a resource draw for large mammals from adjacent mesic southern and northern forests. Further, river networks serve as routes to access these highly productive palustrine environments throughout the year.

When diet choices are made to mitigate risk and uncertainty in the environment, a singular focus is observed on specific resources including large mammals and plant foods that are likely abundant in specific habitats. The diversity of choices available for late summer and fall collection of seeds and nuts provides significant storage potential for high fat foods for the winter. During winter, there is a greater reliance on tree products (i.e., mast) both in terms of winter-use foods and the dual-purpose use of herbs and medicines, since most plants that produce nuts also have multiple uses. For example, winter exploitation of stalk fats and starch is an important as they are a reliable resource. Choices of cultigens as a possible basis for exploitation may have been opportunistic and concordant with productive habitats for both plant and animal products. Fish is an aberration in this simulation with low yields, especially with probable productive riverine settings. This is a result of alternative higher yield choices in the habitat.

The simulation demonstrates the resource pull of heterogeneous environments regardless of uncertainty in the resource landscape. Changes between cultural periods could be interpreted as a similar adaptive strategy over time, exploiting mesic southern forests with concomitant reliance on riverine and wetland environments. The resulting patches and

resources are resilient to the level of uncertainty present. Increasing the net uncertainty in the environment does not change the relative patch and resource importance; uncertainty affects all resources; with key resources being more resilient to change (plants and nuts). Two dimension of the resource structure plays a considerable role in resources selected; the higher yield resources and breadth of plant food items.

The simulation contributes to a better understanding of both methodology and human behavior. Methodologically, the incorporation of stochasticity expands the reality of a model resulting in a different logical framework for decision-making. This may also better reflect the variability between models and actuality. Further, stochasticity basis for decision-making can be conceptualized as boundaries of human behaviors as baseline requirement, wherein all other alternative decision-making rationale operate.

Conclusions

The two linked simulations provide valuable insights into the social and ecological role that variability plays in economic decision-making. Patches preferred in the simulations are mesic southern and northern forests, rivers, and wetland communities. These habitats play a key role in mitigating variability since they are the most stable environments given seasonality and net productivity in the study periods. Given these key habitats, the favored resources are large mammals (i.e., elk, white-tailed deer) and wetland oriented successional plants. Finally, this study allows for the possibility to better understand the role of uncertainty and risk in decision-making. Uncertainty- and risk-based rationales can be conceptualized as boundary conditions for economic decision-making. The two effective strategies identified by this study

are high-yield but low-density resources (large mammals) and low-yield but high-density plant resources (fruits, seeds, nuts). Other alternative decision-making factor (i.e., nutrients, taste, and fat) becomes choices that are made within this bounded rational cognitive space. In turn, this suggests that decision-making approaches can be ordered hierarchically and included within, with risk and uncertainty ranking above and encompassing other proximate factors.

Chapter 7: Archaeology

Introduction

Archaeological studies provide insights into both the underpinnings and mechanisms of cultural adaptation. Studies that include spatial patterns (e.g., land cover distribution and settlement classes) and material culture (zooarchaeology and archaeobotany); once linked with established theoretical underpinnings (i.e., uncertainty and risk) provides the better understanding of changes in both culture and human behavior. This chapter explores cultural and specifically economic adaptation through archaeological data analysis. The analysis is undertaken by land use and diet selection. First, a spatiotemporal analysis of sites and their relationship with prehistoric landscapes explains the land use patterns. Land use is evaluated through archaeological site locales as it relates to past habitats and landscapes; diet selection through archaeobotanical and zooarchaeological analysis.

Land use studies frequently explore causal relationships using the space and time as human-environment interaction variables by exploring complex questions regarding location, association, and spatio-historical contexts within which human groups; settlements, biophysical resources, and infrastructure influence each other over time. These geospatial approaches offer empirical information as well as analytical power (e.g., territories, resource extraction zones, travel corridors etc.). Land use choices can be understood by the use of spatial variables that can be analyzed in relation to concentric or nested zones (buffers) of varying widths from a feature of interest (e.g., sites, rivers, wetlands, soil and elevation classes). Further, the use of geospatial analysis provides us role that these features may play in archaeological phenomena.

The biophysical variables analyzed are derived from primary and contemporary geospatial layers with the use of GIS tools (see Chapter 5). Conversely, cultural variables including sites types (e.g., cemetery/burials, village and camp settings) can be compared to biophysical landscape features. Second, a zooarchaeological and archaeobotanical analysis provides the local level understanding of diet choices. Further, these analyses explore plant and animal diversity present at sites. Quantitative statistical approaches can be used to evaluate the significance and reliability of the faunal and floral variables. In summary, this chapter evaluates the archaeological remains of human behavior from the Late Archaic (LA), Early Woodland (EW) and Middle Woodland (MW) cultural periods with intent of better understanding hunter gatherer land use and diet choices. In preparation for the analysis of land use and diet choices, a background of archaeology of the study area is presented.

Archaeology of the Saginaw Bay Drainage

The Saginaw Bay Drainage (SBD) is a region with a large number of archaeological sites; many with substantial material inventories. The archaeological record here is both the combination of the regional and local patterning of sites and material culture present therein. First, hunter-gatherer (HG) land use activities are often ephemeral with very little impact on the natural environment. At a regional scale, monumental structures like mounds are often the only visible remnants of cultural occupation in an area. These structures have linked with ways people view the environment (Berkes 1986; Bishop 1986; Preston 1986). These complexes may represent both lineal descent and corporate groups. Further, geoarchaeological studies of the Saginaw Valley suggest considerable loss of sites located along riverine and wetland environments due to erosion through fluvial processes and aeolian activity (Arbogast, et al.

2008; Lovis, et al. 1996). The regional pattern of sites provides an understanding of HG subsistence and settlement behaviors meant to buffer social and environmental uncertainty. Summarily, the land use analysis reiterates the importance of the emergent and cyclical wetland communities and the surrounding fluvial networks.

The material record is also an incomplete account of real behavior and biased through site formation processes, natural and cultural transformations and recovery strategies. As a result, the record must be contextualized taking into consideration of processes of site formation and preservation (Binford 1978b, 1981, 1982; Schiffer 1976). Standard taphonomy (scavenging animals and natural processes -flooding, soil acidity) can also alter the record. Human behavior also results in an incomplete record. For example, HG may return a high utility part to a camp site when a kill is made away from the campsite (Binford 1978b; Binford and Bertram 1977). The mode of material disposal will also vary with the function of the site and anticipated length of occupation (Binford 1978b). Ritual activities also bias the archaeological record; Mistassini Cree accord specific bones ritual importance by moving bones to special cache racks (Rogers 1973). Finally, differential modes of recovery including flotation sampling and strategies, screen sizes, differential excavation procedures also play an important role in archaeological bias. For example, many small bones attributed to fish are rarely collected.

Typically, larger bones with high density have greater resistance to physical breakdown (Binford and Bertram 1977; Read 1971; Vierra 1975). The expected contribution of animals can be calculated as proportion of average live body weight or caloric yield. The larger the animal, the larger the percentage of contribution to material inventories. Plant remains can be more

problematic with ambiguity from potential heat treatment for carbonization (in a nonoxidizing atmosphere that it is not turned into ash) and also large, dense inedible discarded parts (e.g., nutshells, fruit pits, seeds) (Asch, et al. 1972; Munson, et al. 1971). Problems with taphonomy force us to treat this model as a regional model. In developing expectations, we are seeking general trends rather than very specific matches with archaeological record.

In the SBD, the differential preservation of organic matter, rate of deposition and subsequent burial and effects of scavengers influence archaeological recovery. Groundwater conditions, soil pH, and freeze-thaw conditions also modify the assemblage. Sites are typically located on sand ridges with highly acidic soils; therefore the preservation is poor and requires alternative investigative approaches. The faunal and floral remains are the best indicators of economic activities and serves as evaluative basis for the models presented. The archaeological record used in the study, both in terms of sites and faunal and floral material is assumed to be a sample of human activities in the region. The cumulative archaeological record is used to determine HG economic models.

Economic Models

The economic studies of the study periods provide a quick summary of existing land use and diet models.

Sites during this LA are interpreted as seasonal occupations with differential seasonal exploitative activities. Summers are broad spectrum exploitation with dispersed fishing, aquatic mammals and wild plants harvesting. Late autumn and winters are periods of deer hunting resulting in seasonal hunting and processing camps. (Fitting 1969; Halsey 1999; Lovis

2009; Robertson, et al. 1999; Taggart 1967). Broad spectrum foraging continues during the winter season with exploitation of small and large mammals with use of stored foods (fruits, deer, and dried fish) as alternatives. Intensive fishing is likely during the spring supplemented with stored foods (Keene 1981b). Riverine sites are likely exploited for spawning species with other aquatic reptiles and mammals are secondary resources. Passenger pigeon likely exploited in lowland nesting areas (Peebles 1978). Other, higher valued birds are likely exploited during migration periods along palustrine and lacustrine habitats. Next, this general model is refined to provide a local interpretation of niche based exploitation aimed at entire range of habitats (uplands, margins, lowlands) to address spatiotemporal variability. Further, this is aided by and in response to travel and information gathering along radial river networks and varied habitat locales (Lovis 1984, 1986, 1989, 1990b; Robertson 1987). Recent research has also introduced the importance of squash and maize likely exchanged down the line from regions further south (Monaghan, et al. 2006; Raviele 2010).

Sites during the EW are a similar settlement model as the LA with winter aggregations at Schultz (20SA2) and summer dispersal and encampment at Kantzler (20BY30) with fishing as the primary activity (Fitting 1969). The proliferation of squash (*Cucurbita Pepo*) and ceramics likely increased the economic productivity and subsistence stability. The subsistence strategy employed is similar to the LA but at greatly reduced intensity - likely a highly mobile lifeways where corridors (rivers) are used to access resource zones and exchange networks outside of the area. Seasonal patterns include a reoccupation of autumn sites during the spring to exploit nuts and squash. Groups dispersed into forest moraines for large and small mammal exploitation, followed by intensive fishing during the early spring (Ozker 1982).

MW Economy is dependent upon the intensification of the EW pattern with inclusion of cultivation practices (Cleland 1966; Cleland and Kearney 1966; Fitting 1975; Luxenburg 1972; Raviele 2010). This pattern is observed by an increased focus on large mammal exploitation (Peebles 1978):121. An alternative interpretation focuses on wetland fauna (waterfowl, fish, aquatic mammals, plants- especially wild rice)(Egan 1990; Lovis 1985; Lovis and Cleland 1993).

Archaeological Sites

Table 7. Sites with fauna and flora					
Data	Site Number	Site Name	Time Period	Relative Dates	Citation
MNI	20SA380	Kretz	LA	4000	Keene 1981 (Keene 1981a, b)
MNI	20SA198	Hart	LA	4000	Keene 1981 (Keene 1981a, b)
MNI	20SA2	Schultz	LA	3500	(Allison 1972; Fitting 1972; Fitting and Allison 1972; Keene 1972; Luxenburg 1972; Shipman 2004)
MNI	20SA209	Younge	LA	4000	(Blackbird 1887; Greenman 1937)
MNI	20SA192	Schmidt	LA	4660	(Cleland and Kearney 1966; Fairchild 1977; Harrison 1966)
MNI	20SA128	Feeheley	LA	3930	
MNI	20BY29	Butterfield/ Schmidt	LA	3950	(Allison 1972; Fitting 1972; Fitting and Allison 1972; Keene 1972; Luxenburg 1972; Shipman 2004)
MNI	20SA581	Weber 1	LA	2990	(Cleland 1989; Lovis 1989; Smith 1989; Smith and Egan 1990)
MNI	20BY79	Third Street Bridge	LA	2880	
NISP	20BY387	Marquette Viaduct South	Terminal LA	2600	(Egan-Bruhy 2002; Lovis 2002; Lovis, et al. 1996)

Table 7. (cont'd)					
Data	Site Number	Site Name	Time Period	Relative Dates	Citation
MNI	20BY387	Marquette Viaduct South	Terminal LA	2600	(Egan-Bruhy 2002; Lovis 2002; Lovis, et al. 1996)
NISP	20BY28	Fletcher/Marquette	Terminal LA	2600	(Egan-Bruhy 2002; Lovis 1985, 2002)
MNI	20SA2	Schultz	EW	2490	(Allison 1972; Fitting 1972; Fitting and Allison 1972; Keene 1972; Luxenburg 1972; Shipman 2004)
MNI	20BY30	Kantzler	EW	2650	(Crumley 1973)
MNI	20BY30	Kantzler	MW Early	2500	(Crumley 1973)
MNI	20SA2	Schultz	MW Early	2480	(Allison 1972; Fitting 1972; Fitting and Allison 1972; Keene 1972; Luxenburg 1972; Shipman 2004)
MNI	20GR13	Kanitz	MW	2200	
MNI	20BY79	Third Street Bridge	MW	2100	
MNI	20BY28	Marquette Viaduct Site	MW	1740	(Egan-Bruhy 2002; Lovis 2002; Lovis, et al. 1996)
NISP	20BY28	Marquette Viaduct Site	MW	1740	(Egan-Bruhy 2002; Lovis 2002; Lovis, et al. 1996)
MNI	20BY30	Kantzler	MW Hopewell	1700	(Crumley 1973)
MNI	20SA2	Schultz	MW Late	1600	(Allison 1972; Fitting 1972; Fitting and Allison 1972; Keene 1972; Luxenburg 1972; Shipman 2004)

The economic models are based on analysis of site and material inventories. The site data is collected and synthesized from the State of Michigan - Office of the State Archaeologist sites database. The geographic location has been obscured to protect site locations and integrity. The zooarchaeological and archaeobotanical data is accumulated and synthesized from a collection of archaeological site reports and published articles (see Appendix C). Taken together, the sites, zooarchaeological and archaeobotanical data are the representation of the

cultural landscape through locales rather than pinpoint locations. This approach conceptualizes individual sites as part of areas, landscapes or persistent places where HGs systematically use, learned through their past experiences, cosmology, folklore, religious beliefs, both through settlement and exploitative experiences (Lovis 2009; Schlanger 1990). These representative sites and locales are important as they form key sources of information used to extrapolate regional patterns of land use. Five key areas are described as locales; the confluence of the Shiawassee, Saginaw, Cass and Tittabawassee rivers (*hereafter Core*), areas adjacent to the Saginaw River valley and Saginaw Bay (*hereafter Lower River Valley*), the confluence of the Chippewa, Pine and Tittabawassee River (*hereafter Midland*), along the Cass and Flint river south of the Core (*hereafter Cass Basin*), and southwest sites near the present day St Charles area (*hereafter Shiawassee*). Information about locales is limited to basic information about location, seasonality, and material culture that relates to land use and diet choices (see appendices for detailed information).

The Core area includes the Hart and Kretz, Feeheley , and Schultz sites. The Hart site (20SA198) is located on a low sand knoll at elevation of 182.9 to 184.5 meters. The knoll is located on what would have been a small island in the delta of the Tittabawassee River during the LA. This site is similar to Feeheley, with a possible presence of a burial component at the north end. The Kretz site (20SA380) is located on a low sand knoll approximately 181.4 m amsl. Cultural remains include deep dense midden. The LA and Late Woodland component are present. The site is a low elevation site, sand dune occupation of a low peninsula extending into Shiawassee bay. Fish is identifiable and fragments of hickory, butternut, and black walnut are also present (Lovis 2009; Robertson 1987; Robertson, et al. 1999).

The Schultz (20SA2) site has the most extensive record of all the sites in the SBD, with a stratified sequence to which most other sites are compared. *Chenopodium* and maize is also found in MW contexts at the Schultz site (Allison 1972; Egan 1993; Fitting 1972; Fitting and Allison 1972; Lovis, et al. 1994, 2001; Luxenburg 1972; Raviele 2010; Shipman 2004). The Feeheley (20SA128) site is a repeatedly occupied LA campsite with a burial component located on a long sand knoll, part of a remnant dune system created after the Nipissing high-water stage of the glacial Great Lakes (Keene 1981b). The dunes form a thin arm of elevated land that extends into the Shiawassee Flats. Between the Nipissing and Algoma high-water stages, this arm of land formed an island or peninsula jutting into Shiawassee Bay. The site is likely a spring or summer camp for nearby Hart or Schmidt site inhabitants (Fitting 1975). Freshwater drumfish (*Aplodinotus grunniens*) yellow perch (*Perca flavescens*), brown bullhead (*Ameiurus nebulosis*), muskrat (*Onadata zibethicus*), chipmunk (*Tamias striatus*), and terrestrial gastropods typically found in damp woodland and marsh-border type environments. Carbonized seed and nut fragments were butternut, acorn, hickory nut, black walnut and one grape seed. Butternut is the most common. Wood charcoal includes red oak, white oak, pine, beech, blue beech, sycamore, black ash, ash, white ash, hickory, maple, white elm, slippery elm and basswood. (Yarnell 1964).

In the Cass basin, Weber I (20SA581) and Schmidt (20SA192) are sites with a summer occupation evidenced by the presence of turtles, large freshwater calcined bivalves. Lake Sturgeon is present at Schmidt, which spawns up rivers that are 2-15 ft in depth (Scott and Crossman 1973:84). White tailed deer (a fawn) is also identified at Schmidt suggesting an occupation at peak fawning period during late May and early June (Cleland and Kearney 1966;

Fairchild 1977). The Weber 1 site is located within an oak-hickory forest, occupants possibly collecting walnuts. Lamb's quarters and plums are present and collected from a diverse range of habitats. The Schmidt site, along the Cass River was occupied year round as a result of high resource densities and diversity is located on a ridge paralleling the Cass River (Cleland and Kearney 1966; Fairchild 1977; Harrison 1966; Keene 1981b). During the LA, the site would likely been a dune or beach environment near to the shore, facing northeast across a small estuary on the southeast side of Shiawassee Bay. Pits are infrequent at Schmidt and consist most of the shallow basin shaped hearths with little change in frequency of fauna between strata (Cleland 1966; Fairchild 1977; Harrison 1966).

In the Lower River Valley, the Fletcher/Marquette Viaduct/Defoe Park and Kantzler sites are key sites (Crumley 1973; Egan-Bruhy 2002; Lovis 1985, 2002; Lovis, et al. 1996). Fletcher site is a multi-component located on the west bank of the Saginaw River in Bay City, MI. This site has three identified locales including the Marquette Viaduct (southwest of Fletcher), Defoe Park (northwest of Fletcher) and Fletcher main locales. The Fletcher site occupations range from the EW to 18th century. The site locale is open woodlands on the inland of the site and on the 181m (595 ft) Algoma shoreline. MW occupation is present on a river levee (185 amsl). Marquette Avenue Site (20BY387) is the northernmost part of the complex (Lovis 1985). During the LA occupation, storage and smudge pits, and hearths concentrated along the edge of the 181m (595ft) terrace are present. The occurrence of cross-bedded gravel in the alluvial sequence suggests regular flooding of this surface.

This pattern is similar to Schultz site where deposition of alluvium and gravels takes place after A.D. 258-321 (Monaghan, et al. 1994; Speth 1972). Analyses of a midden shows

medium to fine alluvial sand divided into Middle and Late Woodland occupations. Smudge pits, hearths, roasting pit complexes and storage features. Features occur predominantly below the Marquette Avenue site. Fletcher (20BY28) is likely a spatially restricted site (not continuous) (Lovis 1985; Lovis, et al. 1996). The State Street site (20BY125) is the southernmost part of the complex with burial activities, groundstone tools, bannerstones, and birdstones in habitation contexts.

Wild resources dominate, while small numbers of cultigens are present as well. Wood charcoal from the MW component shows ring-porous taxa predominate with family/genus suggesting a dry, deciduous forest community (white pine, red pine, black oak, white oak) grew along the Algoma beach ridge, while a wet-mesic community (bur oak, swamp white oak, red ash, American elm) grew closer to the river. Nuts, seeds, and aquatic and terrestrial tuber in low densities are present. A small number of seeds including aster (*Asteraceae*), chenopodium (*Chenopodium* sp.), hawthorn (*Crataegus* sp.), huckleberry (*Gaylussacia baccata*), Virginia creeper (*Parthenocissus quinquefolia*), rose (*Rosaceae*) and figwort (*Scrophulariaceae*) are recovered from MW proveniences. The identification of chenopodium in different contexts during the MW period suggests that there is an intentional exploitation of these seeds. Most of these taxa are limited to disturbed habitats such as campsites and floodplains. Hawthorn and huckleberry are commonly exploited by native communities as well as aquatic tubers exploited during the spring and late fall for their starch content (Erichsen-Brown 1979).

Comparatively, the MW faunal assemblage is diverse with the inclusion of mammals, birds, reptiles, and fish. Clearly, a wetland focus is present (See Appendix C for site flora and fauna). Site characteristics suggest a series of warm season temporary camps (Lovis, et al.

1996). GLO survey data shows a southern deciduous wet-mesic forest community including elm, silver maple, ash, swamp white oak, and bur oak in the immediate vicinity. Mesic forest communities and prairie grew within 5 miles (8km) of the site. A system of sloughs within an extensive riverine environment was present at the site; over time these sloughs actively eroded portions of the levee on which the site is situated (Lovis, et al. 1996; Monaghan and Lovis 2006).

The Liberty Bridge sites (20BY79) sites are likely late summer to fall occupations with Durst and Meadowood points at 181 and 183m (595 and 600 ft amsl. 20BY79 is likely contemporaneous with late occupations at Kantzler. Hearths, smudge pits, caches, and large surface burns characterize the feature assemblage (Lovis 2002). A spatial partition of activities is present. Areas higher up on the terrace is used for butchering, cooking and plant food processing, while another area toward the foot of the terrace was employed for final tool manufacturing or retooling. Ritual material is present at the highest, most inland locations at the site; a cache of Turkey-tail points and a feature of red-ochre pigment (Lovis and Cleland 1993; Robertson 1987).

The Kantzler (20BY30) site is the southernmost site on the west bank of the Saginaw River located at 183 m (597ft) with a meter of stratified deposits. The site has been interpreted as a spring-summer fishing camp (Crumley 1973; Larsen 1973; Lovis 2009).

Approach

For each cultural period, an analysis of sites proximity, site type and occupation persistence to landscape features is catalogued. This association will yield associations at regional scale determined by density of sites, proximity to geomorphologic and cultural

features. These links with features yields landscape scale relationships and provide the basis of local level analysis. At the local level, site locales and archaeological assemblages can be matched with local scale natural features, patches, habitats and resource communities. Further, this allows for the archaeological fauna and flora to be analyzed by relationship of species present to resource communities, exploitative regimes (when animals were chosen), the relative makeup of the assemblage (strategy). How does location, occupation, seasonality, temporal persistence of sites relate to resources? This analysis is intended to identify patterns and changes in subsistence choices and settlement.

Next, two general statistical approaches are carried out. These spatial and quantitative analyses are employed to link the landscape and archaeological material culture. The first spatial approach is proximity techniques used to determine association of sites or group of sites with resource communities or other natural features. The second spatial approach is the identification of regional division of space undertaken by the use of Voronoi diagrams or Thiessen polygons. These are a decomposition of a metric space determined by distances to a specified discrete set of objects in the space, e.g., by a discrete set of points. These spatial diagrams evaluate grouping of sites to determine the organization of space with the use of key site types (residential and burial sites). These sites can be compared to the distribution of sites to determine spatial patterning of sites.

Second, a quantitative approach is used with faunal and floral assemblages in order to determine diversity and change over time. Due to sampling and variable preservation issues, it is difficult to directly measure absolute exploitation rates, although documenting 'relative' change in use is possible using ratios of identified taxa from sites of varying ages. Therefore, I

tested corollary implications of the models, (i.e., that specific species make up increasing proportions of the subsistence base resulting from changes in diet choices). I calculated simple ratios from dated site components, comparing the frequency of specific species (large & small mammal, fish, and plant foods) to other similar products and evaluated the existence of temporal trends in specific species use. This also allows for the observation of evidence for wetland specific resources, resource depression etc. The relative use of resources can be understood through variable indices. Indices are ratios with values from 1-0 (e.g., frequency of ungulate bones/frequency of all bones) or frequency of cervid bones/frequency of cervid + small mammal bones and so forth). This approach provides a relative comparison of resources exploited and change over time. By developing ratios comparing abundance of mammals, fish, birds, and shellfish to each other, we could understand the possibility that people shifted their reliance over time in responses to declining abundance in preferred prey.

Next, diversity analysis using Simpson's Diversity index is conducted to determine the implications of archaeological sites with faunal and floral remains to ascertain the seasonality and association with land use and diet choices. Diversity analysis measures how the number of specimens is distributed among predetermined classes under investigation (Baxter 2001; Kaufman 1998; Kintigh 1984, 1989, 1990).

Two dimensions of diversity are computed: richness, which measures the number of different classes present; and evenness, which measures the uniformity of distribution of relative proportions of these classes (Bobrowsky and Ball 1989; Kintigh 1989; Leonard and Jones 1989). The diversity index will result in richness (i.e., large number of species) and evenness (i.e., low to high breadth of diet species) scores given the types of exploitative

behaviors and coping strategies employed. The rationale is that a site is occupied for longer duration will have a greater number of species present resulting from the exploitation of multiple patches and habitats. Additionally, the presence or absence of key features (e.g., refuse, storage, burials) related to residential sites and possible adaptive strategies employed for uncertain environments. For example, short term sites during warm weather occupations with no hearths has limited remains, whereas the structures used for cold weather may be more substantial and has more material remains.

Table 8. Site diversity		
Diversity Measures	Low evenness	High evenness
Low richness		Short term sites Limited activities
High richness	Long term sites	Intensive exploitation site

Diversity and density of species can indicate different types of sites, therefore exploiting diversity of patches. Longer occupations will exhibit greater diversity of plant and animal species. These variables will provide an understanding of archaeological site types and subsistence strategies.

Table 9. Site occupation diversity		
Site types	Low diversity	High diversity
Low density	Short term specialized task	Short term residential
High density	Long term specialized task, reoccupation	Long term residential

The diversity calculation allows components of a site can be viewed in a continuum (i.e., from small ephemeral limited activity areas to large residential bases where many activities would have occurred) based on the faunal and floral assemblages (Bettinger 1979). Sites are ranked based on different assemblages along a scale of relative diet breadth intensity rather than

specific site categories (Thomas 1989):91. This analysis can be used by employing a jackknife or bootstrapping approach, which can be alternative method to address theoretical and methodological critiques with simulation and regression approaches that quantify diversity among sites and assemblages (Grayson 1984; Kintigh 1984, 1989). Specifically, a jackknife approach entails a resampling technique through repeated calculations of data and removing one of the original observations after each calculation, resulting in a series of jackknife estimates. Comparative population models, assumptions about, or knowledge of structure of the original data is not needed. Like the regression and simulation methods, richness and evenness scores for the data are computed. The richness and evenness scores can be tested statistically to determine if the observed differences are real.

The spatial and diversity analyses provide an operational model of subsistence strategies (i.e., diet, settlement and coping) and group social relations. Stated in this way, prehistoric HG groups can exhibit patterns of behavior where assemblage with high to low diversity with relative richness and evenness scores. For example, high richness and low evenness scores indicate a residential locale with diversity of animals exploited from different patches nearby or afar. A locale with high richness and evenness scores can be a place where HG residential base with exploitation from different types of patches and resources. Conversely, we should be able to identify sites that do not fit a specific expected profile; a site with high evenness in an abundant resource setting suggesting a strategy intended to exploit specific set of resources in a place of plenty. The pattern of site locale and organization or diet choice individually may be analytically ambiguous; the combination of both locales adjacent to

wetland landscapes and changes in pattern in diet provides stronger evidence of diet choice in the SBD.

Results

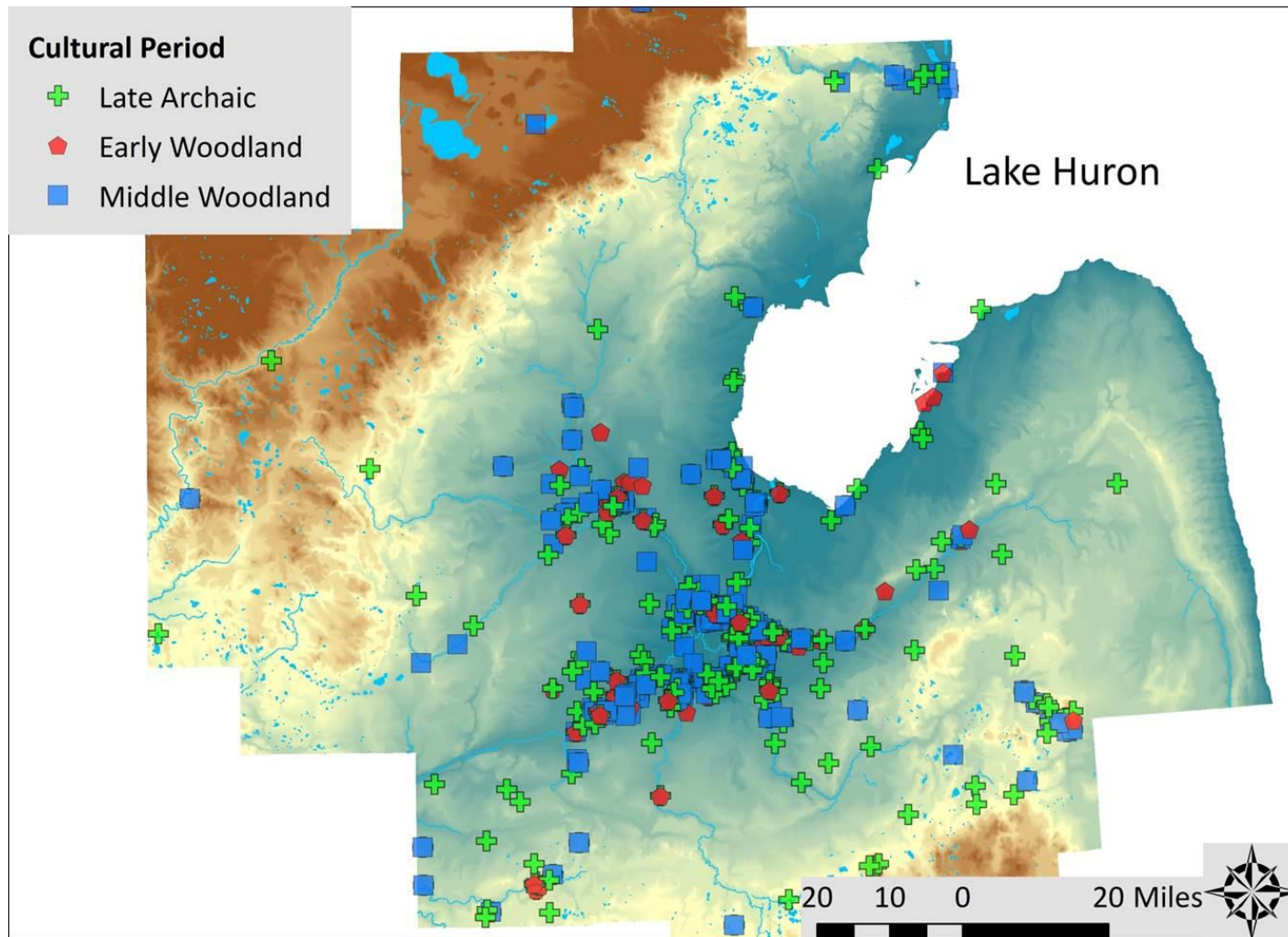


Figure 27. Persistent places

Five separate clusters are present. In addition, a cluster is also present headwaters of Flint River.

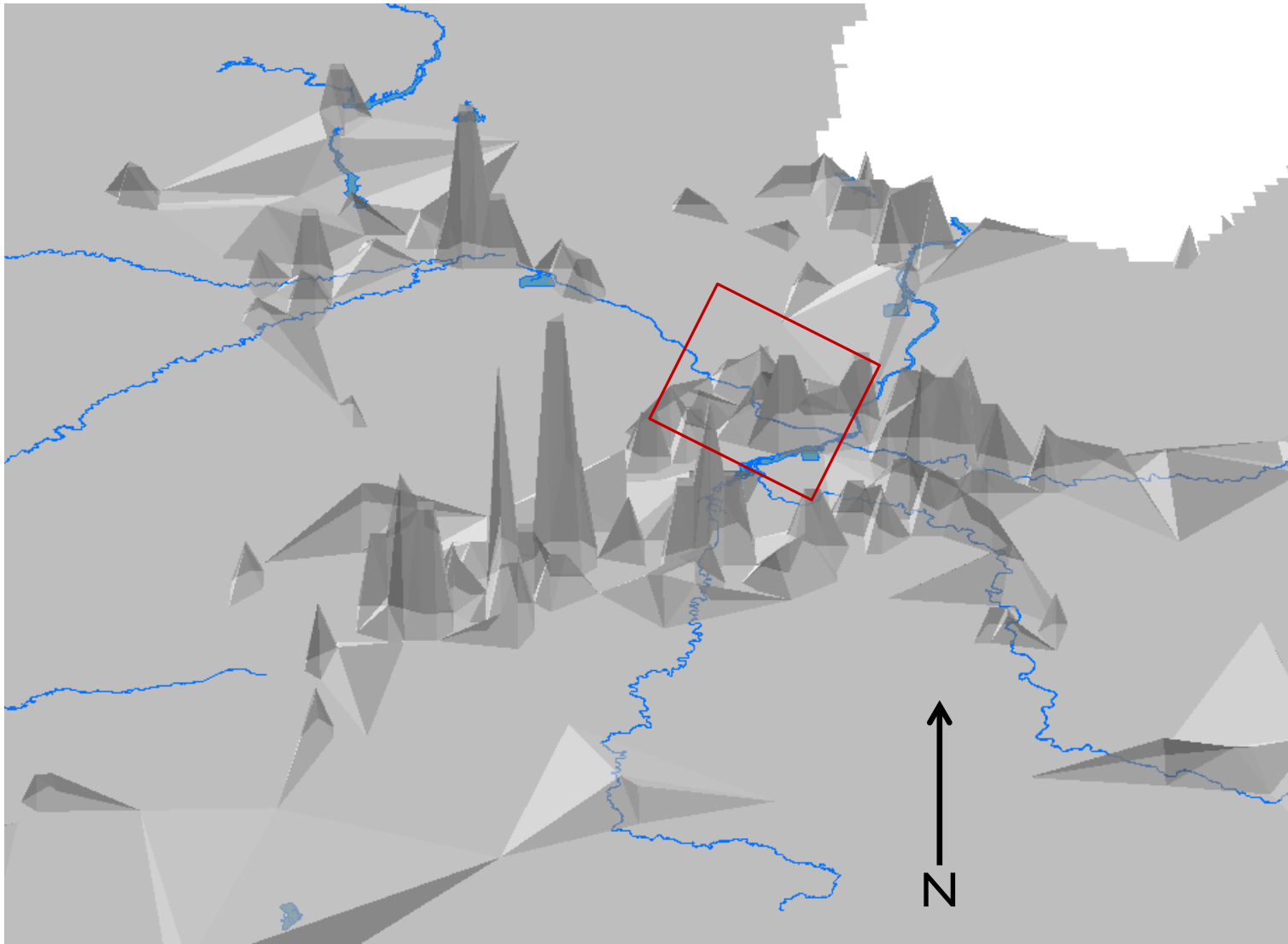


Figure 28. Site density map (Saginaw County in inset)

Beyond the Saginaw core, the larger region has considerable number of sites.

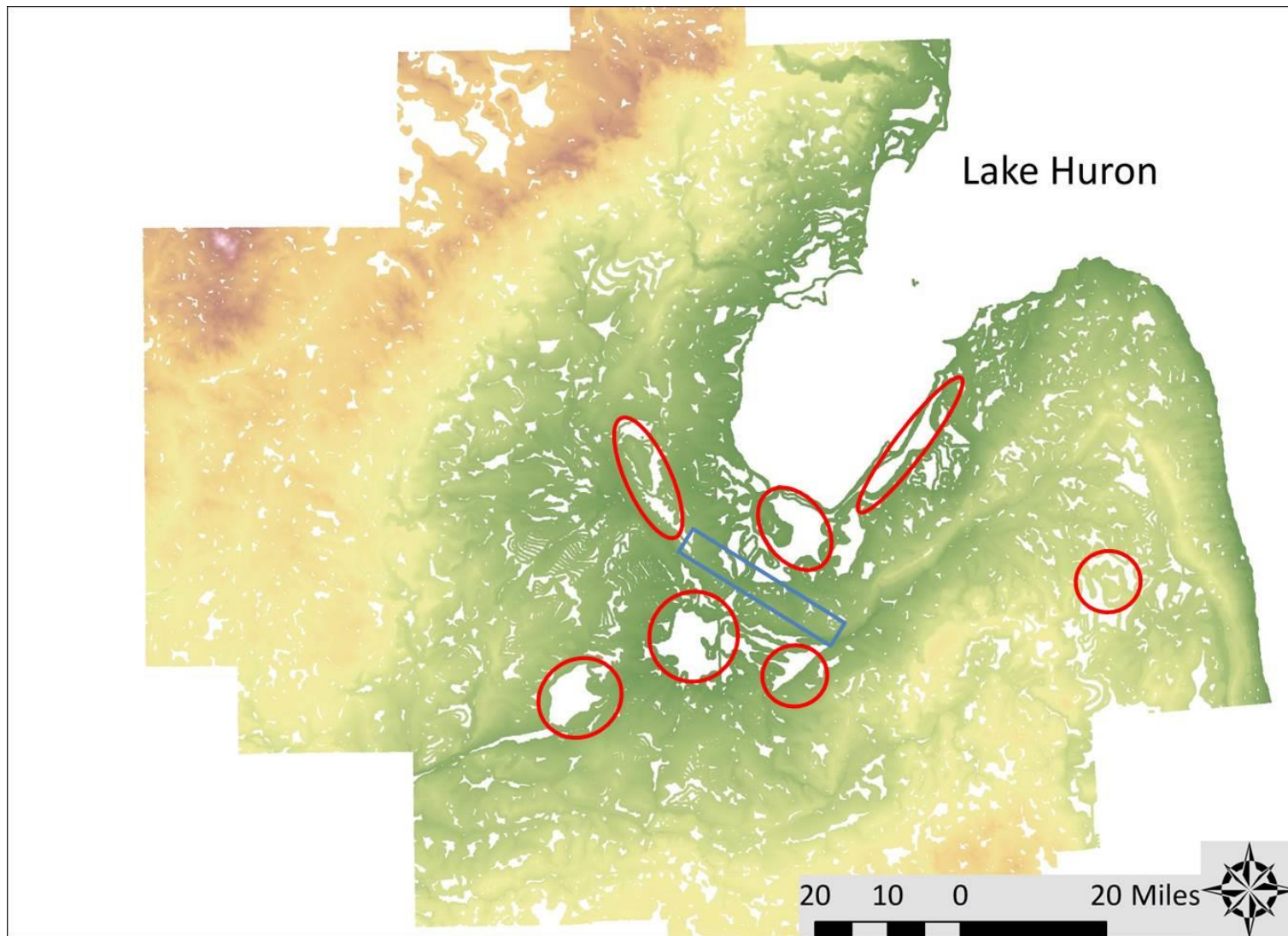


Figure 29. Local base levels and moraines

The moraines overlook local base levels (white areas) of major river networks. These flat areas are ideal locations for pooling of water seasonally and during the LA and to a lesser extent during the MW. Majority of sites are located in proximity to these habitats.

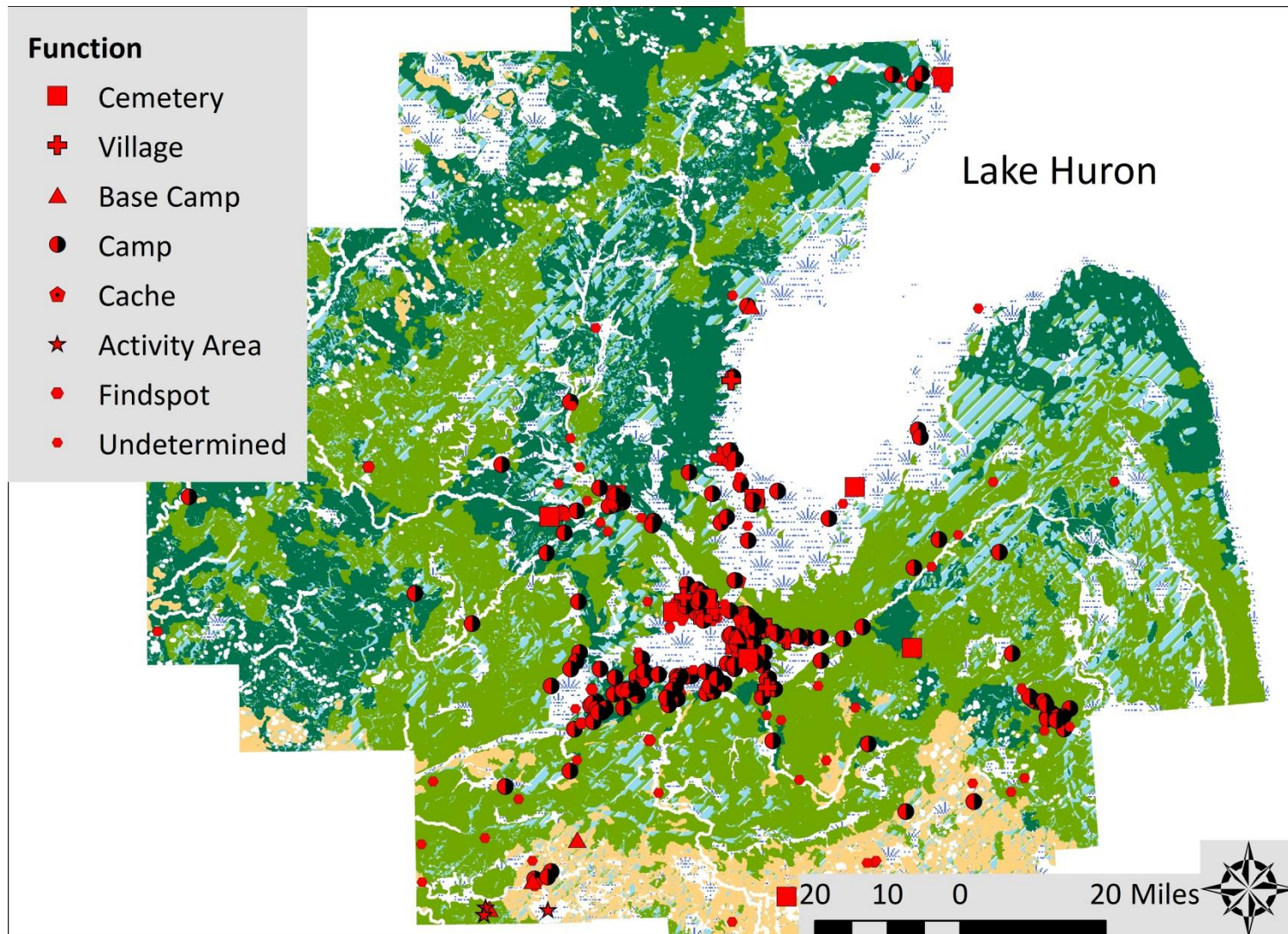


Figure 30. LA sites and land cover

LA sites are located wide spread and adjacent to ephemeral wetlands and major river courses. A number of sites are uniquely located boundaries of wetlands and hardwood forests. Note: see Figure 10 for land cover legend.

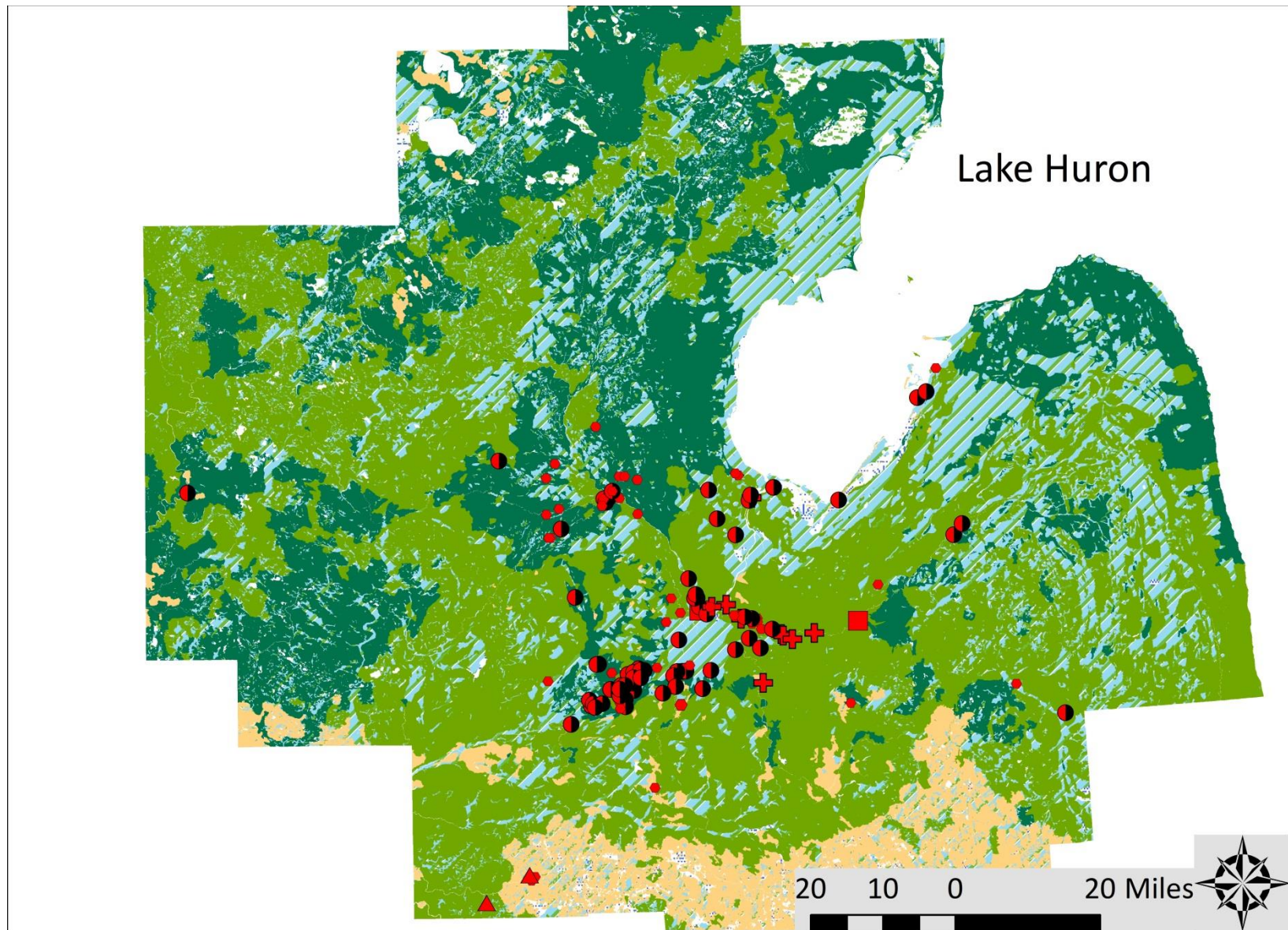


Figure 31. EW sites and land cover

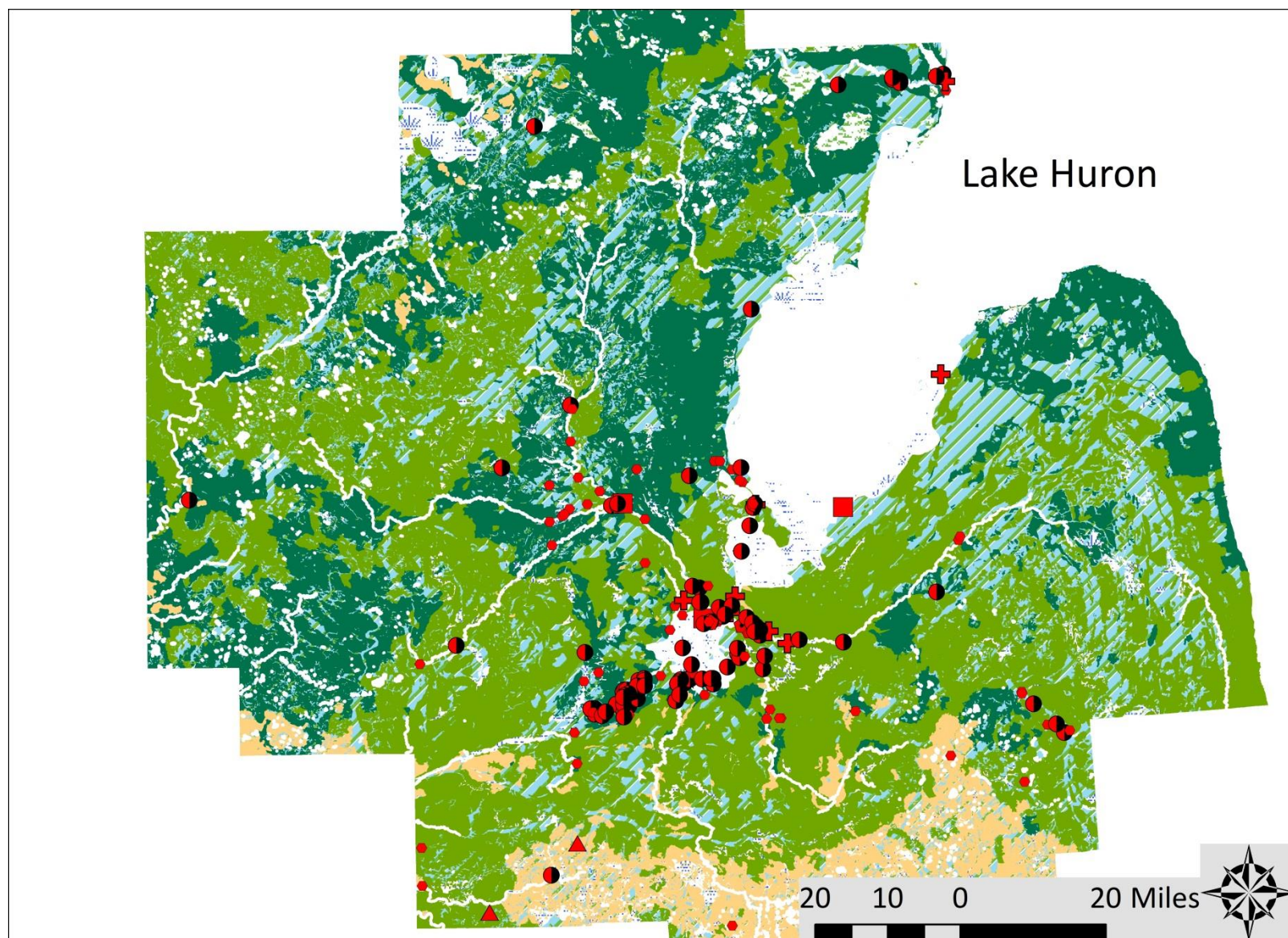


Figure 32. MW sites and land cover.

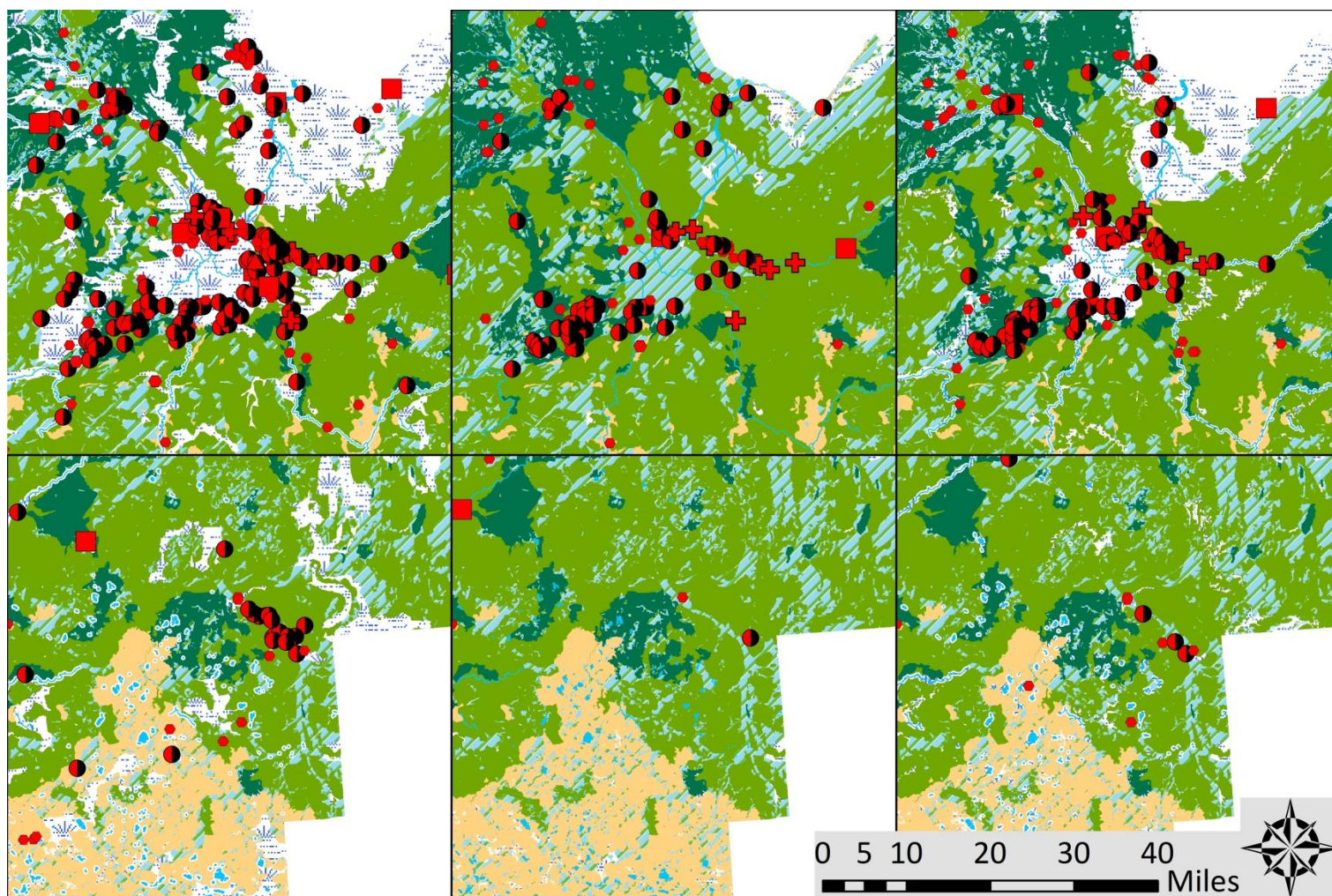


Figure 33. Saginaw and Lapeer County sites and land cover

Sites are numerous and varied in the Flint and Cass River headwaters, with higher site densities during the LA and MW periods. The EW residential sites are located closer to the Core with camp sites further upstream. Conversely, both LA and MW sites are distributed along river networks and along the coast, all of which are adjacent to large wetlands and beech-maple forests. Note: LA (left), EW (middle), MW (right)

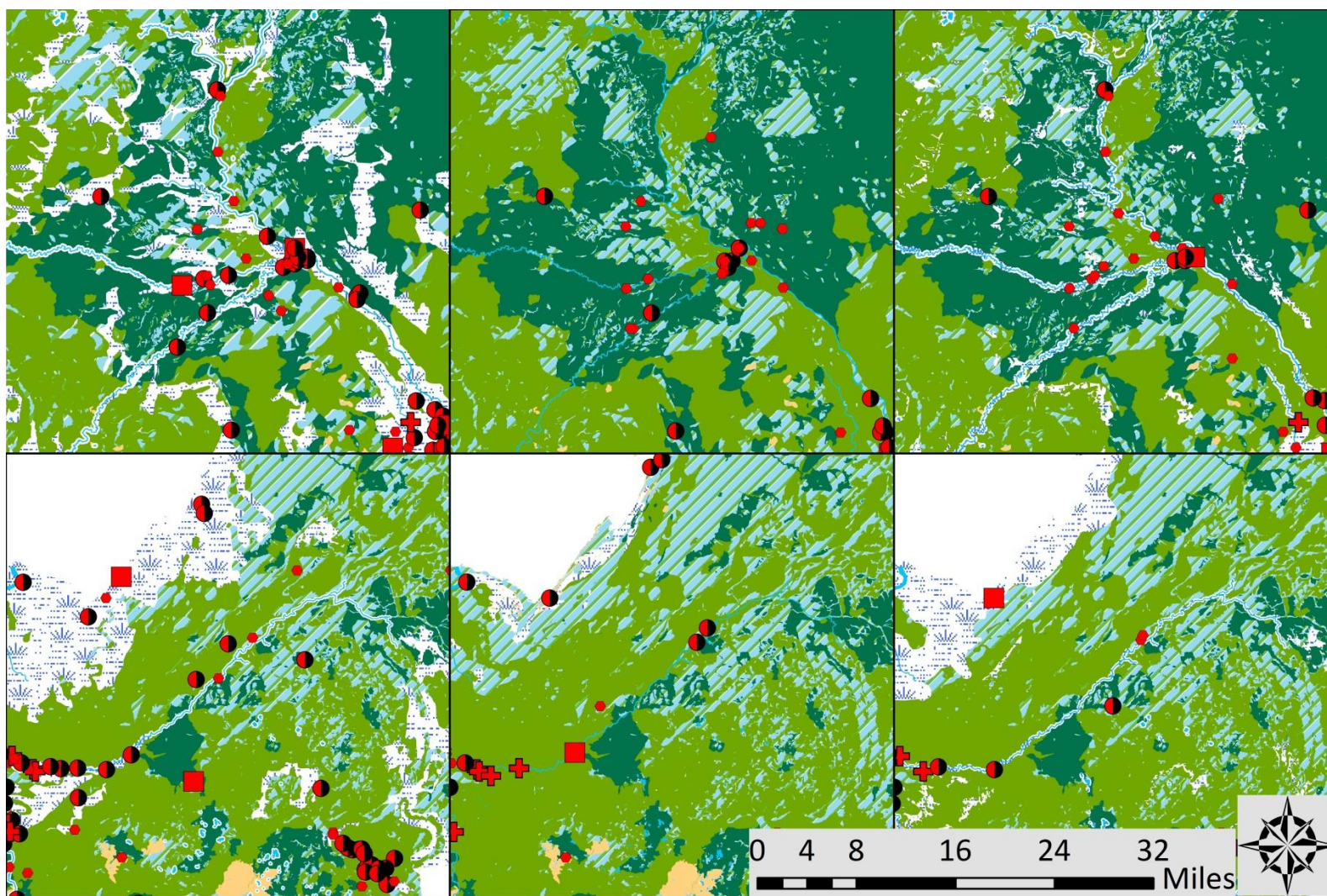


Figure 34. Midland and Tuscola County sites and land cover

LA, EW, and MW sites are adjacent to large transitory wetlands. Wetlands decrease from LA to EW in Bay County coincides with decrease in site type and density during the MW period. See earlier figures for legends

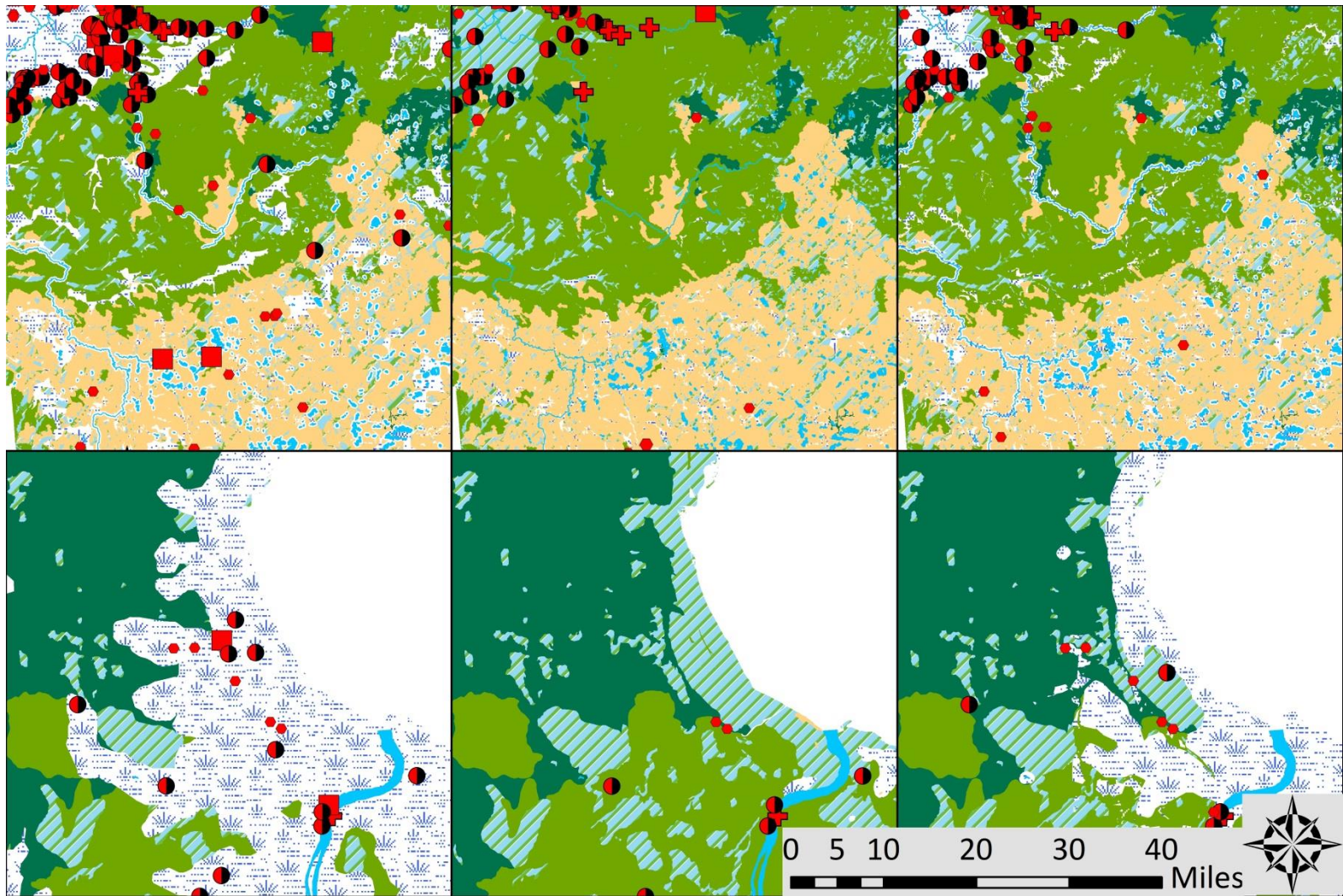


Figure 35. Genesee County and Tobico Marsh areas sites and land cover

LA sites are oriented and surrounding transitory wetlands and along extending tributaries. EW and MW sites are located along tributary networks with larger residential sites focused to the south.

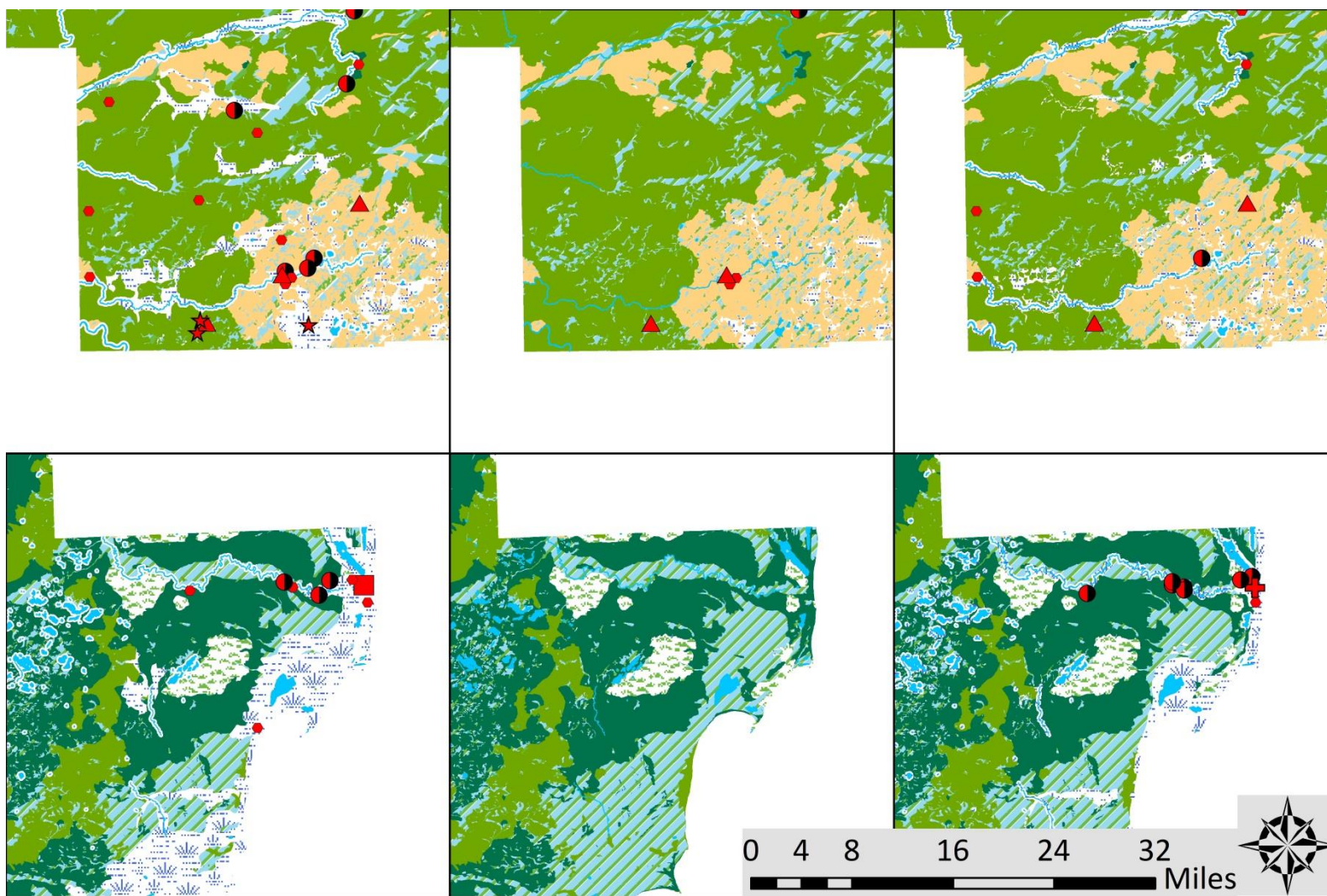


Figure 36. Clinton and Iosco County sites and land cover

Sites located at the river confluences and wetlands show comparable densities with longer term site types present during the LA and MW periods. Genesee sites at Cass River headwaters are located along Beech-Maple forests and adjacent to sites southeast.

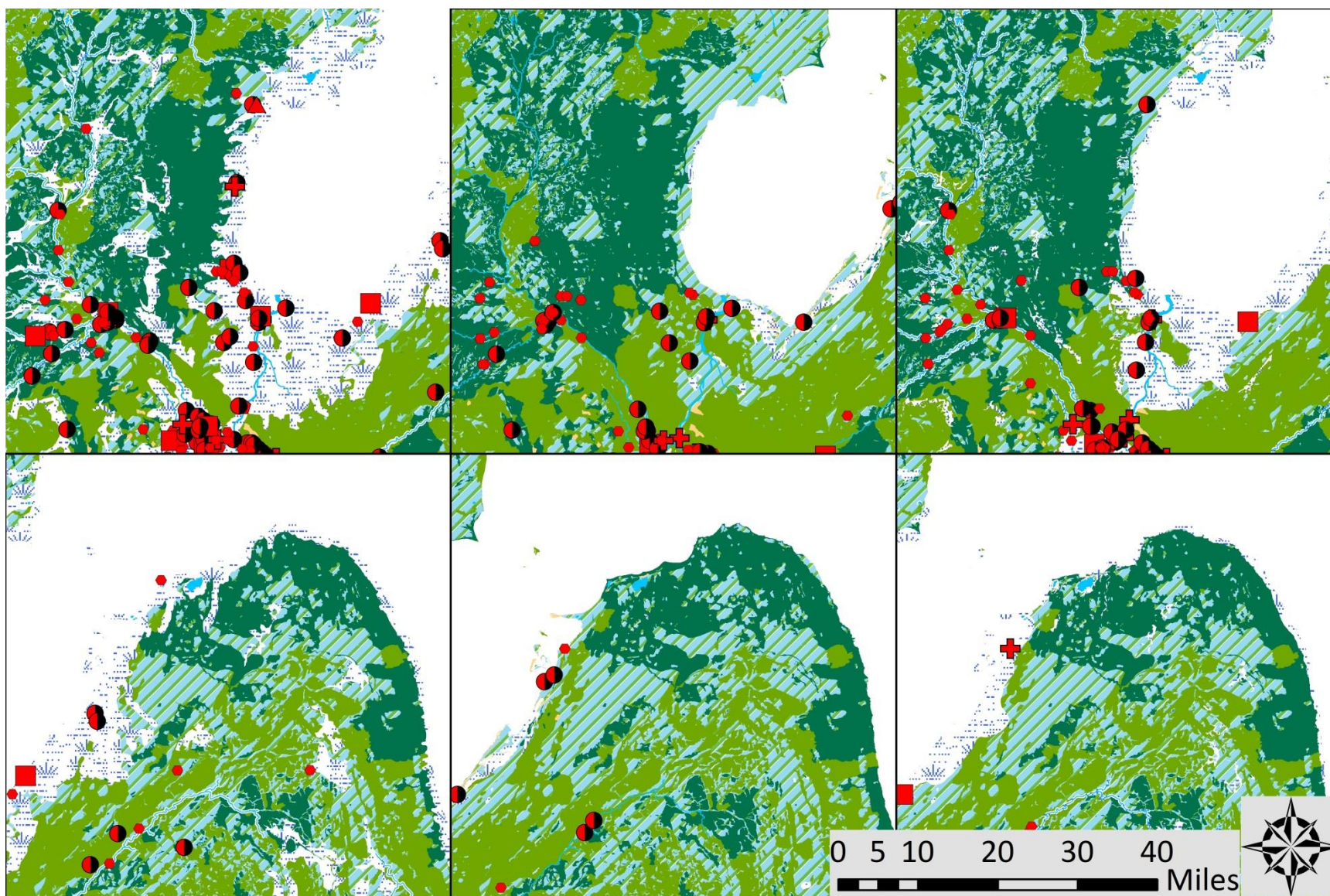


Figure 37. Bay and Huron County sites and land cover.

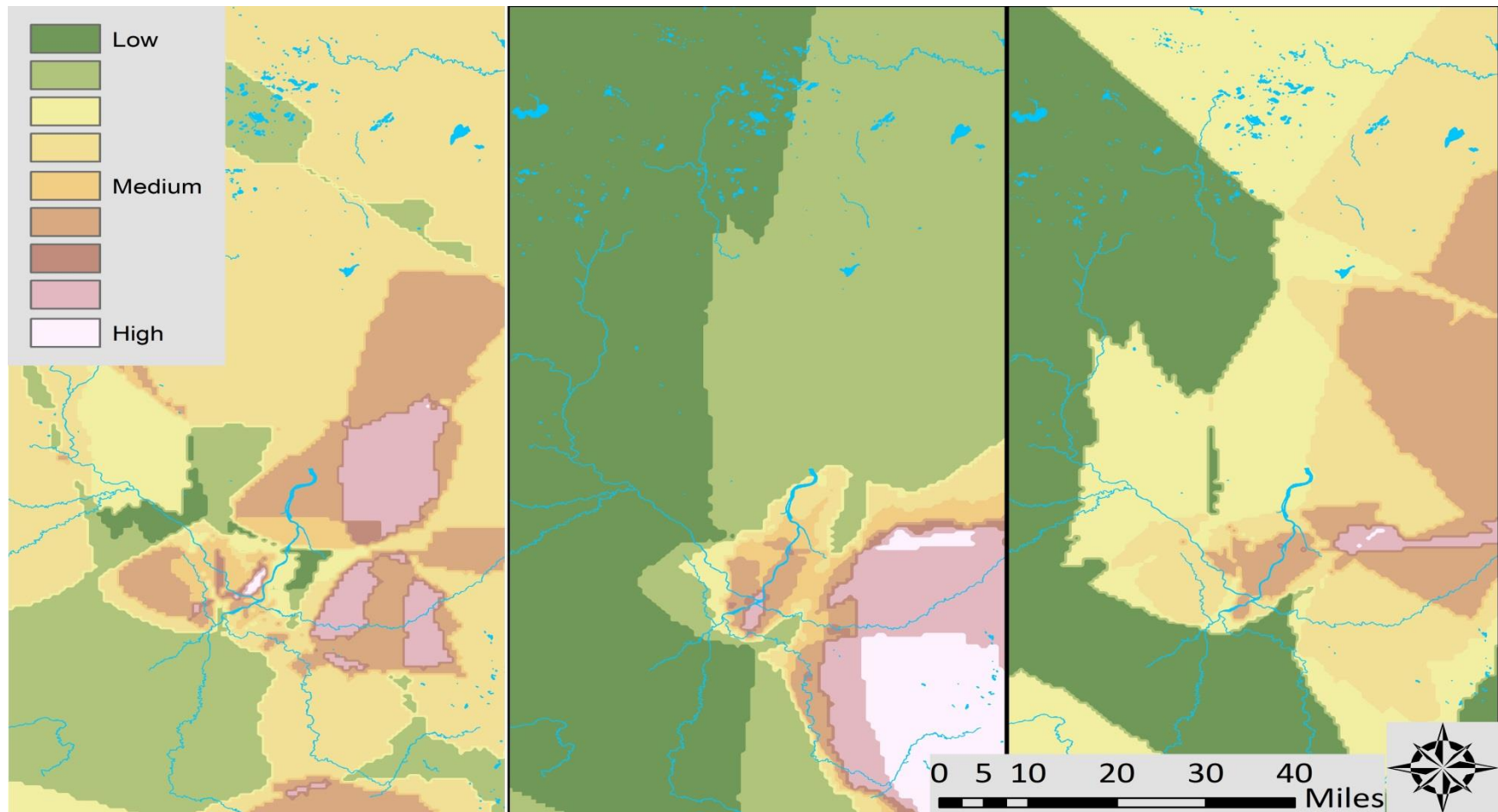


Figure 38. Site interpolation (kriging) .

Spatial statistical method interpolating the presence or absence of sites based on site densities. The method is based on the relative weights of key site types (burials and residential). Kriging allows for the prediction of sites between these areas. The LA sites are located throughout the region along large river networks. EW sites are focused to the southeast (Cass and Flint rivers) and Core wetlands embayment locales, whereas MW sites are limited to the Core embayment area. This interpolation of site densities may also show presence or absence of interaction networks from SBD and other adjacent areas. Note: LA (left), MW (middle), EW (right)

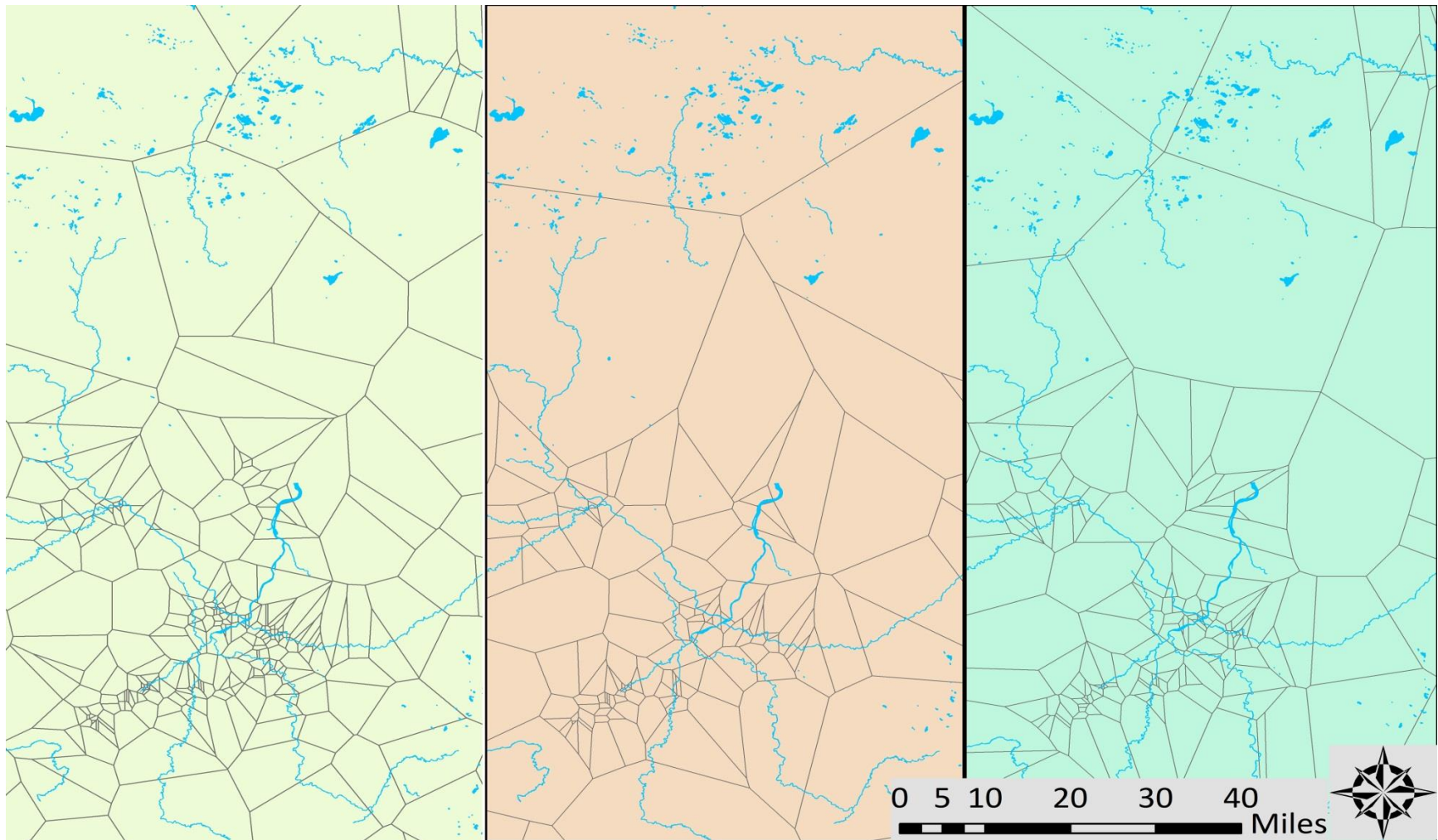


Figure 39. Thiessen polygons

Spatial compartments are used to divide space into a number of regions. Using residential and sacred sites, polygons are identified; these can be used to potentially identify territories. The LA territories are numerous and densely packed. EW and MW are considerably smaller with greater focus on the Core and River Valley persistent locales. Note: LA(left), MW (middle), EW (right)

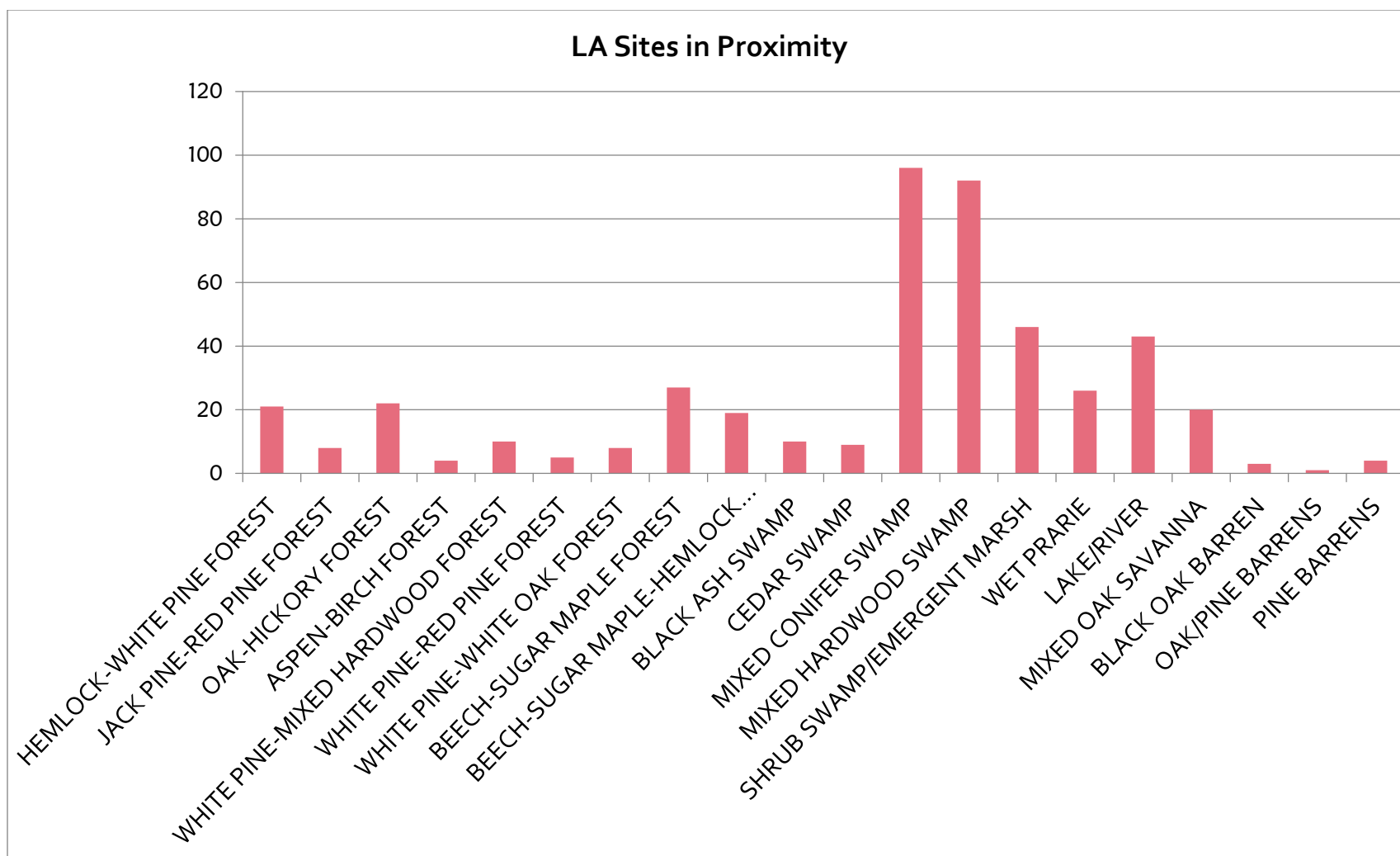


Figure 40. LA sites in proximity to resource communities

Most LA sites are primarily located adjacent to mixed conifer and mixed hardwood swamps. The LA sites are found in most diverse habitats, followed by EW sites. MW site diversity is lowest, at half of the LA levels. Proportionally, MW sites are wetland dominated, whereas LA and EW sites are more diverse. Note: also see Figure 41.

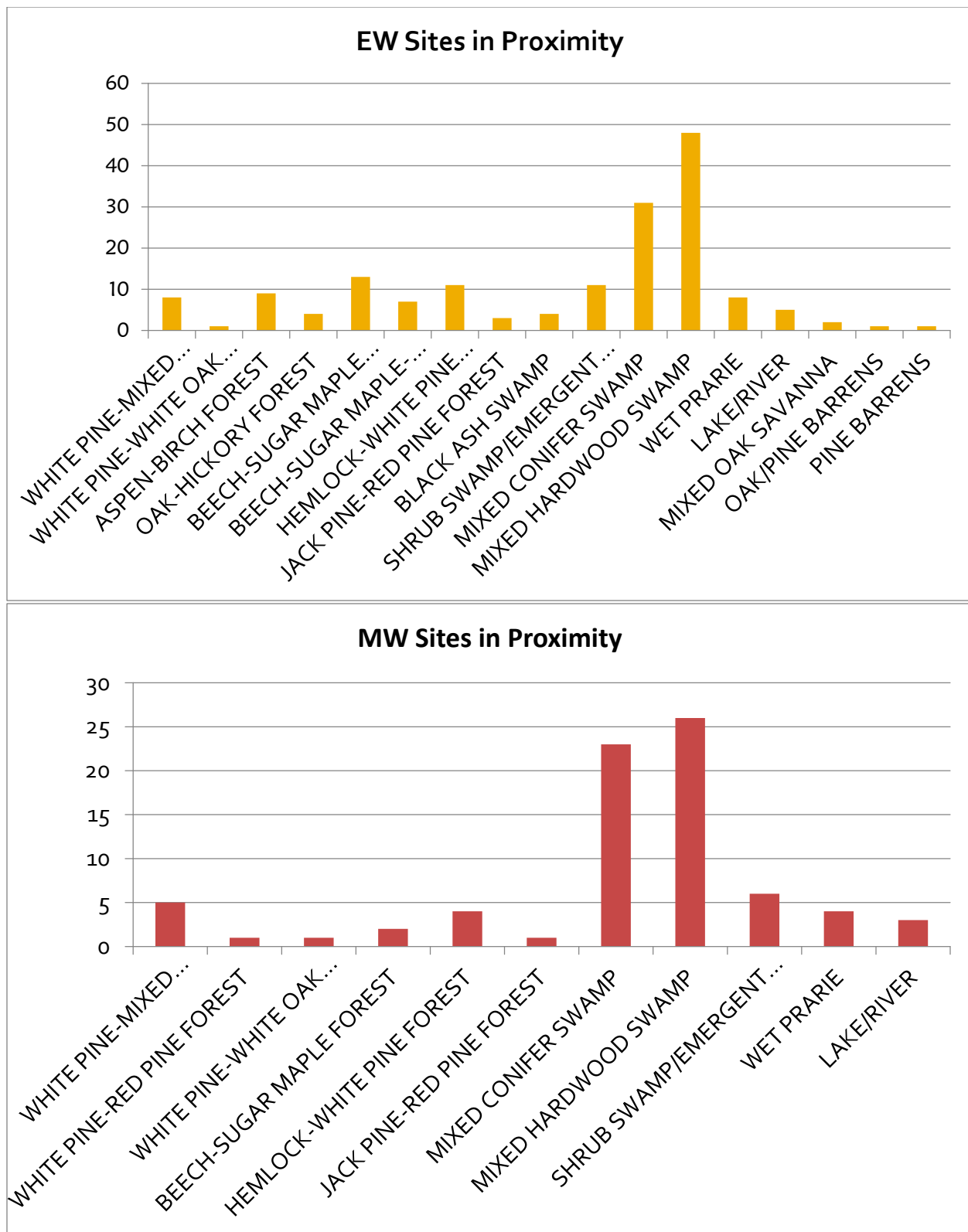


Figure 41. EW and MW sites in proximity to resource communities

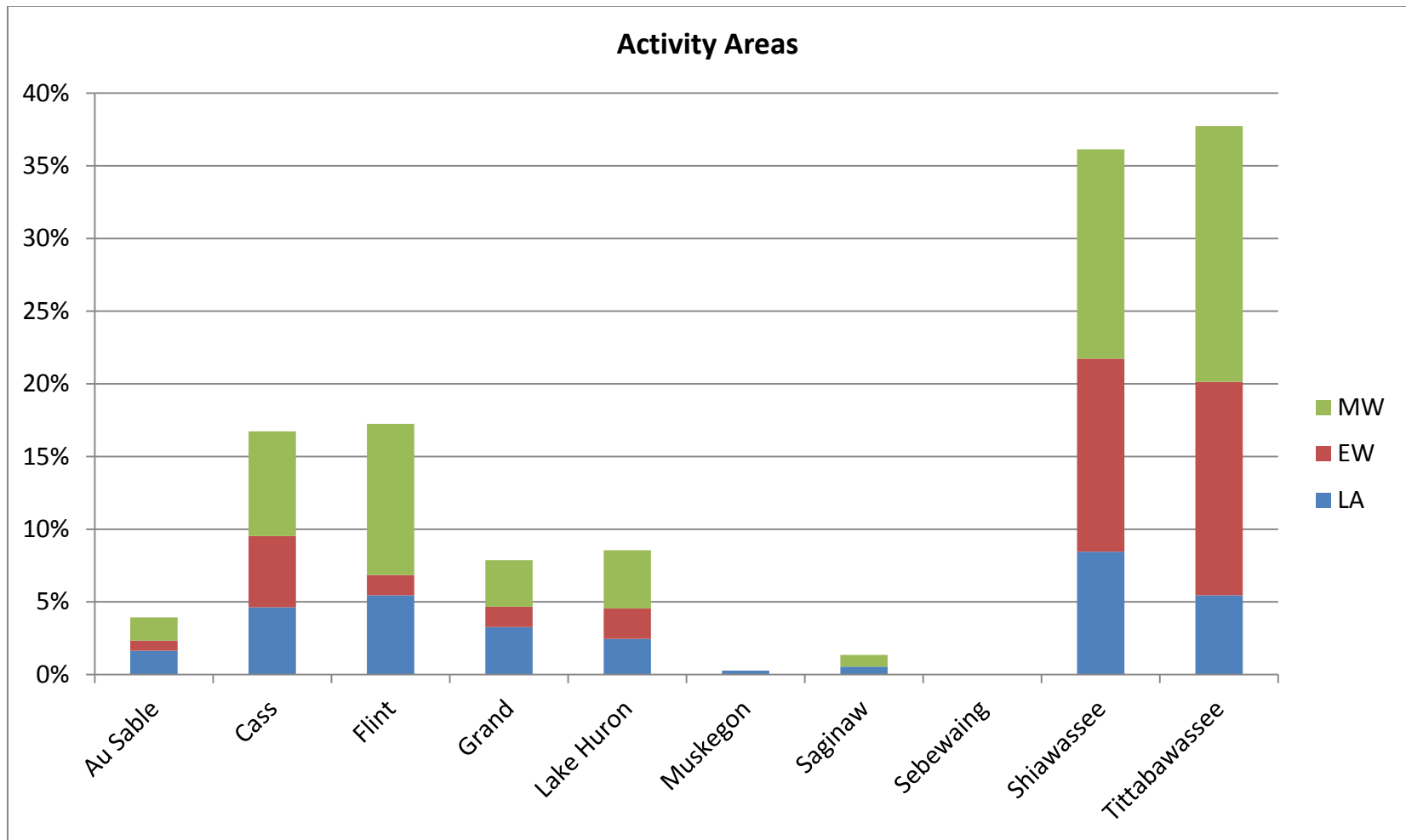


Figure 42. Activity areas

Activity sites increase over time from LA to MW.

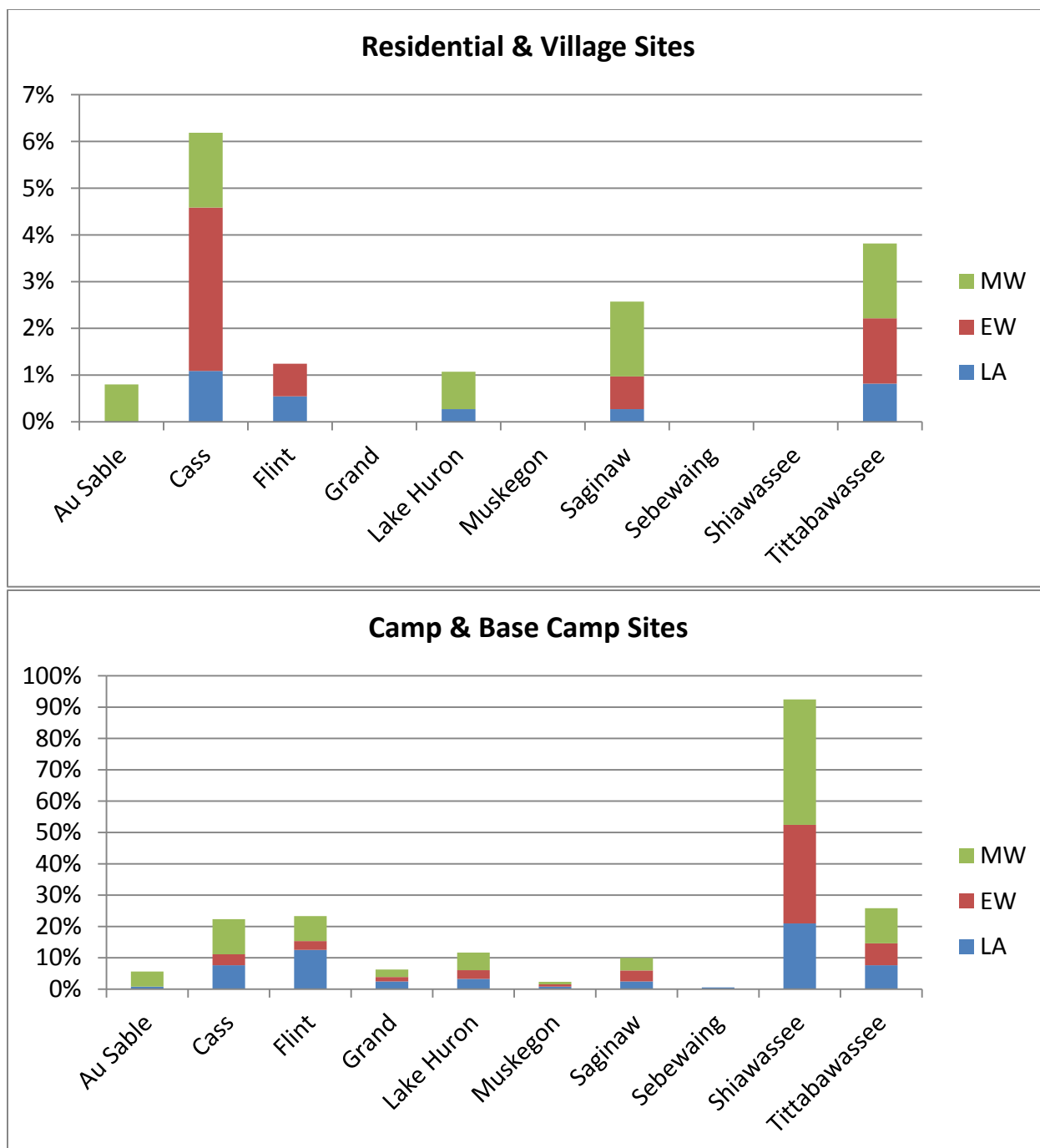


Figure 43. Site type change by river basin

Residential or village sites shift locations between drainages; from the north during LA to the south in EW. EW residential sites increase considerably in the Cass and Flint drainages. Saginaw and Tittabawassee drainages importance increases from LA to MW. Base camps locales are similar amongst the three periods.

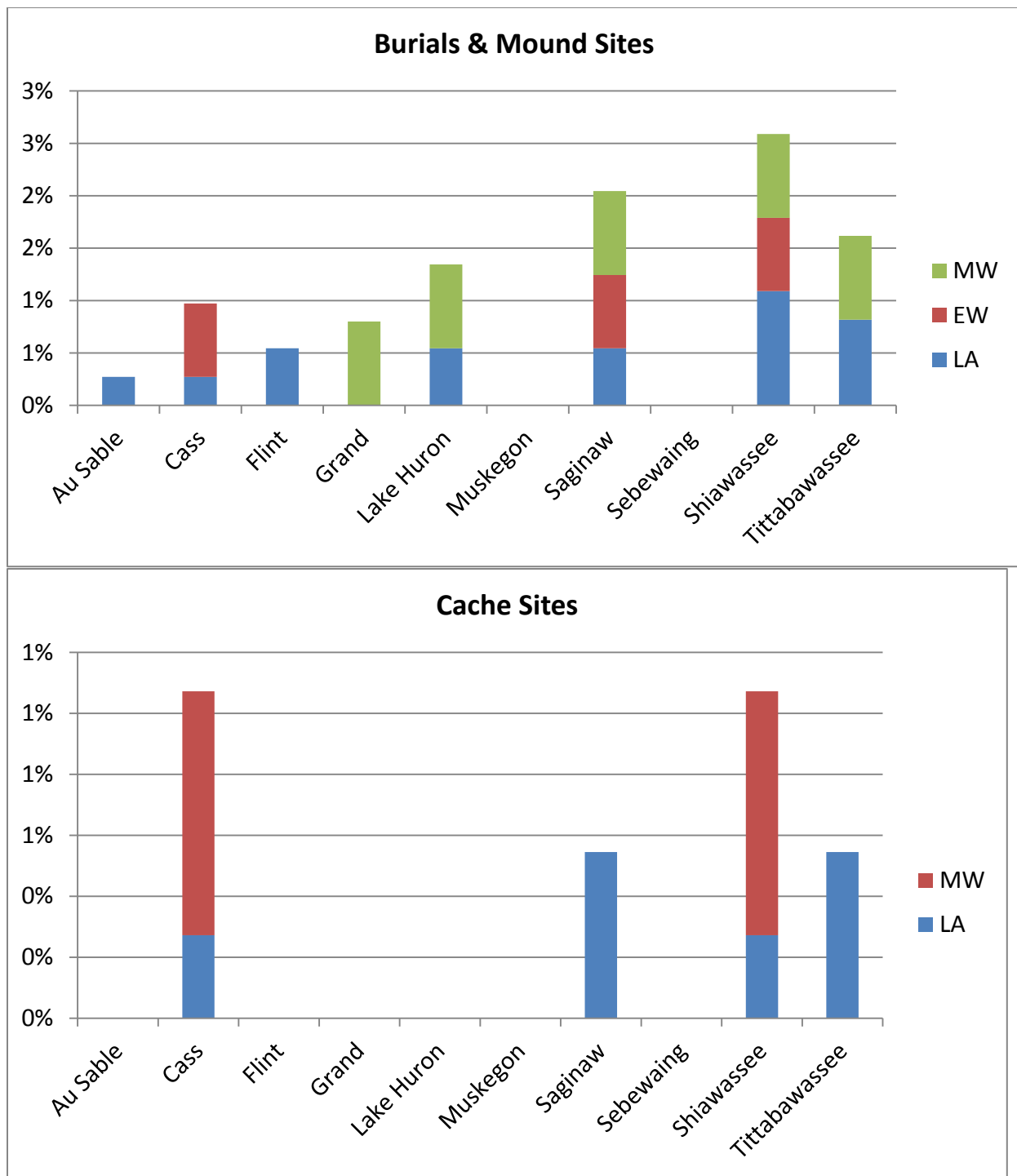


Figure 44. Burial and cache sites change by river basin

Cemetery and mound sites are found mostly in LA and MW periods, primarily focused on the Shiawassee and Saginaw drainages. These sites are nonexistent in the EW, with the exception in the Cass drainage. Cache sites indicate places where they likely revisit on an annual or semi-annual basis.

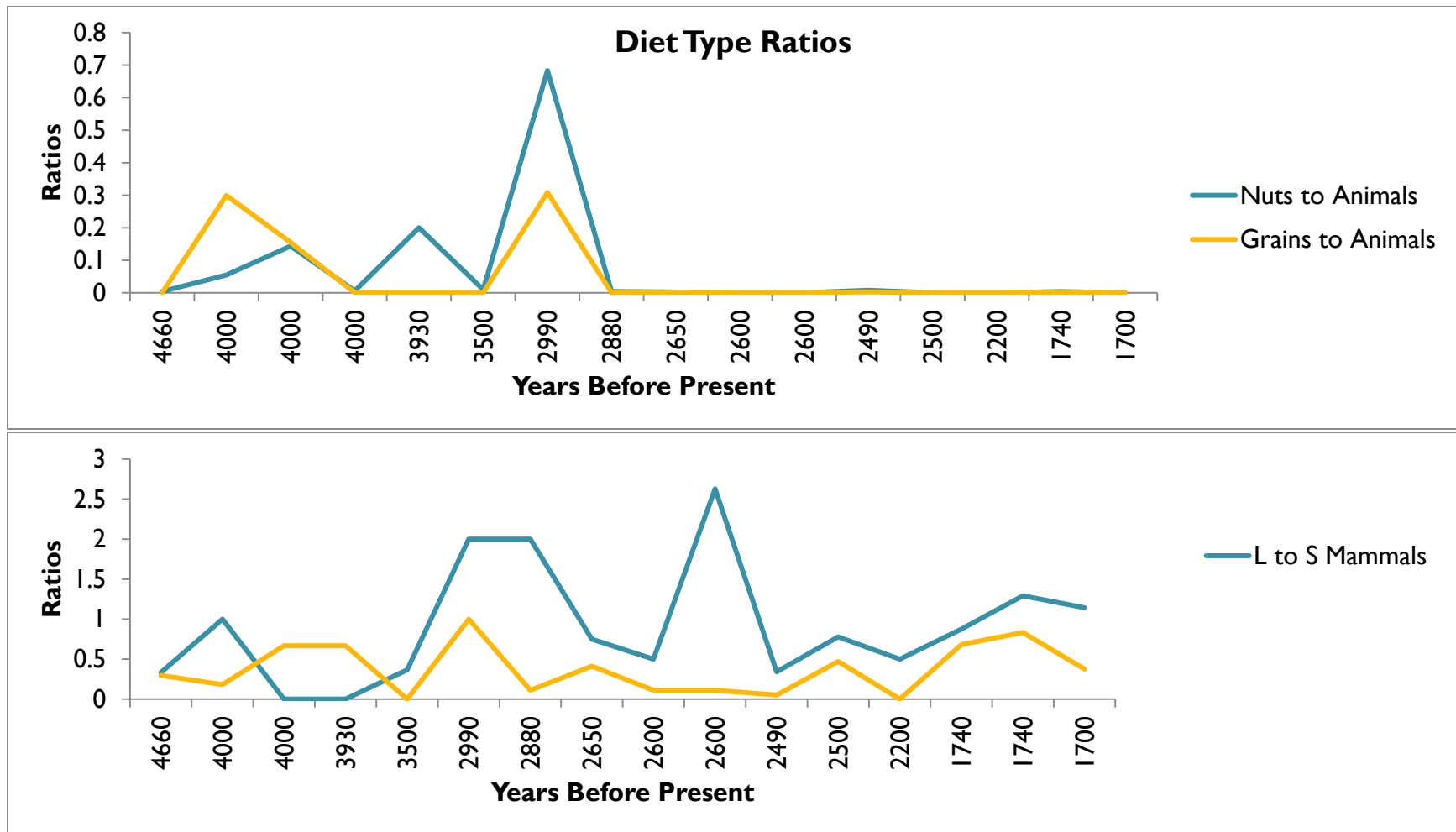


Figure 45. Diet ratio indices over time

The importance of large mammals, increase during the terminal LA and EW periods. Nuts and grains increase in importance through LA. The importance of large and terrestrial animals increases during the MW.

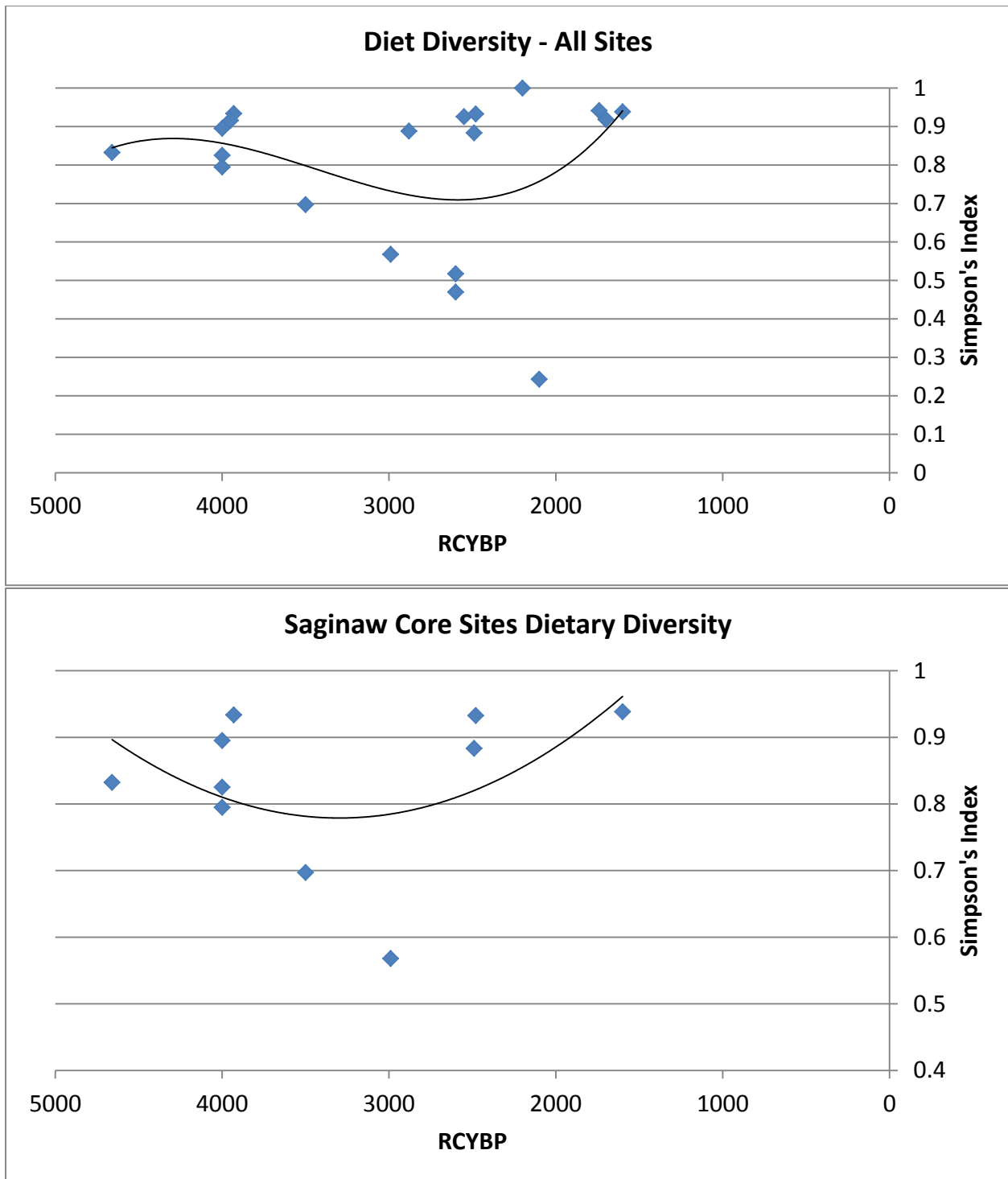


Figure 46. Simpson's diversity index

Diversity of resources exploited in the Saginaw Core remains steady. The Schultz site shows a moderate increase in dietary diversity. Sites away from the core show both a lack and abundance of diversity.

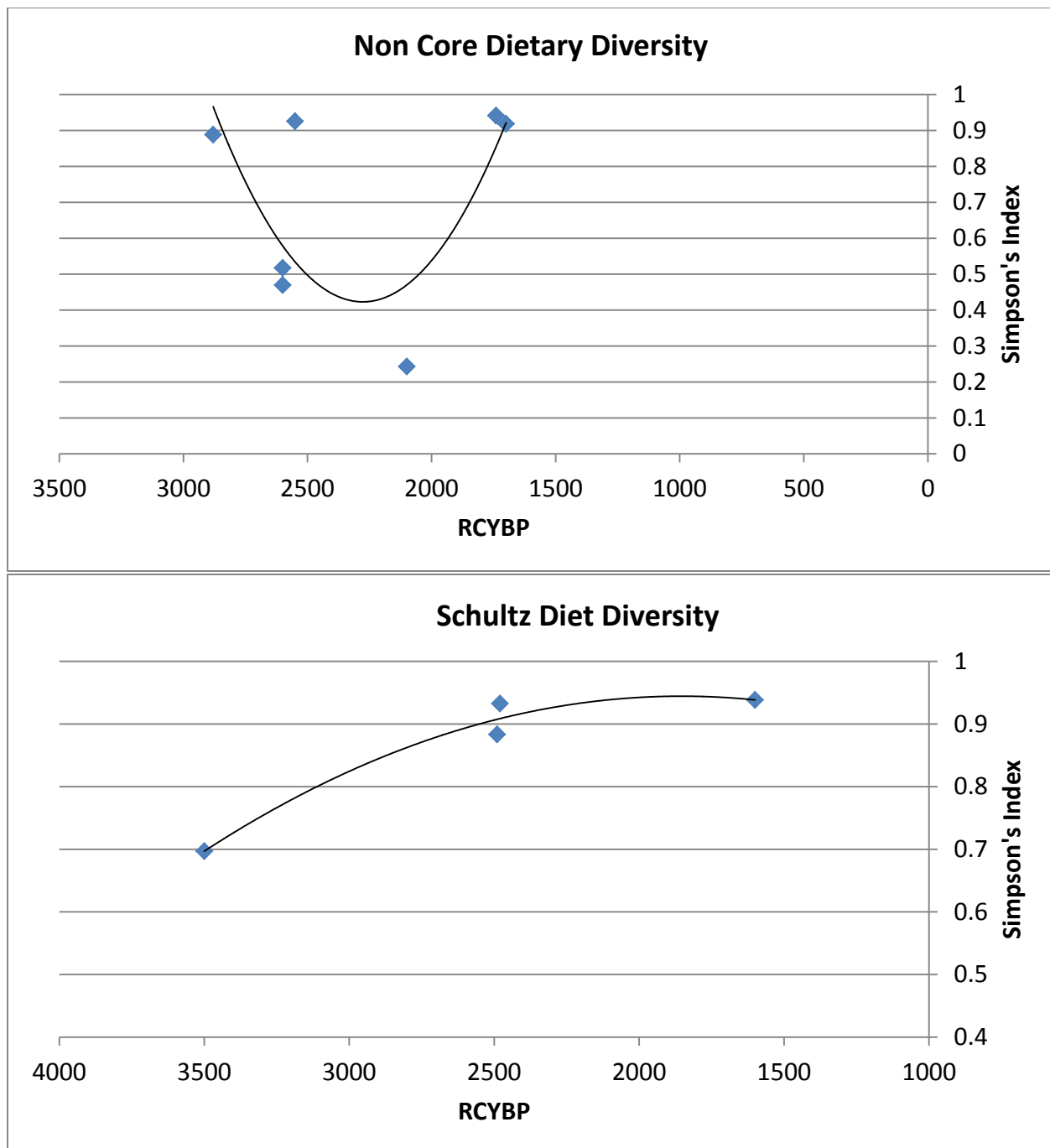


Figure 47. Non core and Schultz diversity index

The regional analysis shows that resource diversity changes considerably. The diversity decreases from LA to EW and increases in MW. In the EW, HG exploit low diversity sites for specific resources, while concurrently exploiting other reliable sites with a greater diversity. HG tradeoff the exploitation of specific sites by expanding the diet breadth at more reliable and dependable sites.

Discussion

The land use and diet analysis presents a few revealing insights into the economic behaviors of HGs in the SBD. The outcomes are an expansion and refinement rather than a departure from existing models of HG land use and diet choices in the study area. At a regional level, analysis of site locales provides an account of land use during the study periods and change over time. First, five persistent locales are occupied in all study periods. These persistent places are identified as the Core, Lower River Valley, Midland, Shiawassee, Cass Basins and a cluster of sites along the Flint headwaters at the border of Flint drainage. (see Figure 27). These persistent places highlight longevity and regional nature of land use in the SBD. These places contract and expand remain as a dominant feature of the landscape throughout time suggesting considerable ritual, economic and cosmological importance.

Land Use

The locales highlighted are associated with key natural features including local base levels, river systems, and wetlands. The resource communities present in locales are heterogeneous and bounded by homogenous forest communities of hemlock white pine forests to the north, and beech maple forests to the south. Site locales adjacent to wetlands and riverine areas provide access to diverse natural resources such as fish, mammals and plants (nuts, seeds); evident early as the LA continuing through the MW. The key factor that determines productivity may be the wetlands present and large scale influence on resource landscapes at any given period (see Chapter 5). The overall stability of this resource base sustains the foraging economy. During periods of climate deterioration and wetland contraction, people modified their economy by incorporating buffering strategies, including

long distance mobility, storage, exchange of food stuffs and network of exchange relationships both within different areas of the SBD and larger regional landscape to the north and south.

First, LA sites are distributed regionally, along the nexus of river networks, drainage boundaries, along upland kettle lakes and linked to the local drainage base levels toward the southwest and along the Saginaw Bay shoreline. Predictions of site distributions show a patchwork of heterogeneous site locales across the basin region (see Figure 38). Analysis of spatial partitioning based on burial, village and mound sites shows large dense cluster radiating outward into larger segments covering the entire study area signifying regional cultural landscape. Spatial partitioning also shows a clear southeast and southwest orientations of partitioned space. These partitions could mirror resource extraction zones or possibly territories as they also bisect multiple river basins and drainages. Location of sites of different types shows culturally important sites along the Core area and along key tributaries of Tittabawassee, Shiawassee and Saginaw river basins. Culturally important village, burial and mound sites are located primarily on the Shiawassee Rivers. Base camps and activity areas are present further along major river networks along both biotic provinces (see Figure 40). Last, coastal sites at the Saginaw river mouth and along wetland fringes play an important role.

Second, EW sites are concentrated along persistent locales and constrained to the core area. Regionally, the EW is not a continuation of the LA pattern. The EW's drier, colder climate with lower water levels and lower incidences of large scale flooding changes the cultural use of the landscape. Sites are located adjacent to inland boundaries of white pine mixed hardwood forests, emergent marshes, hardwood and conifer swamps. The Core sites are the used in

similarly ways but become more transitory. A land use shift toward the southeast is observed; focused on the more productive Carolinian biotic environment along the Cass and Flint Rivers. Site locales also show a southern focus with constrained heterogeneous resource patches in Core and River Valley locales (see

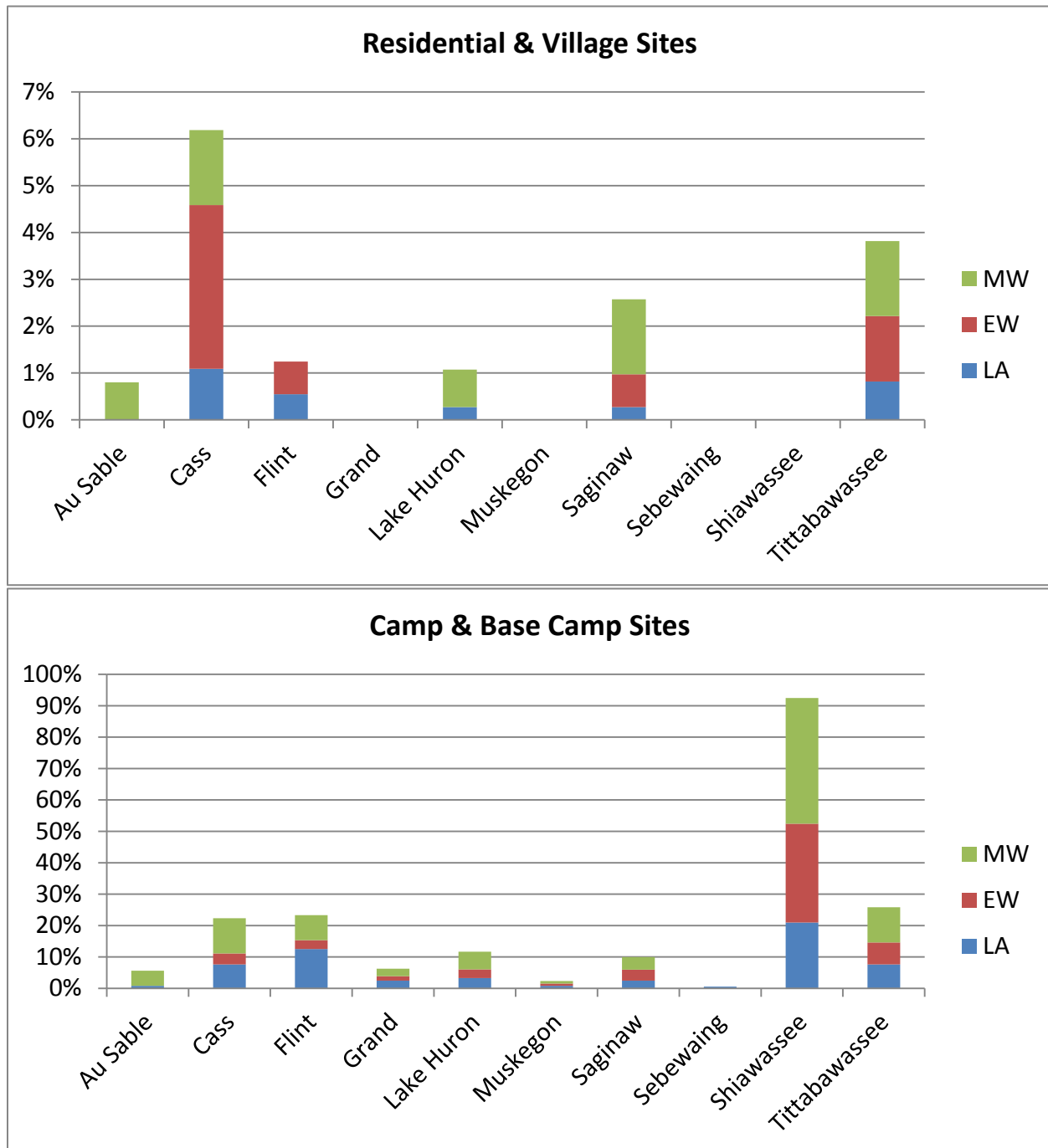


Figure 43). Spatial portioning based on burial, village, mound sites shows similar cluster of spaces in the Core areas, but highly diffused or nonexistent further beyond. Site type analysis show a considerable shift of land use to the Cass river basin, whereas the Shiawassee and Tittabawassee basins are used as activity areas and base camps for resource extraction. A decrease in Tittabawassee basin sites and increase in burial, mounds and village sites along the Cass further supports this shift. The regional cooling and drying trend during this time likely made these the southern riverine areas the most productive areas. The residential sites are located within Quercus (oak) forests along the Flint and Cass river networks. The exchange and travel networks to the north may have been discontinued as the productivity and social networks are likely to have been more productive to the south. EW periods also lack sites along headwaters of major river systems, lesser density of sites along persistent areas and along boundaries of major drainages. EW sites serve as evidence for site association with wetland communities given the alternative habitats present. This area served as a strong resource pull for groups in light of less productive areas further afield.

MW sites are observed to be focused along the Cass and Flint River basins, while cemetery and village complexes are constrained along the Core embayment and expanded along fluvial networks throughout the basin. The MW period is observed to undergo a dramatic shift in land use from the previous period. This period follows a similar LA land use pattern with inland expansion along river valley floodplains. Predicted site distributions also show a coastal focus, with decreased site heterogeneity in Core and River Valley locales (see Figure 40). Partitioning of space based on burials, village sites and mounds shows a larger but lower number of spatial divisions. A considerable change in site locations is observed with

considerable decrease in site densities and a large number located along wetland dominated resource communities and adjacent to or on drainage base levels near the Core area. The MW period is a transformation of the EW pattern with a greater focus on river systems along the Core area with fewer sites along the locales between these basins. Last, the coastal sites become more important with the exploitation of wild rice present along shallow, slow moving inundated coast lines and the Saginaw River mouth.

Zooarchaeology and Archaeobotany

Faunal and floral inventories based on minimum number of individuals (MNI) provide information about food choices. Further, the links between the food choices, sites and adjacent habitats provides comprehensive matrix of possible food procurement strategies. For example, resource chosen may or may not have been selected locally. Groups may use exchange or mobility strategies to procure resources for further afield, storage to procure resources from a different season. This matrix of choices provides insights to adaptive coping and buffering mechanisms, all the while mapping onto to culturally important places. Further, the characteristics of the resources chosen (broad vs. narrow spectrum) links adaptive behavioral strategies and food preferences. To evaluate these interconnections, comparative resource and diet diversity analysis is undertaken providing insights into the economy of individual cultural periods and change over time.

First, the Core area exhibits the highest richness index of faunal and floral remains present (see Figure 45); followed by Lower River Valley sites (see Figure 45) and sites further along river courses (see Figure 45) in all three study periods. Next, the resource ratios analysis of resource use exhibits a number of changes; an increased focus on large mammals relative to

small mammals is evident during the EW period; Terminal LA and EW periods exhibit an increase in the use of nuts and grains relative to mammal exploitation. The terrestrial to aquatic resource ratios are higher in the early LA and decreases toward the Terminal and EW period, and then increases during the MW period. Next, the dietary diversity analysis using the Simpson's index provides a perspective of resource choices. Taking into consideration total faunal and floral material inventories amongst all sites, the overall dietary diversity based on Simpson's index decreases during the EW period. The individual site diversity shows a greater range of food choices at sites during the Early and MW periods. This pattern may suggest more specialized site use (e.g., fishing, nut collecting, and cultivation). The EW's evidenced by exploitation of a comparatively limited set of resources. The resource set is likely linked to the diversity of resources available rather than a change in broad spectrum strategies.

The Core area site diversity remains static over time, with decrease during the EW period suggesting the reliability and relative stability of the wetland areas. Specifically, the Schultz site shows an increase in diversity over time. Sites away from the Core area show decreased variability in diet choices suggesting that these locales are used as base camps and exploitative areas intended for specific subsistence activities during the Early and MW periods. The overall diversity of resources and sites is best explained by a strategy of balancing temporal and spatial choices. The combination of spatial locales and resource choices suggest HG initially pursue a highly diverse (broad spectrum) strategy. Over time, they continue the highly diverse broad spectrum strategy and concurrently increase diversity of sites types exploited. The increase in site diversity allows for exploitation of highly productive resources while maintaining reliable productive bases in dependable areas.

The non-core area sites have the highest variability in food choice diversity. Both, narrow spectrum and broad spectrum exploitation sites are present at the non-core areas. A considerable bifurcation of resource exploitation strategies is present, with two distinct and separate patterns arising over time. This bifurcation of strategies suggests that non-core sites are used differentially. These sites are initially exploited using a broad spectrum strategy, then changing to both, a broad and narrow spectrum dependent upon the site season and location. The narrow spectrum exploitation pattern possibly suggests that groups are logistically procuring specific high value resources (i.e., large mammals or fish). The other broad spectrum sites along the non-core areas are situated at key alternative persistent places.

Overall, the diversity of all sites with resources suggests a significant trajectory of change over time. First, we observe sites with high diet diversity during the LA. Second, a shift toward greater site types but with relatively limited narrow spectrum exploitation is observed. Finally, during the MW, both sites and narrow spectrum exploitation takes place within the backdrop of continuing reliance on reliable wetland habitats. This trajectory suggests that HGs are developing complex adaptive practices in site and resource choices. This provides a tantalizing context for later Late Woodland horticultural and agricultural practices.

Conclusions

This chapter presents insights into short and long term HG economy and culture based on the available archaeological site and diet information. The interpretation provides both an alternative and refined understanding economy of the SBD. The proximity of site locations is keyed to wetland environments throughout the study periods. The diversity of site locales

correlates well with the diversity of wetland habitat communities over time. Dietary analysis suggests an increase in resource diversification in productive wetland habitats, at the same time expanding and specializing in resources at sites in less productive habitats. Throughout the study periods, HG communities adapt through complex strategy of increasing diversity of resource exploitation and concurrently increasing the diversity of sites. This twofold approach allows groups to effectively balance risk and uncertainty in the environment.

Chapter 8: Discussion, Conclusions and Summary

Conclusions and Summary

This project sought to understand the role of uncertainty and risk in hunter-gatherer (HG) economic decision-making. Decision-making is used to explore HG land use and diet choices during the Late Archaic (LA), Early Woodland (EW) and Middle Woodland (MW) cultural periods in the Saginaw Bay Drainage (SBD) of Michigan. In this study, uncertainty and risk is conceptualized as expected and unexpected variability in the natural and social environment. Uncertainty in the natural environment is the spatiotemporal variability of resource landscape and biogeography. Social uncertainty and risk is the amount of information a HG holds about the environment. Further, this project explores this variability and its implications to HG land use and diet from the archaeological record. To this effort, three analytic approaches are employed to explore this variability on economic adaptation, including a creation of a landscape model, a behavioral simulation and an archaeological analysis.

First, a landscape model characterizes the structure (i.e., resources, habitats) of uncertainty and risk that are present in the SBD environment (Chapter 2). The resulting resource landscapes exhibit considerable spatiotemporal heterogeneity. Short-term changes in habitats and resources are determined by seasonal factors resulting from hydrological processes of varying magnitudes, including ponding, flooding, and wetland activation. Long-term changes include changes in distribution and density of local and regional wetland habitats. Prior environmental reconstructions employed limited proxies, primarily through plant cover distributions (Egan 1993; Keene 1981b). This project provides a more refined, detailed, and larger-scale land cover in the SBD, derived from historical and geomorphological proxies and a

simplified hydrological model. The resulting land cover model show that the EW period landscape was a comparatively stable environment (in terms of wetland activity); whereas both the LA and MW periods are highly variable resource environments, with greater unpredictability and intermittently abundant habitats and resource structures.

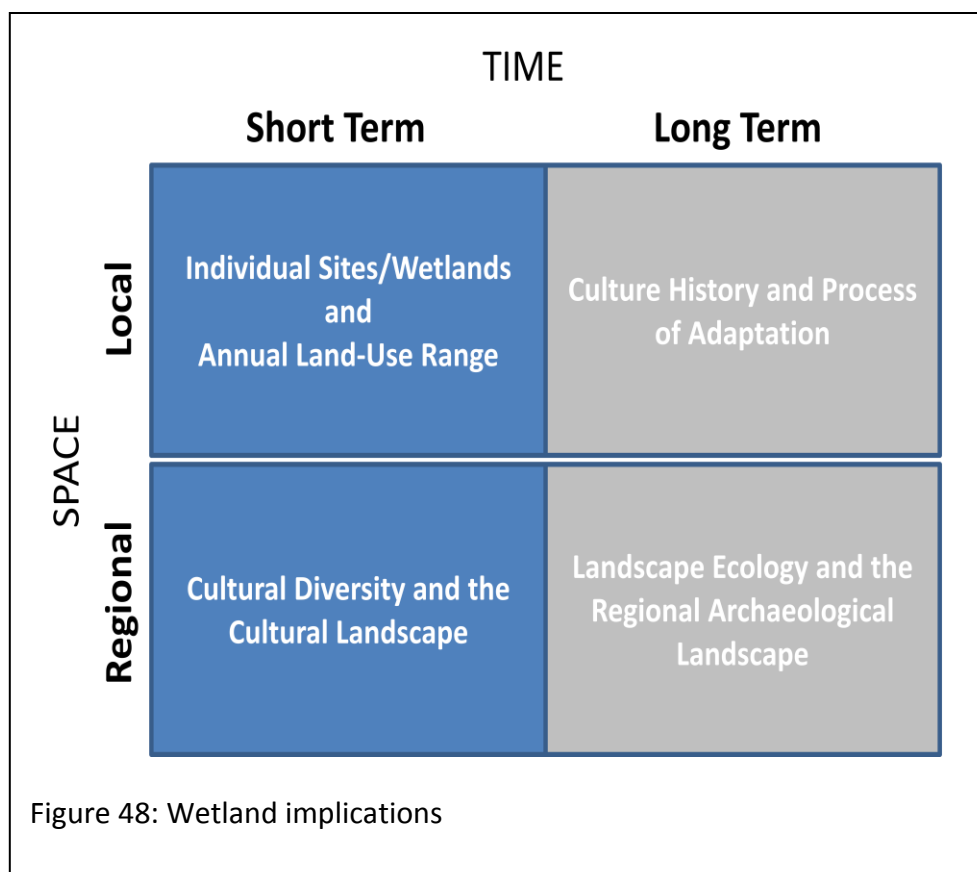
Second, the behavioral simulation illustrates the implications of human choices in variable environments (Chapter 6). Overall, the habitat choice simulation suggests a considerable attraction to riverine and wetland-influenced habitats in the Saginaw core—the confluence of the Saginaw, Tittabawassee, and Shiawassee Rivers—during LA, EW and MW periods. A number of alternative locales were also important, including the Saginaw Bay coastline and Saginaw Valley and Shiawassee embayment; all were associated with productive seasonally reactivated and possibly ephemeral wetland locales. The diet simulation, structured around seasonal and habitat productivity, and sexual division of labor indicates variable levels of a broad-spectrum strategy as the best way to address uncertainty and risk; key amongst them is low risk plant diet and high risk large mammal exploitation. This strategy allows HG to both, exploit highly reliable and risky resources, balancing efficiency and security, at the same time meeting baseline biological requirements for nutrients and alternative resource and social goals (clothing, interaction etc.)

Third, the archaeological analysis provides a long term perspective on land use and diet activities over time. From a regional perspective, the Saginaw core area exhibits the highest diet richness and diversity; surrounding areas exhibit lower richness and lower diversity during all three periods. Other key locales or persistent places apart from Saginaw core also remain important over time. Furthermore, long-term analysis indicates that the LA and MW diets are

more diverse than the EW diet, likely in response to increased variability. A clear pattern of broad vs. narrow spectrum exploitation over time is present with greater reliance on a combination of strategies (mobility, diversification, exchange, pooling and storage) over time.

Project Problems Revisited

At the onset of this research, three problems were posited to frame our existing understanding and subsequent exploration of SBD HGs economic decision-making. Problems include HG effective economic decision-making in variable wetland environments, the longevity



of the hunting and gathering modes of production, and lack of adoption of complex social organization and incipient horticultural economy; all three were framed as issues

relating to the uncertainty and risks in the social and natural environment.

This research,

in turn, contributes to these broad questions through a discussion of implications for; Michigan

archaeology, Eastern Woodland Archaeology, Human Behavioral Ecology and a reflexive critique of the project.

Implications for Michigan Archaeology

Three key contributions are made to Michigan Archaeology, including a better understanding of: the resource environment at the three cultural periods, implications of uncertainty and risk based decision making in temperate and wetland influenced environments, and refinement of land use and diet models in SBD. The outcome of this research refines prior efforts in prehistoric subsistence and settlement models and extends methodological approaches in Michigan and Great Lakes (Arnold 1977; Egan 1993; Keene 1981b; Krist 2001; Lovis, et al. 2001; Robertson 1987).

Resource Environment

First, the resource environment is recreated through a hydrology based landscape model. This model identifies probable distribution and density of wetlands and linked productive locales. This model highlights the considerable influence of wetlands in the regional area throughout the study cultural periods. Second, the study provides HG choices in regards to temperate environments based on a risk and uncertainty decision logic. Third, the archaeological data is used to refine SBD land use and diet choices.

In this study, land use is identified through persistent places and site type classifications. HG use of persistent places can be viewed as a desire to return to a specific place in terms of resource present (i.e., gravity model), or based on an expectation that resources will be found at a specific place (Robertson, et al. 1999). These persistent locales, with the addition of site

type classifications and diet inventories refines of the existing subsistence and settlement annual round.

First, the research contributes to a better understanding of the role of wetlands in HG economy. Prior research in the SBD has repeatedly highlighted the possible importance of wetland environments in HG land use and diet choices. Floods were common, and may have forced seasonal abandonment of key locales and restricting of the resource environment (Keene 1972; Lovis, et al. 2001; Wright 1972; Wright 1964). This study demonstrates that wetlands have considerable implications for HG economy, and Great Lakes and Eastern Woodland archaeology (Figure 38) (Bernick 1998). Wetland environments are more than simply a supporting factor; they are a causal factor in resource and landscape variability and therefore, a factor in HG land use and diet choices (see Chapter 5). All three study period landscapes and diets show considerable influence from stable and unstable, and local and regional wetlands.

The landscape model identifies probable density and distribution of wetlands in the study area (Chapter 5). These wetlands considerably affected the habitats and biogeography of the study area. These wetlands influenced variability at spatial (local and regional) and temporal (seasonally, and long term) scales during the periods of study. Basin-level variability, therefore, plays an important role in the economic adaptation and cultural practices in the area.

The LA and MW lake-level rise extensively altered the core Saginaw low lying areas (Shiawassee embayment, St Charles and coastal areas); lower river gradients increased sedimentation, creating broad and expansive wetland mosaics with highly productive marshes and seasonally inundated areas that gave rise to drier seasonal habitats. Overall, the region was

heavily influenced by seasonal and stochastic forces that greatly affected the resource environment in terms of abundance, predictability, and reliability.

Wetlands likely served as primary and secondary resource locales given the season. Wetlands may even have been informally managed for edible resources such as cattails (Harrington 1967). They are a highly nutritious food (rootstock or rhizome), containing as much protein as maize and more carbohydrates than potatoes (Morton 1975); and are responsive to varying hydrologic regimes. These recreated wetland landscapes (in terms of the method and location used) provide a contextual framework and could be applied to similar locales in the Eastern Woodlands and other time periods as well.

Uncertainty and Risk Based Decision-Making

Second, the research contributes to a better understanding of the role of uncertainty and risk in HG economy. The simulation outcomes show that variable habitats and resources play an important role in economic behaviors. An economy solely intended to alleviate this variability results in strategies that should aim for the exploitation of reliable, abundant and predictable resources. But, the exploitation of these ideal resources may not sufficiently result in meeting minimum requirements due to the effect of both stochastic and predictable variation. Therefore, this study leverages ethnographically based division of labor to simulate alternate strategies to address this variation aimed to meet minimum subsistence goals. This decision logic results in the selection of two broad diet and land use strategies; highly productive but low density resources (i.e., large mammals) and low productivity and high density resources (i.e., plants). Further, four key patches are preferred throughout the annual cycle, including mesic southern and northern forests, riverine and, emergent and ephemeral

wetlands. These habitats have variable, but high productivity throughout the annual round. Taken together, uncertainty and risk based choices can be interpreted as a decision-making boundary conditions intended to meet minimum economic requirements. Other rationales (taste, prestige etc.) are then should be subsumed within these conditions. Decision-making based on this alternate rationales are only engaged after boundary conditions are met. Decision-making models, therefore, need to incorporate uncertainty and risk as a baseline assumption.

Land Use and Diet Models in SBD

Last, the research contributes to a better understanding of the changes in SBD HG economy and culture over time. First, HGs are observed to variably use their resource landscape at different periods dependent upon the extent of wetland influence landscapes. The changes in economy and culture can be broadly characterized as a wetland adaptation focused diet and land use focused on persistent locales.

The archaeological analysis demonstrates key persistent places and the use of broad-spectrum economy over time in SBD. The land use and diet patterns remain similar throughout the study periods but exhibit considerable scalar differences between cultural periods. The archaeological site patterning is focused on key persistent places on the landscape (see Chapter 7). The identified persistent places are long lasting with considerable differences in the dimensions of use; exploitation range, habitat makeup, connectivity with nearby locales, cultural use and importance, and specific diet choices.

In all three periods, HGs focus heavily on riverine, wetland and mesic southern forested environments. During the LA, HGs employ regional and diverse land use strategies

encompassing whole of SBD. During the EW, HGs shift land use to a localized to wetland core. EW wetland environments were locally distributed, where key productive locales were isolated to the Saginaw core. The overall diversity in wetland locales decreased during the EW period, a result of the transformation of past wetlands and successional development of more mature terrestrial areas. During the MW, an expansion of land use is observed, but limited to headwaters of the large river networks along the Saginaw core. MW period wetlands are likely reactivated environments along key large, local-base levels at the confluence of Saginaw, Tittabawassee, and Shiawassee rivers.

The high water levels during the LA and MW periods likely increased the aquatic habitats along major river courses and subsequently made fishing more appealing and accessible. Further, the inundated areas also expanded travel corridors further inland giving easier access upstream habitats.

In summary, HGs cope with rapidly changing landscapes (i.e., annual and inter annual) with a number of strategies, including a highly flexible system of terrestrial and palustrine exploitation. Sites were located on or adjacent to the most diverse habitat settings, primarily in the core center surrounding the Shiawassee embayment and in the southern uplands along boundaries of oak-hickory forests and oak savannas. The combined evidence from landscape and behavioral models, and archaeological analysis provides insight into HG adaptive processes. The evidence presented in this dissertation highlights human longevity and capacity to adapt to variable environments. These outcomes taken together have considerable implications for local Michigan, larger regional Eastern Woodland archaeology as well as Human Behavioral Ecology.

HGs pursue a broad spectrum economy at key locales (Saginaw Core) throughout the study cultural periods. At other locales, the study observes increasing specialization and complexity in the types of sites and exploitation strategies employed over time. Exploitation strategies change from broad spectrum to a combination of broad and narrow spectrum exploitation strategies. The incorporation of narrow spectrum diet can be interpreted as an increase in the use of logistic mobility during the EW and to a greater extent during the MW period. The logistic exploitative forays exploited key resources including fish, large ungulates and nuts (see Binford 1981; Wiessner 1982a).

Diet choices, especially the use of wetland species is remarkable. The diversity and richness calculations show an increased focus along core wetland areas, such as the Schultz site locale, during the EW period, with high richness and relatively low diversity relative to the LA and MW periods (see Chapter 7). Taken together, the land use and diet choices have strong correlation for behavioral strategies in coping with uncertainty and risk in the environment. Broadly, coping and mitigating uncertainty and risk takes places at a landscape level (i.e., persistent places); elevated landforms and along key travel corridors.

These persistent places on the landscapes frame habitat and therefore resource choices. The persistent locales further determine behavioral strategies, including broad and narrow spectrum resource choices, land use and resource exploitation strategies (i.e., logistic vs. residential mobility, collector vs. forager strategies).

The specific annual round includes late spring and summer exploitation of habitats along the confluence of large rivers and along the Saginaw River valley (per Robertson 1987). The summer round is heavily focused on the Saginaw core and Saginaw Bay, with locales

intermediate to both the Fletcher and Marquette Viaduct sites. Intergroup gathering may also take place during these times, possibly keyed to productive wetland resource zones.

During the late summer and early autumn, groups move along large river and stream networks to forested environments (to interior, along river and stream headwaters) for the exploitation of riverine and forested resources. This time of season likely included gathering of stored winter resources, and possibly larger group aggregations.

Winter and early spring were periods when groups moved along elevated moraines and ridges adjacent to forest and riverine boundaries; exploiting wetlands and resources drawn to wetlands. Groups likely revisited productive locales along the core basin as needed. The primary habitats exploited during the annual round include mesic southern forests, riverine and wetland environments. Available large and small mammals were likely exploited opportunistically during all seasons. The diversity of wetlands types and resources were likely a resource pull during most seasons, maybe with the exception of early spring snow melt which likely inundated and activated low lying areas.

In the study area, groups adapted to winter and early spring by shifting not only their population size and composition (distributed foraging) but also their spatial location to upstream locales and by visiting localized productive habitats. Additionally, they likely focused on marginal foods or use stored items from earlier seasons. Overall, the archaeological site and diet patterns suggests a considerable focus on the diverse reliable core areas near confluence of major river systems and activated wetland environments demonstrated by an increase in type of sites present from LA to MW, especially along local base levels with increased moisture inputs.

The differences between cultural periods can be explained by the scale of river network use rather than by any meaningful differential use of these places. Further, Liebig's Law of the Minimum suggests that the most critical period, that of lowest resource availability has strong implications and important effects (limiting maximum carrying capacity) on human adaptation. Winter, therefore, becomes a determinant season in settlement patterns. In the SBD, key winter productive habitats include riverine and intermittent wetland locales (See Chapter 6). Taken together, this research provides a refined archaeological land use and diet model as well as the rationale basis (uncertainty and risk) behind those claims.

Implications for Eastern Woodland Archaeology

In the broader cultural context, the project has sought to understand the place of the SBD in the regional Eastern Woodland through; 1) nature of HG economy, 2) its longevity, and 3) to determine the reasons why HG groups forwent the alternative complex social organization and incipient horticultural practices located to the south.

First, HGs in the SBD should not be characterized as simply bands adapting to changing environments by exploiting the diversity of resources. In actuality, this study indicates considerable evidence for increasing economic and cultural complexity over time. Specifically, an increasing specialization of land use and diet choices is evident. In other words, HGs are adapted to SBD, not simply because of diversification of resource but also through the diversification of cultural and adaptive strategies. This approach allows them to exploit different types of niches, take risks that provide alternative economic resources.

The nature of HG economy during the LA and MW is linked to the variable landscapes and resources. These periods exhibit seasonal and long term variability that is greater in

magnitude than that of the EW period (Chapter 7). The variability of wetland resources, both in terms of productivity and change over time required innovative strategies. During the EW, there is a high correlation between the increased stability of the resource base and the constricted use of the settlement locales.

Second, the longevity of HG adaptation in the area can be attributed to both, social and ecological factors, specifically adaptive cultural practices aimed at coping and buffering uncertainty and risk. The role of wetlands in SBD is important factor in understanding HG longevity in the Eastern Woodlands. The environmental variability and resulting in changes in wetland composition, density and distribution and linked changes in biogeography played an important part in the HG economic decision making. The SBD during the LA and MW periods is unpredictable, with resource abundance at key places with considerable variability, especially during the winters. Unpredictability of landscape and resources require a highly flexible and effective coping strategy.

The diversity and ingenuity of technology also contributed to the continued and increased efficiency of foraging strategies. Ceramics, fishing technology, and lithic improvements all likely contributed to the diversity and efficiency of exploitative strategies in the area. Contrary to large-scale and drastic changes in society, the resiliency of wetland resource exploitation provides an effective resource base for HG longevity while suppressing the accumulation of resources, since those resources often were unpredictable.

Further, another factor that contributes to the longevity is the flexibility of HG economy. Flexibility needs to be understood within the context of all available landscapes and resources. The diversity of habitats and resources afforded groups different opportunities to respond to

environmental fluctuations. Zooarchaeological records demonstrate the exploitation of a diverse set of species—small and large mammals, aquatic birds, and fish. Simpson’s Diversity Index indicates that a broad-spectrum diet and a highly diverse economy were present in both the LA and MW periods (Chapter 7).

The behavioral simulation further supports the possibility of exploitation of diverse resource (see Chapter 6). The Saginaw core, especially the Schultz and Green Point locales, was used in a similar fashion during all three periods. Sites farther toward the bay along the Saginaw River, including the Weber 1 and Marquette Viaduct/Fletcher complexes, show a decrease in diet diversity. The diversity measures in these locales suggest a changing economic model (through forager, collector continuum) during the later EW and MW periods.

HG groups adapted to variability over time through flexibility of land use and diet choices practices. The flexibility of these practices is afforded by HG social structure including group size, division of labor allowed for capability to adapt to environmental changes. Further, local-scale habitat modification, suppression of competing predators, and resource modification likely took place.

Third, HGs relinquished more complex social and economic practices for a number of reasons. Within the study area, land use and diet choices were based on cultural strategies used by groups to cope with varied levels of uncertainty in the resource environment. Next, the wetlands themselves are one factor in why HG forwent adoption of economies to the south. For example, there are a number of key resources that were exploited in wetland-mediated environments and wetlands themselves. Wetlands provide ample opportunity, often year round, for the exploitation of different types of fish, aquatic birds, and mammals. Wetlands are

areas where terrestrial mammals gather for easily accessible resources during a number of seasons. The expectation is that wetland-related species were systematically exploited in these areas.

Second, wild plant foods played an important role in the region, starting from the LA period (Chapter 7). Wetland dynamics alternatively suppressed and encouraged terrestrial plant and animal distributions. Specifically, the stabilization of climate, thus wetland landscapes, may have possibly contributed to a later increased use of cultivated plants and plant products in this area. There is a high level of wild plant foods use, including seeds isolated to the core Schultz site locale (see Chapter 7). The extensive use of seeds and grains is relevant to anthropological questions including ideas regarding incipient cultivation practices. This project does not contribute directly to this issue. But, the study does provide rationale through landscape reconstruction and archaeological synthesis that variable Palustrine landscapes alone provide significant challenges and alternatives to reliable horticulture. Areas where plants would be able to grow would need to be significantly drained or manipulated in order for sustainable (reliable, annual) horticultural practices to be successful.

The likely scenario is an intermediate of both horticulture and sole reliance of wild plant foods; groups likely pursued an opportunistic and informal approach to cultigens (Monaghan, et al. 2006). Informally tended resources are more amenable to the wetland variability than resources that require stable landscape requiring appropriate timing for planting, tending and harvesting.

Although horticulture and even agricultural behaviors can be observed during the Hopewell phenomena and later Mississippian emergence farther south, these strategies are not

readily found in the SBD, likely because of the instability in the environment prompted the use of flexible and alternative strategies to address the existing variability. The gathering and even possible cultivation of key domesticates adapted to riverine and lacustrine conditions could be possible, even though restricted to fine-grained mesic soils. But, cultivation is unlikely due to the regional habitat heterogeneity (wetland variability) and limitations of growing seasons (climate) in the region. Reactivated and unpredictable wetlands habitats likely posed a challenging environment due to annual flooding events, poor soil conditions and climatic deterioration. These factors were likely a severe impediment to the planting, tending and harvesting of annual cultivated plants. Quite possibly, perennial cultigens on the other hand, have a greater longevity due to their ability to germinate after an unsuccessful annual cycle. Informal and opportunistic tending of perennial cultivars could have been possible. Specifically, the likelihood of cultivation in LA and MW period would have been difficult given the conditions described. During the EW, the colder climatic conditions likely limited the possibility of reliable cultivation as well (See Chapter 5).

Long-term cultivation and the development of horticulture required stable amenable soils and climate away from the Saginaw core, which would require a considerable scheduling conflict with long-established subsistence, specifically land use and resource gathering practices. Resource harvest in seasonal wetland environments with increased wild plant and animal productivity occurs at the same time as cultivated plants requires tending and care. The use of horticultural products in the area, later during the Late Woodland periods would require a considerable change in adaptive (economic and social) strategies. For example, wide spread land use changes (assuming maize or any other domesticate is actually planted and harvested)

would be observed, given the considerable hydrological variability present in the Saginaw core during all study periods. The settlement locales would shift toward areas that could possibly grow plants, along the further southern fringes and headwaters of the SBD. These areas would be drier, less influenced by variable hydrology of the Saginaw core.

Even though, horticulture was not practiced, use of wild plant foods is important throughout the study periods as a dependable baseline resource. This continued importance over time may have possibly played a role in the later incorporation of plant domesticates into the economy. Overall, the later increased impetus for the cultivation likely came from the synergistic effects of climatic change, anthropogenic environmental change, technological change, and social innovation during the Late Woodland period.

The role of wild plant foods to mitigate uncertainty and risk clearly has a role to play in our understanding of later transition of horticulture and agriculture. Coupled with plant foods, ceramic innovations during the EW period also increased efficiency and the ability to store and boil seed and starchy products, further linking the role of cultivated plants to environmental uncertainty.

These factors in other areas may have led to reduced mobility and possibly sedentism (Ford 1977; Watanabe 1973; Wiens 1976). For example, an area with highly productive habitats can offer a variety of alternative resources to buffer against fluctuations. These areas contributes to increased sedentism in the Illinois River Valley during the Middle and LA periods (Brown and Vierra 1983; Ford 1977). However, unlike the areas farther south, stability in SBD was juxtaposed with extensive seasonal variation, and possibly multi-year or decadal unpredictability throughout the core basin, with basin-wide inundation and resource instability.

This study questions the long-term capability of a stable arable habitat in the SBD. In the past, this idea was attributed to a poorly drained landscape. This research provides the concept that wetland dynamics provide a significant barrier to such agriculture and an alternative set of choices.

Last, the SBD is integrated into the larger cultural areas by the regional manifestation of LA cultural practices and the MW Hopewellian Interaction Sphere (Charles and Buikstra 2006; Fritz 1990). SBD groups relied on their local adaptation and heavily participated in the interaction and exchange networks, especially during the LA and MW. This participation can be observed as an effective strategy of incorporating both a local SBD and a regional Eastern Woodland economic model. This diversification of strategies leverages both local SBD and regional economy to address increased variability in the resource environment.

Further, innovation and exchange has been associated with increased variability in resource and habitats. The material culture of SBD reflects this pattern with the incorporation of LA and MW Hopewellian features (burial treatment, down-the-line material, and food exchange) (Charles and Buikstra 2006). The increased variability in the environment results in increased exchange and interaction networks to mitigate and cope with variability. The nature of SBD economy, the longevity of the HG mode of production and lack of participation in domesticated economies may be directly linked to HG group's ability to cope and adapt to varied challenges in the environment.

In summary, SBD is more than simply a gathering place at specific times of the year. This area is likely occupied over the long-term and was an important regional locale (regional cultural gathering place) due to seasonally productive environments. Alternatively, other areas

(northwest and along the southwest) of the SBD may have occupied less intensively due to factors including resource marginality, wind buffeting, northern exposures adjacent to but not directly next to water, and lack of accessibility to travel networks that were insufficient to sustain populations.

Additionally, the abandonment of productive locales for alternatives in the area would have been highly risky and severely detrimental to group survival. Thus, the HG culture with its social institutions and belief systems likely promoted flexibility through alternative multi-scalar strategies including diversification, mobility, and exchange; all of which contributed to the resilience of HG lifeways.

Implications for Anthropology/Human Behavioral Ecology

The overarching theme for this research has been to understand how HGs respond to environmental and social uncertainty and risk. This study illustrates that uncertainty and risk have a considerable effect on HG land use and diet choices. HGs buffer and cope with uncertainty and risk through strategies based on the contextual dimensions of variability present (spatial, temporal, and intensity). Based on the patterns observed in the SBD, a set of coping strategy expectation of ‘when, where, what, and how’ is suggested. First, the high imbalance among abundance, predictability, and reliability of a broad resource base results in a large number of coping strategies being employed. For example, the LA period was likely highly spatiotemporally unpredictable and was an intermittently highly productive environment. Second, strategies in response to highly variable and unpredictable environments operate at large regional scales. Third, strategies are employed in both a combined and rank-ordered

fashion: 1) mobility; 2) diversification; 3) exchange and interaction; 4) pooling; and 5) storage (Chapter 7).

Table 10. Coping and buffering strategies -relative basis			
Time Period	Late Archaic	Early Woodland	Middle Woodland
<i>Landscape</i>	Wetland dominated, regional coverage, abundant/ low reliability/ unpredictable	Drier, mature forests, considerably reduced wetland cover, overall stable environments, predictable, decrease abundance, reliable	Flooded, reactivated wetlands, increased unpredictability/increased abundance/ decreasing reliability
<i>Expected Uncertainty and Risk</i>	High	Low	Medium
Economic Strategies	<u>Behavioral Analysis Likelihoods</u>		
<i>Hunting</i>	Medium	High	Medium
<i>Fishing</i>	Medium	High	Medium
<i>Gathering</i>	High	Medium	Medium
Adaptation Strategies	<u>Archaeological Likelihoods</u>		
<i>Mobility</i>	High	Low	Medium
<i>Exchange</i>	Very high – inter and intraregional	Low – intraregional	Very high – inter and intra regional
<i>Diversification (core)</i>	Low	Medium	High
<i>Storage</i>	High	Low	Low
<i>Resource pooling</i>	High	Low	Medium

In this model, storage then becomes the last coping strategy to be employed, partly due to the social implication of developing a surplus and accumulating a labor pool. Mobility, diversification, and exchange are often baseline requirements, but they vary in intensity given the high levels of resource imbalance. This study indicates stability in diet choice diversity (broad spectrum diet) over time, with increased specialization in exploitation strategies as the

environment stabilized. Next, as mobility increases, the exchange and interaction networks likely increase as well. With regard to land use, relatively stable environments result in a lower diversity in habitats used. Conversely, the greater unpredictability and variability of habitats results in the use of more different types of habitats (see Table 10).

Diversification and exchange play a strong role in coping and buffering strategies. An exchange strategy that became important was the use of interaction and exchange networks. Interaction and exchange allow for the buffering of regional variability through extra-regional relationships. During these time periods, sites were located in diverse resource environments that were adjacent and intermediate to neighboring groups, toward both the Kalamazoo Valley and the Southeast River Raisin Drainages (Chapter 7). The headwaters of the Maple and Flint Rivers also had a considerable increase in sites during the LA and MW periods.

Social relationships (marriage and kinship) amongst groups adjacent to SBD may have been used to maintain and reinforce a network of commitments and access to information sources across the region. Social beliefs and rituals likely played an important role in cultural adaptation, and contributed to resource choice in small-scale societies. Regulations over land use, possibly usufruct agreements, likely determined who had the rights, timing, and duration of exploitation. Rituals are likely embedded and woven into the social fabric and reaffirmed during aggregations in key locales such as the Saginaw confluence. Thus, cooperative strategies of exchange, pooled resources including aggregations for ceremony, and ritual are highly important in variable environments. In this way, we observe that regional interactions are likely to be greater in periods of higher uncertainty and risk (Chapter 7).

With increasing uncertainty and broad-spectrum exploitation strategies (both in terms of habitats that are used and diet choices that are made), increased mobility is readily employed. The LA and MW periods are cases in point with greater uncertainty in the landscape. In conjunction with technological advances in ceramics, the groups focus on the core Saginaw Valley, exploiting the seasonally variable yet relatively stable resources that are present.

The key differences between time periods are the scale of flexible foraging through the mobility and exchange networks. LA and MW strategies entail a regional strategy, whereas the EW period entails a more local one. Social interaction and exchanges were likely reinforced during periods of increased uncertainty. There was greater interaction amongst communities with overlapping territories and greater customary practices where groups had access to persistent locales. This increased interaction would require activation of practices to regulate social relations of the intermediate areas outside SBD, as well as in the locally uncertain and abundant resource locales. A threshold effect may have operated, given even greater uncertainty, and may have transformed societies using the pooling or storing of resources. Therefore, given the imbalance in the natural and social environments, the relative use of individual strategies may provide expectations about the type of site locales and material culture that are present.

Critique and Future Directions

Any modeling exercise is complex and contains numerous assumptions that frame the endeavor. The heuristic nature of modeling is intended not to reflect reality but represents a probability of past actualities. A number of adjustments could be made for future applications of this project. First, a hydrological modeling approach using finer scales (space and time) might

yield a better predictive land cover for the study area. This can be accomplished through geoarchaeological studies, expanding our understanding of aeolian and, specifically, fluvial dynamics in the study area. This understanding would provide more information regarding the level of moisture input, drainage, and sequestration in basin and upland areas, and would perhaps result in a broadened and realistic land-cover description for the SBD.

Second, the simulations can yield uninformative results. Often, simulations and other modeling endeavors struggle to find pattern through the noise of varied background behaviors. Isolating key factors would provide a better understanding relationship and interaction to other system components. Overall, this project (in terms of dataset and approach) lays out a research framework, whereby numerous related questions could be explored in the future.

Third, directed archaeological research efforts through systematic surveys and excavation aimed at SBD zooarchaeology and archaeobotany would further clarify models and localized affects in wetland environments. One approach would be to conduct systematic palynological and flotation studies of productive areas to further explore the role of plant foods. Extensive geomorphologic studies and recoveries of fine-grained subsistence remains are rare (but see (Lovis, et al. 2012; Monaghan and Lovis 2006) . Systematic flotation would expand our knowledge of resource use multifold. Last, a number of places (e.g., along headwaters of river systems) do not fit the land use and diet model, especially during the LA period.

Fourth, studies that address travel, interaction, and exchange networks through the use of geospatial and networks approaches—including least-cost path analysis and historical

General Land Office Survey (GLOS) narrative—would provide further knowledge regarding interaction networks through material and information exchange.

APPENDICES

Appendix A: Landscape

Landscape Model Maps, Figures and Tables

Pollen Sites

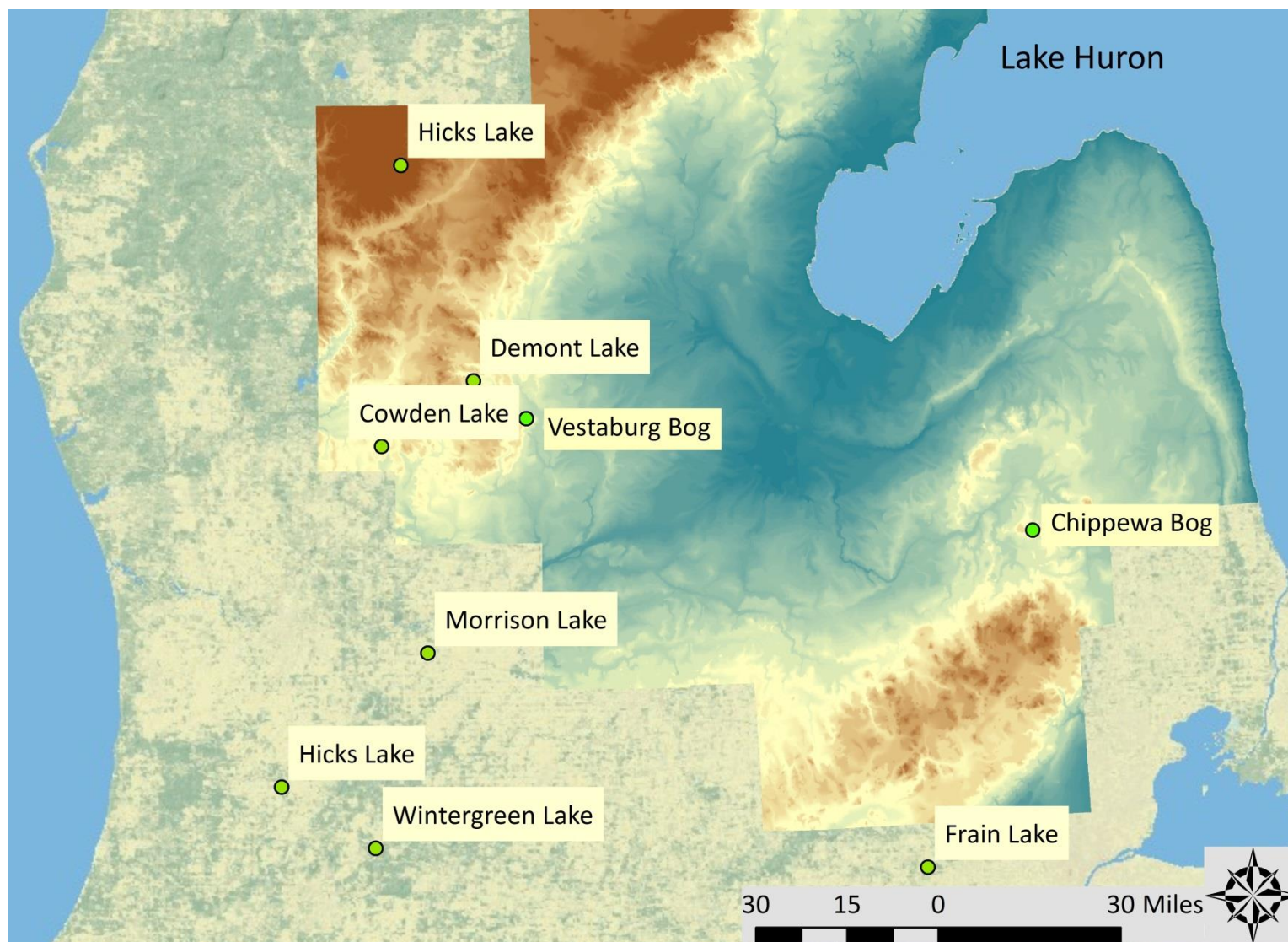


Figure 49. Pollen sites and relative elevation.

River Course Profiles

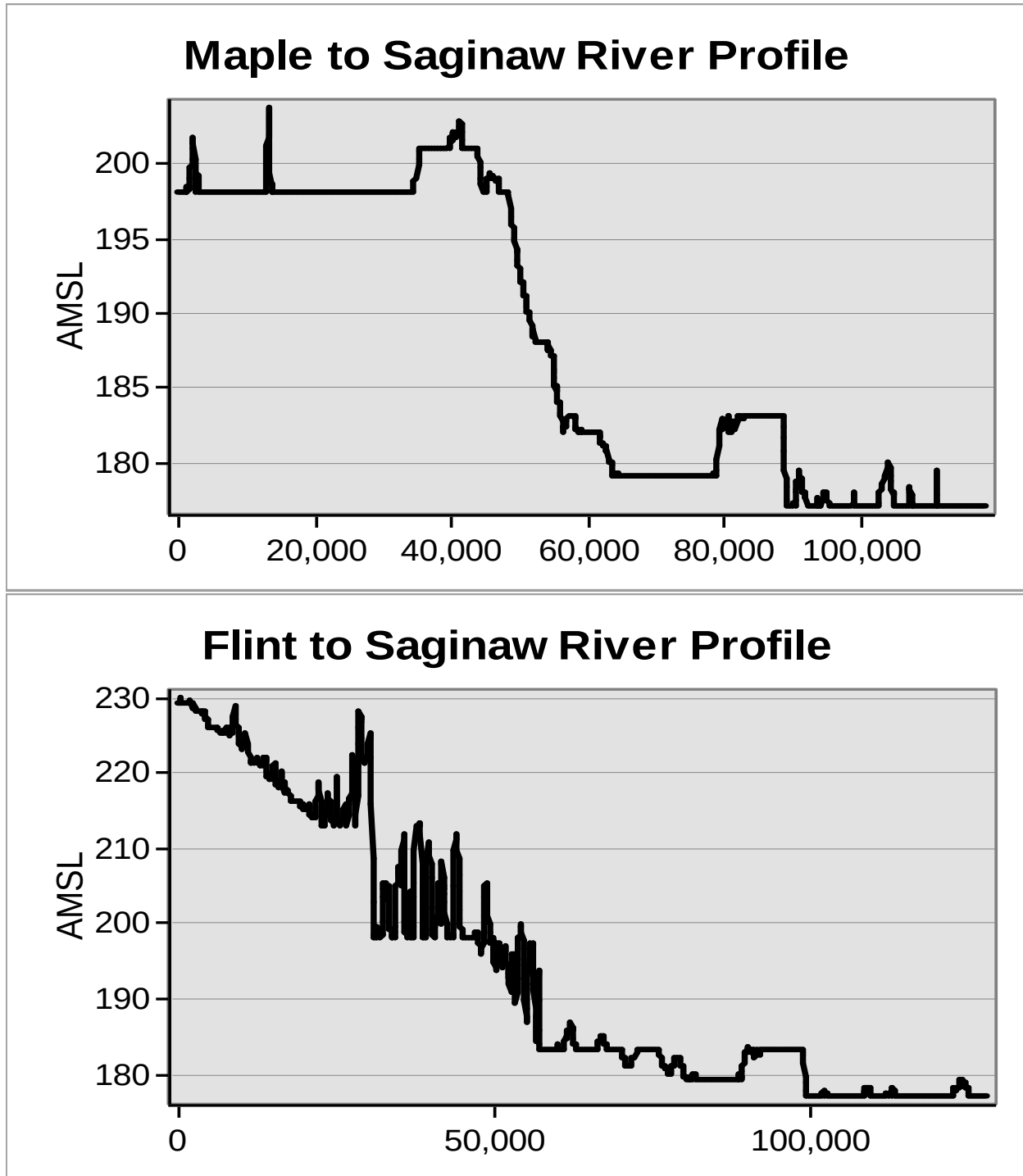


Figure 50. Maple and Flint River course profiles

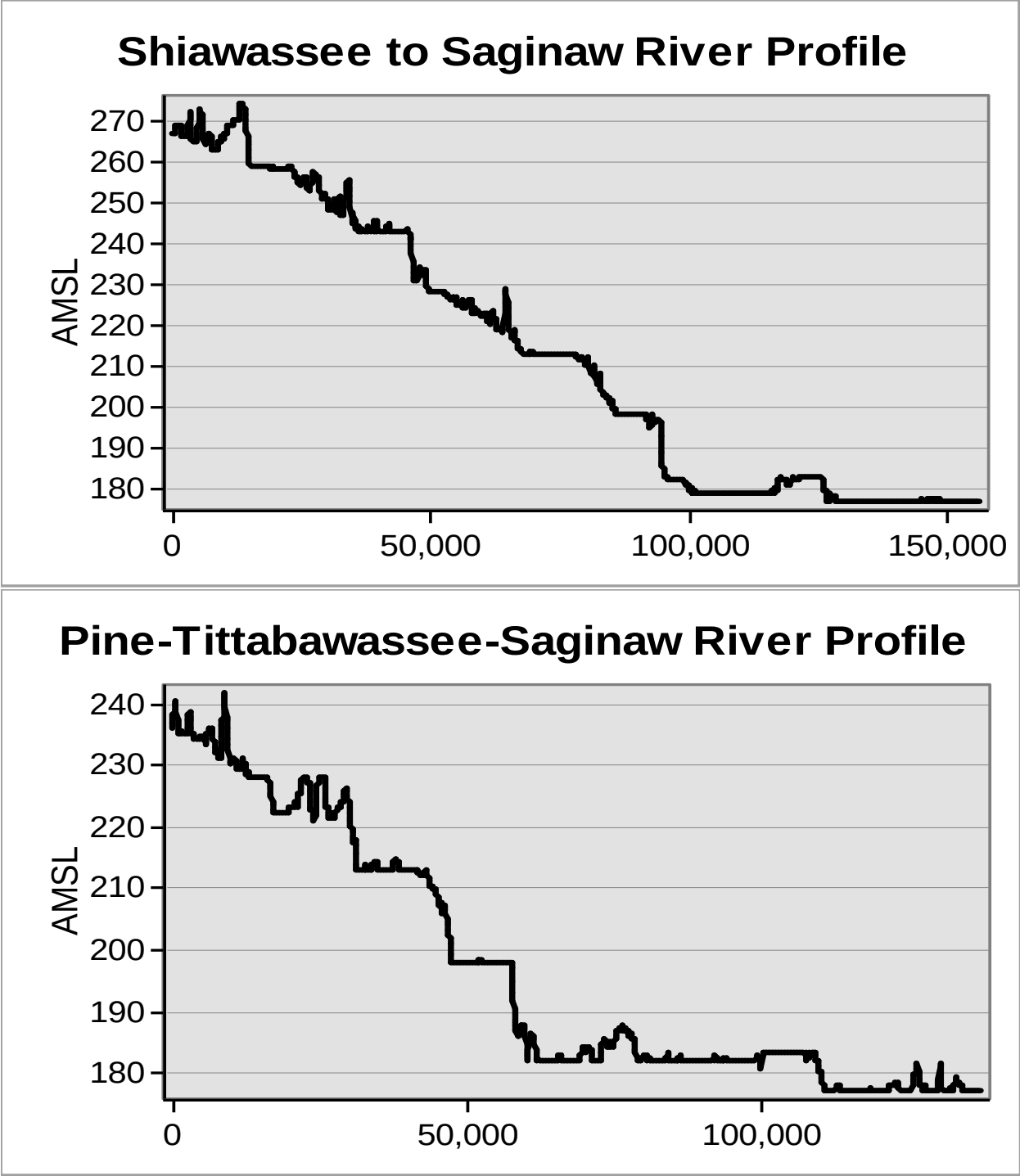


Figure 51. Shiawassee and Pine River course profiles

Landscape Features by Region

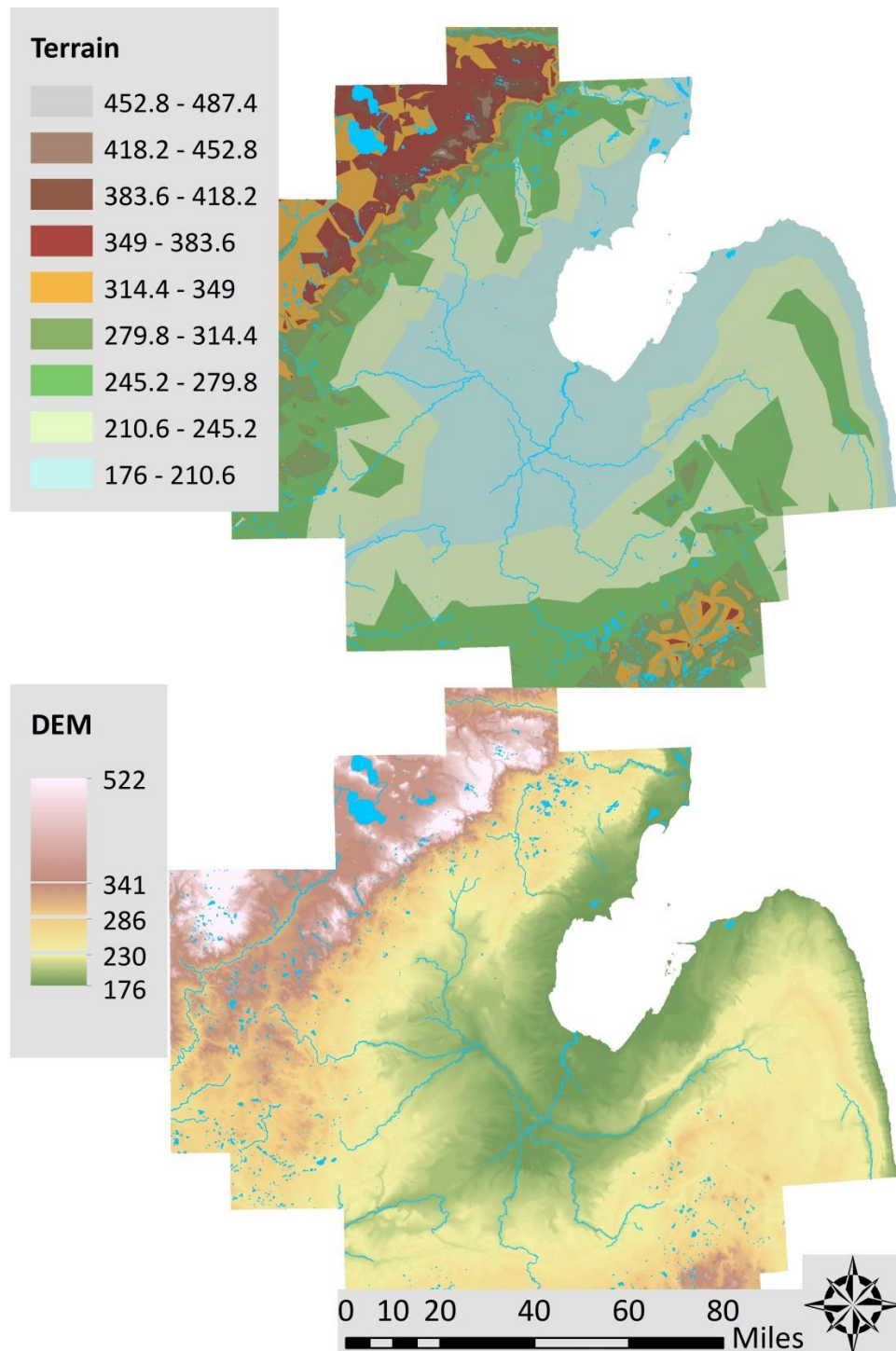


Figure 52. Base model - terrain and digital elevation

Saginaw Bay Drainage topography has limited relief with a large basin surrounded by upland areas.

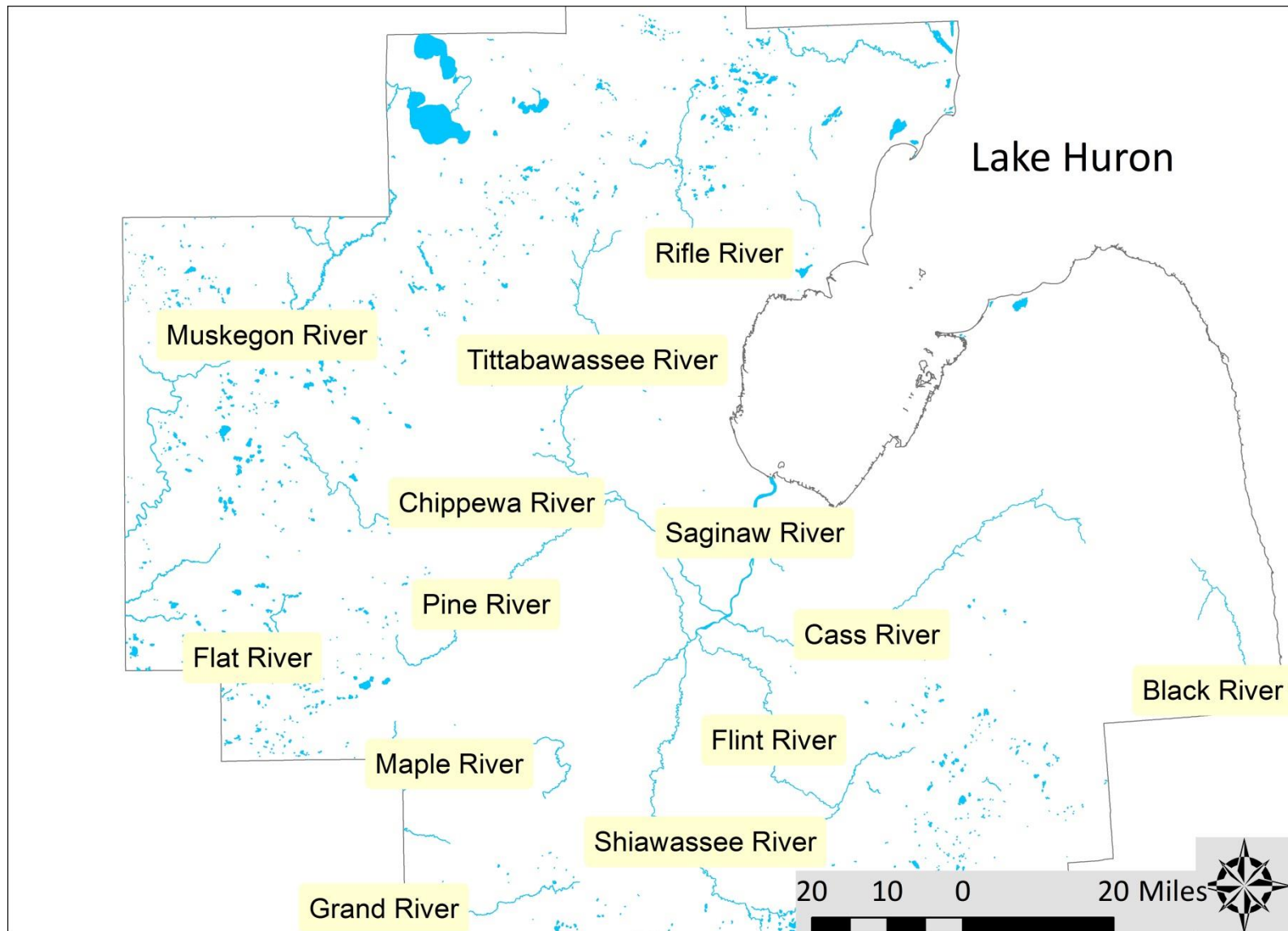


Figure 53. River networks

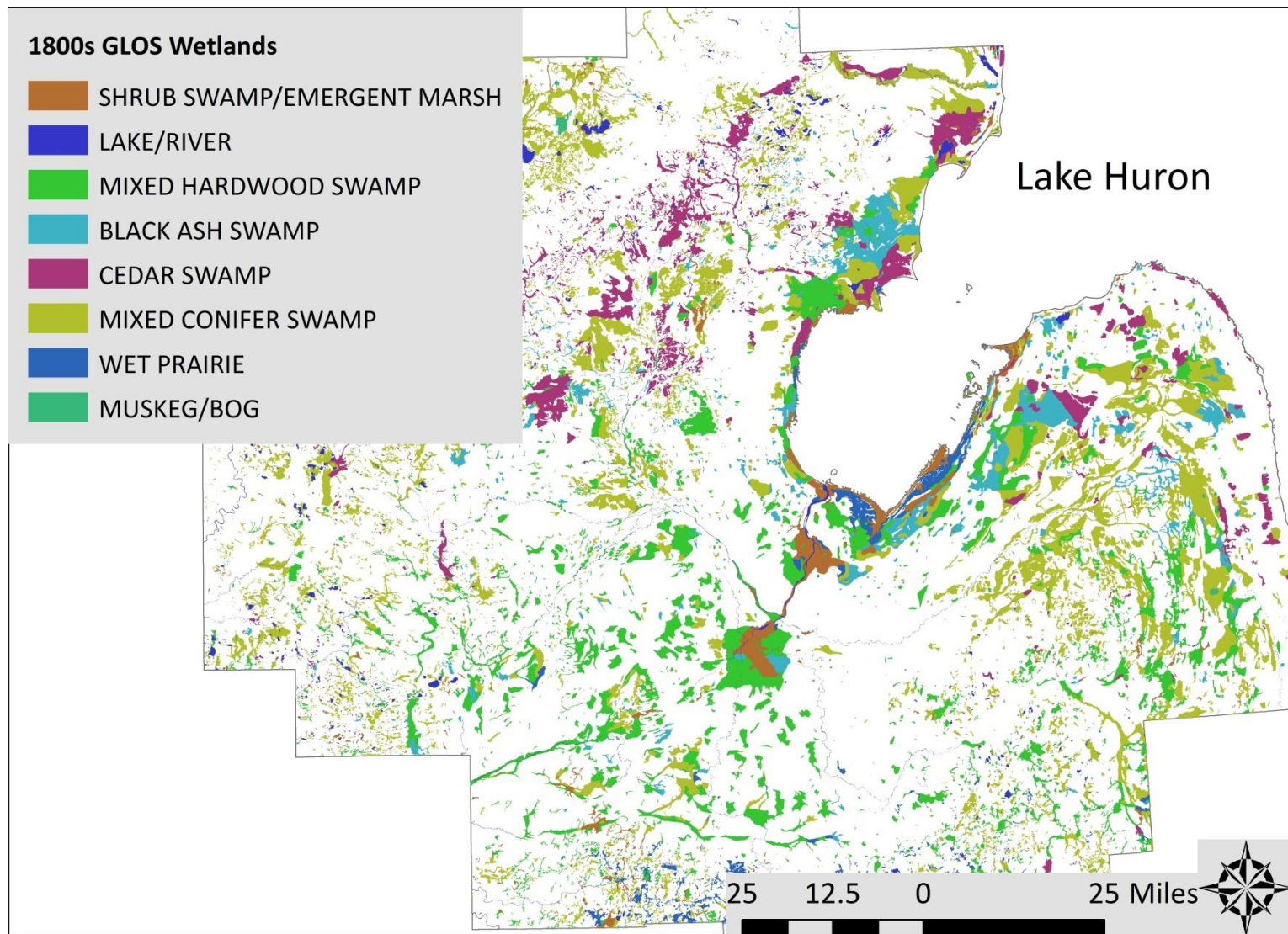


Figure 54. Base model – 1800s wetlands

Key features that define the drainage are centripetal river drainage network and long lived wetland communities.

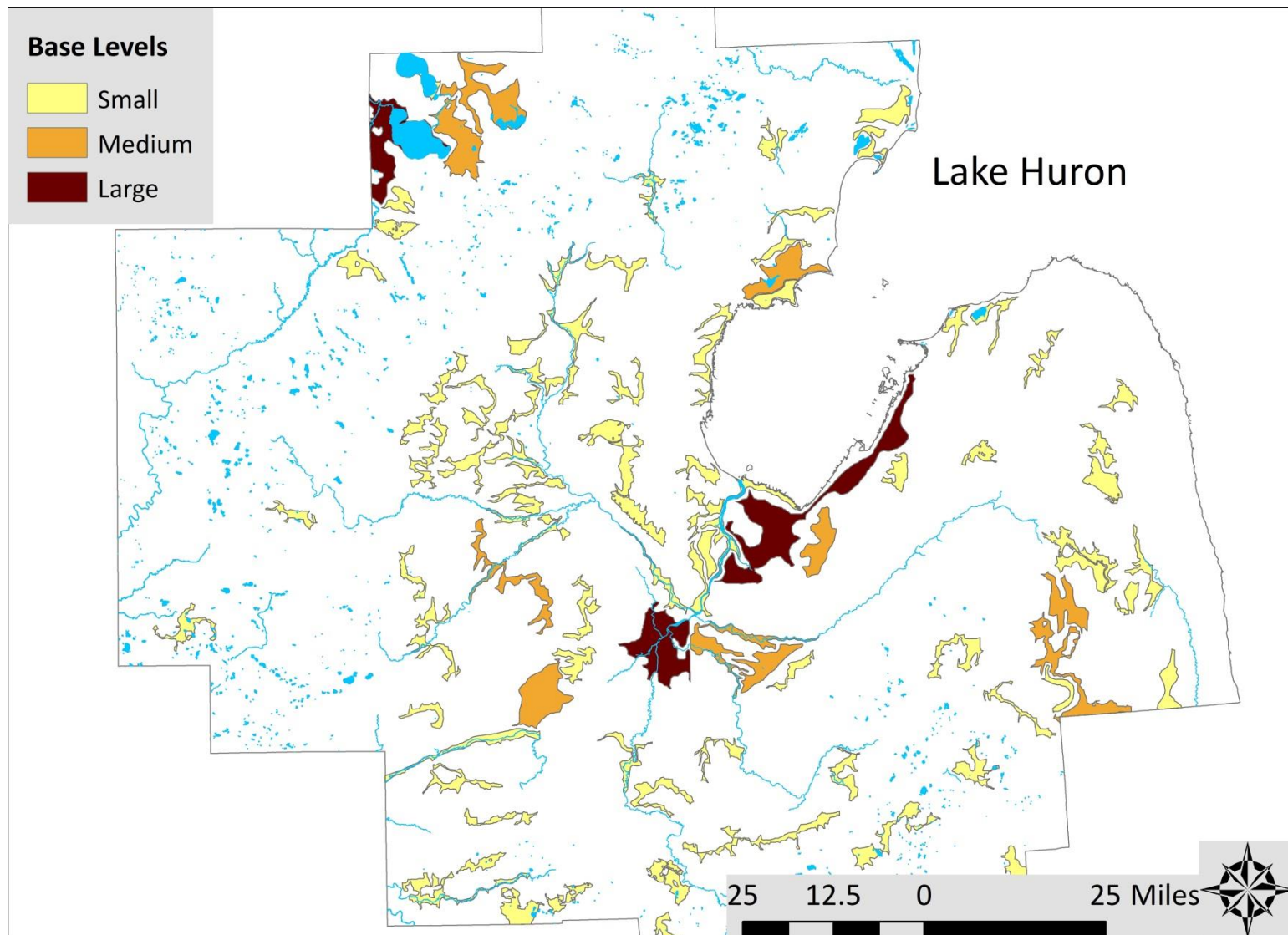


Figure 55. Local base levels

Huron lake levels play a key role in the landcover of the drainage. Local base levels are flat areas with river inputs. Base levels are likely wet and inundated seasonally or over the long term.

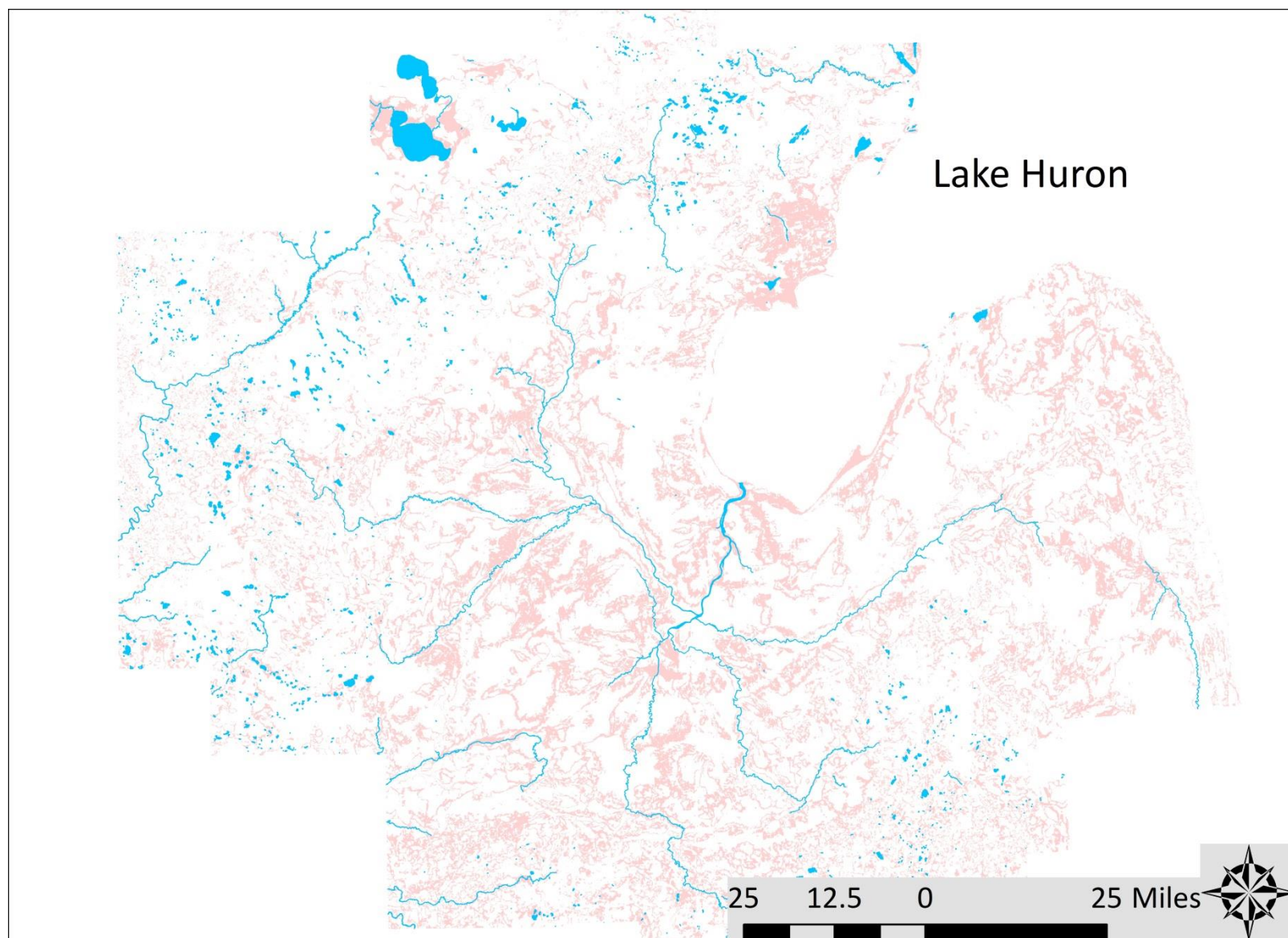


Figure 56. Water table close to surface (<1 meter)

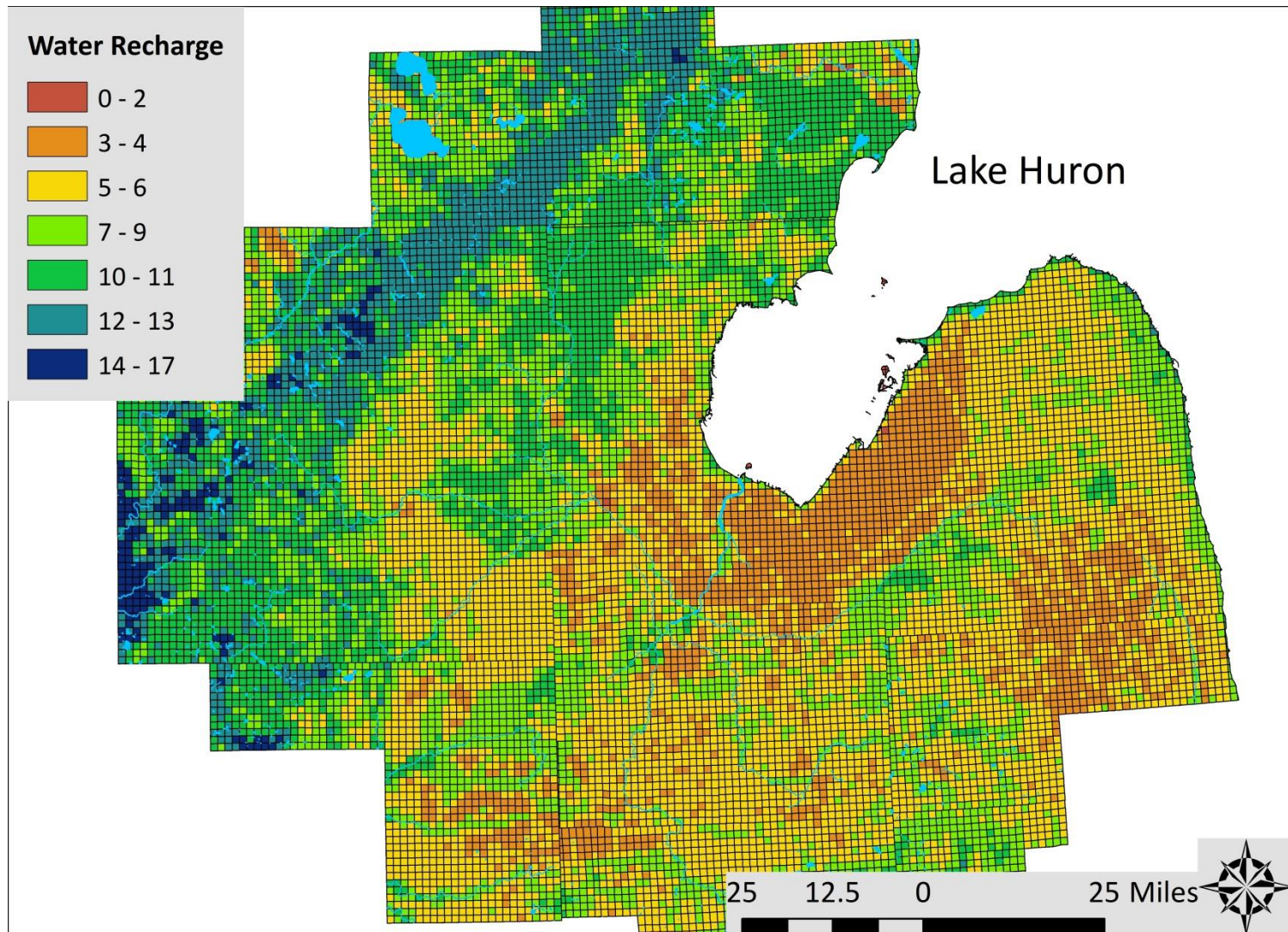


Figure 57. Base model – water table and recharge

The water table and drainage and recharge rates play a role in wetland formation. The combination of both is the areas of potential wetlands.

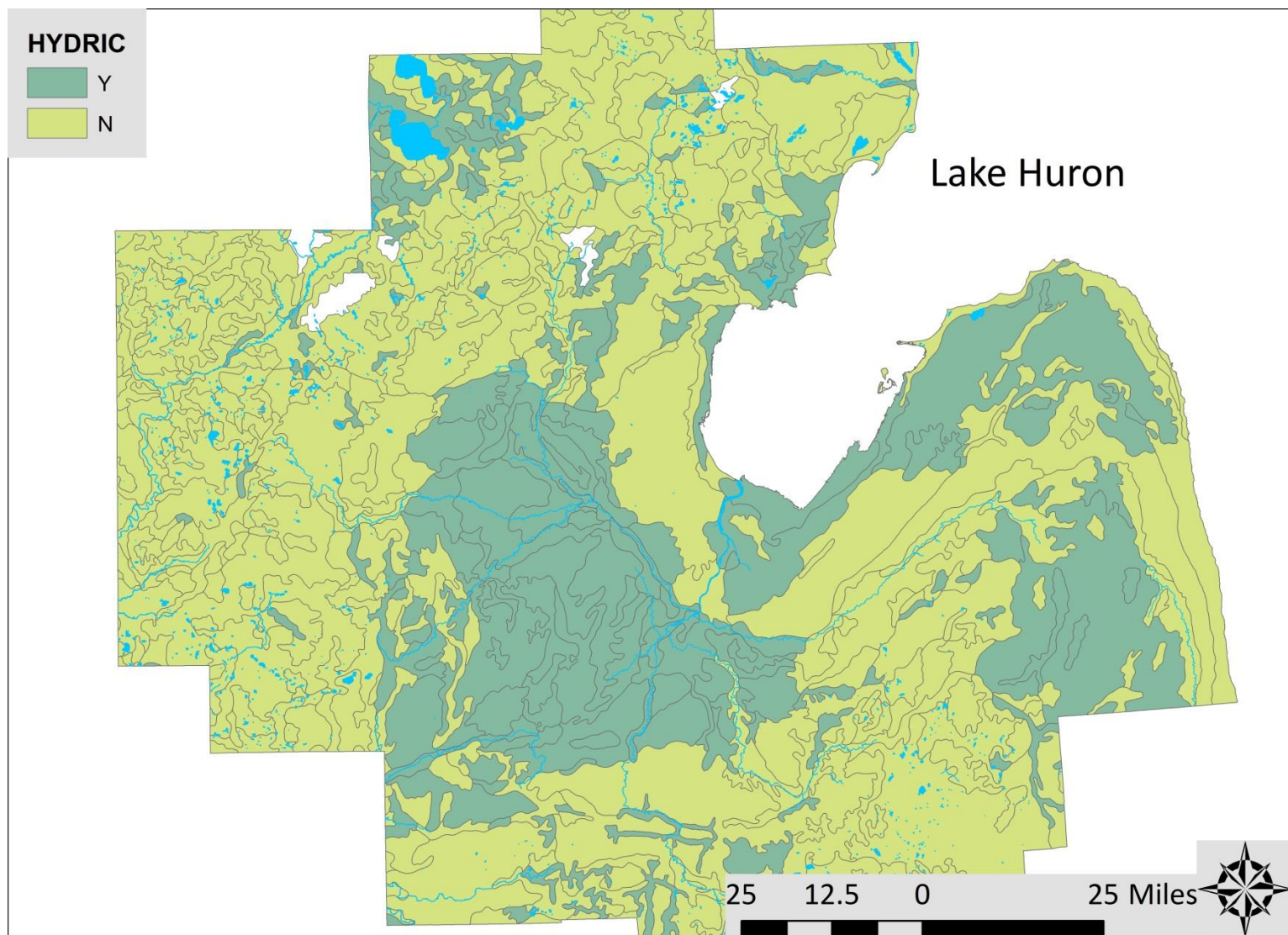


Figure 58. Base model - hydric soils and drainage

The overlay of hydric soils and drainage rates can be used to extend the existing wetland distribution model. Large proportion of the basin soils are poorly drained, therefore, easily ponded and flooded during early spring.

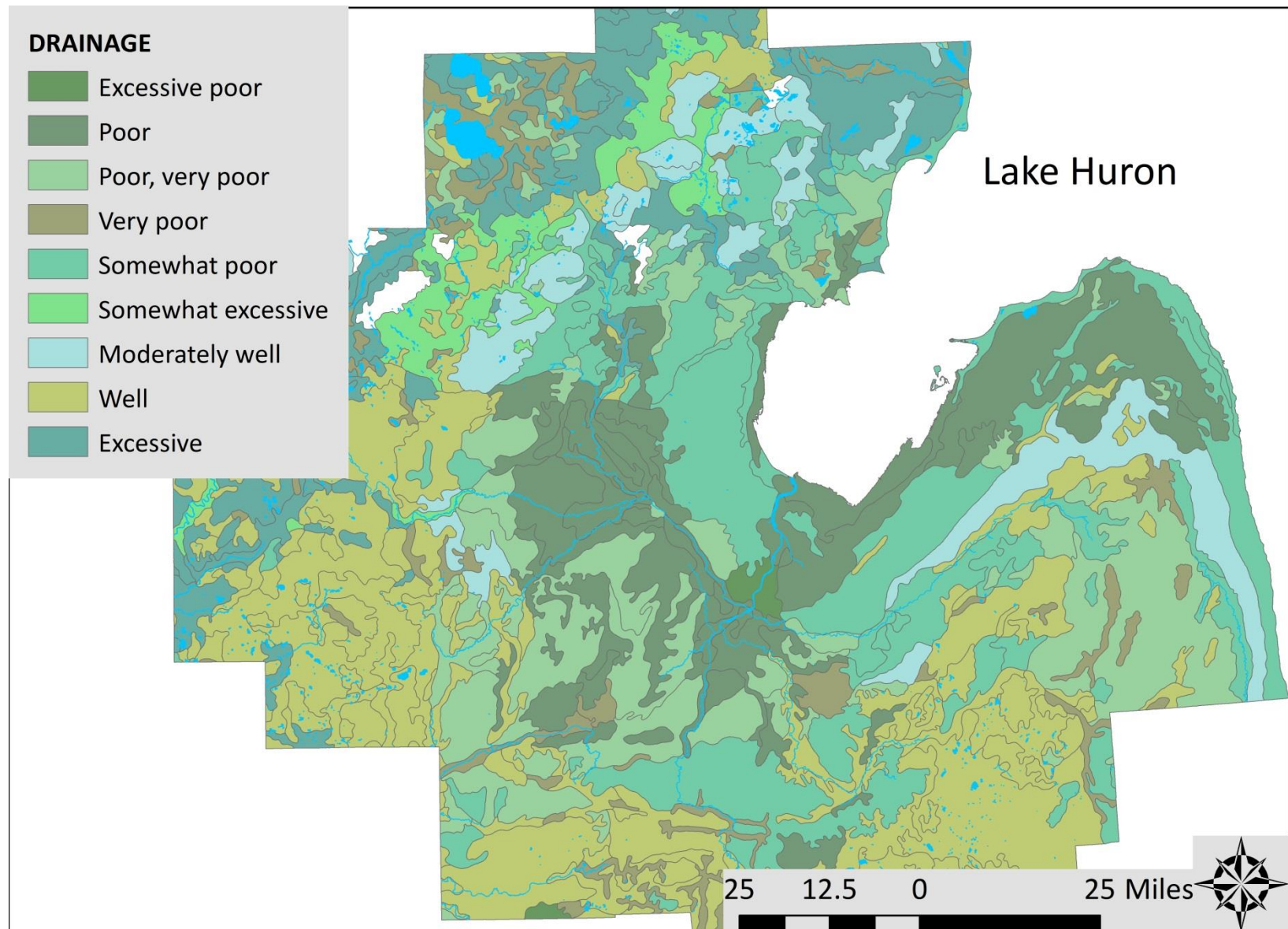


Figure 59. Soils drainage by class

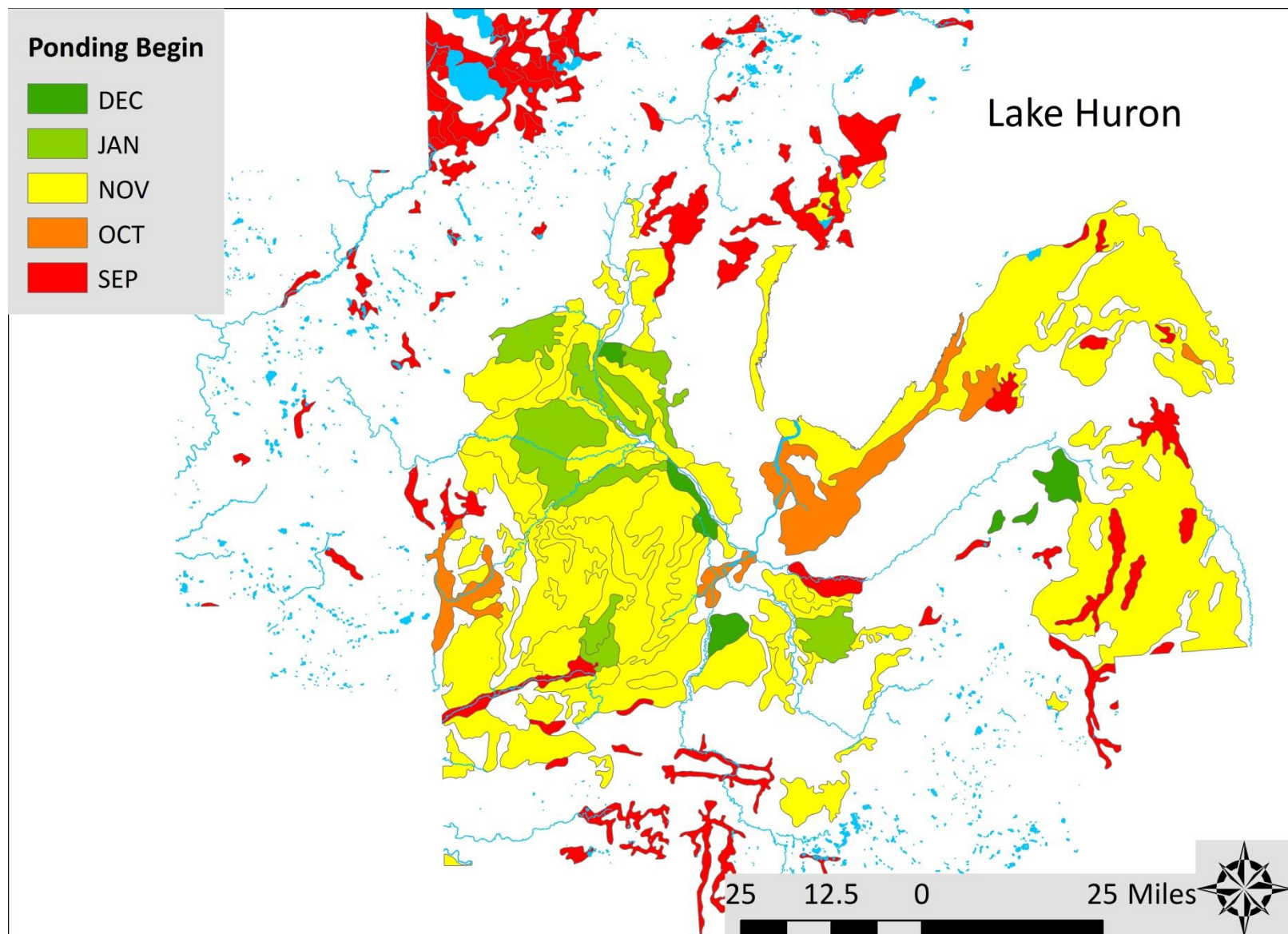


Figure 60. Ponding begin by month

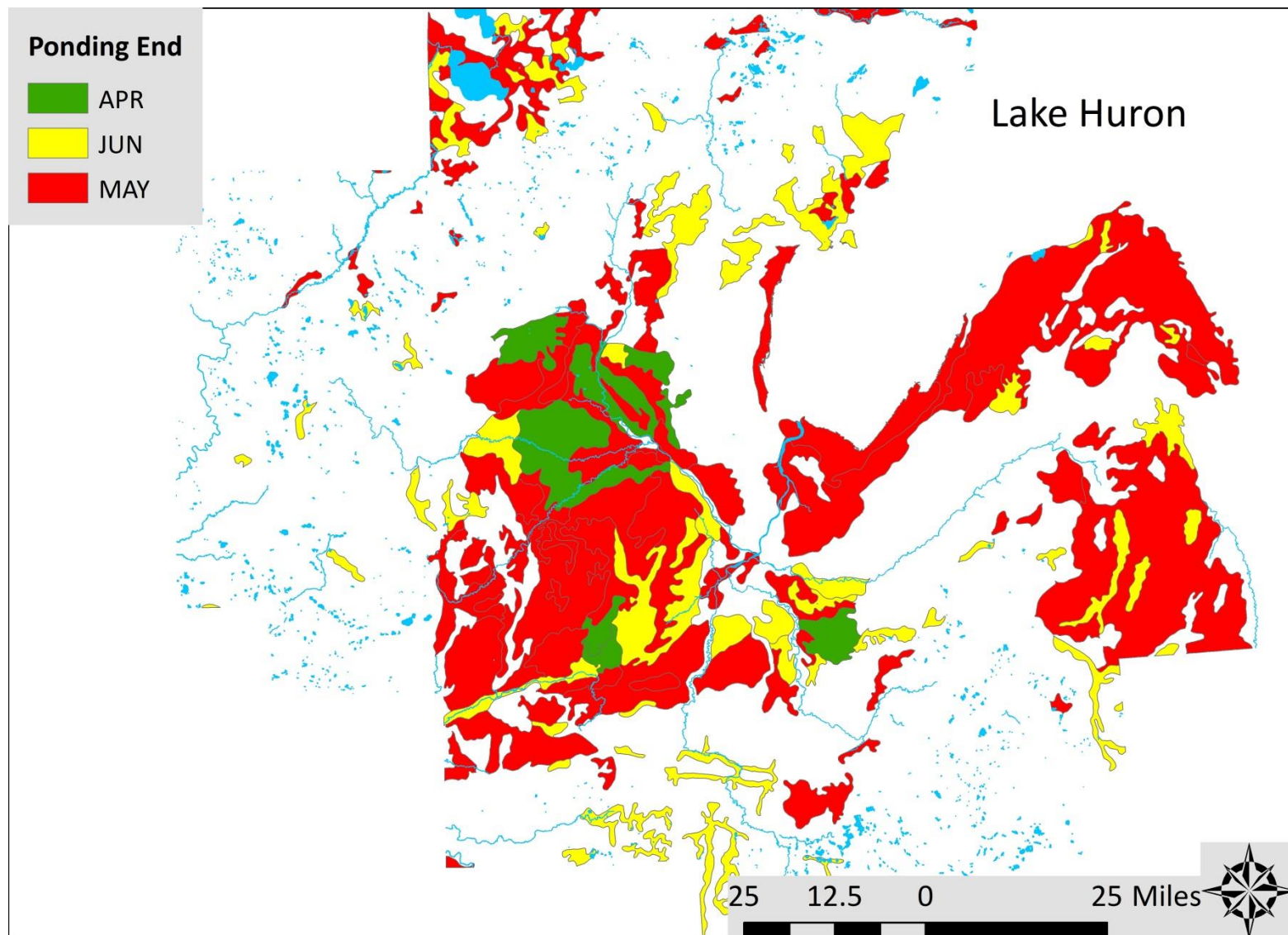


Figure 61. Ponding end by month

A considerable portion of the core basin is ponded during the mid-winter to early summer.

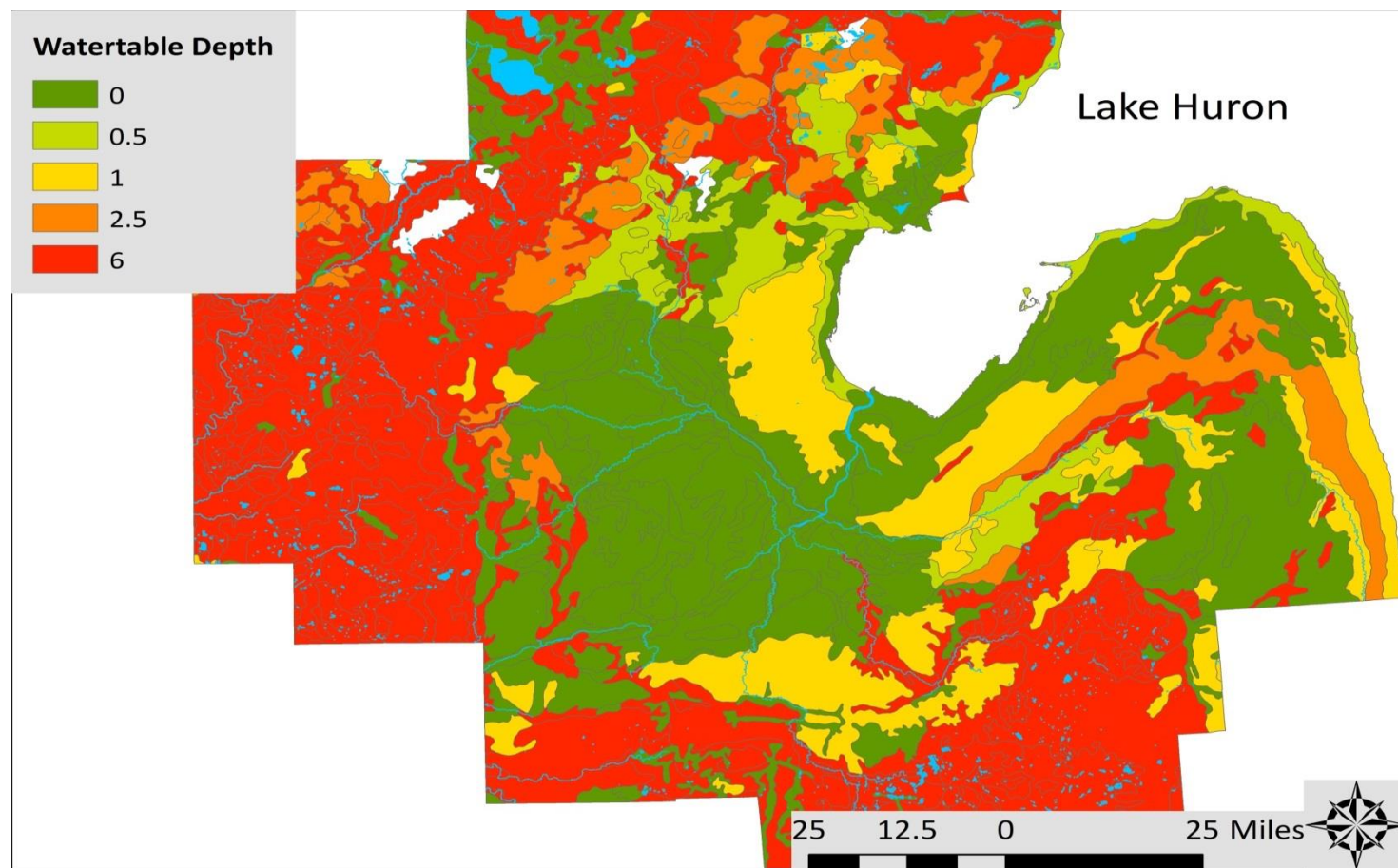


Figure 62. Water table by depth

The seasonal variability of the water table provides insights into likely flooded or ponded low lying areas. A considerable portion of the basin has low and high water table close to the surface.

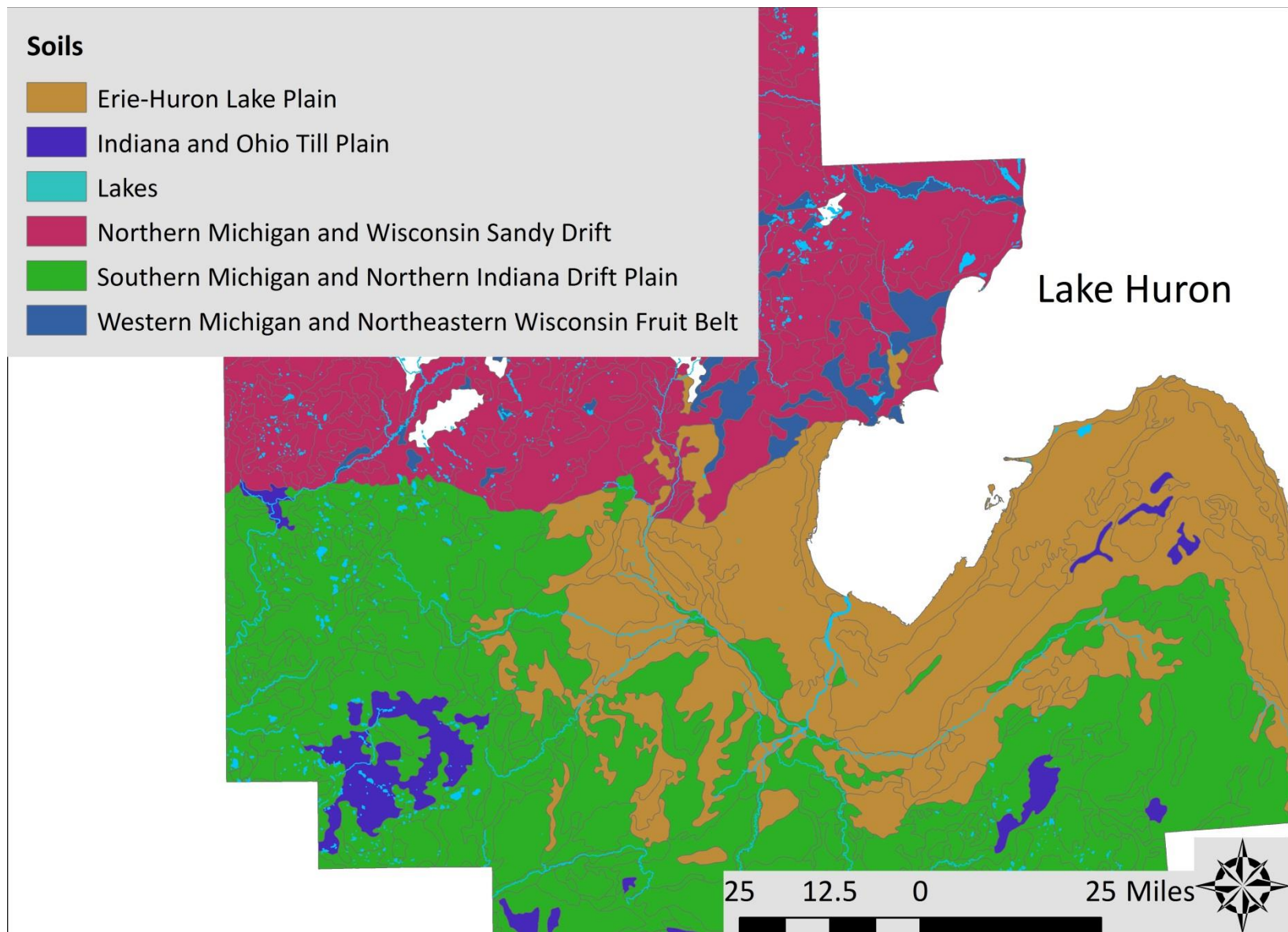


Figure 63. Soils

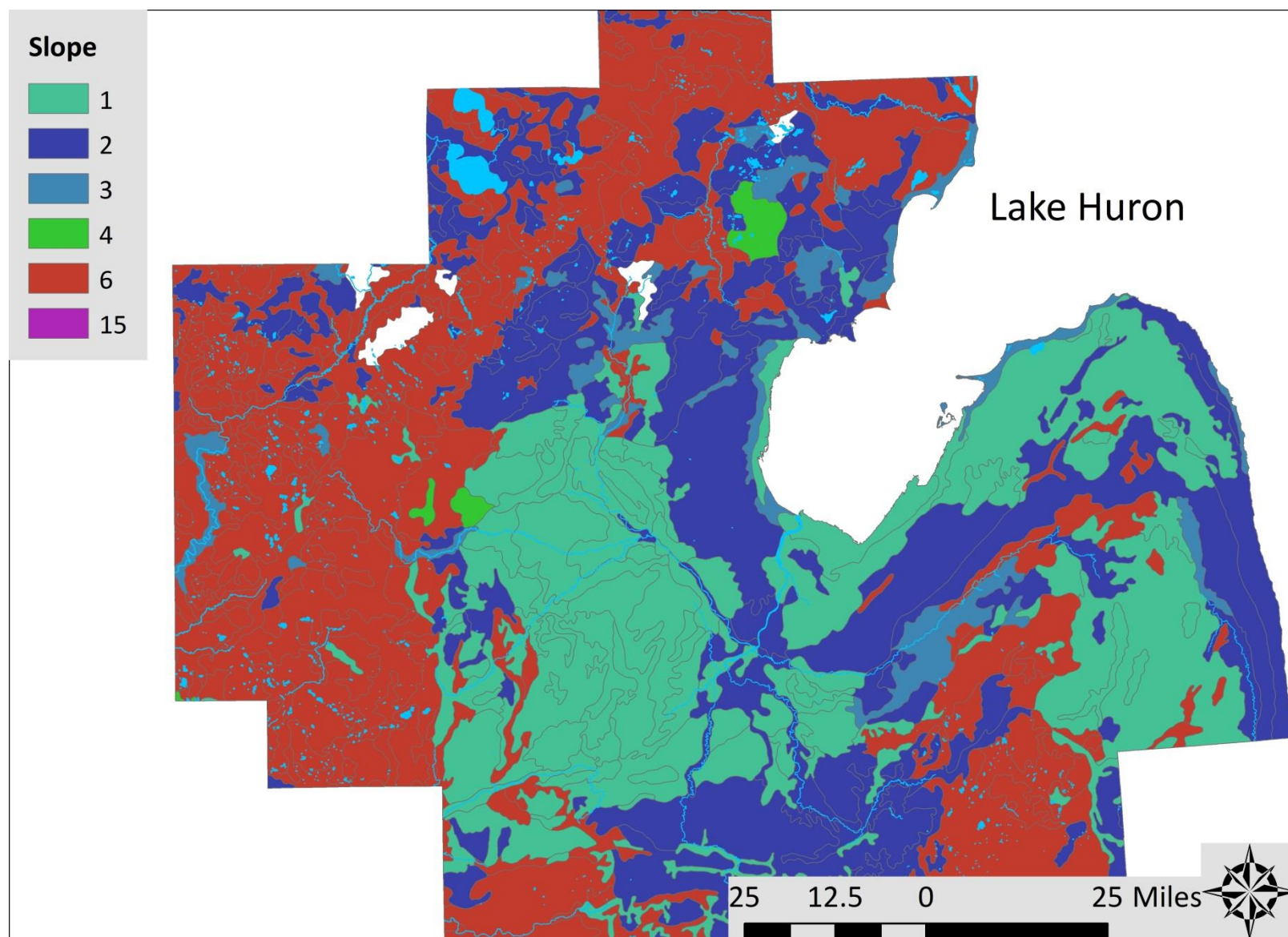


Figure 64. Soils slope

Predictive Landscapes

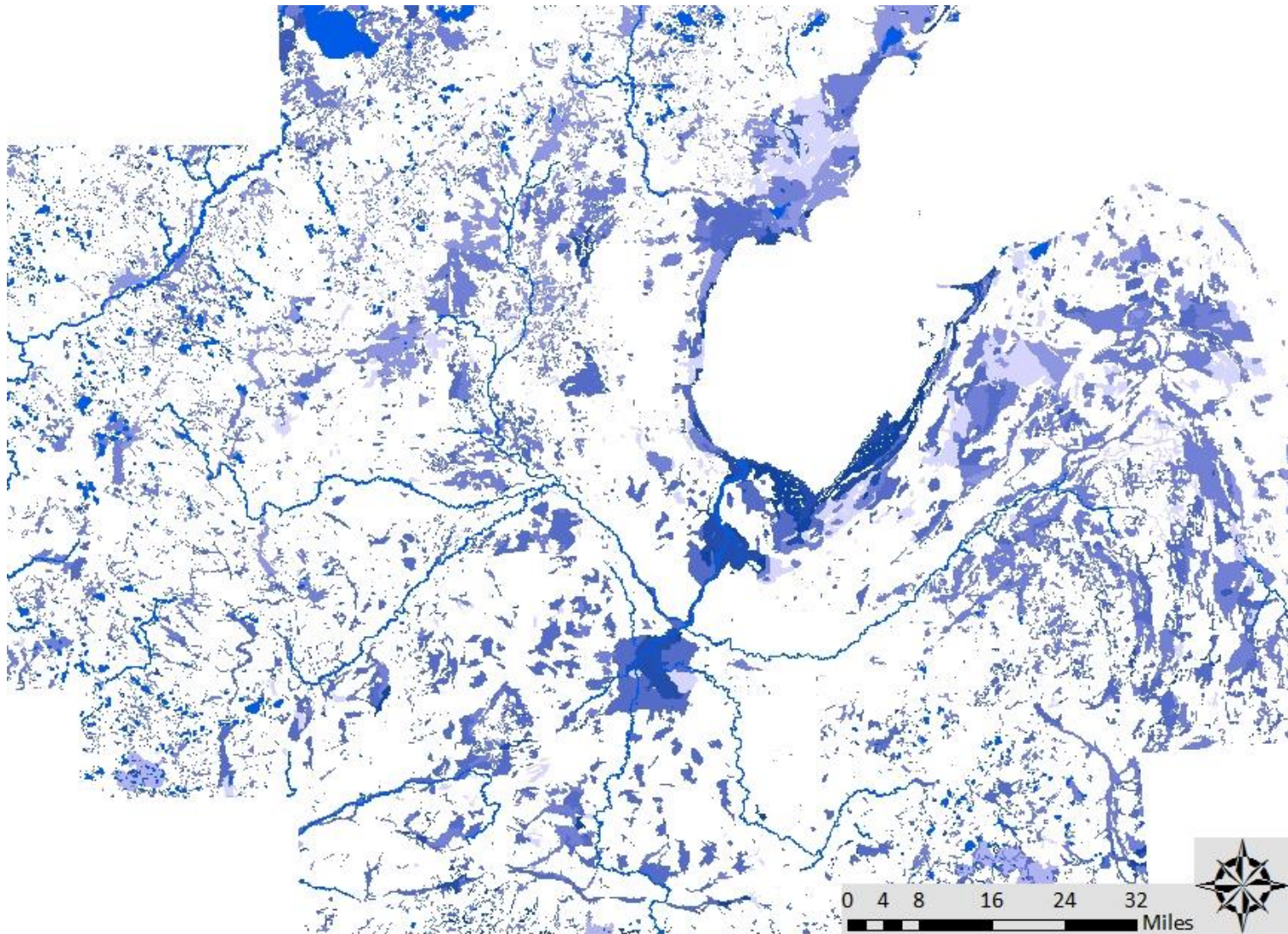


Figure 65. EW composite wetlands

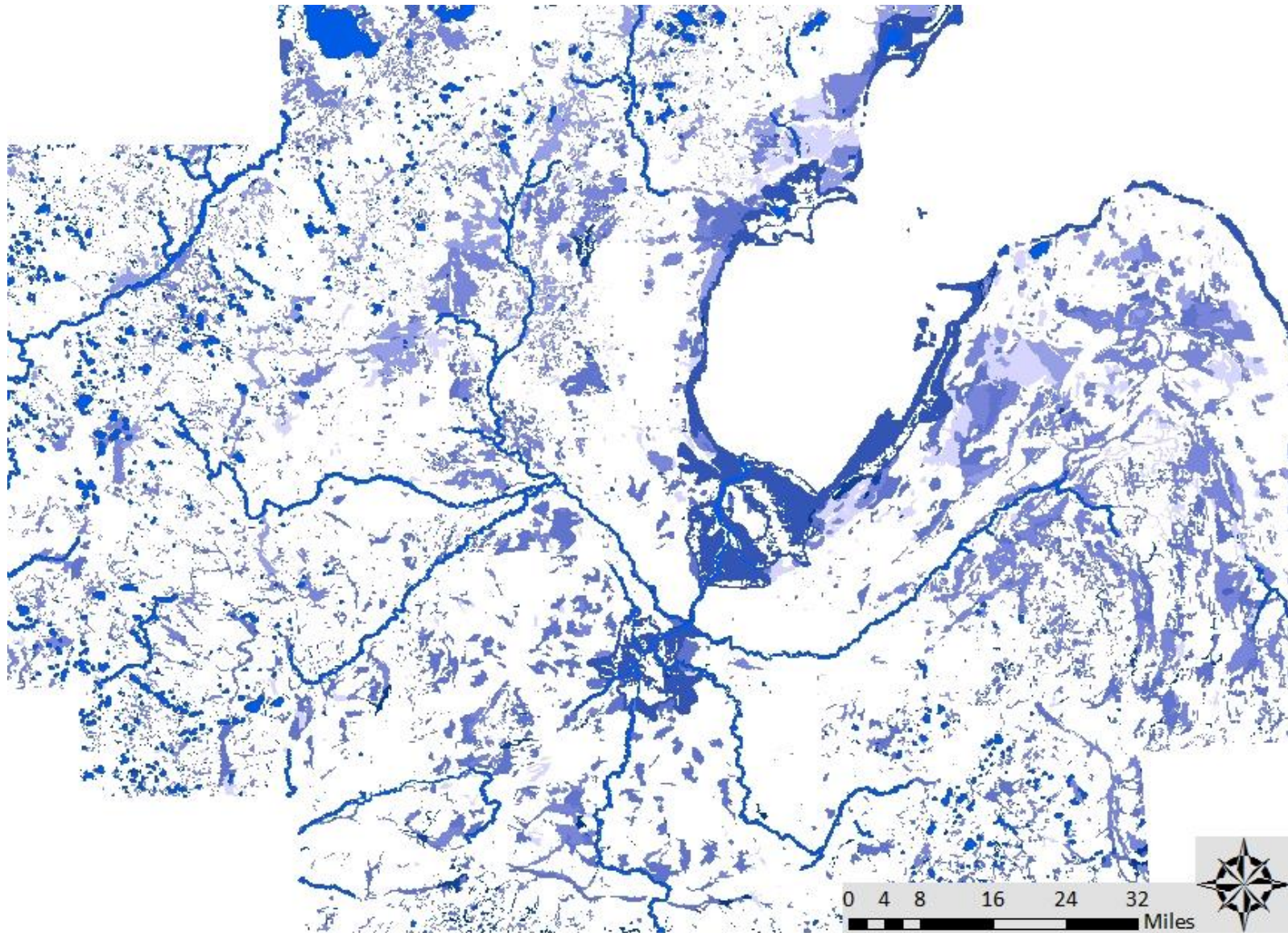


Figure 66. MW composite wetlands

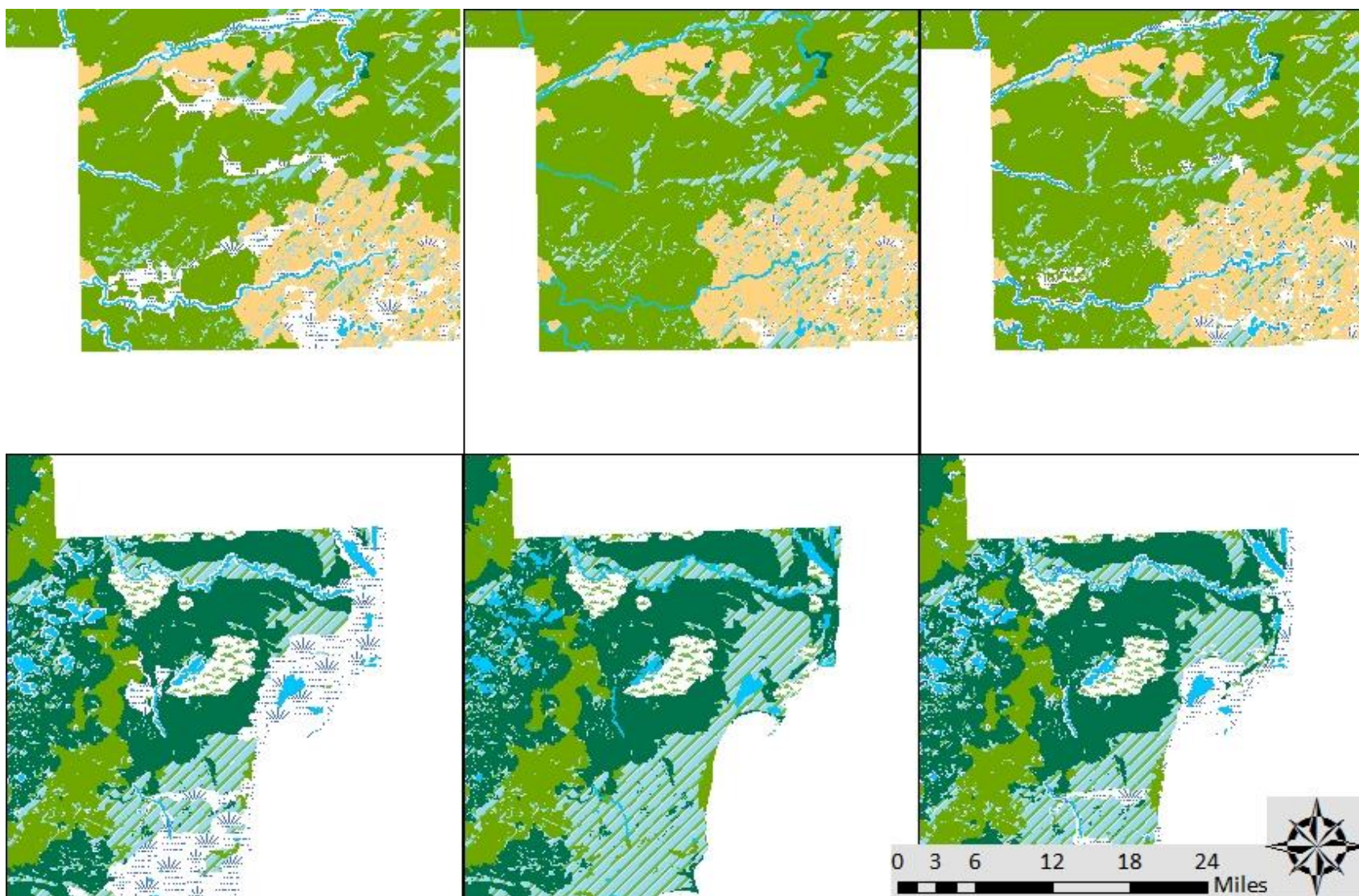


Figure 67. Clinton (top) and Iosco counties (bottom) composite landscape.

LA (left), EW (middle), MW (right)

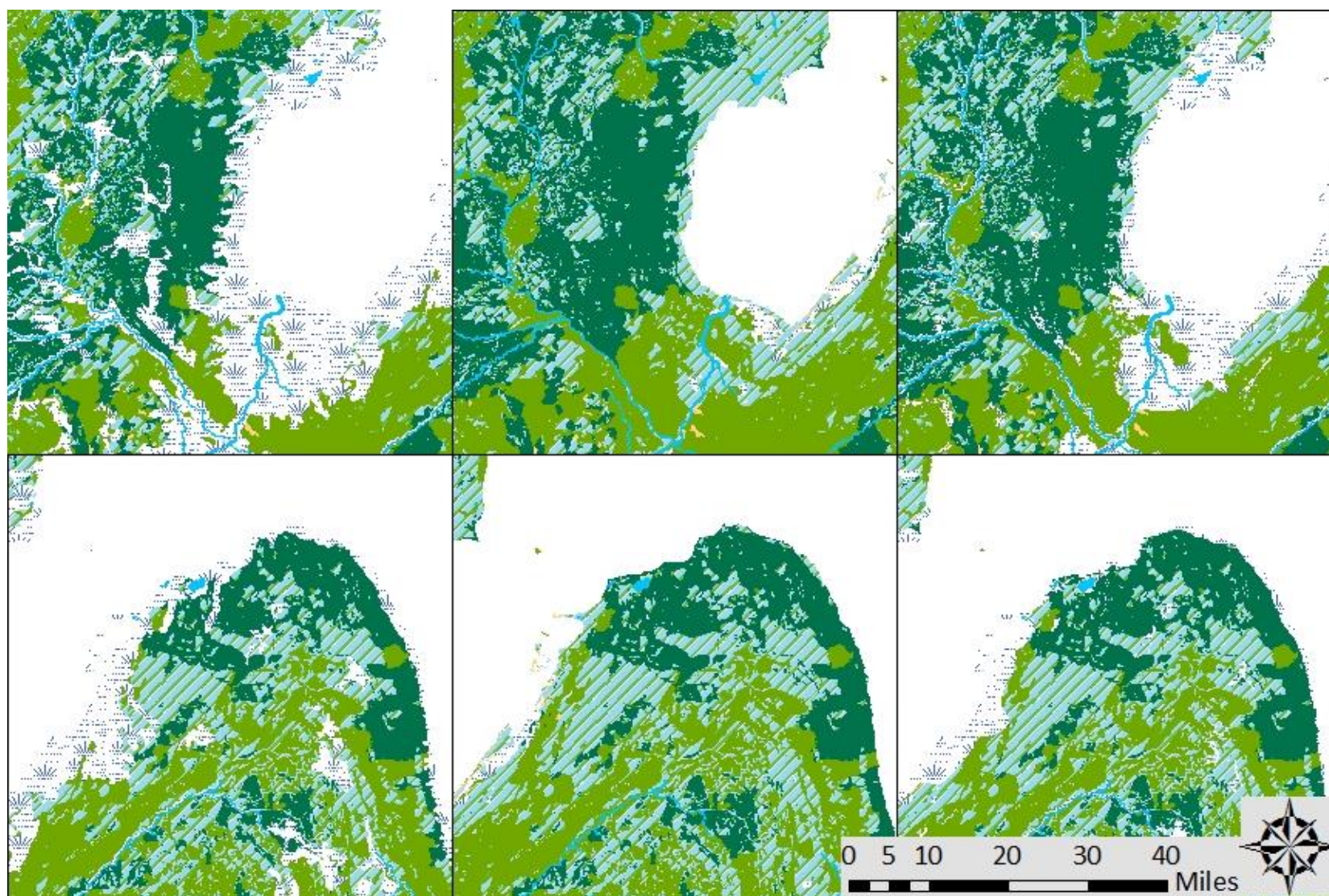


Figure 68. Bay (top) and Huron counties (bottom) composite landscape

Bay County is a low lying area with homogenous wetlands bisected by pine forests.

Landscape Resource Communities

Table 11. Resource communities Modified from (Albert 1995; Albert, et al. 1986; Comer, et al. 1995)			
Resource Community	Ecological Group	Ecological Sub Group	Ecological Sub Sub Group
Alvar	Terrestrial	Primary	
Bog	Palustrine	Bog	
Boreal Forest	Terrestrial	Forest	
Bur Oak Plains	Terrestrial	Savanna	
Cave	Subterranean/Sink		
Coastal Fen	Palustrine	Fen	
Coastal Plain Marsh	Palustrine	Marsh	
Dry Northern Forest	Terrestrial	Forest	
Dry Southern Forest	Terrestrial	Forest	
Dry-mesic Northern Forest	Terrestrial	Forest	
Dry-mesic Prairie	Terrestrial	Prairie	
Dry-mesic Southern Forest	Terrestrial	Forest	
Emergent Marsh	Palustrine	Marsh	
Floodplain Forest	Palustrine	Forest	
Granite Bedrock Glade	Terrestrial	Primary	Bedrock Glade
Granite Bedrock Lakeshore	Terrestrial	Primary	Bedrock Lakeshore
Granite Cliff	Terrestrial	Primary	Inland Cliff
Granite Lakeshore Cliff	Terrestrial	Primary	Lakeshore Cliff
Great Lakes Barrens	Terrestrial	Primary	
Great Lakes Marsh	Palustrine	Marsh	
Hardwood-conifer Swamp	Palustrine	Forest	
Hillside Prairie	Terrestrial	Prairie	
Inland Salt Marsh	Palustrine	Marsh	
Intermittent Wetland	Palustrine	Marsh	

Table 11. (cont'd)			
Modified from (Albert 1995; Albert, et al. 1986; Comer, et al. 1995)			
Resource Community	Ecological Group	Ecological Sub Group	Ecological Sub Sub Group
Interdunal Wetland	Palustrine	Marsh	
Inundated Shrub Swamp	Palustrine	Shrub	
Lakeplain Oak Openings	Terrestrial	Savanna	
Lakeplain Wet Prairie	Palustrine	Prairie	
Lakeplain Wet-mesic Prairie	Palustrine	Prairie	
Limestone Bedrock Glade	Terrestrial	Primary	Bedrock Glade
Limestone Bedrock Lakeshore	Terrestrial	Primary	Bedrock Lakeshore
Limestone Cliff	Terrestrial	Primary	Inland Cliff
Limestone Cobble Shore	Terrestrial	Primary	Cobble Shore
Limestone Lakeshore Cliff	Terrestrial	Primary	Lakeshore Cliff
Mesic Northern Forest	Terrestrial	Forest	
Mesic Prairie	Terrestrial	Prairie	
Mesic Sand Prairie	Terrestrial	Prairie	
Mesic Southern Forest	Terrestrial	Forest	
Muskeg	Palustrine	Bog	
Northern Bald	Terrestrial	Primary	Bedrock Glade
Northern Fen	Palustrine	Fen	
Northern Hardwood Swamp	Palustrine	Forest	
Northern Shrub Thicket	Palustrine	Shrub	
Northern Wet Meadow	Palustrine	Marsh	
Oak Barrens	Terrestrial	Savanna	
Oak Openings	Terrestrial	Savanna	
Oak-pine Barrens	Terrestrial	Savanna	
Open Dunes	Terrestrial	Primary	
Patterned Fen	Palustrine	Fen	
Pine Barrens	Terrestrial	Savanna	

Table 11. (cont'd)			
Modified from (Albert 1995; Albert, et al. 1986; Comer, et al. 1995)			
Resource Community	Ecological Group	Ecological Sub Group	Ecological Sub Sub Group
Poor Conifer Swamp	Palustrine	Forest	
Poor Fen	Palustrine	Fen	
Prairie Fen	Palustrine	Fen	
Rich Conifer Swamp	Palustrine	Forest	
Rich Tamarack Swamp	Palustrine	Forest	
Sand and Gravel Beach	Terrestrial	Primary	
Sandstone Bedrock Lakeshore	Terrestrial	Primary	Bedrock Lakeshore
Sandstone Cliff	Terrestrial	Primary	Inland Cliff
Sandstone Cobble Shore	Terrestrial	Primary	Cobble Shore
Sandstone Lakeshore Cliff	Terrestrial	Primary	Lakeshore Cliff
Sinkhole	Subterranean/Sink		
Southern Hardwood Swamp	Palustrine	Forest	
Southern Shrub-carr	Palustrine	Shrub	
Southern Wet Meadow	Palustrine	Marsh	
Submergent Marsh	Palustrine	Marsh	
Volcanic Bedrock Glade	Terrestrial	Primary	Bedrock Glade
Volcanic Bedrock Lakeshore	Terrestrial	Primary	Bedrock Lakeshore
Volcanic Cliff	Terrestrial	Primary	Inland Cliff
Volcanic Cobble Shore	Terrestrial	Primary	Cobble Shore
Volcanic Lakeshore Cliff	Terrestrial	Primary	Lakeshore Cliff
Wet Prairie	Palustrine	Prairie	
Wet-mesic Flatwoods	Palustrine	Forest	
Wet-mesic Prairie	Palustrine	Prairie	
Wet-mesic Sand Prairie	Palustrine	Prairie	
Wooded Dune and Swale Complex	Palustrine/Terrestrial		

Note. The Saginaw Drainage has the greatest diversity of habitats in Michigan, accounting for over 80% of the total.

Table 12. Relevant resource community descriptions - limited to study area

Adapted and summarized from Michigan Natural Features Inventory publication by (Kost, et al. 2007)

Resource Community	Description
Ephemeral Wetlands Intermittent Wetlands	Intermittent wetland is a sedge- and herb-dominated wetland found along lakeshores or in depressions and characterized by fluctuating water levels, both seasonally and interannually. Intermittent wetlands exhibit traits of both peatlands and marshes, with characteristic vegetation including sedges (<i>Carex</i> spp.), rushes (<i>Juncus</i> spp.), sphagnum mosses, and ericaceous shrubs. The community occurs statewide.
SHRUB SWAMP/EMERGENT MARSH	Inundated shrub swamp is a shrub-dominated community characterized by poor drainage, nearly continuous inundation or saturation, and dominance by buttonbush (<i>Cephalanthus occidentalis</i>). The community typically exhibits a scattered shrub-dominated overstory and sparse herbaceous cover.
	Emergent marsh is a shallow-water wetland along the shores of lakes and streams characterized by emergent narrow- and broad-leaved herbs and grass-like plants as well as floating-leaved herbs. Common plants include water plantain (<i>Alisma plantago-aquatica</i>), sedges (<i>Carex</i> spp.), spike-rushes (<i>Eleocharis acicularis</i> spp.), pond-lilies (<i>Nuphar</i> spp.), pickerel weed (<i>Pontederia cordata</i>), arrowheads (<i>Sagittaria</i> spp.), bulrushes (<i>Schoenoplectus</i> spp.), and cat-tails (<i>Typha</i> spp.). The community occurs on both mineral and organic soils.
MIXED CONIFER SWAMP	Rich conifer swamp is a groundwater-influenced, minerotrophic, forested wetland dominated by northern white-cedar (<i>Thuja occidentalis</i>) that occurs on organic soils (i.e., peat) primarily north of the climatic tension zone in the northern Lower and Upper Peninsulas. The community is also referred to as cedar swamp.
	Poor conifer swamp is a nutrient-poor, forested peatland characterized by acidic, saturated peat, and the prevalence of coniferous trees, sphagnum mosses, and ericaceous shrubs. This system is found predominantly north of the climatic tension zone, and much less frequently in southern Lower Michigan. The community occurs in depressions in glacial outwash and sandy glacial lakeplains and in kettles on pitted outwash and depressions on moraines. Fire occurs naturally during drought periods and creates even-aged, often monospecific, stands of black spruce (<i>Picea mariana</i>). Windthrow, beaver flooding, and insect defoliation are also important disturbance factors influencing species composition and structure.

Table 12. (cont'd)	
Resource Community	Description
MIXED HARDWOOD SWAMP	Hardwood-conifer swamp is a minerotrophic forested wetland dominated by a mixture of lowland hardwoods and conifers, occurring on organic (i.e., peat) and poorly drained mineral soils throughout Michigan. The community occurs on a variety of landforms, often associated with headwater streams and areas of groundwater discharge. Species composition and dominance patterns can vary regionally. Windthrow and fluctuating water levels are the primary natural disturbances that structure hardwood-conifer swamp.
RIVER	Floodplain forest is a bottomland, deciduous or deciduous-conifer forest community occupying low-lying areas adjacent to streams and rivers of third order or greater, and subject to periodic over-the-bank flooding and cycles of erosion and deposition. Species composition and community structure vary regionally and are influenced by flooding frequency and duration. Silver maple (<i>Acer saccharinum</i>) and green ash (<i>Fraxinus pennsylvanica</i>) are typically major overstory dominants. Floodplain forests occur along major rivers throughout the state, but are most extensive in the Lower Peninsula. Species richness is greatest in the southern Lower Peninsula, where many floodplain species reach the northern extent of their range.
WET PRAIRIE	Wet prairie is a native lowland grassland occurring on level, saturated and/or seasonally inundated stream and river floodplains, lake margins, and isolated depressions in southern Lower Michigan. It is typically found on outwash plains and channels near moraines. Soils are primarily loam or silt loam of neutral pH and have high organic content. Dominant species include bluejoint grass (<i>Calamagrostis canadensis</i>) and cordgrass (<i>Spartina pectinata</i>), with sedges (<i>Carex</i> spp.) often important subdominants.
WET PRAIRIE	Wet-mesic prairie is a native lowland grassland occurring on moist, occasionally inundated stream and river floodplains, lake margins, and isolated depressions in southern Lower Michigan. It is typically found on outwash plains and channels near moraines. Soils are primarily loam or silt loam with neutral pH and high organic content. Dominants or subdominants include big bluestem (<i>Andropogon gerardii</i>), Indian grass (<i>Sorghastrum nutans</i>), bluejoint grass (<i>Calamagrostis canadensis</i>), cordgrass (<i>Spartina pectinata</i>), and sedges (<i>Carex</i> spp.).

Table 12. (cont'd)	
Resource Community	Description
BLACK ASH SWAMP	Northern hardwood swamp is a seasonally inundated, deciduous swamp forest community dominated by black ash (<i>Fraxinus nigra</i>) that occurs on neutral to slightly acidic, hydric mineral soils and shallow muck over mineral soils. Located north of the climatic tension zone, northern hardwood swamp is found primarily in depressions on level to hummocky glacial lakeplains, fine- and medium-textured glacial tills, and broad flat outwash plains. Fundamental disturbance factors affecting northern hardwood swamp development include seasonal flooding and windthrow.
BLACK ASH SWAMP	Southern hardwood swamp is a minerotrophic forested wetland occurring in southern Lower Michigan on mineral or occasionally organic soils dominated by a mixture of lowland hardwoods. Conifers are absent or local. The community occupies shallow depressions and high-order stream drainages on a variety of landforms. The canopy is typically dominated by silver maple (<i>Acer saccharinum</i>), red maple (<i>A. rubrum</i>), green ash (<i>Fraxinus pennsylvanica</i>), and black ash (<i>Fraxinus nigra</i>).
CEDAR SWAMP	Rich conifer swamp is a groundwater-influenced, minerotrophic, forested wetland dominated by northern white-cedar (<i>Thuja occidentalis</i>) that occurs on organic soils (i.e., peat) primarily north of the climatic tension zone in the northern Lower and Upper Peninsulas. The community is also referred to as cedar swamp.
MUSKEG/BOG	Muskeg is a nutrient-poor peatland characterized by acidic, saturated peat, and scattered or clumped, stunted conifer trees set in a matrix of sphagnum mosses and ericaceous shrubs. Black spruce (<i>Picea mariana</i>) and tamarack (<i>Larix laricina</i>) are typically the most prevalent tree species. The community primarily occurs in large depressions on glacial outwash and sandy glacial lakeplains. Fire occurs naturally during periods of drought and can alter the hydrology, mat surface, and floristic composition of muskegs. Windthrow, beaver flooding, and insect defoliation are also important disturbance factors that influence species composition and structure. Muskeg is a nutrient-poor peatland characterized by acidic, saturated peat, and scattered or clumped, stunted conifer trees set in a matrix of sphagnum mosses and ericaceous shrubs. Black spruce (<i>Picea mariana</i>) and tamarack (<i>Larix laricina</i>) are typically the most prevalent tree species. The community primarily occurs in large depressions on glacial outwash and sandy glacial lakeplains. Fire occurs naturally during periods of drought and can alter the hydrology, mat surface, and floristic composition of muskegs. Windthrow, beaver flooding, and insect defoliation are also important disturbance factors that influence species composition and structure.

Table 12. (cont'd)	
Resource Community	Description
MUSKEG/BOG	Bog is a nutrient-poor peatland characterized by acidic, saturated peat and the prevalence of sphagnum mosses and ericaceous shrubs. Fire and flooding are the main natural disturbance factors.
BEECH-SUGAR MAPLE-HEMLOCK	Mesic northern forest is a forest type of moist to dry-mesic sites lying mostly north of the climatic tension zone, characterized by the dominance of northern hardwoods, particularly sugar maple (<i>Acer saccharum</i>) and American beech (<i>Fagus grandifolia</i>). Conifers such as hemlock (<i>Tsuga canadensis</i>) and white pine (<i>Pinus strobus</i>) are frequently important canopy associates. This community type breaks into two broad classes: northern hardwood forest and hemlock-hardwood forest. It is primarily found on coarse-textured ground and end moraines, and soils are typically loamy sand to sandy loam. The natural disturbance regime is characterized by gap-phase dynamics; frequent, small windthrow gaps allow for the regeneration of the shade-tolerant canopy species. Catastrophic windthrow occurred infrequently with several generations of trees passing between large-scale, severe disturbance events. Historically, mesic northern forest occurred as a matrix system, dominating vast areas of mesic uplands in the Great Lakes region. These forests were multi-generational, with old-growth conditions lasting many centuries.
BEECH-SUGAR MAPLE FOREST	Mesic southern forest is an American beech- and sugar maple-dominated forest distributed south of the climatic tension zone and found on flat to rolling topography with predominantly loam soils. The natural disturbance regime is characterized by gap-phase dynamics; frequent, small windthrow gaps allow for the regeneration of shade-tolerant, canopy species. Historically, mesic southern forest occurred as a matrix system, dominating vast areas of rolling to level, loamy uplands of the Great Lakes region. These forests were multi-generational, with old-growth conditions lasting many centuries.
HEMLOCK-WHITE PINE FOREST	Mesic northern forest is a forest type of moist to dry-mesic sites lying mostly north of the climatic tension zone, characterized by the dominance of northern hardwoods, particularly sugar maple (<i>Acer saccharum</i>) and American beech (<i>Fagus grandifolia</i>). Conifers such as hemlock (<i>Tsuga canadensis</i>) and white pine (<i>Pinus strobus</i>) are frequently important canopy associates. This community type breaks into two broad classes: northern hardwood forest and hemlock-hardwood forest. It is primarily found on coarse-textured ground and end moraines, and soils are typically loamy sand to sandy loam. The natural disturbance regime is characterized by gap-phase dynamics; frequent, small windthrow gaps allow for the regeneration of the shade-tolerant canopy species. Catastrophic windthrow occurred infrequently with several generations of trees passing between large-scale, severe disturbance events.

Table 12. (cont'd)	
Resource Community	Description
	Historically, mesic northern forest occurred as a matrix system, dominating vast areas of mesic uplands in the Great Lakes region. These forests were multi-generational, with old-growth conditions lasting many centuries.
WHITE PINE-MIXED HARDWOOD	
JACK PINE-RED PINE FOREST	Dry northern forest is a pine- or pine-hardwood-dominated forest type that occurs on dry sandy sites lying mostly north of the climatic tension zone. Two distinct variants are included within this community type, one dominated by jack pine (<i>Pinus banksiana</i>) or jack pine and hardwoods, and the other dominated by red pine (<i>P. resinosa</i>). Prior to European settlement, dry northern forest typically originated in the wake of catastrophic fire. Frequent, low-intensity ground fires maintained red pine systems by removing competing hardwoods.
WHITE PINE-RED PINE	
WHITE PINE-WHITE OAK	
MIXED PINE-OAK	
OAK-HICKORY	Dry-mesic southern forest is a fire-dependent, oak or oak-hickory forest type on generally dry-mesic sites found south of the climatic tension zone in southern Lower Michigan. Frequent fires maintain semi-open conditions, promoting oak regeneration and ground and shrub layer diversity.
MIXED OAK	Dry southern forest is a fire-dependent, oak-dominated forest type on dry sites lying mostly south of the climatic tension zone in southern Lower Michigan. Frequent fires maintain semi-open conditions, promoting oak regeneration and ground and shrub layer diversity.
MIXED OAK SAVANNA	Hillside prairie is a grassland or savanna community that occurs on moderate to steep exposed slopes and crests of hills associated with river valleys, streams, or kettle lakes, surrounded by oak forest or oak savanna. This natural community is almost always found on south- to west-facing slopes, where exposure to sunlight is highest. Soils are typically strongly acid to neutral loamy sand or sandy loam, and often mixed with gravel. Hillside prairie is notable for supporting several state-listed plant species largely restricted to this community type.

Table 12. (cont'd)	
Resource Community	Description
	Lakeplain oak openings are a fire-dependent savanna community, dominated by oaks and characterized by a graminoid-dominated ground layer of species associated with both lakeplain prairie and forest communities. Lakeplain oak openings occur within the southern Lower Peninsula on glacial lakeplains on sand ridges, level sandplains, or adjacent depressions. Open conditions were historically maintained by frequent fire, and in depressions, by seasonal flooding.
SPRUCE-FIR-CEDAR	Poor conifer swamp is a nutrient-poor, forested peatland characterized by acidic, saturated peat, and the prevalence of coniferous trees, sphagnum mosses, and ericaceous shrubs. This system is found predominantly north of the climatic tension zone, and much less frequently in southern Lower Michigan. The community occurs in depressions in glacial outwash and sandy glacial lakeplains and in kettles on pitted outwash and depressions on moraines. Fire occurs naturally during drought periods and creates even-aged, often monospecific, stands of black spruce (<i>Picea mariana</i>). Windthrow, beaver flooding, and insect defoliation are also important disturbance factors influencing species composition and structure.
ASPEN-BIRCH	Southern shrub-carr is a moderate to long persistent successional shrub community dominated by willows (<i>Salix</i> spp.), dogwoods (i.e., <i>Cornus stolonifera</i> , <i>C. foemina</i> , and <i>C. amomum</i>), winterberry (<i>Ilex verticillata</i>), and bog birch (<i>Betula pumila</i>). This community is successional intermediate among a variety of open, herbaceous wetlands (i.e., southern wet meadow, prairie fen, wet-mesic prairie, and lakeplain wet-mesic prairie) and forested wetlands such as rich tamarack swamp and southern hardwood swamp. It typically occurs on saturated, organic soil and is characterized by fluctuating water levels and poor drainage conditions. Southern shrub-carr is found primarily south of the climatic tension zone in southern Lower Michigan and is frequent in other Midwestern states such as Illinois, Indiana, Iowa, Minnesota, and Wisconsin. North of the climatic tension zone, wet-ground, tall shrub communities are typically dominated by tag alder (<i>Alnus rugosa</i>) and are classified as northern shrub thicket.
BLACK OAK BARREN	Oak barrens are a fire-dependent savanna type dominated by oaks, having between 5 and 60% canopy, with or without a shrub layer. Black oak (<i>Quercus velutina</i>) and white oak (<i>Q. alba</i>) typically dominate the scattered overstory. The predominantly graminoid ground layer is composed of species associated with both prairie and forest communities. Oak barrens are found on droughty soils and occur typically on nearly level to slightly undulating glacial outwash in southern Lower Michigan.

Table 12. (cont'd)	
Resource Community	Description
OAK/PINE BARRENS	Oak-pine barrens is a fire-dependent, savanna community dominated by oaks and pines, having between 5 and 60% canopy cover, with or without a shrub layer. The predominantly graminoid ground layer contains plant species associated with both prairie and forest. The community occurs on a variety of landforms on droughty, infertile sand or loamy sands occasionally within southern Lower Michigan but mostly north of the climatic tension zone in the northern Lower and Upper Peninsulas.
PINE BARRENS	Pine barrens is a coniferous, fire-dependent savanna of scattered and clumped trees located north of the climatic tension zone in the northern Lower and Upper Peninsulas. The community occurs on level sandy outwash plains and sandy glacial lakeplains. The droughty sand soils are very strongly to strongly acid, with very poor water-retaining capacity. The community is dominated by jack pine (<i>Pinus banksiana</i>), with northern pin oak (<i>Quercus ellipsoidalis</i>) as a frequent canopy associate. Frequent fires, drought, and growing-season frosts maintain the open canopy conditions.
GRASSLAND	Dry-mesic prairie is a native grassland community dominated by big bluestem (<i>Andropogon gerardii</i>), little bluestem (<i>Andropogon scoparius</i>), and Indian grass (<i>Sorghastrum nutans</i>). The community occurs on sandy loam or loamy sand on level to gently sloping sites of glacial outwash, coarse-textured end moraines, and glacial till plain. The community represents the stands of open grassland that occurred in association with historic oak openings throughout much of southern Lower Michigan. In previous versions of the natural community classification this community was called woodland prairie.
GRASSLAND	A wide variety of soils support mesic northern forest but most typically it occurs on loamy sand to sandy loam and occasionally on sand, loam, and clay. Soils range widely in pH from extremely acidic to moderately alkaline but are more commonly extremely acid to medium acid. Mesic prairie is a native grassland community dominated by big bluestem (<i>Andropogon gerardii</i>), little bluestem (<i>Andropogon scoparius</i>), and Indian grass (<i>Sorghastrum nutans</i>). It occurs on loam, sandy loam or silt loam soils on level or slightly undulating glacial outwash. Historically, mesic prairie dominated large portions of the Midwest ranging from Iowa and southern Minnesota east into southwestern Michigan and northern Ohio. In Michigan, mesic prairie occurred historically in Kalamazoo, St. Joseph, Cass, Branch, Calhoun, Berrien, and Van Buren Counties.

Table 12. (cont'd)	
Resource Community	Description
EXPOSED BEDROCK	Limestone bedrock lakeshore is a sparsely vegetated natural community dominated by lichens, mosses, and herbaceous vegetation. This community, which is also referred to as alvar pavement and limestone pavement lakeshore, occurs along the shorelines of northern Lake Michigan and Lake Huron on broad, flat, horizontally bedded expanses of limestone or dolomite bedrock. On the Lake Michigan shoreline, limestone bedrock lakeshore is concentrated along the Garden Peninsula and the southern part of Schoolcraft County. Along Lake Huron, it is located east of the Les Cheneaux Islands, on Drummond Island, and on Thunder Bay Island.
SAND DUNE	Open dunes is a grass- and shrub-dominated multi-seral community located on wind-deposited sand formations near the shorelines of the Great Lakes. Dune formation and the patterning of vegetation are strongly affected by lake-driven winds. The greatest concentration of open dunes occurs along the eastern and northern shorelines of Lake Michigan, with the largest dunes along the eastern shoreline due to the prevailing southwest winds.

Table 13. Resource community soils

Summarized from Michigan Natural Features Inventory by (Kost, et al. 2007)

Resource Community	Soils
Alvar	Alvar soils are characterized by shallow soil over bedrock, with soil depth usually less than 25 cm (10 in). Soil texture is primarily loamy sand or sandy loam. Soil is saturated, or locally inundated in the spring, but becomes droughty later in summer. Thin layers of organic soil may develop in shallow depressions that remain wet for longer periods. Soil is mildly to moderately alkaline.
Bog	The organic soils are composed of saturated fibric peat that contains partially decomposed sphagnum mosses and frequently, fragments of sedges and wood. Like the surface water, peat soils are extremely acidic, cool, and characterized by low nutrient availability and oxygen levels. The water-retaining capacity of sphagnum peat is tremendous and as a result bogs are saturated, anoxic systems with water tables near the surface. Peat composition changes with depth and is influenced by the successional history of a given site. Fiber content and hydraulic conductivity of peat soils usually decrease with depth.
Boreal Forest	Sand, loamy sand, and sandy loam soils are typically moderately acid to neutral, but heavier soils (e.g., silty loam and clay loams) and more acid and alkaline conditions are also found. Boreal forests that occur over bedrock or cobble are often characterized by shallow organic soils or mor humus. Where conifers dominate the canopy, the litter layer is typically more acidic than the underlying organic and mineral soils. Water-retaining capacity of the soils is variable with sandy soils typically being well-drained and soils with heavier texture, such as loams, ranging from moderately drained to poorly drained. Inland boreal forest systems usually occur on moderately to poorly drained lakeplain or outwash.
Bur Oak Plains	Soils were fertile, fine-textured, loam, sandy loam or silt loam with neutral pH and good water-retaining capacity. Soils contained moderate to high amounts of organic matter and supported high abundance of graminoids and forbs.
Cave	There is no information on soil development within Michigan's caves, but since they are derived from limestone or dolomite, soils are likely mildly to moderately alkaline.
Coastal Fen	Soils of coastal fen may range from neutral to moderately alkaline, fine-textured sand to clay in areas immediately adjacent to the lake, to marl and organic sediments in protected coastal embayments less influenced by storm waves. When lake levels rise, areas closer the lakeshore become inundated and storm waves can wash away loose organic and marl sediments.

Table 13. (cont'd)	
Resource Community	Soils
Coastal Plain Marsh	The sandy soils underlying coastal plain marshes are strongly to very strongly acidic and nutrient-poor. Organic deposits of peat or sandy peat may overlay the sandy substrate, and in some basins a clay layer may occur several meters below the surface.
Dry Northern Forest	Soils are coarse-textured, well-sorted, excessively drained dry sands with low amounts of organic matter and low water-holding capacity. The droughty soils are extremely acid to very strongly acid with low nutrient content and high frost proclivity.
Dry Sand Prairie	Soils of dry sand prairies are typically very strongly acid to medium acid loamy sand with low water-retaining capacity.
Dry Southern Forest	The soils of dry southern forest are infertile, well-drained sand, loamy sand, or sandy loam with medium to strongly acid pH and low water-retaining capacity.
Dry-mesic Northern Forest	Sand or loamy sand soils are extremely acid to very strongly acid and coarse- to medium-textured. A surface layer of mor humus is normally present due to the accumulation of pine needles.
Dry-mesic Prairie	Soils are typically strongly acid to circumneutral sandy loam or occasionally loamy sand with moderate water-retaining capacity.
Dry-mesic Southern Forest	Soils are typically sandy loam or loam and slightly acid to neutral in pH.
Emergent Marsh	Emergent marsh can develop on all textures of glacial sediment, including rock, gravel, sand, silt, or clay. Typically there is an accumulation of circumneutral to alkaline, fine organic sediments overlying the mineral soil. Where organic sediments are acid, the wetlands tend to develop into peatlands rather than remain as marsh.

Table 13. (cont'd)	
Resource Community	Soils
Floodplain Forest	Soil is highly variable and strongly correlated with fluvial landforms. The coarsest sediment is deposited on the natural levee, immediately adjacent to the stream channel, where the soil texture is often sandy loam to loam. Progressively finer soil particles are deposited with increasing distance from the stream. Soil texture of the first bottom is often silt loam, with silty clay loam to clay-textured soil often occurring in swales and backswamps. Cycles of periodic over-the-bank flooding followed by soil aeration when the floodwaters recede generally prevent the accumulation of organic soils. However, an accumulation of sapric peat can develop farther from the river due to a relatively low flood frequency, low flow velocity, and prolonged soil saturation resulting from a high water table. Floodplain soils are generally circumneutral to mildly alkaline. Slightly acid soils are generally only found on hummocks of organic soil in backswamps or meander-scar swamps. Floodplain soils are characterized by high nutrient availability and an abundance of soil water throughout much of the growing season.
Granite Bedrock Glade	Soil development is generally restricted to cracks and depressions within the rock, where plant debris and sand and gravel resulting from mechanical and biological weathering of the bedrock can accumulate. These soils are typically very shallow and low in nutrients. Thin soils are typically 1 to 4 cm (0.4 to 1.6 in) deep, strongly acidic, and characterized by low moisture availability. Exfoliation of rock slabs and frost wedging is characteristic of granite and contributes to soil formation. Numerous large boulders, slabs, and small granitic rocks occur scattered throughout the glades, and talus slopes occur at the base of many bedrock exposures.
Granite Bedrock Lakeshore	Because the granitic rocks along the coast are highly polished and extremely resistant to weathering, very little soil development takes place. Storm waves and ice scour also regularly remove developing soils. Freshly broken rock surfaces are circumneutral to mildly alkaline in pH, but the surface of weathered bedrock is acid. Some organic soil development takes place in cracks, under low shrubs, or in pools. Vascular plants are typically limited to these shallow cracks, exfoliation depressions, and pool edges where moisture and available nutrients are concentrated.
Granite Cliff	Soil development is limited to shallow organic soils that form from decaying roots and other plant material that accumulates in cracks, crevices, ledges, and flat areas or depressions in the bedrock. Soils accumulate primarily along the cliff summit, on talus slopes, and at the base of the cliff. The thin organic soils are typically acid but can range from slightly acid to slightly alkaline depending on the rock type.

Table 13. (cont'd)	
Resource Community	Soils
Granite Lakeshore Cliff	Soil development is limited to organic soils that form from decaying roots and other plant material that accumulates in cracks, crevices, and depressions in the bedrock, primarily along the cliff summit. The thin organic soils are acidic.
Great Lakes Barrens	The sand soils are circumneutral and dry. Subsoil water levels in depressions are periodically elevated by changes in Great Lakes water levels.
Great Lakes Marsh	Where bedrock is at or near the surface, bedrock chemistry affects wetland species composition. Soils derived from Precambrian crystalline bedrock along Lake Superior are generally acid and favor the development of poor fen or bog communities. In contrast, soils derived from marine deposits in the lower Great Lakes, including shale and marine limestone, dolomite, and evaporites, are typically more calcareous (less acid), creating the preferred habitat for calciphilic aquatic plant species and development of more minerotrophic communities such as wet meadow and coastal fen.
Hardwood-conifer Swamp	Substrate conditions are heterogeneous, and are often highly variable within a single stand. The most common condition is a thin layer of organic soil over a poorly drained mineral substrate. Organic soils are typically saturated, highly decomposed, sapric peat (i.e., muck) and frequently contain pieces of coarse wood throughout their soil profiles. Areas of deep (>1 m) organic deposition are common, especially in seeps. Substrate pH is also highly variable. Saturated mucks are typically of neutral pH, but may be acidic near the surface, especially where associated with sphagnum mosses or where coniferous needle mats accumulate. Mineral soils are often acidic. Vegetation (living and dead), depth to the water table, and groundwater movement all influence substrate alkalinity.
Hillside Prairie	Soils are well-drained, sandy loam to loamy sand and can range from strongly acid to neutral. Gravel is often present at or near the surface. One occurrence of hillside prairie is associated with exposed pre-glacial fluvial deposits of shale and conglomerate rocks.
Inland Salt Marsh	This community occurs on peat, muck, or mineral soils saturated by sodium- or chlorine-rich groundwater seeping from saline aquifers. Soils of an intact salt marsh in Michigan were found to be high in sodium, chloride, potassium, calcium, and magnesium and have a pH that ranged from medium acid to moderately alkaline.

Table 13. (cont'd)	
Resource Community	Soils
Interdunal Wetland	The saturated sand and pond water of interdunal wetlands along the lower Great Lakes is neutral to moderately alkaline because of traces of calcareous minerals in the lake-edge sands. The sand, which is sometimes covered by a thin layer of muck, is similar in composition to that of the surrounding beach ridges or dunes, consisting largely of quartz with lesser amounts of feldspar, magnetite, and traces of other minerals, such as calcite, garnet, and hornblende. On Lake Superior, there is little or no calcite, and alkalinity is typically lower than in the other Great Lakes. In the Straits of Mackinac region, the underlying soil in interdunal wetlands is sometimes fine-textured loams or clays rich in calcium carbonate. Carbonate-rich groundwater flows from adjacent sand dunes or nearby limestone or dolomite uplands, providing nutrients for rapid growth of stonewort (<i>Chara</i> spp.) and other algae. The metabolism of these algae produces calcium carbonate, which precipitates as a fine, white mud-like substance called marl. As marl deposits accumulate, sometimes reaching more than a meter in depth, they facilitate the formation of northern fen.
Intermittent Wetland	The sandy soils underlying intermittent wetlands are strongly to very strongly acidic and are primarily sands or occasionally loamy sands. Shallow organic deposits of peat or sandy peat may overlay the sandy substrate and in some basins, a clay layer may occur below the surface.
Inundated Shrub Swamp	Soils are typically shallow muck over gleyed clay, silty clay, or sandy clay. Soil pH ranges from strongly acid to moderately alkaline, with organic portions of the soil profile being more acidic than mineral portions. Although soil typically remains inundated throughout the year due to the underlying impermeable clay, the upper soil layers may become dry in mid to late summer and during periods of persistent drought.
Lakeplain Oak Openings	Soils are typically mildly alkaline, very fine sandy loams, loamy sands, or sands with moderate water-retaining capacity.
Lakeplain Wet Prairie	Soils are medium- to fine-textured, slightly acid to moderately alkaline sands, sandy loams, or silty clays with poor to moderate water-retaining capacity.
Lakeplain Wet-mesic Prairie	Soils of this natural community are fine-textured, slightly acid to moderately alkaline sands, sandy loams, or silty clays with poor to moderate water-retaining capacity.
Limestone Bedrock Glade	While large areas of limestone are bare of soil, where soils have developed, they are typically organic soils less than 30 cm (12 in) in depth. Soils are circumneutral and are generally saturated or flooded in

Table 13. (cont'd)	
Resource Community	Soils
	the fall and spring, but are often droughty during summer months. Where there is no surface soil development, organic soils may accumulate in broad cracks (grykes) in the limestone pavement, where shrubs and trees often establish.
Limestone Bedrock Lakeshore	Almost no soil development takes place directly on the limestone pavement, where storm waves and ice routinely scour the rock surface. Consequently, plant establishment is generally limited to cracks, joints, and depressions in the bedrock, where small amounts of organic matter, cobble, and finer sediments accumulate. Because it is formed from marine organisms, limestone bedrock is rich in calcium carbonates, resulting in a mildly alkaline soil ph. Resistance of the bedrock to erosion is variable. Both limestone and dolostone are readily dissolved by rainwater, producing solution depressions and cracks that often connect to the underlying groundwater system. However, limestone rich in mineral soil particles originating from terrestrial sources is resistant to solution and typically contains few cracks.
Limestone Cliff	Soil development is primarily limited to thin organic soils that form from decaying roots and other plant materials along the top of the cliff escarpment and ledges, in cracks and crevices in the bedrock, and at the base of the cliff. Breakdown of limestone and plant debris results in a sandy to loamy, organic-rich soil, with mildly alkaline to alkaline ph.
Limestone Cobble Shore	The size of the cobbles and both the depth and texture of underlying sediments vary greatly and can affect both the diversity and stability of the plant community. While most of the beach surface consists of cobbles of varying size, the underlying parent material is either limestone bedrock or fine-textured till. Between the cobbles there is rock, mineral, or organic soils. Soil texture is typically heavy clay or loam, but in some areas these fine-textured soils are overlain with a thin veneer of sand. Organic sediments can accumulate to 5 cm or more in protected inner portions of the shore. Regardless of the soil texture, pH is mildly to moderately alkaline. Deep accumulations of large cobbles tend to be quite dry and are nearly unvegetated. In contrast, shallow accumulations of small gravel and cobbles, especially when mixed with a moist sandy substrate, tend to support denser and more diverse plant cover.
Limestone Lakeshore Cliff	Soil development is primarily limited to thin organic soils that form from decaying roots and other plant materials along the top of the cliff escarpment and ledges, in cracks and crevices in the bedrock, and at the base of the cliff. Breakdown of limestone and plant debris results in a sandy to loamy, organic-rich soil, with mildly alkaline ph.

Table 13. (cont'd)	
Resource Community	Soils
Mesic Northern Forest	A wide variety of soils support mesic northern forest but most typically it occurs on loamy sand to sandy loam and occasionally on sand, loam, and clay. Soils range widely in pH from extremely acidic to moderately alkaline but are more commonly extremely acid to medium acid.
Mesic Prairie	Soils supporting mesic prairie are very strongly acid to mildly alkaline loam or sandy loam and occasionally silt loam with moderate water-retaining capacity. The soil profile often contains a B horizon dominated by clay. Mesic prairies in Michigan occur on both mollisols, which are considered true prairie soils, and udic alfisols, which cover much of southern Lower Michigan and are considered gray to brown forest soils.
Mesic Sand Prairie	Soils are predominantly strongly acid to neutral sandy loam and occasionally loamy sand. The dry-mesic to mesic condition of the sandy soils is facilitated by a relatively high water table and, in some sites, by organic content within the sand matrix, which increases water-holding capacity. Mesic sand prairie experiences seasonal water table fluctuations, with the wettest conditions occurring in spring and driest periods in late summer and fall.
Mesic Southern Forest	The community occurs on a variety of soil types, but loam is the predominant texture. Soils supporting mesic southern forest include sand, sandy loam, loamy sand, loam, silt loam, silty clay loam, clay loam, and clay. Soils are typically well-drained with high water-holding capacity and high nutrient and soil organism content. High soil fertility is maintained by nutrient inputs from the decomposition of deciduous leaves and coarse woody debris. Where American beech is dominant in the canopy, its leaf litter can have a podzolizing effect on the soil, increasing the acidity. Soil pH ranges widely from slightly acidic to moderately alkaline.
Muskeg	The organic soils of muskegs are composed of peat, which forms a continuous mat ranging in thickness from one to eight meters but is typically one to three meters deep and overlays sand. The depth of peat and soil moisture increases with peatland age and can vary within a site. Peat depth is typically greatest near the center of a peatland and decreases toward the margin or in areas with groundwater influence. The rooting zone within muskegs is quite shallow, typically confined to the uppermost 15 cm of the surface peat, where there is sufficient oxygen to maintain aerobic respiration. The surface peats of muskegs are dominated by saturated fibric peat, which is loosely compacted and spongy, contains partially decomposed sphagnum moss with fragments of wood and occasionally sedge, and like the surface water, is extremely acidic, cool, and characterized by low nutrient availability and low oxygen

Table 13. (cont'd)	
Resource Community	Soils
	levels. Peat composition changes with depth and varies with the successional history of a given peatland. Generally, fiber content and hydraulic conductivity decrease with depth. Deep humidified peats can effectively seal basins and create a perched water table.
Northern Bald	The soils are thin, slightly acid sandy soil over bedrock. Areas of exposed bedrock that lack soil development are common. Thin organic sediments accumulate in joints, cracks, and depressions and are important substrates for vegetation.
Northern Fen	The organic soils of northern fens are composed of peat and/or marl, which are typically one to three meters deep. The surface peats may range from sapric to fibric, and like the surface water, are neutral to alkaline and characterized by high cation availability. Northern fens are minerotrophic peatlands, receiving constant inputs of cold groundwater that is rich in calcium and magnesium carbonates from having moved over or percolated through base-rich bedrock or calcareous glacial deposits. Because groundwater is the primary source of water input, the hydro-period of fens is relatively stable; the soils remain saturated throughout the year but are seldom inundated by more than a few centimeters of water. Northern fens often contain or develop on extensive areas of marl, a grayish, mineral substrate with a smooth, silty texture that develops when metabolism by algae results in precipitation of calcium carbonate. Areas containing marl deposits such as old glacial lakebeds are level and referred to as marl flats. Shallow water supporting populations of marl-producing algae commonly overlays marl flats. Dispersed throughout extensive areas of marl flats are low peat mounds or islands that support a continuous carpet of sphagnum mosses and a full complement of bog and poor conifer swamp species. The pH of peat islands is extremely acidic as a result of the reducing effect of sphagnum mosses and raised elevation above the underlying calcareous groundwater.
Northern Hardwood Swamp	Soils are poorly to very poorly drained and often consist of a shallow layer of muck (i.e., sapric peat) overlaying mineral soil. The texture of mineral soils is most commonly fine sandy clay loam to fine loam and an underlying impermeable clay lens is often present.

Table 13. (cont'd)	
Resource Community	Soils
Northern Shrub Thicket	The soils of northern shrub thicket are wet to moist, nutrient-rich, well-decomposed sapric peat, or occasionally mineral soil. The pH ranges widely from alkaline to acidic with medium acidity being the most prevalent condition. The soils are characterized by high nutrient levels due to the nitrogen-fixing ability of alder. Northern shrub thickets are non-stagnant wetlands with high levels of dissolved oxygen and soil nitrogen. Soils range from poorly drained to well drained, with most sites remaining saturated throughout the growing season. The community is typically flooded in spring.
Northern Wet Meadow	Northern wet meadow typically occurs on organic soils such as well-decomposed sapric peat, but saturated mineral soil may also support the community. Soil pH typically ranges from strongly acid to neutral. Northern wet meadow occurs on more acidic soils compared to southern wet meadow, which is found on neutral to strongly alkaline soils.
Oak Barrens	Characteristic soils of oak barrens are infertile, coarse-textured, well-drained sand or loamy sand with medium to slightly acid pH and low water-retaining capacity. The drought soils contain little organic matter and lack the fine-textured illuvial horizon associated with the richer and more productive soils of the oak openings.
Oak Openings	Soils of oak openings are well-drained, moderately fertile, sandy loams, or loams with slightly acid to neutral pH and low to moderate water-retaining capacity.
Oak-pine Barrens	Soils of oak-pine barrens are typically infertile, excessively well-drained sand or loamy sand with medium to slightly acid pH and low water-retaining capacity. Soils range from coarse-textured loam sands on moraines to very fine-textured sands on lakeplains. The soils contain little organic matter and are droughty.
Open Dunes	Dune sand consists largely of quartz (87-94%), with lesser amounts of feldspar (10-18%), magnetite (1-3%), and traces of other minerals, such as calcite, garnet, and hornblende. Sand particles are rounded and frosted by continuous collisions with other sand grains. Because the sand contains calcareous minerals, it is neutral to slightly alkaline.

Table 13. (cont'd)	
Resource Community	Soils
Patterned Fen	Peat (including fibric, hemic, and sapric peat) forms the substrate for both the strings and flarks of patterned fen communities. Peat can be several meters deep (10 to 25 feet for Lake Agassiz peatlands of Minnesota) and is derived from sedges, sphagnum mosses, reeds, and moderately decomposed woody material. The saturated peat ranges from medium acid to circumneutral. The flarks tend to be wetter, slightly acidic to circumneutral, and more minerotrophic than the strings, although nutrient availability and pH can differ greatly both within and among patterned peatland systems. The amount of water in the flarks also varies depending on local hydrology, precipitation, and season.
Pine Barrens	The soil is primarily excessively drained, very strongly to strongly acid sand, and relatively infertile. Thin bands of finer textured soil (loamy sand to sandy clay loam) are often present near moraines or ice-contact landforms. Such fine banding improves soil-water availability, resulting in more rapid tree growth and a faster rate of succession to forest.
Poor Conifer Swamp	The organic soils of poor conifer swamps are composed of peat, which forms a continuous mat that can be as little as 15 cm (6 in) deep but is often at least 40 cm (16 in) deep. The rooting zone within poor conifer swamps is typically quite shallow, confined to the upper 15 cm (6 in) of the surface peat. Depth of peat and soil moisture varies within a site. Peat depth is typically greatest near the center of a peatland and decreases toward the peatland margin or in areas with groundwater influence. The surface peats of poor conifer swamps are dominated by saturated fibric peat, which is loosely compacted and spongy, contains partially decomposed sphagnum moss with fragments of wood and occasionally sedge, and like the surface water, is extremely acidic, cool, and characterized by low nutrient availability and oxygen levels.
Poor Fen	The organic soils of poor fens are composed of peat, which frequently forms a shallow, continuous mat ranging from one to three meters in depth. Organic soils near the surface are fibric peat and very strongly to strongly acid with low nutrient availability. Low levels of groundwater input combined with high water-retaining capacity of fibric peat produce continuously saturated conditions in the rooting zone of poor fens. The water table of poor fens is stable, typically at the soil surface with soils remaining saturated but seldom flooded. The surface waters of poor fens are characterized by very strong to strong acidity, low available nutrients, low specific conductivity, cool temperatures, moderate levels of dissolved organic matter, and anaerobic conditions.

Table 13. (cont'd)	
Resource Community	Soils
Prairie Fen	Prairie fen occurs on saturated organic soil and marl, a calcium carbonate (CaCO ₃) precipitate. Marl deposits can accumulate to depths greater than one meter in lakes and shallow calcareous water as a result of metabolism by algae. The organic soils are typically mildly alkaline, with marl deposits reaching slightly higher levels of alkalinity. The soil profile of prairie fens often contains distinct zones of sedge peat, woody peat, and marl. Thus, the organic deposits may change with depth throughout the soil profile from fibric peat to hemic peat or well-decomposed sapric peat (muck) depending on a fen's successional history and past disturbance regime. The white- to grayish-colored marl may be present as discrete, sometimes thick, bands within the soil profile or at the surface, where it may occupy small pools surrounding groundwater springs, or cover extensive portions of a fen.
Rich Conifer Swamp	The soils are composed of saturated, coarse woody peat and may vary significantly in depth of organic matter. The organic soils are typically neutral to moderately alkaline but may be very strongly acid near the surface where sphagnum mosses dominate the ground layer. The structure and species composition of rich conifer swamp are strongly influenced by the constant flow of mineral-rich, cold groundwater through the organic soils.
Rich Tamarack Swamp	The organic soils underlying rich tamarack swamp are typically comprised of deep (> 2.5 m) peat containing large amounts of woody debris and occasionally layers of sedge-dominated peat. The soil profile often contains or is underlain by marl, a calcium carbonate precipitate that accumulates as sediment in shallow lake bottoms. Because glacial till in southern Michigan is typically high in calcium and magnesium, the groundwater discharge into rich tamarack swamp has high levels of alkalinity and dissolved calcium and magnesium carbonates.
Sand and Gravel Beach	The dynamic nature of open sand and gravel beaches greatly inhibits soil development. Uprooted trees accumulate on some beaches, fostering localized sand accretion and often vegetation establishment. Finer organic material also builds up seasonally on beaches, and can include plant debris, algae, and dead lake or wetland organisms such as insects, fish, and zebra mussels (<i>Dreissena polymorpha</i>), a small invasive bivalve mussel. These aggregations can be large, greatly increasing the nutrient availability and changing the sediment characteristics of the beach, although these changes are often temporary due to the dynamics of the shoreline environment. Storm waves and winter ice typically prevent permanent vegetation establishment and soil development. Where organic sediments are protected from erosive forces, vegetation can establish, stabilize the shoreline, and thus eliminate portions of the open beach.

Table 13. (cont'd)	
Resource Community	Soils
Sandstone Bedrock Lakeshore	Almost no soil development occurs on the sandstone bedrock. Soil development and plant establishment are limited to cracks, joints, and depressions in the bedrock where small amounts of sand and organic matter accumulate. The breakdown of sandstone and plant matter results in an acidic, sandy, organic-rich soil. Soil depth is shallow due to wave, wind, and ice action.
Sandstone Cliff	There is almost no soil development on the cliffs except for shallow organic soil development along the narrow cliff summit and in crevices in the cliff face where sand particles, decaying roots, and plant debris accumulate. The breakdown of sandstone and plant matter results in an acidic, sandy, organic-rich soil.
Sandstone Cobble Shore	Little or no soil development occurs on sandstone cobble shore. The few plants that establish are rooted in sand and gravel deposits under the coarse cobble. The size of the weathered and eroded sandstone cobbles ranges from 2 to 3 cm (0.75 to 1.0 in) in diameter to over 20 cm (8 in) in diameter, and large sandstone and conglomerate boulders or slabs can be common.
Sandstone Lakeshore Cliff	There is almost no soil development on the cliffs except for shallow organic soil development along the narrow cliff summit and ledges, in crevices in the cliff face, and at the base of the cliff where sand particles, decaying roots, and plant debris accumulate. The breakdown of sandstone and plant matter results in an acidic, sandy, organic-rich soil.
Sinkhole	The soils within most of Michigan's karst features are derived from limestone or dolomite, and are thus mildly to moderately alkaline and fine-textured. Some of the sinkholes in Montmorency, Otsego, and Presque Isle Counties are overlain by outwash sands and support vegetation characteristic of acid sands — no bedrock is exposed in these sinkholes.
Southern Hardwood Swamp	Soils are typically loam or silt loam, sometimes sandy loam or clay loam, of neutral to mildly alkaline pH (sandy substrates are more acidic), and sometimes covered by a thin layer of muck. An underlying impermeable clay lens is often present and allows for prolonged pooling of water. Occasionally the community occurs on deep sapric peat, especially inland, where stands may be associated with conifer or hardwood-conifer, minerotrophic peatlands.
Southern Shrub-carr	Shrub-carr is usually found on seasonally inundated, saturated organic soils such as sapric peat with neutral to mildly alkaline pH and the capacity to retain excessive water.

Table 13. (cont'd)	
Resource Community	Soils
Southern Wet Meadow	Southern wet meadow typically occurs on neutral to strongly alkaline organic soils (i.e., sapric to hemic peat), but saturated mineral soil may also support the community. Because of the calcareous nature of the glacial drift in the regions where southern wet meadow occurs, its soils typically contain high levels of calcium and magnesium.
Submergent Marsh	Loose, poorly consolidated organic soils characterize most submergent plant beds, which can establish on almost all types of mineral soil, and even over bedrock. Such organic soils can be meters thick and are often easily eroded by boat traffic. In the more acid, low nutrient lakes, the accumulation of organic sediments can be minimal, but this is quite variable. The pH of organic sediments can range from acid to alkaline and is largely dependent on the pH of the lake or stream water and underlying mineral substrate.
Volcanic Bedrock Glade	Continental glacial ice sheets from about 10,000 years ago left large areas of bedrock devoid of soil. Some organic soil has developed in pockets and cracks within the volcanic rock, but there are also large areas with no soil, where lichens and mosses are the predominant vegetation. The prevalent rock formations are Precambrian-age Copper Harbor Conglomerates and Portage Lake Volcanics. The volcanic rock formed from vast sheets of flowing lava, interbedded with thin layers of conglomerate, which consisted of both pebbles and cobbles. Basalt, the predominant bedrock of the glades, ranges from medium acid to mildly alkaline in pH. Arctic-alpine vegetation is more common on the conglomerate and on volcanic rock characterized by many vesicles (vesicular basalt), which have more irregularities and cracks for soil development and root anchoring, than on massive basalt, which typically lacks vesicles.
Volcanic Bedrock Lakeshore	Almost no soil development takes place on either the massive, fine-grained basalts or the volcanic conglomerates. The only places where plants are able to establish are in cracks, joints, vesicles, and depressions in the bedrock, where small amounts of organic matter accumulate. Cracks, joints, and depressions are much more abundant on the volcanic conglomerate, but still provide relatively few places for soil development. Freshly broken rock surfaces are mildly alkaline in pH.
Volcanic Cliff	There is little soil development on the steep rock face of the cliffs. Some organic soil development occurs in crevices in the rock face, on the upper lip of the cliffs, and at the base of the cliff face.

Table 13. (cont'd)	
Resource Community	Soils
Volcanic Cobble Shore	Little or no soil development occurs on volcanic cobble shore. The few plants that establish probably root in sand and gravel deposits under the cobble, which can be more than a meter in depth. On the Keweenaw Peninsula, the size of the cobbles ranges from 2 to 3 cm (0.75 to 1 in) in diameter to over 20 cm (8 in) in diameter, and large sections of the shoreline consist of similar-sized cobbles. The largest cobbles are located at the extreme east end of the peninsula, where the cobble shoreline is steepest and storm waves the most severe.
Volcanic Lakeshore Cliff	There is little soil development on the steep rock face of the cliffs. Some organic soil development occurs in crevices in the rock face and on the upper lip of the cliffs.
Wet Prairie	Soils are typically sandy loam or silt loam but can also be silty clay or clay. Soils are characterized by neutral pH, high organic content, and good water-retaining capacity. Organic deposits (muck) are absent or form only a thin layer over mineral soil.
Wet-mesic Flatwoods	Surface soils are typically medium to slightly acid sandy loam to loam and overlay mildly to moderately alkaline sandy clay loam, clay loam, or clay. An underlying impermeable clay lens is often present, which allows for prolonged pooling of water. Seasonal water level fluctuations lead to mottling of the mineral soil layers.
Wet-mesic Prairie	Soils are typically loam or silt loam and less frequently sandy loam, silty clay, or clay. Soils are characterized by neutral pH, with high organic content, and good water-retaining capacity. Organic deposits (muck) are absent or form only a thin layer over mineral soil.
Wet-mesic Sand Prairie	Soils are loamy sand, loamy fine sand or fine sand and are typically strongly acid to neutral. Soils often have high organic content, which increases water-holding capacity, and may be covered by a thin layer of muck. A high water table contributes to the wet-mesic condition of the sandy soils.
Wooded Dune and Swale Complex	Given the complexity and variation of wooded dune and swale complexes, soils can range from calcareous sands in the foredunes to deep acidic peat or alkaline marl in well-established swales.

Soil Classification

Table 14. Soil moisture			
Meters Below Surface	Categories		
0 meter or less		Wet soil	Fen soil
0 meter	Slightly water logged	Moist soil	Summer - partially drained but still wet, trees grow on pedestals
0-1 meter	Moist areas	Mesic-moist soil	Summer – full drained in flat lands
1 meter	Mesic-moist areas	Mesic soil	
1-2 meters	Mesic areas	Mesic soil	Activated during early spring, water input from higher elevation
2 meters		Dry soil	
2 meters or greater	Dry areas	Dry soil	
5 meters and greater	Dry areas	Very dry soil	

Appendix B: Simulation

Simulation Model Code, Results, Figures and Tables

Simulation Code – Visual Basic

```
*****
'* Program: Foraging simulation
'* Language: Visual Basic for Applications with Microsoft Excel
'* Author: Jubin J. Cheruvelil
'* Date: 1/1/2011
'* Comments: This code runs a spatial simulation. The start or entry point
'* is the Main() routine. Main() routine calls the
'* Select_Patch_Resources. The Select_Patch_Resources() calls two
'* key subroutines: Patch_Select() and Resource_Select().
'*
'*
*****

Option Explicit
Option Base 1
*****
'* Global Variables
'* Date: 1/1/2011
*****

Dim Factor As Double
Dim Culture As String
Dim Cancel As Boolean
Dim Start_day As Integer
Dim End_day As Integer
Dim Patch_type As String
Dim Gender As String
Dim Resource As String
Dim Calories As String
Dim Current_family As String
Dim NumFamilies As Integer
Dim Unit_start As Integer
Dim Unit_end As Integer
Dim Family_start As Integer
Dim Family_end As Integer
Dim Member_start As String
Dim Member_end As String
Dim Member As Integer
Dim Runs As Integer
Dim Workbook_open As Boolean
Dim Uncertainty_Factor As Double
*****
'#####
'* On Click commands
*
```

```

'* Date: 1/1/2011                                     *
'#####*
'*****

Private Sub RunSim_Click()
Dim sheet As Worksheet
Set sheet = ActiveWorkbook.Sheets("Initialize_Params")
Call Main
End Sub
Private Sub StopSim_Click()
Cancel = True
Application.ActiveWorkbook.Save
End Sub
Private Sub Main()
'*****
'#####*
'* Main routine, calls all other functions                *
'* Date: 1/1/2011                                         *
'#####*
'*****

'check if cancel has been clicked from initialize worksheet
Workbook_open = 0
Cancel = False
    If Cancel Then
        Exit Sub
    End If
'start program - begin with initialize, end with finalize
Call Initialize
Call Get_Patch_Resources
Call Finalize
End Sub
Private Sub Get_Patch_Resources()
'*****
'*****
'* Patch and Resource Main routine. Calls two key functions    *
'*     1. Calls Patch_Select & Resource_Select                *
'*     2. Sets up output files.                                *
'* Date: 1/1/2011                                           *
'*****
'*****

Dim Season As String 'retrieved from Get_day_season routine
Dim Month As String 'retrieved from Get_day_season routine
Dim Current_season As String
Dim Current_month As String
Dim Date_exploit As Date 'retrieved from Get_day_season routine

```

```

Dim i As Integer
Dim j As Integer
Dim k As Integer
Dim h As Integer
Dim g As Integer
Dim C_short As String
Dim Family_unit As Integer
Dim Member_gender As String
Dim PatchArray(3) As Variant
Dim Cultural_period(3) As Variant
Dim result As Variant
Dim Sim As Workbook
Dim Output_open As Boolean
Dim Output_row As Long
Dim Workbook_path As String
Dim sheet As Worksheet
Dim Wkbook_Name_Path As String
Dim Wkbook_name As String
Dim Wksheet_Name As String
Dim Wksheet_create As Boolean

'Set up culture array
Cultural_period(1) = "Late Archaic"
Cultural_period(2) = "Early Woodland"
Cultural_period(3) = "Middle Woodland"

'Setup the code workbook
Set Sim = Workbooks("Simulation Workbook.xlsm")
'Sim.Activate
Workbook_path = Sim.path & "\"
Calculate
    Call Get_values("Simulation Workbook.xlsm")
'Setup output workbook for each simulation.
'Output_open = True
Output_open = False
If Output_open = False Then
    Dim OutputWkb As Workbook
    Wkbook_Name_Path = AddNew_Wkbook(C_short, Workbook_path, Wkbook_name)
    Set OutputWkb = Workbooks(Wkbook_name)
    OutputWkb.Activate
    Output_open = True
End If
'Set output_row to keep track of output sheet row
Output_row = 2

```

```

For g = LBound(Cultural_period) To UBound(Cultural_period)
    'Start logic to loop through runs, days, family units etc.
    Wksheet_create = True
    If Wksheet_create Then
        Select Case Cultural_period(g)
            Case "Late Archaic"
                C_short = "LA"
            Case "Early Woodland"
                C_short = "EW"
            Case Else
                C_short = "MW"
        End Select

        Wksheet_Name = AddNew_Wksheet(Wkbook_name, C_short, g)
    End If

    For h = 0 To Runs
        'Reactivate code workbook
        Sim.Activate
        'Loop through each day in the calendar for annual cycle.
        'Start at day 1 and end at day 365.
        For i = Start_day To End_day
            Debug.Print "Day" & i
            Date_exploit = Get_day_season(i, Current_season, _
                Current_month, Sim.Name)

            Season = Current_season
            Month = Current_month

            'Loop through each family unit. Each member selects resources.
            For j = Unit_start To Unit_end
                Debug.Print "Family Unit: " & j
                Family_unit = j
                Call Patch_Select(h, Sim.Name, Month, Culture, Arr:=PatchArray)
                ' Reselect patch when with each new family unit.
                ' Reset family unit to first unit.
                For k = Member_start To Member_end
                    'Sim.Activate
                    'Set Member_Gender
                    Member_gender = LookupGender(Sim.Name, j, k)
                    'Selects resources, returns current row for output sheet.
                    'MsgBox Uncertainty_Factor
                    Output_row = Resource_Select(Wkbook_name, Wksheet_Name, _
                        h, i, j, Season, Month, Member_gender, _
                        Output_row, Sim.Name, Uncertainty_Factor, _

```



```

        Arr:=PatchArray)

    Next k
  Next j
Next i
Next h
Next g
End Sub
'*****
'* Function Name: Get all constant values stored in worksheet      *
'* Date: 1/1/2011                                           *
'* Comments: this function is called from any function.      *
'*                                           *
'*****

Sub Get_values(Wkbook_name As String)
Dim sheet As Worksheet
Dim Workbk As Workbook
Set Workbk = Workbooks(Wkbook_name)
Set sheet = Workbk.Sheets("Initialize_Params")
'Selects time period of simulation. Time period determines the number and
' patch type available for exploitation.
Culture = sheet.Cells(3, 6)
Start_day = sheet.Cells(3, 2)
End_day = sheet.Cells(4, 2)
Runs = sheet.Cells(5, 2)
NumFamilies = sheet.Cells(7, 2)
Factor = sheet.Cells(18, 2)
Unit_start = sheet.Cells(8, 2)
Unit_end = sheet.Cells(9, 2)
Member_start = sheet.Cells(10, 2)
Member_end = sheet.Cells(11, 2)
Uncertainty_Factor = sheet.Cells(18, 2)
End Sub
'*****
'* Function Name: Get all family members of a band unit      *
'* Date: 1/1/2011                                           *
'* Comments: this function is called from any function.      *
'*                                           *
'*****

Private Sub Get_Family(Wkbook_name)
Dim Member As Integer
Dim row_num As Integer
Dim sheet As Worksheet

```

```

Dim Workbook As Workbook
Set Workbook = Workbooks("wkbook_name")
Set sheet = Workbook.Sheets("Family_Unit")
row_num = Application.WorksheetFunction.Match(1, sheet.Range("C1:C21"), 0)
Current_family = sheet.Cells(row_num, 1)
Gender = sheet.Cells(row_num, 2)
End Sub
'*****
'* Function Name: Finalize Simulation *
'* Date: 1/1/2011 *
'* Comments: this function is called from any function. *
'* *
'*****
Private Sub Finalize()
Application.Calculation = xlCalculationAutomatic
Application.ScreenUpdating = True
End Sub
'*****
'* Function Name: AddNew Workbook *
'* Date: 1/1/2011 *
'* Comments: this function can be called from any function. *
'* *
'*****
Function AddNew_Wkbook(Culture As String, path As String, ByRef Wkbook_name) As String
Dim Newbook As Workbook
Dim Name As String
Dim C_short As String
Dim Date_string As String
Dim Time_string As String

Date_string = Format(Now(), "yyyymmdd")
Time_string = Format(Time(), "HHMM")
On Error Resume Next
Name = Culture & "SimRun" & Date_string & "_" & Time_string & ".xls"

Set Newbook = Workbooks.Add ' Create a new WorkBook
With Newbook
.Title = "Behavioral Simulation"
.Subject = "Output"
.SaveAs Filename:=path & Name
End With
Wkbook_name = Name
AddNew_Wkbook = path & Name
End Function

```

```

'*****
'* Function Name: AddNew Worksheet
'* Date: 1/1/2011
'* Comments: this function can be called from any function.
'*
'*****

Function AddNew_Wksheet(Wkbook_name As String, C_short As String, _
    Run As Integer) As String
Dim Newsheet As Worksheet
Dim OutputWkbook As Workbook
Dim Name As String
Dim Time_string As String
On Error Resume Next
Time_string = Format(Time(), "HHMM")
Name = C_short & Run & "_" & Time_string
    Set OutputWkbook = Workbooks(Wkbook_name)
    'OutputWkbook.Activate
    Set Newsheet = OutputWkbook.Sheets.Add(After:=Sheets(Worksheets.Count))
    Newsheet.Name = Name
    AddNew_Wksheet = Name
End Function
'*****

'* Function Name: Close Workbook
'* Date: 1/1/2011
'* Comments: this function can be called from any function.
'*
'*****

Sub Close_output(Output As String)
Workbooks(Output).Activate
ActiveWorkbook.Close True
' closes the active workbook and saves any changes
End Sub

Sub Initialize()
'*****
'* Initialize subroutine, called from Main()
'* Date: 1/1/2011
'*****

Dim sheet As Worksheet
Dim Culture As String

Application.Calculation = xlCalculationManual
Application.ScreenUpdating = False
Application.EnableEvents = True
End Sub

```

```

'*****
'* Function Name: Get_day_season                                *
'* Support routines, called from Main()                        *
'* Date: 1/1/2011                                             *
'*****

Function Get_day_season(Day_current As Integer, ByRef Season_current _
As String, ByRef Month_Current As String, Wkbook As String) As Date
Dim row_num As Integer
Dim Workbk As Workbook
Dim sheet As Worksheet

Set Workbk = Workbooks(Wkbook)
Set sheet = Workbk.Sheets("Month_Day") '
'Application.Calculation = xlCalculationManual
'sheet.Select
'Get initial values from initialize parameters worksheet.
row_num = Application.WorksheetFunction.Match(Day_current, _
    sheet.Range("A1:A367"), 1)
Get_day_season = sheet.Cells(row_num, 3)
Season_current = sheet.Cells(row_num, 5)
Month_Current = sheet.Cells(row_num, 4)
End Function
'*****

'* Function Name: LookupGender                                *
'* Date: 1/1/2011                                             *
'* Support routine                                             *
'*****

Function LookupGender(Wkbook As String, Unit_No As Integer, Member_No As Integer) As
String
'Declare variables in function.
Dim range1 As Range
Dim range2 As Range
Dim Combo As Variant
Dim Workbk As Workbook
Set Workbk = Workbooks(Wkbook)
Dim sheet As Worksheet
Set sheet = Workbk.Sheets("Family_Unit")
Set range1 = sheet.Range("D2:D26")
Set range2 = sheet.Range("E2:E26")
Combo = Unit_No & Member_No
LookupGender = _
    sheet.Application.WorksheetFunction.Lookup(Combo, range1, range2)
On Error Resume Next
End Function

```

```

'*****
'* Function Name: Patch_Selection *
'* Date: 1/1/2011 *
'* Comments: this function is called from (). Function selects *
'* the most productive patch in a given season *
'*
'*****

Function Patch_Select(Run As Integer, Wkbook_name As String, Month As String, Culture As
String, _
    Arr As Variant) As Variant
Dim sheet As Worksheet
Dim sheetname As String
Dim range1 As Variant
Dim range2 As Range
Dim range3 As Range
Dim range4 As Range
Dim range6 As Range
Dim range7 As Range
Dim range8 As Range
Dim range9 As Range
Dim range10 As Range

Dim Col_curr_patch As Integer
Dim ColumnStart As Variant
Dim N As Long
Dim row As Double
Dim rowx As Double
Dim wrkbook As Workbook
'Set worksheet as the patch sheet.

Set wrkbook = Workbooks(Wkbook_name)
Set sheet = wrkbook.Sheets("Patch")
Set range1 = sheet.Range("B51:B55")
Set range8 = sheet.Range("A7:AX34") 'for autofilter

Select Case Month
Case "January"
    Set range2 = sheet.Range("O50:O56")
    Set range9 = sheet.Range("P50:P56")
    Set range10 = sheet.Range("Q50:Q56")

Case "February"
    Set range2 = sheet.Range("R50:R56")
    Set range9 = sheet.Range("S50:S56")

```

```

Set range10 = sheet.Range("T50:T56")

Case "March"
    Set range2 = sheet.Range("U50:U56")
    Set range9 = sheet.Range("V50:V56")
    Set range10 = sheet.Range("W50:W56")

Case "April"
    Set range2 = sheet.Range("X50:X56")
    Set range9 = sheet.Range("Y50:Y56")
    Set range10 = sheet.Range("Z50:Z56")

Case "May"
    Set range2 = sheet.Range("AA50:AA56")
    Set range9 = sheet.Range("AB50:AB56")
    Set range10 = sheet.Range("AC50:AC56")

Case "June"
    Set range2 = sheet.Range("AD50:AD56")
    Set range9 = sheet.Range("AE50:AE56")
    Set range10 = sheet.Range("AF50:AF56")

Case "July"
    Set range2 = sheet.Range("AG50:AG56")
    Set range9 = sheet.Range("AH50:AH56")
    Set range10 = sheet.Range("AI50:AI56")

Case "August"
    Set range2 = sheet.Range("AJ50:AJ56")
    Set range9 = sheet.Range("AK50:AK56")
    Set range10 = sheet.Range("AL50:AL56")

Case "September"
    Set range2 = sheet.Range("AM50:AM56")
    Set range9 = sheet.Range("AN50:AN56")
    Set range10 = sheet.Range("AO50:AO56")

Case "October"
    Set range2 = sheet.Range("AP50:AP56")
    Set range9 = sheet.Range("AQ50:AQ56")
    Set range10 = sheet.Range("AR50:AR56")

Case "November"
    Set range2 = sheet.Range("AS50:AS56")

```

```

Set range9 = sheet.Range("AT50:AT56")
Set range10 = sheet.Range("AU50:AU56")

Case "December"
    Set range2 = sheet.Range("AV50:AW56")
    Set range9 = sheet.Range("AW50:AX56")
    Set range10 = sheet.Range("AX50:AY56")

Case Else
End Select
'*****
*
' Autofilter code start: selects top X number of a list or table.      *
'*****
*
'clear the destination of autofilter copy
sheet.Range("$A$50:$AZ$60").Clear
'Select top 5 patches to be exploited
'Get relative column for field value
Col_curr_patch = range2.Column
'Selection.AutoFilter
range8.AutoFilter _
    Field:=Col_curr_patch, Criteria1:="5", _
    Operator:=xlTop10Items
With range8
    On Error Resume Next
    Set range6 = .Offset(1).Resize(.Rows.Count - 1, 1) _
        .SpecialCells(xlCellTypeVisible)
End With
If range6 Is Nothing Then
    MsgBox "No data to copy"
Else
    Set range7 = range8
    range7.Offset(1, 0).Resize(range7.Rows.Count - 1).Copy _
        Destination:=sheet.Range("A51")
End If

sheet.ShowAllData
range8.AutoFilter
sheet.Rows("2:6").EntireRow.Hidden = True
'*****
*
' Autofilter code end: selects top X number of a list or table      *

```

```

'*****
*
ColumnStart = Split(Cells(, range2.Column).Address, "$")(1)
range2(10).Formula = "=sum(" & ColumnStart & "51:" & _
    ColumnStart & "55)"
'Set up relative probability
'fill relative yield - O column

With range9
.Cells(2).Select
.Cells(1) = "RelativeProb"
.Cells(2).Formula = "=" & ColumnStart & "51" & "/" & _
    "$" & ColumnStart & "$59"
ColumnStart = Split(Cells(, range9.Column).Address, "$")(1)
Selection.AutoFill Destination:=Range(ColumnStart & "51:" & _
    ColumnStart & "55"), Type:=xlFillDefault
End With

'fill cumulative probability column
'ColumnStart = Split(Cells(, range10.Column).Address, "$")(1)
With range10
.Cells(1).Value = "CumulativeProb"
.Cells(2).Value = 0
.Cells(3).Formula = "=sum(" & ColumnStart & "$51:$" & _
    ColumnStart & "51)"
.Cells(3).Select
ColumnStart = Split(Cells(, range10.Column).Address, "$")(1)
Selection.AutoFill Destination:=Range(ColumnStart & "52:" & _
    ColumnStart & "55"), Type:=xlFillDefault
End With
'sheet.Calculate
Range("A50:AX60").Calculate
'Select one or three different patches for exploitation based on productivity
'Return three patches back to calling routine
For N = LBound(Arr) To UBound(Arr)
    Dim patch_sel_temp As Variant
    Dim Randomnumber As Double
    Dim nos_patch As Integer
    'Initialize randomize number - generates duplicates
    'Rnd (-1)
    'Randomize 10
    Randomnumber = Rnd

```



```
'Find a row where random number matches the cumulative probability  
' of that patch
```

```
row = sheet.Application.WorksheetFunction.Match(Randomnumber, range10, 1)
```

```
If row = 0 Then
```

```
    row = RandomNum(1, 5)
```

```
    ' MsgBox "no row"
```

```
    ' End
```

```
End If
```

```
patch_sel_temp = sheet.Application.WorksheetFunction.Index(range1, row)
```

```
'If row = 0 Then
```

```
    ' MsgBox "no patch"
```

```
    ' End
```

```
'End If
```

```
Arr(N) = patch_sel_temp
```

```
'Degrade the patch after selecting the resources.
```

```
Select Case Culture
```

```
    Case "Late Archaic"
```

```
        Set range3 = Range("B79:B107")
```

```
        Set range4 = Range(Cells(79, 7 + Run), Cells(107, 7 + Run))
```

```
        If Run = 0 Then
```

```
            range4(1) = "Run: " & Run
```

```
        End If
```

```
        rowx = sheet.Application.WorksheetFunction.Match(patch_sel_temp, range3, 0)
```

```
        rowy = range4(rowx).row
```

```
        columny = range4.Column + Run
```

```
        nos_patch = sheet.Cells(rowy, columny).Value
```

```
        sheet.Cells(rowy, columny).Value = nos_patch + 1
```

```
    Case "Early Woodland"
```

```
        Set range3 = Range("B110:B138")
```

```
        Set range4 = Range(Cells(110, 7 + Run), Cells(138, 7 + Run))
```

```
        If Run = 1 Then
```

```
            range4(1) = "Run: " & Run
```

```
        End If
```

```
        rowx = sheet.Application.WorksheetFunction.Match(patch_sel_temp, range3, 0)
```

```
        rowy = range4(rowx).row
```

```
        columny = range4.Column + Run
```

```
        nos_patch = sheet.Cells(rowy, columny).Value
```

```
        sheet.Cells(rowy, columny).Value = nos_patch + 1
```

```
    Case "Middle Woodland"
```

```
        Set range3 = Range("B141:B169")
```

```
        Set range4 = Range(Cells(141, 7 + Run), Cells(169, 7 + Run))
```

```

    If Run = 1 Then
        range4(1) = "Run: " & Run
    End If
    rowx = sheet.Application.WorksheetFunction.Match(patch_sel_temp, range3, 0)
    rowy = range4(rowx).row
    columny = range4.Column + Run
    nos_patch = sheet.Cells(rowy, columny).Value
    sheet.Cells(rowy, columny).Value = nos_patch + 1

    Case Else
    End Select
'At times, the array is not populated for some reason - resolve later.
If Arr(N) = "" Then
    Arr(1) = "SHRUB SWAMP/EMERGENT MARSH"
    Arr(2) = "Intermittent Wetlands"
    Arr(3) = "RIVER"
End If
Next N

Set range1 = Nothing
Set range2 = Nothing
Set range6 = Nothing
Set range7 = Nothing
Set range9 = Nothing
Set range10 = Nothing
End Function
'*****
'* Function Name: Resource_Selection *
'* Date: 1/1/2011 *
'* Comments: this function is called from Patch_Resources(). *
'* Function selects the resources in a given season *
'* *
'*****
Function Resource_Select(Wkbook_name As String, Wksheet_Name As String, _
    Run As Integer, Day As Integer, Unit As Integer, _
    Season As String, Month As String, _
    Gender As String, _
    Output_row As Long, SimName As String, _
    Uncertainty_Factor As Double, Arr As Variant) As Long
Dim sheet As Worksheet
Dim sheetname As String
Dim range1 As Variant
Dim range2 As Range
Dim range3 As Range

```

```

Dim range4 As Range
Dim range5 As Range
Dim range6 As Range
Dim range7 As Range
Dim Randomnumber As Double
Dim N As Integer
Dim row As Double
Dim Total_calories As Long
Dim Column As Integer
Dim TotCaloricPotential As Long
Dim MinCaloricPotential As Long
Dim MinCalories As Long
Dim patch_sel_temp As String
Dim Patch_status As Boolean
Dim Calories_collected As Long
Dim Total_yield As Long 'Max # of calories in @month@patch
Dim Resource_selected As String
Dim Resource_calories As Long 'Calorie yield of resource selected
Dim Resource_category As String
Dim Resource_prob As Long
Dim Workbook_open As Boolean
Dim Current_row As Long
Dim Common_name As String
Dim Exploit_no As Integer
Dim ProbCapture As Double
Dim M_F_Pref As Double
Dim Wkbook As Workbook

```

```

'Select month_season of exploitation
Set Wkbook = Workbooks(SimName)
Select Case Month
Case "January"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "February"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "March"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "April"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "May"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "June"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "July"

```

```

    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "August"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "September"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "October"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "November"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case "December"
    Set sheet = Wkbook.Sheets(Month & "_patch")
Case Else
    Set sheet = Wkbook.Sheets(Month & "_patch")
End Select
sheet.Activate

```

```

Set range1 = sheet.Range("AG181:AG201") 'Prob of capture
Set range2 = sheet.Range("AH181:AH201") 'Gender probability
Set range3 = sheet.Range("AI181:AI201") 'Capture probability
Set range4 = sheet.Range("AJ181:AJ201") 'Cumulative total yield
Set range5 = sheet.Range("AK181:AK201") 'Cumulative probability
Set range6 = sheet.Range("A181:A201") 'Resource lookup column
Set range7 = sheet.Range("E1:AF1")
'reset output row first time in a run

```

```

For N = LBound(Arr) To UBound(Arr)
    'Determine the patch being exploited
    patch_sel_temp = Arr(N)
    'MsgBox patch_sel_temp
    'determine column where relevant patch is located.
    'Add four to range value when referencing it without the range.
    Column = sheet.Application.WorksheetFunction.Match(patch_sel_temp, _
        range7, 0) + 4

```

```

'Determine total yield of resources @month@patch
Total_yield = sheet.Cells(2, Column).Value
Call SetupProbGrid(SimName, sheet.Name, patch_sel_temp, Column, Gender)

```

```

Calories_collected = 0
Patch_status = True
Exploit_no = 0
'Select resource until forager collects required calories or patch is degraded _
    or three exploitative activities are undertaken.
'Randomly select resources based on cumulative probability

```

```

Do Until (Calories_collected > 10000 Or Patch_status = False _
    Or Exploit_no = 4)
    If Calories_collected > (Total_yield * 0.3) Then
        Patch_status = False
    End If
    'Randomize 12345
    Randomnumber = Rnd()
    'Find a row where random number matches the cumulative probability
    ' of that patch
    sheet.Calculate
    row = sheet.Application.WorksheetFunction.Match _
        (Randomnumber, range5, 1)
    If row > 10 Then
        row = RandomNum(1, 10)
    End If

    Resource_selected = sheet.Application.WorksheetFunction.Index _
        (range6, row)

    Resource_calories = Range("C181:C201")(row, 1)
    If Gender = "Child" Then
        Resource_calories = Resource_calories * 0.4
    End If

    Resource_category = Range("D181:D201")(row, 1)
    Common_name = Range("B181:B201")(row, 1)
    ProbCapture = range1(row, 1)
    M_F_Pref = range2(row, 1)

    Randomnumber = Rnd
    If Randomnumber > Uncertainty_Factor Then
        Resource_calories = 0
    End If

    Calories_collected = Calories_collected + Resource_calories

    'missing values - uncertainty factor,
    Output_row = Output_record(Wkbook_name, Wksheet_Name, Month, Run, Day, Unit, _
        Season, Output_row, _
        Gender, patch_sel_temp, Resource_selected, Resource_category, _
        Common_name, Randomnumber, Resource_calories, Calories_collected, _
        Uncertainty_Factor, ProbCapture, M_F_Pref)

```

```

        'Send back current row to calling routine.
        Resource_Select = Output_row
        Exploit_no = Exploit_no + 1
    Loop
Next N
Set range1 = Nothing
Set range2 = Nothing
Set range3 = Nothing
Set range4 = Nothing
Set range5 = Nothing
Set range6 = Nothing
Set range7 = Nothing
End Function
'*****
'* Function Name: SetupProbGrid() *
'* Date: 1/1/2011 *
'* Comments: Function sets up the relative cumulative probability grid for *
'* stochastic selection of resources *
'*****
Sub SetupProbGrid(Wkbook_name As String, sheet_patch As String, patch_name As String, _
    Column As Integer, Gender As String)

Dim Workbk
Dim sheet As Worksheet
Dim columnletter As String

Dim range1 As Range
Dim range6 As Range
Dim range7 As Range
Set Workbk = Workbooks(Wkbook_name)
Set sheet = Workbk.Sheets(sheet_patch)
Set range1 = sheet.Range("A3:AF170") 'for autofilter
columnletter = Split(Cells(, Column).Address, "$")(1)
'*****
*
' Autofilter code start: selects top X number of a list or table. *
'*****
*
'Select top 10 resources to be exploited
'clear autofilter copy destination
sheet.Range("A180:AL202").Clear
'Get relative column for field value
'Col_curr_patch = range2.Column

```

```

range1.AutoFilter _
    Field:=Column, Criteria1:="10", _
    Operator:=xlTop10Items
'Copy it down to new Application

'Recalculate total value
'reinitialize cumulative probability
With range1
    On Error Resume Next
    Set range6 = .Offset(1, 0).Resize(.Rows.Count - 1, 1) _
        .SpecialCells(xlCellTypeVisible)
'On Error GoTo 0
End With
If range6 Is Nothing Then
    MsgBox "No data to copy"
Else
    Set range7 = range1
    range7.Copy Destination:=sheet.Range("A181")
    range7.Offset(1, 0).Resize(range7.Rows.Count - 1).Copy _
        Destination:=sheet.Range("A181")
End If

sheet.ShowAllData
range1.AutoFilter
'*****
*
' Autofilter code end: selects top X number of a list or table *
'*****
*
'fill probability of capture
Dim range2 As Range
Set range2 = Range("AG180:AG190")
With range2
    .Cells(1).Value = "ProbCapture"
    .Cells(2).Formula = _
        "=INDEX(Resource!$BB$2:$BB$169, MATCH($A181,Resource!$F$2:$F$169,0))"
    .Cells(2).Select
    .Cells(2).NumberFormat = "0.000"
    .Cells(2).AutoFill Destination:=Range("AG181:AG190"), Type:=xlFillDefault
End With

'fill in net or base yield once a resource is captured.
Dim range2A As Range
Set range2A = Range("C180:C190")

```

```

With range2A
    .Cells(1).Value = "Base Yield"
    .Cells(2).Formula = "=INDEX(Resource!$BC$2:$BC$169,
MATCH($A181,Resource!$F$2:$F$169,0))"
    .Cells(2).Select
    .Cells(2).NumberFormat = "0.0"
    .Cells(2).AutoFill Destination:=Range("C181:C190"), Type:=xlFillDefault
End With

'fill in gender preference
Dim range3 As Range
Set range3 = Range("AH180:AH190")
With range3
    .Cells(1).Value = "M_F Pref"
    If Gender = "Female" Then
        .Cells(2).Formula = _
            "=INDEX(Resource!$T$2:$T$169, MATCH($A181,Resource!$F$2:$F$169,0))"
    Else
        .Cells(2).Formula = _
            "=INDEX(Resource!$S$2:$S$169, MATCH($A181,Resource!$F$2:$F$169,0))"
    End If
    .Cells(2).Select
    .Cells(2).NumberFormat = "0.000"
    .Cells(2).AutoFill Destination:=Range("AH181:AH190"), Type:=xlFillDefault
End With

'fill in cumulative yield of calories with capture and gender preference
Dim range4 As Range
Set range4 = Range("AI180:AI190")
Range("AI179").Formula = "=sum(AI181:AI190)"
With range4
    .Cells(1).Value = "CumulativeProb"
    .Cells(2).Formula = "=$AG181*$AH181*" & "$" & columnletter & "181"
    .Cells(2).Select
    .Cells(2).NumberFormat = "0.00"
    .Cells(2).AutoFill Destination:=Range("AI181:AI190"), Type:=xlFillDefault
End With

'fill relative yield
Dim range5 As Range
Set range5 = Range("AJ180:AJ190")
With range5
    .Cells(1).Value = "RelProbability"

```



```

.Cells(2).Formula = "=(AI181/$AI$179)*100"
.Cells(2).Formula = "=(AI181/$AI$179)"
.Cells(2).Select
.Cells(2).NumberFormat = "0.00"
.Cells(2).AutoFill Destination:=Range("AJ181:AJ190"), Type:=xlFillDefault
End With

'fill cumulative probability column
Dim range9 As Range
Set range9 = Range("AK180:AK190")
With range9
    .Cells(1).Value = "CumulativeProb"
    .Cells(2).Value = 0
    .Cells(3).Formula = "=SUM(AJ$181:$AJ181)"
    .Cells(3).Select
    .Cells(2).NumberFormat = "0.00"
    .Cells(3).AutoFill Destination:=Range("AK182:AK190"), _
        Type:=xlFillDefault
End With
Range("A180:AL191").Calculate
'sheet.calculate
Set range9 = Nothing
Set range5 = Nothing
Set range4 = Nothing
Set range3 = Nothing
Set range2 = Nothing
Set range2A = Nothing
Set range1 = Nothing
Set range6 = Nothing
Set range7 = Nothing
End Sub
'*****
'* Function Name: Put record into output sheet. *
'* Date: 1/1/2011 *
'* Comments: this function is called from Select_resource() *
'* *
'*****
Function Output_record(Wkbook As String, Wksheet As String, Month As String, _
    Run As Integer, Day As Integer, Unit As Integer, _
    Season As String, Current_row As Long, _
    Gender As String, Patch_selected As String, _
    Resource_selected As String, Resource_category As String, _
    Common_name As String, Randomnumber As Variant, _
    Calorie_yield As Long, _

```

```
Total_calories As Long, Uncertainty_Factor As Double, _  
ProbCapture As Double, M_F_Pref As Double) As Long
```

```
Dim OutputWkbook As Workbook
```

```
Dim OutputSheet As Worksheet
```

```
Dim Updated_row As Long
```

```
'On Error Resume Next
```

```
Set OutputWkbook = Workbooks(Wkbook)
```

```
Set OutputSheet = OutputWkbook.Worksheets(Wksheet)
```

```
If Current_row = 1000 Then
```

```
    OutputWkbook.Save
```

```
End If
```

```
If Current_row = 2 Then
```

```
    OutputSheet.Cells(Current_row - 1, 1).Value = "Run #"
```

```
    OutputSheet.Cells(Current_row - 1, 2).Value = "Day"
```

```
    OutputSheet.Cells(Current_row - 1, 3).Value = "Month"
```

```
    OutputSheet.Cells(Current_row - 1, 4).Value = "Season"
```

```
    OutputSheet.Cells(Current_row - 1, 5).Value = "Unit"
```

```
    OutputSheet.Cells(Current_row - 1, 6).Value = "Gender"
```

```
    OutputSheet.Cells(Current_row - 1, 7).Value = "Patch_selected"
```

```
    OutputSheet.Cells(Current_row - 1, 8).Value = "Resource_selected"
```

```
    OutputSheet.Cells(Current_row - 1, 9).Value = "Resource_category"
```

```
    OutputSheet.Cells(Current_row - 1, 10).Value = "Common_name"
```

```
    OutputSheet.Cells(Current_row - 1, 11).Value = "Rand"
```

```
    OutputSheet.Cells(Current_row - 1, 12).Value = "Calorie_yield"
```

```
    OutputSheet.Cells(Current_row - 1, 13).Value = "Total_calories"
```

```
    OutputSheet.Cells(Current_row - 1, 14).Value = "Uncertainty_Factor"
```

```
    OutputSheet.Cells(Current_row - 1, 15).Value = "ProbCapture"
```

```
    OutputSheet.Cells(Current_row - 1, 16).Value = "M_F_Preference"
```

```
End If
```

```
OutputSheet.Cells(Current_row, 1).Value = Run
```

```
OutputSheet.Cells(Current_row, 2).Value = Day
```

```
OutputSheet.Cells(Current_row, 3).Value = Month
```

```
OutputSheet.Cells(Current_row, 4).Value = Season
```

```
OutputSheet.Cells(Current_row, 5).Value = Unit
```

```
OutputSheet.Cells(Current_row, 6).Value = Gender
```

```
OutputSheet.Cells(Current_row, 7).Value = Patch_selected
```

```
OutputSheet.Cells(Current_row, 8).Value = Resource_selected
```

```
OutputSheet.Cells(Current_row, 9).Value = Resource_category
```

```
OutputSheet.Cells(Current_row, 10).Value = Common_name
```

```

OutputSheet.Cells(Current_row, 11).Value = Randomnumber
OutputSheet.Cells(Current_row, 12).Value = Calorie_yield
OutputSheet.Cells(Current_row, 13).Value = Total_calories
OutputSheet.Cells(Current_row, 14).Value = Uncertainty_Factor
OutputSheet.Cells(Current_row, 15).Value = ProbCapture
OutputSheet.Cells(Current_row, 16).Value = M_F_Pref
Output_record = Current_row + 1 'add row identifier
End Function
'*****
'* Function Name: Generate Random numbers between 2 values      *
'* Date: 1/1/2011                                           *
'* Comments: this function is called from any function.      *
'*                                                         *
'*****

Function RandomNum(Low As Double, High As Double)
RandomNum = (High - Low) * Rnd() + Low
End Function

```

Simulation Variables

Table 15. Hunter-gatherer family unit composition			
Id	Unit No.	Member No.	Gender
1	1	1	Male
2	1	2	Female
3	1	3	Female
4	1	4	Child
5	1	5	Child
6	2	1	Male
7	2	2	Female
8	2	3	Male
9	2	4	Female
10	2	5	Female
11	3	1	Male
12	3	2	Female
13	3	3	Female
14	3	4	Child
15	3	5	Child
16	4	1	Female
17	4	2	Female
18	4	3	Female
19	4	4	Female
20	4	5	Female
21	5	1	Male
22	5	2	Male
23	5	3	Male
24	5	4	Male
25	5	5	Male

Table 16: Species size, abundance and density

Common Name	Species	Size	Abundance	Density (square mile) 0 < 1.
White-tailed Deer	<i>Odocoileus virginianus</i>	Large	Low	0
Black bear	<i>Ursus americanus</i>	Large	Low	0
Wolf, dog	<i>Canis sp. (lupus, familiaris)</i>	Medium	Low	0
Moose	<i>Alces alces</i>	Large	Low	0
Wapiti/Elk	<i>Cervus canadensis</i>	Large	Low	1
Red fox	<i>Vulpes fulva</i>	Small	Low	0
Raccoon	<i>Procyon lotor</i>	Medium	Low	0
Otter	<i>Lontra canadensis</i>	Small	Low	1
Bobcat	<i>Lynx rufus</i>	Medium	Low	1
Squirrel	<i>Sciurus sp.</i>	Small	Low	2
Fisher	<i>Martes pennanti</i>	Small	Low	4
Shrew	<i>Blarina sp.</i>	Small	Low	4
Marten	<i>Martes americana</i>	Small	Low	6
Mouse	<i>Peromyscus sp.</i>	Small	Low	10
Vole	<i>Microtus sp.</i>	Small	Low	10
Beaver	<i>Castor canadensis</i>	Medium	Medium	15
Muskrat	<i>Ondatra zibethicus</i>	Small	Low	16
Woodchuck	<i>Marmota monax</i>	Small	Low	16
Chipmunk	<i>Tamias sp.</i>	Small	Low	20
Mink	<i>Mustela vison</i>	Small	Low	22
Porcupine	<i>Erethizon dorsatum</i>	Small	Low	30
Mice/Rats	<i>Muridae sp.</i>	Small	Low	40
Rabbits	<i>Leporidae sp. (Sylvilagus)</i>	Small	Medium	50
Great Horned Owl	<i>Bubo virginianus</i>	Medium	0.0080	1
Common Loon	<i>Gavia immer</i>	Medium	Low	3
Hooded merganser	<i>Lophodytes cucullatus</i>	Medium	Low	22

Table 16. (cont'd)				
Common Name	Species	Size	Abundance	Density (square mile) 0 < 1.
Blue-winged teal	<i>Anas discors</i>	Small	0.6720	26
Mallard	<i>Anas platyrhynchos</i>	Medium	0.1650	13
Common merganser	<i>Mergus merganser</i>	Medium	Low	22
Crow	<i>Corvus brachyrhynchos</i>	Small	0.1570	4
Sandhill crane	<i>Grus canadensis</i>	Large	Low	14
Wild turkey	<i>Meleagris gallopavo</i>	Large	Medium	21
Baldpate, widgeon	<i>Anas americana</i>	Small	0.2380	92
Red-breasted merganser	<i>Mergus serrator</i>	Medium	Low	22
Pied-billed grebe	<i>Podilymbus podiceps</i>	Medium	Low	3
Ring-necked duck	<i>Aythya collaris</i>	Medium	0.2100	37
Greater Scaup	<i>Aythya marila</i>	Small	0.0150	93
American Bittern	<i>Botaurus lentiginosus</i>	Small	0.2460	55
Passenger Pigeon	<i>Ectopistes migratorius</i>	Small	High	67
Great Blue Heron	<i>Ardea herodias</i>	Large	0.1280	86
Bluegill	<i>Lepomis cf. macrochirus</i>	Medium	Medium	20
Yellow perch (ringed, striped or jack perch, green hornet)	<i>Perca flavescens</i>	Medium	Medium	7
Burbot (Cod)	<i>Lota lota lacustris</i>	Medium	High	3
White bass/Hybrid striped bass	<i>Monroe chrysops</i>	Medium	Medium	19
Channel catfish (spotted, speckled or silver catfish)	<i>Ictalurus punctatus</i>	Medium	Medium	16
Walleye pike (marble-eyes, 'eye, walter, walleyed pike, jack, jackfish, pickerel)	<i>Stizostedion vitreum</i>	Medium	Medium	4
Black bullhead (common bullhead, horned pout)	<i>Ictalurus melas</i>	Medium	Medium	7
Sucker	<i>Catostomus sp. (catostomus,</i>	Medium	Medium	11

Table 16. (cont'd)				
Common Name	Species	Size	Abundance	Density (square mile) 0 < 1.
	commersoni)			
Sturgeon	<i>Acipenser fulvescens</i>	Large	Medium	15
Largemouth bass (black bass, green bass, green trout, slough bass)	<i>Micropterus salmoides</i>	Medium	Medium	14
Longnosed gar	<i>Lepisosteus oculatus</i>	Medium	Medium	13
Smallmouth bass (bronzeback, brown or redeye bass, redeye, white or mountain trout)	<i>Micropterus dolomieu</i>	Medium	Medium	11
Crappie	<i>Pomoxis sp.</i>	Medium	Medium	22
Sauger (also <i>Sander canadensis</i>)	<i>Stizostedion canadense</i>	Medium	Medium	18
Black crappie	<i>Pomoxis nigromaculatus</i>	Medium	Medium	1
Lake trout (togue, mackinaw, great gray trout, laker)	<i>Salvelinus namaycush</i>	Medium	Medium	11
Redhorse	<i>Moxostoma sp.</i> (<i>macrolepidotum</i>)	Medium	Medium	7
Sunfish	<i>Centrarchidae</i>	Medium	Medium	4
Yellow bullhead (white-whiskered bullhead, yellow cat)	<i>Ictalurus natalis</i>	Medium	Medium	20
Bowfin (dogfish, grindle, mudfish, cypress trout, lake lawyer, beaver fish)	<i>Amia calva</i>	Medium	Medium	25
Northern Pike (pickerel, jack, gator, hammerhandle, snot rocket)	<i>Esox lucius</i>	Medium	Medium	9
Brown bullhead (marbled or speckled bullhead, red cat)	<i>Ictalurus nebulosus</i>	Medium	Medium	4
Drumfish (sheepshead, croaker, thunderpumper, grinder, bubbler)	<i>Aplodinotus grunniens</i>	Medium	Medium	6

Table 16. (cont'd)				
Common Name	Species	Size	Abundance	Density (square mile) 0 < 1.
Northern water snake	<i>Nerodia sipedon</i>		Low	7
Garter snake	<i>Thamnophis sp.</i>		Low	3
Frogs and toads	<i>Anura sp.</i>		Low	1
Blanding's turtle	<i>Emydoidea blandingii</i>		Low	6
Painted turtle	<i>Chrysemys picta</i>		Medium	1
Snapping turtle	<i>Chelydra serpentina</i>		Low	6
Softshell turtles	<i>Trionyx sp.</i>		Low	5
mollusk	Generic	cluster	Low	10
Gastropod - three-ridge valvata	Generic	individual	Medium	15
Sedge or grass	<i>Carex lupulina</i>	cluster	High	12
Sedge or grass	<i>Carex pensylvanica</i>	cluster	High	3
Sedge or grass	<i>Carex blanda</i>	cluster	High	17
Cattail	<i>Typha latifolia</i>	cluster	High	2
Dock	<i>Rumex spp.</i>	cluster	High	24
Flatsedge	<i>Cyperus</i>	cluster	High	7
Wild or False Lily-of-the-Valley	<i>Maianthemum canadense</i>		High	14
Aster	<i>Aster cordifolius</i>		High	6
Spreading Dogbane	<i>Apocynum androsaemifolium</i>		High	13097
Wild Bergamot	<i>Monarda fistulosa</i>		High	13097
Anise-root	<i>Osmorhiza longistylis</i>		High	13097
May-apple, Mandrake	<i>Podophyllum peltatum</i>		High	13097
Dandelion	<i>Taraxacum officinale</i>		High	13097
Wild Geranium, spotted cranesbill	<i>Geranium maculatum</i>		High	13097
Bindweed	<i>Convolvulus arvensis</i>		High	13097

Table 16. (cont'd)				
Common Name	Species	Size	Abundance	Density (square mile) 0 < 1.
Wild Basil, Dogmint	<i>Satureja vulgaris</i>		High	13097
Sumac	<i>Rhus glabra</i>		High	
Panic-grass	<i>Panicum spp.</i>		High	
June grass, Kentucky Bluegrass, Speargrass, Fowl Bluegrass	<i>Poa pratensis</i>		High	
Carrion Flower Greenbriar	<i>Smilax lasioneura</i>		High	
Golden rod	<i>Solidago</i> Sp.		High	
Early Meadow- rue Quicksilver- weed	<i>Thalictrum dioicum</i>		High	
Smooth Yellow Violet	<i>Viola pensylvanica</i>		High	
Common Blue Violet	<i>Viola sororia</i> (Sens. Lat.) (Glabrous plants like this one have been referred to V. Papilionacea)		High	
Michigan Lily	<i>Lilium michiganense</i>		High	
Greenbrier	<i>Smilax cirrata</i>		High	
Wild columbine, Rock-bells, Meetinghouses, honey suckle	<i>Aquilegia canadensis</i>		High	
Wild sarsaparilla	<i>Aralia nudicaulis</i>		High	
Yellow rocket	<i>Barbarea vulgaris</i>		High	
White Avens	<i>Geum canadense</i>		High	
Large Flowered Trillium	<i>Trillium grandiflorum</i>		High	
Hoary Puccoon	<i>Lithospermum canescens</i>		High	
Prairie-dock; Rosin-weed	<i>Silphium terebinthinaceum</i>		High	
Hophornbeam	<i>Ostrya virginiana</i>		High	
Sycamore	<i>Platanus occidentalis</i>		High	
Snakeroot (medicinal)	<i>Polygala senega</i>		High	

Table 16. (cont'd)				
Common Name	Species	Size	Abundance	Density (square mile) 0 < 1.
Sassafras	<i>Sassafras albidum</i>		High	
St. John's wort (medicinal)	<i>Hypericum</i>		High	
Dogwood	<i>Cornus rugosa</i>		High	
Mint	<i>Lamiaceae</i>		High	
Northern swamp dogwood	<i>Cornus racemosa</i>		High	
Swamp rose	<i>Rosa palustris</i>		High	
Poison Ivy	<i>Toxicodendron radicans</i>		High	
Fringed Loosestrife	<i>Lysimachia ciliata</i>		High	
Prickly-ash	<i>Zanthoxylum americanum</i>		High	
False Solomon's Seal	<i>Smilacina racemosa</i>		High	
Three-leaved False Solomon's Seal	<i>Smilacina stellata</i>		High	
Sensitive fern	<i>Onoclea Sensibilis</i>		High	
Wild cherry	<i>Prunus Virginiana</i>		High	5
Huckleberry	<i>Gaylussacia baccata</i>		High	5
Mustard	<i>Brassicaceae</i> sp.		High	5
Stickyweed	<i>Galium aparine</i>		High	5
American elderberry	<i>Sambucus canadensis</i>		High	5
Serviceberry/Shadbush	<i>Amelanc (Amelanchier Medikus)</i>		High	5
Black cherry	<i>Prunus serotina</i>		High	46
Hackberry	<i>Celtis occidentalis</i>		High	85
Grape(Riverbank grape)	<i>Vitis riparia</i>		High	1881
Nannyberry	<i>Viburnum</i> sp.		High	3091
Wild strawberry	<i>Fragaria virginiana</i>		High	3091
Black Raspberry	<i>Rubus occidentalis</i>		High	9686
Squash	<i>Cucurbita pepo</i>		High	13097
Cape Gooseberry	<i>Physalis</i>		High	13097

Table 16. (cont'd)				
Common Name	Species	Size	Abundance	Density (square mile) 0 < 1.
Knotweed	<i>Polygonum pensylvanicum</i>		High	19152
Maize	<i>Zea mays</i>	cluster	High	13097
Sumpweed (Iva annua)	<i>Iva annua</i>	cluster	High	13097
Wild rice	<i>Zizania aquatica</i>	cluster	High	13097
Amaranth	<i>Amaranthus hypochondriacus</i>	cluster	High	13097
Woodland Sunflower	<i>Helianthus divaricatus</i>		High	13097
Goosefoot(quinoa)	<i>Chenopodium</i>	cluster	High	19865
American Chestnut	<i>Castanea dentata</i>	cluster	High	5
Black Walnut	<i>Juglans nigra</i>	cluster	High	5
Shellbark Hickory	<i>Carya laciniosa</i>	cluster	High	5
Hazelnut	<i>Corylus americana</i>	cluster	High	5
Shagbark Hickory	<i>Carya ovata</i>	cluster	High	23
Butternut/white walnut	<i>J. cinerea</i>	cluster	High	23
Hickory	<i>Carya</i>	cluster	High	68
Oak/acorn	<i>Quercus nigra</i>	cluster	High	854
American beech	<i>Fagus americana</i>	cluster	High	875
Mulberry	<i>Morus rubra</i>		High	3
Hawthorn	<i>Crataegus calpodendron</i>		High	3
Swamp White Oak	<i>Quercus bicolor</i>		High	4
Red Oak	<i>Quercus rubra</i>		High	854
Black Maple	<i>Acer nigrum</i>		High	3913
Hog-peanut	<i>Amphicarpaea bracteata</i>		High	13097
Black Oak	<i>Quercus kelloggii</i>		High	
Pine	<i>Pinus banksiana Lamb</i>		High	
Slippery Elm	<i>Ulmus rubra</i>		High	
Elm	<i>Ulmus americana</i>		High	

Table 16. (cont'd)				
Common Name	Species	Size	Abundance	Density (square mile) 0 < 1.
Eastern Redbud	<i>Cercis canadensis</i>		High	
American Basswood	<i>Tilia americana</i>		High	
Poplar/cottonwood	<i>Populus tremuloides</i>		High	
White Ash	<i>Fraxinus americana</i>		High	
Sweet Birch	<i>Betula lenta</i>		High	
White Spruce	<i>Picea glauca</i>		High	
Mountain ash	<i>Sorbus americana</i>			
Pear	<i>Pyrus sp.</i>		High	

Table 17. Simulation species weight and calorie yield

Common Name	Avg. Cal. /Lb.	Avg. Weight	Total Calorie Yield
White-tailed Deer	537	150	886
Black bear	717	300	21510
Wolf, dog	1185	59	13445
Moose	500	850	425000
Wapiti/Elk	496	600	297600
Red fox	601	11	6611
Raccoon	1017	20	20340
Otter	601	20	12020
Bobcat	601	25	15025
Squirrel	601	1.25	751.25
Fisher	601	7	4207
Shrew	601	0.0312	18.7512
Marten	601	2.18	1310.18
Mouse	601	0.046	27.646
Vole	601	0.08125	48.83125
Beaver	664	40	26560
Muskrat	732	18	13176
Woodchuck	601	8	4808
Chipmunk	601	0.1875	112.6875
Mink	601	1.875	1126.875
Porcupine	601	14	8414
Mice/Rats	601	0.5	300.5
Rabbits	512	2.8	1433.6
Great Horned Owl	701	3	1051.5
Common Loon	701	9	18927
Hooded merganser	701	1.4	21590.8
Blue-winged teal	701	0.8	14808.625
Mallard	955	2.4	29796
Common merganser	701	3.4	52434.8
Crow	701	1	2804
Sandhill crane	701	8	78512
Wild turkey	711	12	179172
Baldpate, widgeon	701	1.6	103187.2
Red-breasted merganser	701	2.3	35470.6
Pied-billed grebe	701	1	2103
Ring-necked duck	701	1.5	38905.5
Greater Scaup	701	1.5	97789.5
American Bittern	701	1.5	57832.5

Table 17. (cont'd)			
Common Name	Avg. Cal. /Lb.	Avg. Weight	Total Calorie Yield
Passenger Pigeon	239	0.37	5924.81
Great Blue Heron	701	5.3	319515.8
Bluegill	401	0.44	3528.8
Yellow perch (ringed, striped or jack perch, green hornet)	412	0.5	1442
Burbot (Cod)	407	1	1221
White bass/Hybrid striped bass	661	3	37677
Channel catfish (spotted, speckled or silver catfish)	430	3	20640
Walleye pike (marble-eyes, 'eye, walter, walleyed pike, jack, jackfish, pickerel)	398	2	3184
Black bullhead (common bullhead, horned pout)	401	0.3215	902.4505
Sucker	401	2	8822
Sturgeon	476	20	142800
Largemouth bass (black bass, green bass, green trout, slough bass)	661	3	27762
Longnosed gar	400	3	15600
Smallmouth bass (bronzeback, brown or redeye bass, redeye, white or mountain trout)	661	3	21813
Crappie	401	0.75	6616.5
Sauger (also <i>Sander canadensis</i>)	401	1	7218
Black crappie	401	0.75	300.75
Lake trout (togue, mackinaw, great gray trout, laker)	539	8	47432
Redhorse	401	5	14035
Sunfish	401	0.5	802
Yellow bullhead (white-whiskered bullhead, yellow cat)	401	1	8020
Bowfin (dogfish, grindle, mudfish, cypress trout, lake lawyer, beaver fish)	401	3	30075
Northern Pike (pickerel, jack, gator, hammerhandle, snot rocket)	398	3	10746
Brown bullhead (marbled or speckled bullhead, red cat)	401	1	1604
Drumfish (sheepshead, croaker,	401	3	7218

Table 17. (cont'd)			
Common Name	Avg. Cal. /Lb.	Avg. Weight	Total Calorie Yield
thunderpumper, grinder, bubbler)			
Northern water snake	421.755	4	1687.02
Garter snake	421.755	2	843.51
Frogs and toads	331.055	3	993.165
Blanding's turtle	403.615	5	2018.075
Painted turtle	403.615	1	403.615
Snapping turtle	403.615	2	807.23
Softshell turtles	403.615	5	2018.075
mollusk	60	10	600
Gastropod - three-ridge valvata	7	1	7
Sedge or grass	113	15	20340
Sedge or grass	113	63	21357
Sedge or grass	113	21	40341
Cattail	113	21	4746
Dock	113	69	187128
Flatsedge	113	62	49042
Wild or False Lily-of-the-Valley	195.005	51	9945.255
Aster	195.005	8	1560.04
Spreading Dogbane	195.005	19	3705.095
Wild Bergamot	195.005	50	9750.25
Anise-root	195.005	87	16965.435
May-apple, Mandrake	195.005	32	6240.16
Dandelion	195.005	20	3900.1
Wild Geranium, spotted cranesbill	10	67	670
Bindweed	10	40	400
Wild Basil, Dogmint	10	12	120
Sumac	195.005	38	7410.19
Panic-grass	195.005	59	11505.295
June grass, Kentucky Bluegrass, Speargrass, Fowl Bluegrass	195.005	70	13650.35
Carrion Flower Greenbriar	195.005	88	17160.44
Golden rod	195.005	96	18720.48
Early Meadow- rue Quicksilver-weed	195.005	9	1755.045
Smooth Yellow Violet	195.005	26	5070.13
Common Blue Violet	195.005	94	18330.47
Michigan Lily	195.005	89	17355.445
Greenbrier	195.005	53	10335.265

Table 17. (cont'd)			
Common Name	Avg. Cal. /Lb.	Avg. Weight	Total Calorie Yield
Wild columbine, Rock-bells, Meetinghouses, honey suckle	195.005	14	2730.07
Wild sarsaparilla	195.005	25	4875.125
Yellow rocket	195.005	97	18915.485
White Avens	195.005	70	13650.35
Large Flowered Trillium	195.005	6	1170.03
Hoary Puccoon	195.005	86	16770.43
Prairie-dock; Rosin-weed	195.005	56	10920.28
Hophornbeam	195.005	37	7215.185
Sycamore	195.005	6	1170.03
Snakeroot (medicinal)	10	23	230
Sassafras	10	12	120
St. John's wort (medicinal)	10	28	280
Dogwood	10	18	180
Mint	10	40	400
Northern swamp dogwood	10	91	910
Swamp rose	10	50	500
Poison Ivy	10	72	720
Fringed Loosestrife	10	54	540
Prickly-ash	10	5	50
False Solomon's Seal	10	61	610
Three-leaved False Solomon's Seal	10	22	220
Sensitive fern	10	84	840
Wild cherry	145.12	4	580.48
Huckleberry	167.795	1	167.795
Mustard	163.26	10	1632.6
Stickyweed	145.12	6	870.72
American elderberry	331.055	10	3310.55
Serviceberry/Shadbush	353.73	5	1768.65
Black cherry	145.12	2	290.24
Hackberry	145.12	6	870.72
Grape(Riverbank grape)	399.08	6	2394.48
Nannyberry	145.12	2	290.24
Wild strawberry	145.12	9	1306.08
Black Raspberry	281.17	9	2530.53
Squash	2450	6	14700
Cape Gooseberry	194	10	1940
Knotweed	1587.25	3	4761.75
Maize	1601	3	4803

Table 17. (cont'd)			
Common Name	Avg. Cal. /Lb.	Avg. Weight	Total Calorie Yield
Sumpweed (Iva annua)	1601	8	12808
Wild rice	1601	9	14409
Amaranth	1601	8	12808
Woodland Sunflower	2500	3	7500
Goosefoot(quinoa)	1668	8	13344
American Chestnut	965.955	5	4829.775
Black Walnut	2798.095	7	19586.665
Shellbark Hickory	2979.495	7	20856.465
Hazelnut	2847.98	2	5695.96
Shagbark Hickory	2979.495	5	14897.475
Butternut/white walnut	2775.42	5	13877.1
Hickory	2775.42	7	19427.94
Oak/acorn	1755.045	8	14040.36
American beech	2612.16	4	10448.64
Mulberry	195.005	10	1950.05
Hawthorn	195.005	3	585.015
Swamp White Oak	20	9	180
Red Oak	20	8	160
Black Maple	1500	7	10500
Hog-peanut	195.005	1	195.005
Black Oak	20	1	20
Pine	400	1	400
Slippery Elm	400	10	4000
Elm	400	9	3600
Eastern Redbud	400	1	400
American Basswood	400	5	2000
Poplar/cottonwood	400	3	1200
White Ash	400	2	800
Sweet Birch	400	6	2400
White Spruce	1500	7	10500
Mountain ash	195.005	6	1170.03
Pear	195.005	6	1170.03

Table 18. Male and female resource preference probabilities		
Common Name	Male Preference	Female Preference
White-tailed Deer	0.681	0.214
Black bear	0.709	0.188
Wolf, dog	0.671	0.003
Moose	0.812	0.182
Wapiti/Elk	0.871	0.006
Red fox	0.378	0.335
Raccoon	0.622	0.559
Otter	0.344	0.388
Bobcat	0.41	0.581
Squirrel	0.383	0.609
Fisher	0.467	0.466
Shrew	0.408	0.443
Marten	0.578	0.355
Mouse	0.336	0.653
Vole	0.462	0.56
Beaver	0.561	0.458
Muskrat	0.499	0.626
Woodchuck	0.63	0.478
Chipmunk	0.416	0.386
Mink	0.447	0.493
Porcupine	0.358	0.343
Mice/Rats	0.636	0.474
Rabbits	0.632	0.582
Great Horned Owl	0.634	0.435
Common Loon	0.629	0.642
Hooded merganser	0.488	0.386
Blue-winged teal	0.548	0.414
Mallard	0.599	0.446
Common merganser	0.504	0.664
Crow	0.654	0.514
Sandhill crane	0.459	0.523
Wild turkey	0.531	0.523
Baldpate, widgeon	0.557	0.435
Red-breasted merganser	0.633	0.339
Pied-billed grebe	0.444	0.656
Ring-necked duck	0.622	0.465
Greater Scaup	0.448	0.594
American Bittern	0.471	0.358
Passenger Pigeon	0.475	0.399

Table 18. (cont'd)		
Common Name	Male Preference	Female Preference
Great Blue Heron	0.347	0.521
Bluegill	0.833	0.245
Yellow perch (ringed, striped or jack perch, green hornet)	0.788	0.1
Burbot (Cod)	0.982	0.3
White bass/Hybrid striped bass	0.778	0.287
Channel catfish (spotted, speckled or silver catfish)	0.959	0.24
Walleye pike (marble-eyes, 'eye, walter, walleyed pike, jack, jackfish, pickerel)	0.715	0.016
Black bullhead (common bullhead, horned pout)	0.82	0.04
Sucker	0.777	0.138
Sturgeon	0.672	0.188
Largemouth bass (black bass, green bass, green trout, slough bass)	0.973	0.036
Longnosed gar	0.729	0.076
Smallmouth bass (bronzeback, brown or redeye bass, redeye, white or mountain trout)	0.742	0.047
Crappie	0.773	0.153
Sauger (also <i>Sander canadensis</i>)	0.789	0.23
Black crappie	0.81	0.31
Lake trout (togue, mackinaw, great gray trout, laker)	0.869	0.158
Redhorse	0.829	0.057
Sunfish	0.95	0.049
Yellow bullhead (white-whiskered bullhead, yellow cat)	0.831	0.318
Bowfin (dogfish, grindle, mudfish, cypress trout, lake lawyer, beaver fish)	0.975	0.252
Northern Pike (pickerel, jack, gator, hammerhandle, snot rocket)	0.928	0.04
Brown bullhead (marbled or speckled bullhead, red cat)	0.984	0.239
Drumfish (sheepshead, croaker, thunderpumper, grinder, bubbler)	0.732	0.277
Northern water snake	0.549	0.435
Garter snake	0.396	0.414
Frogs and toads	0.448	0.619

Table 18. (cont'd)		
Common Name	Male Preference	Female Preference
Blanding's turtle	0.574	0.561
Painted turtle	0.471	0.535
Snapping turtle	0.542	0.381
Softshell turtles	0.628	0.338
mollusk	0.22	0.958
Gastropod - three-ridge valvata	0.141	0.905
Sedge or grass	0.095	0.823
Sedge or grass	0.172	0.81
Sedge or grass	0.186	0.784
Cattail	0.227	0.937
Dock	0.173	0.864
Flatsedge	0.013	0.91
Wild or False Lily-of-the-Valley	0.164	0.715
Aster	0.014	0.85
Spreading Dogbane	0.071	0.944
Wild Bergamot	0.254	0.828
Anise-root	0.148	0.827
May-apple, Mandrake	0.066	0.827
Dandelion	0.192	0.84
Wild Geranium, spotted cranesbill	0.233	0.689
Bindweed	0.217	0.703
Wild Basil, Dogmint	0.248	0.774
Sumac	0.204	0.896
Panic-grass	0.175	0.717
June grass, Kentucky Bluegrass, Speargrass, Fowl Bluegrass	0.059	0.929
Carrion Flower Greenbriar	0.195	0.867
Golden rod	0.21	0.974
Early Meadow- rue Quicksilver-weed	0.311	0.706
Smooth Yellow Violet	0.043	0.812
Common Blue Violet	0.323	0.743
Michigan Lily	0.238	0.824
Greenbrier	0.331	0.789
Wild columbine, Rock-bells, Meetinghouses, honey suckle	0.158	0.852
Wild sarsaparilla	0.196	0.697
Yellow rocket	0.186	0.975
White Avens	0.039	0.936

Table 18. (cont'd)		
Common Name	Male Preference	Female Preference
Large Flowered Trillium	0.127	0.748
Hoary Puccoon	0.036	0.861
Prairie-dock; Rosin-weed	0.088	0.856
Hophornbeam	0.319	0.719
Sycamore	0.074	0.746
Snakeroot (medicinal)	0.042	0.858
Sassafras	0.208	0.683
St. John's wort (medicinal)	0.1	0.806
Dogwood	0.307	0.767
Mint	0.206	0.995
Northern swamp dogwood	0.194	0.718
Swamp rose	0.263	0.757
Poison Ivy	0.022	0.701
Fringed Loosestrife	0.307	0.84
Prickly-ash	0.158	0.91
False Solomon's Seal	0.321	0.969
Three-leaved False Solomon's Seal	0.13	0.808
Sensitive fern	0.006	0.762
Wild cherry	0.17	0.972
Huckleberry	0.151	0.675
Mustard	0.161	0.893
Stickyweed	0.019	0.823
American elderberry	0.332	0.965
Serviceberry/Shadbush	0.162	0.886
Black cherry	0.112	0.787
Hackberry	0.151	0.883
Grape(Riverbank grape)	0.147	0.715
Nannyberry	0.19	0.734
Wild strawberry	0.112	0.861
Black Raspberry	0.009	0.676
Squash	0.011	0.979
Cape Gooseberry	0.123	0.981
Knotweed	0.096	0.923
Maize	0.087	0.783
Sumpweed (Iva annua)	0.009	0.952
Wild rice	0.113	0.827
Amaranth	0.133	0.988
Woodland Sunflower	0.063	0.811
Goosefoot(quinoa)	0.137	0.826

Table 18. (cont'd)		
Common Name	Male Preference	Female Preference
American Chestnut	0.227	0.711
Black Walnut	0.035	0.708
Shellbark Hickory	0.226	0.786
Hazelnut	0.243	0.754
Shagbark Hickory	0.282	0.749
Butternut/white walnut	0.243	0.963
Hickory	0.277	0.68
Oak/acorn	0.139	0.763
American beech	0.018	0.971
Mulberry	0.25	0.811
Hawthorn	0.144	0.744
Swamp White Oak	0.218	0.88
Red Oak	0.103	0.74
Black Maple	0.211	0.677
Hog-peanut	0.066	0.697
Black Oak	0.085	0.706
Pine	0.264	0.973
Slippery Elm	0.171	0.925
Elm	0.324	0.791
Eastern Redbud	0.315	0.779
American Basswood	0.032	0.785
Poplar/cottonwood	0.041	0.954
White Ash	0.276	0.775
Sweet Birch	0.103	0.939
White Spruce	0.115	0.685
Mountain ash	0.277	0.947
Pear	0.308	0.812

Table 19. Resource probability matrix January to July

Common Name	January	February	March	April	May	June	July
White-tailed Deer	0.85	0.69	0.63	1.00	1.00	0.95	0.90
Black bear	0.008	0.075	0.097	0.096	0.95	0.95	0.95
Wolf, dog	0.65	0.93	0.92	0.96	0.92	0.75	0.85
Moose	0.87	0.65	0.57	0.83	0.90	0.95	0.63
Wapiti/Elk	0.59	0.80	0.67	0.96	0.95	0.94	0.93
Red fox	0.97	0.91	0.91	0.97	0.52	0.40	0.43
Raccoon	0.27	0.67	0.82	0.91	0.96	0.91	0.96
Otter	0.19	0.91	0.99	0.95	0.75	0.74	0.48
Bobcat	0.80	0.83	0.32	0.73	0.40	0.90	0.52
Squirrel	0.98	0.95	0.93	0.93	0.98	0.95	0.96
Fisher	0.32	0.61	0.97	0.98	0.45	0.25	0.69
Shrew	0.78	0.55	0.95	1.00	0.96	0.96	0.99
Marten	0.96	0.97	0.90	0.93	0.38	0.89	0.97
Mouse	0.044	0.98	0.95	0.92	0.12	0.44	0.49
Vole	0.34	0.60	0.67	0.66	0.33	0.56	0.27
Beaver	0.61	0.16	0.77	0.74	0.87	0.34	0.56
Muskrat	0.67	0.49	0.76	0.97	0.99	0.94	0.96
Woodchuck	0.16	0.76	0.96	0.92	0.93	1.00	0.91
Chipmunk	0.024	0.98	0.92	0.95	0.14	0.95	0.93
Mink	0.18	0.92	1.00	0.95	0.99	0.82	0.88
Porcupine	0.32	0.22	0.88	0.99	0.97	0.94	0.84
Mice/Rats	0.31	0.79	0.19	0.71	0.77	0.43	0.61
Rabbits	0.46	1.00	0.92	0.93	0.92	0.98	0.98
Great Horned Owl	0.92	0.94	0.90	0.91	0.75	0.23	0.77
Common Loon	0.75	0.37	0.19	0.96	0.11	0.27	0.29
Hooded merganser	0.92	0.97	0.29	0.13	0.39	0.62	0.64

Table 19. (cont'd)

Common Name	January	February	March	April	May	June	July
Blue-winged teal	0.39	0.34	0.78	0.92	0.91	0.92	0.93
Mallard	0.11	0.22	0.93	0.95	0.94	0.99	0.27
Common merganser	0.82	0.12	0.33	0.73	0.95	0.98	0.82
Crow	0.14	1.00	0.98	0.98	0.91	0.93	0.35
Sandhill crane	0.36	0.30	0.54	1.00	0.90	0.91	0.80
Wild turkey	0.43	0.81	0.53	0.59	0.17	0.44	0.23
Baldpate, widgeon	0.80	0.86	0.94	0.94	0.36	0.73	0.33
Red-breasted merganser	0.89	0.50	0.93	0.97	1.00	0.89	0.24
Pied-billed grebe	0.74	0.57	0.61	0.99	0.72	0.57	0.43
Ring-necked duck	0.14	0.55	0.99	0.91	0.35	0.77	0.20
Greater Scaup	0.86	0.60	0.30	0.40	0.34	0.47	0.94
American Bittern	0.66	0.63	0.93	0.44	0.83	0.56	0.50
Passenger Pigeon	0.12	0.74	0.59	0.92	0.96	0.97	0.95
Great Blue Heron	0.47	0.30	0.97	0.91	0.98	0.34	0.42
Bluegill	0.54	0.77	0.42	0.92	0.92	0.96	0.48
Yellow perch (ringed, striped or jack perch, green hornet)	0.20	0.50	0.96	0.99	0.48	0.80	0.40
Burbot (Cod)	0.95	0.97	0.70	0.89	0.56	0.44	0.83
White bass/Hybrid striped bass	0.88	0.83	0.93	0.97	0.98	0.96	0.26
Channel catfish (spotted, speckled or silver catfish)	0.71	0.32	0.37	0.80	0.57	0.99	0.92
Walleye pike (marble-eyes, 'eye, walter, walleyed pike, jack, jackfish, pickerel)	0.61	0.63	0.90	0.97	0.67	0.64	0.16
Black bullhead (common bullhead, horned pout)	0.35	0.13	0.88	0.96	0.97	0.97	0.24

Table 19. (cont'd)							
Common Name	January	February	March	April	May	June	July
Sucker	0.82	0.36	0.16	0.93	0.90	0.28	0.19
Sturgeon	0.15	0.61	0.25	0.97	0.94	0.96	0.55
Largemouth bass (black bass, green bass, green trout, slough bass)	0.20	0.55	0.41	0.49	0.95	0.95	0.48
Longnosed gar	0.65	0.13	0.90	0.40	0.67	0.32	0.18
Smallmouth bass (bronzeback, brown or redeye bass, redeye, white or mountain trout)	0.20	0.14	0.19	0.30	0.98	0.95	0.40
Crappie	0.65	0.65	0.34	0.79	0.97	0.98	0.51
Sauger (also <i>Sander canadensis</i>)	0.60	0.49	0.89	0.98	0.94	0.99	0.76
Black crappie	0.24	0.12	0.81	0.94	0.99	0.95	0.32
Lake trout (togue, mackinaw, great gray trout, laker)	0.39	0.16	0.87	0.58	0.64	0.44	0.63
Redhorse	0.66	0.70	0.44	0.38	0.93	0.98	0.54
Sunfish	0.58	0.42	0.70	0.69	0.95	0.93	0.91
Yellow bullhead (white-whiskered bullhead, yellow cat)	0.37	0.90	0.14	0.79	0.76	0.97	0.94
Bowfin (dogfish, grindle, mudfish, cypress trout, lake lawyer, beaver fish)	0.31	0.56	0.79	0.48	0.54	0.25	0.26
Northern Pike (pickerel, jack, gator, hammerhandle, snot rocket)	0.22	0.26	0.94	0.93	0.87	0.62	0.51

Table 19. (cont'd)							
Common Name	January	February	March	April	May	June	July
Brown bullhead (marbled or speckled bullhead, red cat)	0.71	0.22	0.44	0.70	0.50	0.91	0.98
Drumfish (sheepshead, croaker, thunderpumper, grinder, bubbler)	0.43	0.76	0.18	0.54	0.96	0.94	0.44
Northern water snake	0.092	0.047	0.055	0.472	0.118	0.306	0.475
Garter snake	0.089	0.026	0.039	0.32	0.646	0.111	0.594
Frogs and toads	0.018	0.039	0.021	0.071	0.832	0.922	0.486
Blanding's turtle	0.027	0.098	0.082	0.078	0.941	0.611	0.893
Painted turtle	0.008	0.06	0.06	0.071	0.933	0.97	0.807
Snapping turtle	0.011	0.029	0	0.097	0.395	0.571	0.556
Softshell turtles	0.054	0.055	0.001	0.6	0.635	0.816	0.423
mollusk	0.058	0.058	0.055	0.271	0.574	0.90	0.98
Gastropod - three-ridge valvata	0.037	0.096	0.062	0.746	0.79	0.93	0.91
Sedge or grass	0.004	0.08	0.009	0.052	0.063	1.00	0.94
Sedge or grass	0.096	0.085	0.025	0.024	0.066	0.97	0.95
Sedge or grass	0.04	0	0.089	0.007	0.066	0.98	0.95
Cattail	0.63	0.65	0.44	0.48	0.39	0.92	1.00
Dock	0.052	0.025	0.025	0.028	1.00	0.95	0.94
Flatsedge	0.072	0.051	0.077	0.001	0.025	0.033	0.91
Wild or False Lily-of-the-Valley	0	0.042	0.027	0.073	0.96	0.95	0.93
Aster	0.075	0.052	0.033	0.07	0.036	0.009	0.028
Spreading Dogbane	0.099	0.063	0.086	0.013	0.013	0.086	0.069
Wild Bergamot	0.061	0.016	0.027	0.085	0.068	0.007	0.088

Table 19. (cont'd)							
Common Name	January	February	March	April	May	June	July
Anise-root	0.084	0.057	0.045	0.093	0.021	0.085	0.078
May-apple, Mandrake	0.076	0.023	0.07	0.094	0.045	0.027	0.007
Dandelion	0.037	0.048	0.098	0.082	0.013	0.023	0.046
Wild Geranium, spotted cranesbill	0.082	0.096	0.049	0.008	0.032	0.054	0.03
Bindweed	0.012	0.068	0.022	0.062	0.043	0.048	0.068
Wild Basil, Dogmint	0.021	0.016	0.091	0.03	0.096	0.066	0.065
Sumac	0.068	0.038	0.033	0.94	0.97	0.857	1.00
Panic-grass	0.064	0.04	0.026	0.004	0.042	0.94	0.98
June grass, Kentucky Bluegrass, Speargrass, Fowl Bluegrass	0.034	0.093	0.084	0.015	0.029	0.97	0.99
Carrion Flower Greenbriar	0.015	0.08	0.021	0.07	0.099	0.675	0.697
Golden rod	0.03	0.097	0.044	0.043	0.087	0.623	0.94
Early Meadow- rue Quicksilver-weed	0.097	0.096	0.095	0.008	0.543	0.95	0.98
Smooth Yellow Violet	0.094	0.09	0.72	0.92	0.91	0.91	0.397
Common Blue Violet	0.022	0.054	0.543	0.98	0.93	0.92	0.288
Michigan Lily	0.061	0.05	0.074	0.085	0.367	0.95	0.95
Greenbrier	0.01	0.026	0.044	0.1	0.345	0.879	0.656
Wild columbine, Rock-bells, Meetinghouses, honey suckle	0	0.047	0.071	0.486	0.986	0.938	0.922
Wild sarsaparilla	0.017	0.088	0.082	0.09	0.008	0.197	0.968
Yellow rocket	0.011	0.048	0	0.09	0.554	0.943	0.926
White Avens	0.071	0.04	0.005	0.015	0.464	0.937	0.947
Large Flowered Trillium	0.014	0.024	0.007	0.064	0.439	0.955	0.927

Table 19. (cont'd)

Common Name	January	February	March	April	May	June	July
Hoary Puccoon	0.031	0.011	0.009	0.041	0.372	0.984	0.935
Prairie-dock; Rosin-weed	0.013	0.061	0.03	0.025	0.07	0.775	0.94
Hophornbeam	0.008	0.02	0.064	0.95	0.97	0.828	0.066
Sycamore	0.023	0.091	0.053	0.014	0.922	0.28	0.233
Snakeroot (medicinal)	0.056	0.075	0.013	0.1	0.558	0.938	1.00
Sassafras	0.058	0.075	0.041	0.013	0.941	0.917	0.986
St. John's wort (medicinal)	0.034	0.062	0.034	0.018	0.091	0.47	1.00
Dogwood	0.058	0.055	0.024	0.001	0.94	0.99	0.94
Mint	0.048	0	0.019	0.013	0.035	0.263	1.00
Northern swamp dogwood	0.079	0.064	0.014	0.058	0.739	0.956	0.923
Swamp rose	0.029	0.051	0.019	0.095	0.071	0.119	0.93
Poison Ivy	0.018	0.1	0.081	0.069	0.41	0.517	0.385
Fringed Loosestrife	0.094	0.098	0.001	0.081	0.354	0.91	0.94
Prickly-ash	0.084	0.041	0.049	0.716	0.533	0.183	0.406
False Solomon's Seal	0.014	0.043	0.007	0.064	0.93	0.93	0.701
Three-leaved False Solomon's Seal	0.052	0.009	0.072	0.051	0.94	0.92	0.765
Sensitive fern	0.095	0.095	0.099	0.085	0.95	0.95	0.419
Wild cherry	0.41	0.124	0.215	0.1	0.003	0.035	0.117
Huckleberry	0.008	0.077	0.062	0.449	0.953	0.974	0.159
Mustard	0.028	0.09	0.086	0.035	0.132	0.988	0.999
Stickyweed	0.08	0.031	0.063	0.044	0.122	0.909	0.926
American elderberry	0.018	0.038	0.021	0.019	0.087	0.179	0.955
Serviceberry/Shadbush	0.077	0.048	0.009	0.107	0.951	0.938	0.912
Black cherry	0.014	0.021	0.092	0.039	0.055	0.095	0.004
Hackberry	0.455	0.082	0.073	0.354	0.035	0.017	0.071
Grape(Riverbank grape)	0.292	0.017	0.071	0.308	0.9	0.935	0.914

Table 19. (cont'd)

Common Name	January	February	March	April	May	June	July
Nannyberry	0.4	0.047	0.085	0.139	0.99	1.00	0.92
Wild strawberry	0.307	0.076	0.098	0.322	0.91	1.00	0.99
Black Raspberry	0.162	0.086	0.095	0.113	0.95	0.91	0.96
Squash	0.099	0.073	0.024	0.041	0.052	0.019	0.362
Cape Gooseberry	0.094	0.062	0.042	0.069	0.031	0.028	0.031
Knotweed	0.002	0.008	0.07	0.078	0.013	0.948	0.986
Maize	0.284	0.207	0.448	0.057	0.023	0.096	0.057
Sumpweed (Iva annua)	0.197	0.167	0.051	0.063	0.042	0.098	0.587
Wild rice	0.256	0.018	0.062	0.088	0.025	0.831	0.943
Amaranth	0.204	0.013	0.053	0.052	0.016	0.075	0.57
Woodland Sunflower	0.041	0.088	0.064	0.024	0.799	0.987	0.972
Goosefoot(quinoa)	0.261	0.003	0.055	0.012	0.011	0.009	0.844
American Chestnut	0.453	0.378	0.476	0.432	0.471	0.19	0.841
Black Walnut	0.365	0.437	0.103	0.419	0.391	0.258	0.151
Shellbark Hickory	0.427	0.297	0.138	0.405	0.43	0.358	0.467
Hazelnut	0.381	0.106	0.197	0.296	0.16	0.482	0.723
Shagbark Hickory	0.122	0.385	0.285	0.222	0.38	0.445	0.291
Butternut/white walnut	0.34	0.183	0.134	0.426	0.103	0.363	0.313
Hickory	0.24	0.248	0.141	0.31	0.483	0.373	0.404
Oak/acorn	0.5	0.313	0.274	0.131	0.443	0.322	0.324
American beech	0.174	0.267	0.177	0.466	0.166	0.277	0.266
Mulberry	0.119	0.384	0.172	0.235	0.247	0.082	0.059
Hawthorn	0.206	0.477	0.457	0.097	0.135	0.329	0.373
Swamp White Oak	0.152	0.342	0.197	0.144	0.495	0.036	0.437
Red Oak	0.153	0.131	0.114	0.191	0.016	0.345	0.008
Black Maple	0.186	0.076	0.384	0.2	0.108	0.288	0.101
Hog-peanut	0.447	0.077	0.192	0.088	0.483	0.421	0.28

Table 19. (cont'd)							
Common Name	January	February	March	April	May	June	July
Black Oak	0.307	0.059	0.357	0.211	0.494	0.049	0.458
Pine	0.153	0.173	0.439	0.081	0.048	0.383	0.178
Slippery Elm	0.304	0.086	0.382	0.485	0.62	0.143	0.433
Elm	0.399	0.111	0.158	0.19	0.085	0.772	0.571
Eastern Redbud	0.148	0.406	0.484	0.171	0.255	0.588	0.562
American Basswood	0.433	0.139	0.194	0.107	0.31	0.019	0.195
Poplar/cottonwood	0.233	0.489	0.279	0.267	0.364	0.551	0.058
White Ash	0.07	0.052	0.286	0.517	0.647	0.657	0.226
Sweet Birch	0.351	0.398	0.258	0.708	0.531	0.11	0.035
White Spruce	0.31	0.462	0.209	0.764	0.518	0.411	0.139
Mountain ash	0.377	0.193	0.286	0.502	0.613	0.412	0.152
Pear	0.75	0.69	0.04	0.09	0.09	0.09	0.05

Table 20. Resource probability matrix August to December

Common Name	August	September	October	November	December
White-tailed Deer	0.97	0.91	0.97	0.98	0.78
Black bear	0.99	0.92	0.95	0.54	0.78
Wolf, dog	0.62	0.61	0.54	0.55	0.63
Moose	0.70	0.95	0.99	0.90	1.00
Wapiti/Elk	0.93	0.99	0.93	1.00	0.68
Red fox	0.71	0.91	0.92	0.71	0.94
Raccoon	0.96	1.00	0.91	0.98	0.40
Otter	0.56	0.48	0.79	0.69	0.16
Bobcat	0.47	0.30	0.83	0.81	0.80
Squirrel	0.96	0.35	0.68	0.29	0.12
Fisher	0.84	0.29	0.64	0.53	0.82
Shrew	0.92	0.96	0.43	0.42	0.82
Marten	0.93	0.98	1.00	0.97	0.95
Mouse	0.80	0.98	0.94	0.064	0.024
Vole	0.65	0.23	0.60	0.53	0.80
Beaver	0.89	0.14	0.36	0.83	0.85
Muskrat	0.94	0.96	0.26	0.33	0.33
Woodchuck	0.96	0.98	0.99	0.94	0.69
Chipmunk	0.99	0.35	0.46	0.026	0.08
Mink	0.81	0.16	0.67	0.84	0.62
Porcupine	0.28	0.73	0.31	1.00	0.91
Mice/Rats	0.42	0.73	0.14	0.56	0.56
Rabbits	0.97	0.70	0.16	0.76	0.83
Great Horned Owl	0.14	0.45	0.27	0.39	0.81
Common Loon	0.18	0.93	0.92	0.54	0.76
Hooded merganser	0.42	0.93	0.93	0.22	0.87
Blue-winged teal	0.29	0.99	0.75	0.45	0.23
Mallard	0.84	0.95	0.92	0.76	0.32
Common merganser	0.77	0.98	0.96	0.12	0.60
Crow	0.86	0.15	0.25	0.90	0.23
Sandhill crane	0.47	0.35	0.44	0.82	0.62
Wild turkey	0.37	0.84	0.76	0.87	0.66
Baldpate, widgeon	0.86	1.00	0.68	0.46	0.91
Red-breasted merganser	0.47	0.94	0.95	0.35	0.80
Pied-billed grebe	0.56	0.98	0.90	0.38	0.83
Ring-necked duck	0.56	0.93	0.97	0.24	0.70
Greater Scaup	0.98	0.75	0.12	0.90	0.96
American Bittern	0.40	0.28	0.27	0.37	0.95

Table 20. (cont'd)					
Common Name	August	September	October	November	December
Passenger Pigeon	1.00	0.98	0.96	0.14	0.50
Great Blue Heron	0.69	0.40	0.45	0.93	0.91
Bluegill	0.80	0.27	0.52	0.72	0.74
Yellow perch (ringed, striped or jack perch, green hornet)	0.43	0.75	0.75	0.20	0.39
Burbot (Cod)	0.86	0.39	0.18	0.50	0.98
White bass/Hybrid striped bass	0.16	0.75	0.71	0.56	0.52
Channel catfish (spotted, speckled or silver catfish)	0.49	0.59	0.40	0.70	0.15
Walleye pike (marble-eyes, 'eye, walter, walleyed pike, jack, jackfish, pickerel)	0.86	0.35	0.47	0.43	0.42
Black bullhead (common bullhead, horned pout)	0.67	0.79	0.63	0.60	0.37
Sucker	0.19	0.67	0.16	0.86	0.67
Sturgeon	0.68	0.49	0.55	0.31	0.14
Largemouth bass (black bass, green bass, green trout, slough bass)	0.42	0.42	0.70	0.42	0.57
Longnosed gar	0.41	0.81	0.71	0.31	0.41
Smallmouth bass (bronzeback, brown or redeye bass, redeye, white or mountain trout)	0.83	0.12	0.38	0.43	0.73
Crappie	0.56	0.49	0.85	0.28	0.50
Sauger (also <i>Sander canadensis</i>)	0.47	0.27	0.77	0.57	0.59
Black crappie	0.82	0.80	0.42	0.81	0.63
Lake trout (togue, mackinaw, great gray trout, laker)	0.20	0.51	0.69	0.12	0.76
Redhorse	0.55	0.72	0.32	0.79	0.68
Sunfish	0.99	0.48	0.34	0.48	0.47
Yellow bullhead (white-whiskered bullhead, yellow cat)	0.97	0.91	0.66	0.41	0.18
Bowfin (dogfish, grindle, mudfish, cypress trout, lake lawyer, beaver fish)	0.29	0.59	0.60	0.60	0.61

Table 20. (cont'd)					
Common Name	August	September	October	November	December
Northern Pike (pickerel, jack, gator, hammerhandle, snot rocket)	0.86	0.26	0.60	0.52	0.80
Brown bullhead (marbled or speckled bullhead, red cat)	0.76	0.75	0.12	0.37	0.89
Drumfish (sheepshead, croaker, thunderpumper, grinder, bubbler)	0.70	0.87	0.43	0.60	0.53
Northern water snake	0.27	0.373	0.003	0.011	0.049
Garter snake	0.678	0.844	0.018	0.044	0.009
Frogs and toads	0.282	0.077	0.047	0.076	0.065
Blanding's turtle	0.459	0.377	0.425	0.297	0.022
Painted turtle	0.311	0.158	0.012	0.058	0.037
Snapping turtle	0.153	0.302	0.374	0.098	0.045
Softshell turtles	0.455	0.35	0.065	0.084	0.01
mollusk	0.98	0.624	0.012	0.056	0.074
Gastropod - three-ridge valvata	0.91	0.889	0.083	0.089	0.064
Sedge or grass	1.00	0.91	0.068	0.041	0.016
Sedge or grass	0.97	0.94	0.012	0.01	0.07
Sedge or grass	0.95	0.94	0.058	0.073	0.05
Cattail	0.55	0.20	0.53	0.36	0.27
Dock	0.93	0.98	0.046	0	0.078
Flatsedge	0.99	0.95	0.057	0.051	0.037
Wild or False Lily-of-the-Valley	0.058	0.071	0.022	0.005	0.022
Aster	0.96	0.96	0.93	0.06	0.083
Spreading Dogbane	0.943	0.984	0.972	0.049	0.075
Wild Bergamot	0.906	0.921	0.986	0.067	0.032
Anise-root	0.95	0.991	0.946	0.03	0.096
May-apple, Mandrake	0.985	0.993	0.979	0.025	0.083
Dandelion	0.958	0.972	0.979	0.013	0.008
Wild Geranium, spotted cranesbill	0.95	0.97	0.97	0.06	0.074
Bindweed	0.97	0.90	0.92	0.007	0.088
Wild Basil, Dogmint	0.906	0.927	0.928	0.085	0.088
Sumac	0.98	0.058	0.063	0.011	0.036
Panic-grass	0.246	0.036	0.074	0.029	0.024

Table 20. (cont'd)					
Common Name	August	September	October	November	December
June grass, Kentucky Bluegrass, Speargrass, Fowl Bluegrass	0.90	0.97	0.367	0.007	0.029
Carrion Flower Greenbriar	0.162	0.174	0.90	0.96	0.452
Golden rod	0.99	0.95	0.447	0.061	0.013
Early Meadow- rue Quicksilver-weed	0.84	0.005	0.032	0.012	0.021
Smooth Yellow Violet	0.041	0.066	0.071	0.097	0.006
Common Blue Violet	0.099	0.058	0.011	0.071	0.038
Michigan Lily	0.247	0.071	0.096	0.076	0.028
Greenbrier	0.778	0.347	0.99	0.98	0.639
Wild columbine, Rock-bells, Meetinghouses, honey suckle	0.863	0.078	0.003	0.008	0.099
Wild sarsaparilla	0.906	0.341	0.078	0.058	0.023
Yellow rocket	0.451	0.085	0.065	0.06	0.001
White Avens	0.57	0.067	0.075	0.04	0.095
Large Flowered Trillium	0.786	0.073	0.07	0.042	0.062
Hoary Puccoon	0.504	0.062	0.091	0.005	0.073
Prairie-dock; Rosin-weed	0.92	0.92	0.878	0.057	0.043
Hophornbeam	0.011	0.066	0.08	0.004	0.07
Sycamore	0.218	0.709	0.962	0.389	0.098
Snakeroot (medicinal)	0.95	0.97	0.227	0.069	0.029
Sassafras	0.946	0.94	0.96	0.702	0.032
St. John's wort (medicinal)	0.98	0.96	0.83	0.007	0.073
Dogwood	0.21	0.006	0.079	0.021	0.052
Mint	0.99	1.00	0.004	0.086	0.047
Northern swamp dogwood	0.229	0.062	0.087	0.034	0.035
Swamp rose	0.98	0.446	0.018	0.98	0.98
Poison Ivy	0.93	0.92	0.611	0.047	0.063
Fringed Loosestrife	0.99	0.9	0.001	0.053	0.058
Prickly-ash	0.97	0.91	0.606	0.085	0.005
False Solomon's Seal	0.1	0.063	0.081	0.073	0.039
Three-leaved False Solomon's Seal	0.083	0.068	0.058	0.007	0.043
Sensitive fern	0.06	0.012	0.072	0.067	0.097
Wild cherry	0.912	0.987	0.981	0.335	0.31
Huckleberry	0.117	0.149	0.491	0.327	0.227
Mustard	0.938	0.294	0.276	0.192	0.431

Table 20. (cont'd)					
Common Name	August	September	October	November	December
Stickyweed	0.999	0.339	0.419	0.229	0.399
American elderberry	0.945	0.114	0.328	0.175	0.45
Serviceberry/Shadbush	0.981	0.317	0.19	0.295	0.225
Black cherry	0.28	0.987	0.987	0.19	0.231
Hackberry	0.003	0.901	0.933	0.491	0.263
Grape(Riverbank grape)	0.119	0.014	0.009	0.119	0.471
Nannyberry	0.147	0.006	0.013	0.04	0.022
Wild strawberry	0.454	0.012	0.081	0.023	0.024
Black Raspberry	0.397	0.049	0.052	0.095	0.001
Squash	0.988	0.927	0.388	0.345	0.03
Cape Gooseberry	0.957	0.945	0.95	0.318	0.008
Knotweed	0.983	0.993	0.24	0.174	0.097
Maize	0.043	0.081	0.039	0.073	0.44
Sumpweed (Iva annua)	0.924	0.905	0.921	0.821	0.122
Wild rice	0.929	0.921	0.839	0.473	0.189
Amaranth	0.946	0.9	0.951	0.513	0.157
Woodland Sunflower	0.918	0.988	0.956	0.8	0.377
Goosefoot(quinoa)	0.955	0.922	0.965	0.779	0.397
American Chestnut	0.922	0.937	0.929	0.575	0.265
Black Walnut	0.645	0.929	0.971	0.889	0.497
Shellbark Hickory	0.555	0.927	0.905	0.723	0.175
Hazelnut	0.957	0.94	0.95	0.631	0.247
Shagbark Hickory	0.873	0.988	0.937	0.806	0.441
Butternut/white walnut	0.871	0.957	0.974	0.636	0.18
Hickory	0.763	0.96	0.988	0.726	0.169
Oak/acorn	0.828	0.908	0.916	0.507	0.327
American beech	0.606	0.968	0.925	0.629	0.164
Mulberry	0.295	0.563	0.704	0.075	0.15
Hawthorn	0.14	0.741	0.691	0.473	0.441
Swamp White Oak	0.35	0.595	0.638	0.458	0.312
Red Oak	0.078	0.818	0.521	0.222	0.403
Black Maple	0.279	0.53	0.82	0.185	0.261
Hog-peanut	0.86	0.68	0.56	0.239	0.145
Black Oak	0.175	0.557	0.884	0.296	0.323
Pine	0.419	0.156	0.486	0.076	0.104
Slippery Elm	0.063	0.197	0.399	0.206	0.071
Elm	0.369	0.451	0.281	0.122	0.436
Eastern Redbud	0.358	0.319	0.191	0.017	0.338

Table 20. (cont'd)					
Common Name	August	September	October	November	December
American Basswood	0.238	0.348	0.521	0.355	0.181
Poplar/cottonwood	0.397	0.304	0.442	0.044	0.107
White Ash	0.344	0.028	0.474	0.269	0.443
Sweet Birch	0.444	0.483	0.338	0.006	0.383
White Spruce	0.445	0.478	0.099	0.058	0.473
Mountain ash	0.274	0.169	0.248	0.212	0.095
Pear	0.01	0.09	0.03	0.07	0.09

Simulation Results

Table 21. Late Archaic land use				
COVERTYPE	LA Count	LA (SqMiles)	LA%	LA Degraded
Intermittent Wetlands		0.0	0%	0
SHRUB SWAMP/EMERGENT MARSH	2009	83.6	1%	294
MIXED CONIFER SWAMP	5203	1095.8	7%	110
MIXED HARDWOOD SWAMP	2380	657.4	4%	108
RIVER	1	804.9	5%	470
WET PRAIRIE	693	105.5	1%	61
BLACK ASH SWAMP	708	174.9	1%	60
CEDAR SWAMP	982	314.9	2%	57
MUSKEG/BOG	47	8.6	0%	6
MESIC SOUTHERN FORESTS: BEECH-SUGAR MAPLE FOREST	572	1843.0	12%	182
MESIC NORTHERN FORESTS: BEECH-SUGAR MAPLE-HEMLOCK	375	3003.1	20%	164
MESIC NORTHERN FORESTS: HEMLOCK-WHITE PINE FOREST	659	1487.4	10%	128
DRY NORTHERN FORESTS: JACK PINE-RED PINE FOREST	165	578.8	4%	28
WHITE PINE-MIXED HARDWOOD	138	718.5	5%	209
WHITE PINE-RED PINE	352	411.1	3%	122
WHITE PINE-WHITE OAK	60	109.8	1%	24
MIXED PINE-OAK	21	28.4	0%	17
DRY MESIC SOUTHERN FORESTS: OAK-HICKORY	283	614.3	4%	102
DRY SOUTHERN FORESTS MIXED OAK	102	167.9	1%	14
MIXED OAK SAVANNA	81	169.3	1%	125
SPRUCE-FIR-CEDAR	2	0.7	0%	30
ASPEN-BIRCH	103	89.9	1%	33

Table 21. (cont'd)				
COVERTYPE	LA_Count	LA_SqMiles	LA%	LA Degraded
BLACK OAK BARREN	142	422.7	3%	0
OAK/PINE BARRENS	40	43.2	0%	0
PINE BARRENS	97	117.3	1%	0
EXPOSED BEDROCK	0	0.0	0%	0
SAND DUNE	2	0.0	0%	1
GRASSLAND	9	1.4	0%	0

Table 22. Exploited resources by calories							
Resource	January	February	March	April	May	June	
Grass_Herb	6596	9411	14898	9822	17330	23565	
Large Mammals	13247	13330	11219	12062	10186	8966	
Birds	8436	4021	11352	5964	7855	1817	
Fish	2633	1076	1679	3195	3207	2006	
Nuts	2	0	48	0	0	0	
Small mammal	443	103	0	301	148	0	
Seeds_Grains	0	0	0	0	0	131	
Herb/Medicine	0	0	0	296	20	0	
Seed_Fruit	0	0	0	0	0	17	
Mollusk	0	0	0	0	0	0	
Reptile	0	0	0	0	0	0	
Tree_Fruit	0	0	0	0	0	0	
	July	August	September	October	November	December	Total
Grass_Herb	31227	30402	27730	6259	2804	5018	185062
Large Mammals	7284	7632	7815	13752	14170	11695	131358
Birds	2146	1398	2027	4366	5698	16500	71580
Fish	0	0	0	624	557	2166	17143
Nuts	0	0	95	698	641	0	1484
Small mammal	0	0	0	57	363	0	1415
Seeds_Grains	0	0	0	602	560	0	1293
Herb/Medicine	0	0	88	588	0	0	992
Seed_Fruit	0	0	0	0	0	0	17
Mollusk	0	0	0	0	0	0	0
Reptile	0	0	0	0	0	0	0
Tree_Fruit	0	0	0	0	0	0	0

Table 23. Male exploited resources							
Resource	January	February	March	April	May	June	
Large Mammals	4114	4159	3927	3848	3666	3540	
Grass_Herb	455	727	1458	791	1560	3388	
Birds	1497	839	2705	1242	1813	508	
Fish	961	460	660	1233	1269	875	
Small mammal	83	10	0	50	29	0	
Herb/Medicine	0	0	0	12	1	0	
Nuts	0	0	3	0	0	0	
Seeds_Grains	0	0	0	0	0	4	
Mollusk	0	0	0	0	0	0	
Reptile	0	0	0	0	0	0	
Seed_Fruit	0	0	0	0	0	0	
Tree_Fruit	0	0	0	0	0	0	
	July	August	September	October	November	December	Total
Large Mammals	2976	3064	3169	4573	4417	3773	45226
Grass_Herb	6243	6030	5261	540	176	371	27000
Birds	704	460	650	884	1125	3215	15642
Fish	0	0	0	251	211	810	6730
Small mammal	0	0	0	13	62	0	247
Herb/Medicine	0	0	17	44	0	0	74
Nuts	0	0	5	16	17	0	41
Seeds_Grains	0	0	0	10	24	0	38
Mollusk	0	0	0	0	0	0	0
Reptile	0	0	0	0	0	0	0
Seed_Fruit	0	0	0	0	0	0	0
Tree_Fruit	0	0	0	0	0	0	0

Table 24. Female exploited resources							
Resource	January	February	March	April	May	June	
Grass_Herb	5590	7869	11768	8114	13719	15755	
Birds	4957	2158	5273	3280	3711	530	
Large Mammals	4230	4259	2652	3553	2124	1157	
Fish	400	98	194	442	313	89	
Nuts	2	0	44	0	0	0	
Seeds_Grains	0	0	0	0	0	120	
Small mammal	266	76	0	185	80	0	
Herb/Medicine	0	0	0	271	17	0	
Seed_Fruit	0	0	0	0	0	11	
Mollusk	0	0	0	0	0	0	
Reptile	0	0	0	0	0	0	
Tree_Fruit	0	0	0	0	0	0	
	July	August	September	October	November	December	Total
Grass_Herb	16999	16509	15707	5091	2418	4192	123731
Birds	529	347	539	2333	3224	9140	36021
Large Mammals	626	737	784	3883	4545	3458	32008
Fish	0	0	0	75	69	296	1976
Nuts	0	0	81	656	593	0	1376
Seeds_Grains	0	0	0	572	492	0	1184
Small mammal	0	0	0	32	221	0	860
Herb/Medicine	0	0	47	468	0	0	803
Seed_Fruit	0	0	0	0	0	0	11
Mollusk	0	0	0	0	0	0	0
Reptile	0	0	0	0	0	0	0
Tree_Fruit	0	0	0	0	0	0	0

Table 25. Total exploited calories by female							
Calories_F	January	February	March	April	May	June	
Large Mammals	346944550	323940900	856935000	1.1E+09	7E+08	3.8E+08	
Grass_Herb	11585438	22923858	30572941	2.1E+07	4E+07	6E+07	
Birds	20003626	8832954	11881639	1.2E+07	1E+07	1309778	
Nuts	47018	0	893342	0	0	0	
Seeds_Grains	0	0	0	0	0	2180000	
Fish	3436720	828240	1666000	3779440	3E+06	809200	
Small mammal	5443065	1051750	0	3220012	2E+06	0	
Herb/Medicine	0	0	0	2606175	160875	0	
Seed_Fruit	0	0	0	0	0	111110	
Mollusk	0	0	0	0	0	0	
Reptile	0	0	0	0	0	0	
Tree_Fruit	0	0	0	0	0	0	
Calories - F	July	August	September	October	November	December	Totals
Large Mammals	2E+08	2.5E+08	250326500	1.2E+09	1.431E+09	1.203E+09	8.24E+09
Grass_Herb	7.1E+07	7.1E+07	67034764	1.6E+07	3006252	9688733	4.24E+08
Birds	1635816	997866	1318826	8635973	12584786	24692261	1.16E+08
Nuts	0	0	1692648	1.4E+07	11390975	0	28398068
Seeds_Grains	0	0	0	9774296	5712368	0	17666664
Fish	0	0	0	675920	618800	2694160	17278800
Small mammal	0	0	0	589860	4190040	0	16020227
Herb/Medicine	0	0	830115	7546305	0	0	11143470
Seed_Fruit	0	0	0	0	0	0	111110
Mollusk	0	0	0	0	0	0	0
Reptile	0	0	0	0	0	0	0
Tree_Fruit	0	0	0	0	0	0	0

Table 26. Exploited calories by male

Calories - M	January	February	March	April	May	June	
Large Mammals	1.364E+09	1.284E+09	1.281E+09	1.2E+09	1E+09	1.2E+09	
Grass_Herb	1166047	2340456	3871493	2255028	5E+06	1.2E+07	
Fish	8349040	3988880	5750080	1.1E+07	1E+07	7682640	
Birds	6159858	2825028	5826186	4640480	6E+06	1230223	
Small mammal	1734380	150250	0	830428	508500	0	
Herb/Medicine	0	0	0	107250	10725	0	
Nuts	0	0	47018	0	0	0	
Seeds_Grains	0	0	0	0	0	80000	
Mollusk	0	0	0	0	0	0	
Reptile	0	0	0	0	0	0	
Seed_Fruit	0	0	0	0	0	0	
Tree_Fruit	0	0	0	0	0	0	
Calories - M	July	August	September	October	November	December	Totals
Large Mammals	9.5E+08	9.9E+08	1048944000	1.4E+09	1.402E+09	1.331E+09	1.46E+10
Grass_Herb	2.6E+07	2.6E+07	22171504	1868229	219672	690995	1.03E+08
Fish	0	0	0	2122960	1789760	7092400	58509920
Birds	2298097	1334053	1583703	3163649	4133052	8317117	47538114
Small mammal	0	0	0	223740	1200060	0	4647358
Herb/Medicine	0	0	251550	767520	0	0	1137045
Nuts	0	0	94036	371165	266416	0	778635
Seeds_Grains	0	0	0	164040	268968	0	513008
Mollusk	0	0	0	0	0	0	0
Reptile	0	0	0	0	0	0	0
Seed_Fruit	0	0	0	0	0	0	0
Tree_Fruit	0	0	0	0	0	0	0

Resource reference

Table 27. Possible resource list			
Modified from (Baker 1983; Banfield 1974; Burt 1957; Voss 1972)			
Type category	Species	Common Name	Type
Mammals	<i>Cervus canadensis</i>	Wapiti/Elk	Ungulate
Mammals	<i>Odocoileus virginianus</i>	White-tailed Deer	Ungulate
Mammals	<i>Procyon lotor</i>	Raccoon	Carnivore
Mammals	<i>Ursus americanus</i>	Black bear	Carnivore
Mammals	<i>Castor canadensis</i>	Beaver	Rodent
Mammals	<i>Ondatra zibethicus</i>	Muskrat	Rodent
Mammals	<i>Canis sp. (lupus, familiaris)</i>	Wolf, dog	Carnivore
Mammals	<i>Martes americana</i>	Marten	Carnivore
Mammals	<i>Marmota monax</i>	Woodchuck	Rodents
Mammals	<i>Mustela vison</i>	Mink	Carnivore
Mammals	<i>Lynx rufus</i>	Bobcat	Carnivore
Mammals	<i>Erethizon dorsatum</i>	Porcupine	Rodents
Mammals	<i>Lontra canadensis</i>	Otter	Carnivore
Mammals	<i>Martes pennanti</i>	Fisher	Carnivore
Mammals	<i>Sciurus sp.</i>	Squirrel	Rodent
Mammals	<i>Leporidae sp. (Sylvilagus)</i>	Rabbits	Lagomorph
Mammals	<i>Vulpes fulva</i>	Red fox	Carnivore
Mammals	<i>Alces alces</i>	Moose	Ungulate
Mammals	<i>Blarina sp.</i>	Shrew	Insectivore
Mammals	<i>Tamias sp.</i>	Chipmunk	Rodent
Mammals	<i>Muridae sp.</i>	Mice/Rats	Rodent
Mammals	<i>Peromyscus sp.</i>	Mouse	Rodent
Mammals	<i>Microtus sp.</i>	Vole	Rodent

Table 27. (cont'd)			
Type category	Species	Common Name	Type
Osteichthyes; Fish	<i>Acipenser fulvescens</i>	Sturgeon	Sturgeon family
Osteichthyes; Fish	<i>Perca flavescens</i>	Yellow perch (ringed, striped or jack perch, green hornet)	Perch family
Osteichthyes; Fish	<i>Amia calva</i>	Bowfin (dogfish, grindle, mudfish, cypress trout, lake lawyer, beaver fish)	Bowfin family
Osteichthyes; Fish	<i>Aplodinotus grunniens</i>	Drumfish (sheepshead, croaker, thunderpumper, grinder, bubbler)	Drum family
Osteichthyes; Fish	<i>Monroe chrysops</i>	White bass/Hybrid striped bass	Sunfish family
Osteichthyes; Fish	<i>Micropterus salmoides</i>	Largemouth bass (black bass, green bass, green trout, slough bass)	Sunfish family
Osteichthyes; Fish	<i>Micropterus dolomieu</i>	Smallmouth bass (bronzeback, brown or redeye bass, redeye, white or mountain trout)	Sunfish family
Osteichthyes; Fish	<i>Esox lucius</i>	Northern Pike (pickerel, jack, gator, hammerhandle, snot rocket)	Pike family
Osteichthyes; Fish	<i>Stizostedion vitreum</i>	Walleye pike (marble-eyes, 'eye, walter, walleyed pike, jack, jackfish, pickerel)	Perch family
Osteichthyes; Fish	<i>Ictalurus punctatus</i>	Channel catfish (spotted, speckled or silver catfish)	Catfish family
Osteichthyes; Fish	<i>Lepisosteus oculatus</i>	Longnosed gar	Gar family

Table 27. (cont'd)			
Type category	Species	Common Name	Type
Osteichthyes; Fish	<i>Salvelinus namaycush</i>	Lake trout (togue, mackinaw, great gray trout, laker)	Salmon family
Osteichthyes; Fish	<i>Ictalurus melas</i>	Black bullhead (common bullhead, horned pout)	Catfish family
Osteichthyes; Fish	<i>Ictalurus natalis</i>	Yellow bullhead (white-whiskered bullhead, yellow cat)	Catfish family
Osteichthyes; Fish	<i>Ictalurus nebulosus</i>	Brown bullhead (marbled or speckled bullhead, red cat)	Catfish family
Osteichthyes; Fish	<i>Moxostoma</i> sp. (<i>macrolepidotum</i>)	Redhorse	Sucker family
Osteichthyes; Fish	<i>Pomoxis</i> sp.	Crappie	Sunfish family
Osteichthyes; Fish	<i>Catostomus</i> sp. (catostomus, commersoni)	Sucker	Sucker family
Osteichthyes; Fish	<i>Centrarchidae</i>	Sunfish	Sunfish family
Osteichthyes; Fish	<i>Lepomis</i> cf. <i>macrochirus</i>	Bluegill	Sunfish family
Osteichthyes; Fish	<i>Pomoxis nigromaculatus</i>	Black crappie	Sunfish family
Osteichthyes; Fish	<i>Stizostedion canadense</i>	Sauger (also <i>Sander canadensis</i>)	Perch family
Osteichthyes; Fish	<i>Lota lota lacustris</i>	Burbot (Cod)	Freshwater cod family
Birds			
Avian	<i>Ectopistes migratorius</i>	Passenger Pigeon	Bird
Avian	<i>Anas discors</i>	Blue-winged teal	Bird
Avian	<i>Anas americana</i>	Baldpate, widgeon	Bird

Table 27. (cont'd)			
Type category	Species	Common Name	Type
Avian	<i>Anas platyrhynchos</i>	Mallard	Bird
Avian	<i>Aythya collaris</i>	Ring-necked duck	Bird
Avian	<i>Mergus merganser</i>	Common merganser	Bird
Avian	<i>Mergus serrator</i>	Red-breasted merganser	Bird
Avian	<i>Gavia immer</i>	Common Loon	Bird
Avian	<i>Podilymbus podiceps</i>	Pied-billed grebe	Bird
Avian	<i>Meleagris gallopavo</i>	Wild turkey	Bird
Avian	<i>Lophodytes cucullatus</i>	Hooded merganser	Bird
Avian	<i>Corvus brachyrhynchos</i>	Crow	Bird
Avian	<i>Botaurus lentiginosus</i>	American Bittern	Bird
Avian	<i>Ardea herodias</i>	Great Blue Heron	Bird
Avian	<i>Grus canadensis</i>	Sandhill crane	Bird
Avian	<i>Aythya marila</i>	Greater Scaup	Bird
Avian	<i>Bubo virginianus</i>	Great Horned Owl	Bird
Botanical			
-Cultigen/grain	<i>Chenopodium</i>	Goosefoot	Dicot/Green
-Cultigen/grain	<i>Zea mays</i>	Maize	Grass
-Cultigen/grain	<i>Iva annua</i>	Sumpweed	Dicot
-Cultigen/grain	<i>Carex</i> sp.	Sedge	Monocot/sedge/Perennial
-Cultigen/grain	<i>Cyperus</i>	Flatsedge	Monocot/sedge
-Cultigen/grain	<i>Zizania aquatica</i>	Wild rice	Monocot
-Nut	<i>Quercus</i>	Oak/acorn	Deciduous nut
-Nut	<i>Carya</i>	Hickory	Deciduous nut

Table 27. (cont'd)			
Type category	Species	Common Name	Type
-Nut	<i>J. cinerea</i>	Butternut/white walnut	Deciduous nut
-Nut	<i>Juglans nigra</i>	Black Walnut	Deciduous nut
-Nut	<i>Corylus americana</i>	Hazelnut	Deciduous nut shrub
-Nut	<i>Castanea dentata</i>	American Chestnut	Tree; nut
-Seed/fruit	<i>Cucurbita pepo</i>	Squash	Vining herb
-Seed/fruit	<i>Amphicarpaea bracteata</i>	Hog-peanut	Dicot
-Seed/fruit	<i>Geranium maculatum</i>	Wild Geranium, spotted cranesbill	
-Seed/fruit	<i>Pyrus sp.</i>	Mountain ash	Small tree
-Seed/fruit	<i>Physalis</i>	Cape Gooseberry	Dicot
-Seed/fruit	<i>Convolvulaceae</i>	Bindweed	
-Seed/fruit	<i>Brassicaceae sp.</i>	Mustard	Dicot/Herb
-Seed/fruit	<i>Fragaria virginiana</i>	Wild strawberry	
-Seed/fruit	<i>Galium aparine</i>	Stickyweed	Dicot
-Seed/fruit	<i>Helianthus divaricatus</i>	Woodland Sunflower	Dicot/Perennial herb
-Seed/fruit	<i>Polygala senega</i>	Snakeroot (medicinal)	Dicot/ annual herb
-Seed/fruit	<i>Rubus occidentalis</i>	Black Raspberry	Dicot
-Seed/fruit	<i>Celtis occidentalis</i>	Hackberry	Tree
-Seed/fruit	<i>Vitis sp.</i>	grape seed	Dicot/Perennial
-Seed/fruit	<i>Crataegus sp.</i>	Hawthorn	
-Seed/fruit	<i>Viburnum sp.</i>	Nannyberry	Dicot/Shrub
-Seed/fruit	<i>Rhus sp</i>	Sumac	Dicot/Shrub

Table 27. (cont'd)			
Type category	Species	Common Name	Type
-Seed/fruit	<i>Polygonum pensylvanicum</i>	Knotweed	Dicot/Annual herb
-Seed/fruit	<i>Prunus spp.</i>	Wild cherry	
-Seed/fruit	<i>Sambucus canadensis</i>	American elderberry	Dicot /Shrub
-Seed/fruit	<i>Prunus serotina</i>	Black cherry	
-Seed/fruit	<i>Amelanc (Amelanchier Medikus)</i>	Serviceberry/Shadbush	Dicot/Shrub
-Seed/fruit	<i>Aster cordifolius</i>	Aster	Dicot
-Seed/fruit	<i>Sassafras albidum</i>	Sassafras	Tree
-Seed/fruit	<i>Hypericum</i>	St. John's wort (medicinal)	Dicot/Perennial/Shrub/Herb
-Seed/fruit	<i>Cornus rugosa</i>	Dogwood	Dicot/Semi-shrub
-Seed/fruit	<i>Gaylussacia baccata</i>	Huckleberry	Dicot
-Seed/fruit	<i>Lamiaceae</i>	Mint	Dicot/Perennial herb
-Seed/fruit	<i>Rosa palustris</i>	Swamp rose	Dicot/Shrub
-Charcoal	<i>Pinus</i>	Pine	Gymnosperms/Conifers
-Charcoal	<i>Fraxinus alba</i>	Ash	Dicot
-Charcoal	<i>P. resinosa</i>	Red pine	Large tree
-Charcoal	<i>P. strobus</i>	White Pine	Large tree
-Charcoal	<i>Ulmus rubra</i>	Slippery Elm	Medium tree
-Charcoal	<i>Ulmus sp.</i>	Elm	Deciduous
-Charcoal	<i>Cercis canadensis</i>	Redbud	Small tree
-Charcoal	<i>Tilia americana</i>	Basswood	Large tree
-Charcoal	<i>Q. nigra</i>	Black Oak	Large tree

Table 27. (cont'd)			
Type category	Species	Common Name	Type
-Charcoal	<i>Q. bicolor</i>	Swamp White Oak	Medium tree
-Charcoal	<i>Q. rubra</i>	Red Oak	Large tree
-Charcoal	<i>Populus tremuloides</i>	Poplar/cottonwood	Medium to large tree
-Charcoal	<i>Carya laciniosa</i>	Shellbark Hickory	Medium to large tree
-Charcoal	<i>Carya ovata</i>	Shagbark Hickory	Medium to large tree
-Charcoal	<i>Cornus racemosa</i>	Northern swamp dogwood	Dicot/Shrub
-Charcoal	<i>Fagus americana</i>	American beech	Deciduous
-Charcoal	<i>Ostrya virginiana</i>	Hophornbeam	Deciduous
-Charcoal	<i>Fraxinus sp</i>	Ash	Dicot
-Charcoal	<i>Fagus grandifolia</i>	American beech	Dicot
-Charcoal	<i>Acer spp.</i>	Maple	Dicot
-Charcoal	<i>Betula spp.</i>	Birch	Dicot
-Charcoal	<i>Morus rubra</i>	Mulberry	
-Charcoal	<i>Platanus occidentalis</i>	Sycamore	Dicot; large tree
-Charcoal	<i>Picea</i>	Spruce	Conifer
-Other (non-specified)	<i>Typha</i>	Cattail	Angiosperm/Monocot/Perennial Herb
-Other (non-specified)	<i>Rumex spp.</i>	Dock	Dicot/Perennial herbs
-Other (non-specified)	<i>Panicum spp.</i>	Panic-grass	Grass
-Other (non-specified)	<i>Silphium terebinthinaceum</i>	Prairie-dock; Rosin-weed	Perennial herb
-Other (non-specified)	<i>Smilacina racemosa</i>	False Solomon's Seal	Perennial herb

Table 27. (cont'd)			
Type category	Species	Common Name	Type
-Other (non-specified)	<i>Smilacina stellata</i>	Three-leaved False Solomon's Seal	Perennial herb
-Other (non-specified)	<i>Maianthemum canadense</i>	Wild or False Lily-of-the-Valley	Perennial herb
-Other (non-specified)	<i>Onoclea Sensibilis</i>	Sensitive fern	Fern
-Other (non-specified)	<i>Poa pratensis</i>	June grass, Kentucky Bluegrass, Speargrass, Fowl Bluegrass	Perennial grass
-Other (non-specified)	<i>Smilax lasioneura</i>	Carrion Flower Greenbriar	Vine
-Other (non-specified)	<i>Solidago</i> Sp.	Golden rod	Perennial herb; dicot
-Other (non-specified)	<i>Thalictrum dioicum</i>	Early Meadow- rue Quicksilver-weed	Perennial herb; dicot
-Other (non-specified)	<i>Viola pensylvanica</i>	Smooth Yellow Violet	Perennial herb; dicot
-Other (non-specified)	<i>Viola sororia</i> (Sens. Lat.) (Glabrous plants like this one have been referred to V. Papilionacea)	Common Blue Violet	Perennial herb; dicot
-Other (non-specified)	<i>Zanthoxylum americanum</i>	Prickly-ash	Shrub/small tree
-Other (non-specified)	<i>Lilium michiganense</i>	Michigan Lily	Perennial herb; monocot
-Other (non-specified)	<i>Lysimachia ciliata</i>	Fringed Loosestrife	Perennial herb; dicot

Table 27. (cont'd)			
Type category	Species	Common Name	Type
-Other (non-specified)	<i>Carex blanda</i>	Sedge or grass	Monocot/sedge/Perennial
-Other (non-specified)	<i>Carex lupulina</i>	Sedge or grass	Monocot/sedge/Perennial
-Other (non-specified)	<i>Carex pensylvanica</i>	Sedge or grass	Monocot/sedge/Perennial
-Other (non-specified)	<i>Smilax cirrata</i>	Greenbrier	Vine
-Other (non-specified)	<i>Toxicodendron radicans</i>	Poison Ivy	Vine
-Other (non-specified)	<i>Apocynum androsaemifolium</i>	Spreading Dogbane	Dicot
-Other (non-specified)	<i>Aquilegia canadensis</i>	Wild columbine, Rock-bells, Meetinghouses, honey suckle	Dicot
-Other (non-specified)	<i>Aralia nudicaulis</i>	Wild sarsaparilla	Dicot; shrub
-Other (non-specified)	<i>Barbarea vulgaris</i>	Yellow rocket	Dicot; biennial herb
-Other (non-specified)	<i>Geum canadense</i>	White Avens	Dicot; perennial herb
-Other (non-specified)	<i>Satureja vulgaris</i>	Wild Basil, Dogmint	Dicot
-Other (non-specified)	<i>Monarda fistulosa</i>	Wild Bergamot	Dicot

Table 27. (cont'd)			
Type category	Species	Common Name	Type
-Other (non-specified)	<i>Osmorhiza longistylis</i>	Anise-root	Dicot
-Other (non-specified)	<i>Podophyllum peltatum</i>	May-apple, Mandrake	
-Other (non-specified)	<i>Trillium grandiflorum</i>	Large Flowered Trillium	Perennial herb; monocot
-Other (non-specified)	<i>Lithospermum canescens</i>	Hoary Puccoon	Perennial herb; monocot
-Other (non-specified)	<i>Taraxacum officinale</i>	Dandelion	Dicot
Reptile/Amphibian	<i>Anura</i> sp.	Frogs and toads	Amphibian
Reptile/Amphibian	<i>Emydoidea blandingii</i>	Blanding's turtle	Reptile
Reptile/Amphibian	<i>Chrysemys picta</i>	Painted turtle	Reptile
Reptile/Amphibian	<i>Chelydra serpentina</i>	Snapping turtle	Reptile
Reptile/Amphibian	<i>Nerodia sipedon</i>	Northern water snake	Reptile
Reptile/Amphibian	<i>Thamnophis</i> sp.	Garter snake	Reptile
Reptile/Amphibian	<i>Trionyx</i> sp.	Softshell turtles	Reptile
Mollusks	<i>Amblema costata</i>	mollusk	Freshwater mussel
Mollusks	<i>Elliptio dilatatus</i>	mollusk	Freshwater mussel
Mollusks	<i>Fusconaia flava</i> (Raf.)	mollusk	Freshwater mussel
Mollusks	<i>Quadrula pustulosa</i> (Lea)	mollusk	Freshwater mussel
Mollusks	<i>Pleurobema (cordatum) coccineum</i> (Conrad)	mollusk	Freshwater mussel
Mollusks	<i>Cyclonaias tuberculata</i>	mollusk	Freshwater mussel

Table 27. (cont'd)			
Type category	Species	Common Name	Type
Mollusks	<i>Lasmigona costata</i> (Raf.)	mollusk	Freshwater mussel
Mollusks	<i>Strophitus rugosus</i> (Swain.)	mollusk	Freshwater mussel
Mollusks	<i>Lampsilis siliquoidea</i> (L)	mollusk	Freshwater mussel
Mollusks	<i>Obovaria subrotunda</i> (Raf.)	mollusk	Freshwater mussel
Mollusks	<i>Ligumia (Recta) lattissima</i> (Raf.)	mollusk	Freshwater mussel
Mollusks	<i>Actinonaias carinata</i> (Barnes)	mollusk	Freshwater mussel
Mollusks	<i>Discus cronkhitei</i>	mollusk	Terrestrial snail
Mollusks	<i>Anguispira kochi</i>	mollusk	Terrestrial snail
Mollusks	<i>Anodonta grandis footiana</i> (Say) Goodrich	mollusk	Freshwater mussel
Mollusks	<i>Micromya (Villosa) Iris</i> (Lea) Goodrich	mollusk	Freshwater mussel
Mollusks	<i>Amblema costata</i> (Rafinesque) Goodrich	mollusk	Freshwater mussel
Mollusks	<i>Ligumia recta</i> (Lamarck) Goodrich	mollusk	Freshwater mussel
Mollusks	<i>Valvata tricarinata</i> (Say)	Gastropod - three-ridge valvata	Freshwater snail
Mollusks	<i>Goniobasis livescens</i> (Say)	Gastropod	Freshwater snail
Mollusks	<i>Somatogyrus</i> sp.	Gastropod	Freshwater snail
Mollusks	<i>Amnicola lustrica</i> (Pilsbry)	Gastropod	Freshwater snail

Table 27. (cont'd)			
Type category	Species	Common Name	Type
Mollusks	<i>Lymnaea columella</i> (Say)	Gastropod - "American ribbed fluke snail"	Freshwater snail
Mollusks	<i>Helisoma Campanulatum</i>	Gastropod	Freshwater snail
Mollusks	<i>Stenotrema monodon</i> (Racket)	Gastropod	Terrestrial snail
Mollusks	<i>Mesodon thyroidus</i> (Say)	Gastropod - white-lip globe	Terrestrial snail
Mollusks	<i>Triodopsis albolabris</i> (Say)	Gastropod	Terrestrial snail
Mollusks	<i>Triodopsis multilineata</i> (Say)	Gastropod - AKA <i>Webbhelix</i> genus	Terrestrial snail
Mollusks	<i>Anguispira alternata</i>	Gastropod - flamed disc or flamed tigersnail	Terrestrial snail
Mollusks	<i>Anguispira solitaria</i> (Say)	Gastropod	Terrestrial snail
Mollusks	<i>Helicodiscus parallelus</i> (Say)	Gastropod - compound coil	Terrestrial snail
Mollusks	<i>Haplotrema concavium</i> (Say)	Gastropod - gray-footed lancetooth	Terrestrial snail
Mollusks	<i>Mesomphix cuprea</i> (Say)	Gastropod	Terrestrial snail
Mollusks	<i>Amnicola Limosa</i> (Say)	Gastropod	Freshwater snail
Mollusks	<i>Pomatiopsis lapidaria</i> (Say)	Gastropod	Freshwater snail

Table 27. (cont'd)			
Type category	Species	Common Name	Type
Mollusks	<i>Lymnaea (Staginicola) palustris</i> (Say)	Gastropod - marsh snail	Freshwater snail
Mollusks	<i>Helisoma trivolvis</i> (Say)	Gastropod	Freshwater snail
Mollusks	<i>Retinella rhoadsi</i> (Pilsbry)	Gastropod	Terrestrial snail
Mollusks	<i>Succinea ovalis</i> (Say)	Gastropod - oval ambersnail	Terrestrial snail
Mollusks	<i>Campelema decisum</i> (Say)	Gastropod	Freshwater snail
Mollusks	<i>Helisoma anceps</i> (Conrad)	Gastropod	Freshwater snail
Mollusks	<i>Zonitidae</i>	mollusk	
Mollusks	<i>Pelecypoda</i>	mollusk	

Table 28. Resource calories, size and weight			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Cervus canadensis</i>	<u>496 calories cooked/raw lb.</u>	Length: 92-108 in. male, 84-96 in. female. Height: 57-69 in. male, 37-45 in. female.	580-1000 lbs. male, 500-650 lbs. female
<i>Odocoileus virginianus</i>	<u>537 calories cooked/raw lb.</u>	Length: 75 to 85 in. males, 63 to 79 in. females	150 to 310 lbs. males, 90 to 210 lbs. females
<i>Procyon lotor</i>	<u>1017 calories cooked/raw lb.</u>	Length: 23.5 in + tail (9.5 in)	12 to 30 lbs.
<i>Ursus americanus</i>	<u>717 calories, cooked/raw lb.</u>	Length: 54 to 70 in. males; 47 to 50 in. females	250 to 500 lbs. males; 225 to 450 lbs. females
<i>Castor canadensis</i>	<u>664 calories, cooked/raw lb.</u>	Length: 36 to 43 in. adults + tail (11.75-13.75 in.)	30 to 60 lbs. in adults
<i>Ondatra zibethicus</i>	<u>732 calories cooked/raw lb.</u>	Length: 18.5 in. adult. Height: not listed	28 to 53 oz.
<i>Canis sp. (lupus, familiaris)</i>		Length: 61 in. male, 59 in. females	67.3 lbs. male, 57.9 lbs. female
<i>Martes americana</i>		Length: 16.5 in. males, 14.75 in. females. Tails about 1/3 the length of animal's body.	35.25 to 51.25 oz. in males, 25.5 to 35.25 in females.
<i>Marmota monax</i>		Length: 18 in. + tail, adult.	5 to 12 lbs., adults.
<i>Mustela vison</i>		Length: 14.75 in. male, 13 in female (+tail).	20 to 44 oz. Male, 17 to 33.5 oz. female.
<i>Lynx rufus</i>		Length: 29.5 male, 26.75 female.	14-40 lbs. Male, 9 to 36 female.
<i>Erethizon dorsatum</i>		Length: 22 in (+~8 in. tail)	14.4 lbs. male, 14.8 lbs. female
<i>Lontra canadensis</i>		Length: 37.5 in to 51.5 in males, 35.5 to 45.5 in females	15 to 30 lbs. male, 10 to 25 lbs. female

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Martes pennanti</i>		Length: 36.25 to 41.25 in. males, 31.5 to 35.5 in. females (+tail length)	6.0 to 12.0 lbs. male, 4.0 to 6.5 lbs. female
<i>Sciurus</i> sp.	<u>541 calories cooked/raw lb.</u>	Length: 16.5 to 21 in.+ tail (8-10 in.) adults	12 to 24 oz. In adults
<i>Leporidae</i> sp. (<i>Sylvilagus</i>)	<u>32 calories per oz.</u>	Length: 15.75 to 19.25 in	32 to 64 oz.
<i>Vulpes fulva</i>		Length: 38 in. males, 41 in. females	8 to 15 lbs.
<i>Alces alces</i>		Length: 90 to 104 in.; Width: 71 in. males, 69 in. females.	725 to 850 lbs. females; 850 to 1,200 lbs. males
<i>Blarina</i> sp.		Length: 4.25 to 5.5 in	0.5 to 1 oz.
<i>Tamias</i> sp.		Length: 9 to 11 in.	2.4 to 4.0 oz.
<i>Muridae</i> sp.		Length: 5 7/8 to 17.5 in.	0.5 to 17 oz.
<i>Peromyscus</i> sp.		Length: 5 5/8 to 7 5/8 inches	0.5 to 1 oz.
<i>Microtus</i> sp.		Length: 4 7/8 to 6 1/8 inches	1.1 to 1.8 oz.
<i>Acipenser fulvescens</i>		20 to 55 in.	5 to 40 lbs.
<i>Perca flavescens</i>		8 to 11 in.	6 to 10 oz.
<i>Amia calva</i>		12 to 24 in.	2 to 5 lbs.
<i>Aplodinotus grunniens</i>		10 to 14 in.	2 to 5 lbs.
<i>Monroe chrysops</i>		Length: 45 cm. maximum	3.5 lbs. maximum
<i>Micropterus salmoides</i>		12 to 20 in.	1 to 5 lbs.
<i>Micropterus dolomieu</i>		12 to 20 in.	1 to 4 lbs.
<i>Esox lucius</i>		18 to 24 in.	2 to 5 lbs.
<i>Stizostedion vitreum</i>		14 to 17 in.	1 to 3 lbs.
<i>Ictalurus punctatus</i>		12 to 20 in.	3 to 4 lbs.
<i>Lepisosteus oculatus</i>		24 to 36 in.	2 to 5 lbs.
<i>Salvelinus namaycush</i>		60 cm (24 inches)	7 to 10 lbs.

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Ictalurus melas</i>		8 to 10 in.	4 to 6 oz.
<i>Ictalurus natalis</i>		8 to 10 in.	1 to 2 lbs.
<i>Ictalurus nebulosus</i>		8 to 10 in.	4 oz. to 2 lbs.
<i>Moxostoma</i> sp. (<i>macrolepidotum</i>)		12 to 24 in.	2 to 10 lbs.
<i>Pomoxis</i> sp.		7 to 12 in.	10 oz. to 1 lb.
<i>Catostomus</i> sp. (<i>catostomus</i> , <i>commersoni</i>)		15 to 20 in.	2 lbs.
<i>Centrarchidae</i>	<u>97 calories per 3 oz. meat</u>	3 to 11 in. depending on species	4 oz. to 1 lb.
<i>Lepomis</i> cf. <i>macrochirus</i>		12-30 cm	5-10 oz.
<i>Pomoxis nigromaculatus</i>		Up to 40 cm	10 oz. to 1 lb.
<i>Stizostedion canadense</i>		Up to 50 cm	8 oz. to 2 lbs.
<i>Lota lota lacustris</i>		Up to 80 cm	Around 1 lb.
<i>Ectopistes migratorius</i>		-	-
<i>Anas discors</i>		Length: 15.5 inches (39 cm), wingspan 23 inches	13 oz.
<i>Anas americana</i>		Length: 19 inches (48 cm), wingspan 32 inches	1.6 lbs.
<i>Anas platyrhynchos</i>	<u>472 calories per 1 cup meat</u>	Length: 23 inches (58 cm), wingspan 35 inches	2.4 lbs.
<i>Aythya collaris</i>		Length: 17 inches; wingspan 25 inches	1.5 lbs.
<i>Mergus merganser</i>		Length: 25 inches; wingspan 34 inches	3.4 lbs.

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Mergus serrator</i>		Length: 23 inches; wingspan 30 inches	2.3 lbs.
<i>Gavia immer</i>		Length: 32 inches; wingspan, 46 inches	9 lbs.
<i>Podilymbus podiceps</i>		Length: 13 inches; wingspan 16 inches	1 lb.
<i>Meleagris gallopavo</i>		Length: 37 inches female, 46 inches male; wingspan 50 inches female, 64 inches male	9.2 lbs. female, 16.2 lbs. male
<i>Lophodytes cucullatus</i>		Length: 18 inches; wingspan 24 inches	1.4 lbs.
<i>Corvus brachyrhynchos</i>		Length: 17.5 inches; wingspan 39 inches	1 lb.
<i>Botaurus lentiginosus</i>		Length: 28 inches; wingspan, 42 inches	1.5 lbs.
<i>Ardea herodias</i>		Length: 46 inches; wingspan 72 inches	5.3 lbs.
<i>Grus canadensis</i>		Length: 41-46 inches; wingspan 73-77 inches	7.3-10.6 lbs.
<i>Aythya marila</i>		42–51 cm long with a 71–80 cm wingspan	-
<i>Bubo virginianus</i>		Wingspan 4-5 ft.	-
<i>Chenopodium</i>		Stem 1-3 dm long; seeds 1 mm wide.	-
<i>Zea mays</i>			
<i>Iva annua</i>		-	-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Carex sp.</i>		Stems 3-10 dm long	-
<i>Cyperus</i>		Stems 5-30 cm tall	
<i>Zizania aquatica</i>	<u>166 calories per 1 cup</u>	Stems 1-3 meters long; grain 1-2 cm long	-
<i>Quercus</i>		Up to 80 feet (24 meters)	-
<i>Carya</i>			
<i>J. cinerea</i>			
<i>Juglans nigra</i>	<u>185 calories per 1 oz.</u>		
<i>Corylus americana</i>	<u>178 calories per 1 oz.</u>	Up to 10 feet (3 meters)	-
<i>Castanea dentata</i>		Up to 18-25 m high and 50-100 cm in diameter	-
<i>Cucurbita pepo</i>		Up to 2 m long	-
<i>Amphicarpaea bracteata</i>		-	-
<i>Geranium maculatum</i>		-	-
<i>Pyrus sp.</i>		30 ft. high, 14 inches in diameter	-
<i>Physalis</i>		Up to 12 inches (30 cm)	-
<i>Convolvulaceae</i>		Up to 15 feet (4.5m)	-
<i>Brassicaceae sp.</i>		Stems 3-8 dm long; fruit 1-4 cm long	-
<i>Fragaria virginiana</i>		Up to 8 inches (20 cm)	-
<i>Galium aparine</i>		Stems 2-8 dm long	-
<i>Helianthus divaricatus</i>		Up to 10 feet (3 meters)	-
<i>Polygala senega</i>		Stems 1-4 dm long	-
<i>Rubus occidentalis</i>			
<i>Celtis occidentalis</i>		12-18 m high and 30-60 cm in diameter	-
<i>Vitis sp.</i>		Fruit 6-12 mm wide.	-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Crataegus sp.</i>			
<i>Viburnum sp.</i>		Up to 12 feet (3.6 m)	-
<i>Rhus sp</i>		Up to 2 m high	-
<i>Polygonum pensylvanicum</i>		Stems erect, 3-20 dm long; fruit up to 3 mm long.	-
<i>Prunus spp.</i>		Up to 25 feet (7.5 m)	-
<i>Sambucus canadensis</i>		Up to 3 meters tall	-
<i>Prunus serotina</i>			
<i>Amelanc (Amelanchier Medikus)</i>		Up to 2 meters tall; fruit 1 cm long.	-
<i>Aster cordifolius</i>		Up to 12 inches (30 cm)	-
<i>Sassafras albidum</i>		6-15 m high and 20-60 cm in diameter	
<i>Hypericum</i>		Fruit a 4-6mm capsulate.	-
<i>Cornus rugosa</i>		1-3 m tall	
<i>Gaylussacia baccata</i>		Stems 3-10 dm long; leaves 2-5 cm long and 1-2.5 cm wide; flowers 4-6 mm long; fruit 6-8 mm long (with 10 nutlets)	-
<i>Lamiaceae</i>		-	-
<i>Rosa palustris</i>		Shrub 2 meters tall; leaflets 2-6 cm long/1-2 cm wide; fruit 1-10 mm wide.	-
<i>Pinus</i>		Up to 100 feet (30 m)	-
<i>Fraxinus alba</i>		Tree up to 15 meters tall; trunk 30-60 cm wide; fruit 2.5-5 cm long, 6-10 mm wide.	-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>P. resinosa</i>		20-30 m high and 60-100 cm in diameter	-
<i>P. strobus</i>		20-30 m high and 60-100 cm in diameter	-
<i>Ulmus rubra</i>		15-21 m high and 30-60 cm in diameter	
<i>Ulmus</i> sp.		Up to 60 feet (18 m)	-
<i>Cercis canadensis</i>		4-8 m tall and 20-30 cm in diameter	-
<i>Tilia americana</i>		Up to 80 feet (24 m); 40-120 cm in diameter	-
<i>Q. nigra</i>		18-24 m high and 40-120 cm in diameter	
<i>Q. bicolor</i>		15-21 m high and 60-100 cm in diameter	-
<i>Q. rubra</i>		20-30 m high and 40-100 cm in diameter	
<i>Populus tremuloides</i>		18-25 m high and 100-150 cm in diameter	
<i>Carya laciniosa</i>		18-22 m high and 60-80 cm in diameter	-
<i>Carya ovata</i>		18-22 m high and 30-80 cm in diameter	-
<i>Cornus racemosa</i>		Shrub 1-3 meters tall; fruit 5 mm wide	-
<i>Fagus americana</i>		Up to 18-26 m high and 50-100 cm in diameter	-
<i>Ostrya virginiana</i>		Up to 50 feet (15 m); 20-30 cm in diameter	-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Fraxinus sp</i>		Tree up to 15 meters tall; trunk 30-60 cm wide; fruit 2.5-5 cm long, 6-10 mm wide.	-
<i>Fagus grandifolia</i>		Up to 100 feet (30 m)	-
<i>Acer spp.</i>		Up to 100 feet, depending on species.	-
<i>Betula spp.</i>		Up to 100 feet (30 meters) depending on species	-
<i>Morus rubra</i>		Up to 30 feet (9 m)	-
<i>Platanus occidentalis</i>		30 meters tall or more; trunk up to 2 meters wide; leaves 20 cm long and wide; fruit 2-3 cm wide.	-
<i>Picea</i>		Up to 25-30 meters tall; 75 feet for some species	-
<i>Typha</i>		1-2.5 meter high; fruit 1 cm long	-
<i>Rumex spp.</i>		Stems stout, to 12 dm long	
<i>Panicum spp.</i>		Stems 6-15 dm long; head (panicle) 5-15 cm long above the stem	-
<i>Silphium terebinthinaceum</i>		Stems 1-3 m long	-
<i>Smilacina racemosa</i>		Stems 1-5 dm long	-
<i>Smilacina stellata</i>		Stems 1-5 dm long	-
<i>Maianthemum canadense</i>		Stems 5-20 cm long	-
<i>Onoclea Sensibilis</i>		Leaf blades 15-40 cm long and 15-35 cm wide total	-
<i>Poa pratensis</i>		Stems 4-12 dm long, head 1-3 dm long	-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Smilax lasioneura</i>		10 m long	-
<i>Solidago</i> Sp.		Stems 0.5-2 m long; leaves 6-15 cm long/1-4 cm wide; fruit 1-2 mm long	-
<i>Thalictrum dioicum</i>		Stems 1-2 m long	-
<i>Viola pensylvanica</i>		Leaves from base of plant, 10 cm wide	
<i>Viola sororia</i> (Sens. Lat.) (Glabrous plants like this one have been referred to V. Papilionacea)		Leaves from base of plant, 10 cm wide	
<i>Zanthoxylum americanum</i>		Up to 3 m tall	-
<i>Lilium michiganense</i>		Stems 3-8 dm long; leaves 4-10 cm long and 3-8 mm wide	-
<i>Lysimachia ciliata</i>		Stems 3-12 dm long; leaves 4-15 cm long and 2-3 cm wide	-
<i>Carex blanda</i>		Stems 3-10 dm long	-
<i>Carex lupulina</i>		Stems 3-12 dm long; leaves 4-15mm wide	-
<i>Carex pensylvanica</i>		Stems 3-10 dm long	-
<i>Smilax cirrata</i>		10 m long	-
<i>Toxicodendron radicans</i>		Over 1 m long	
<i>Apocynum androsaemifolium</i>		-	-
<i>Aquilegia canadensis</i>		Up to 4 ft. (1.2 m)	-
<i>Aralia nudicaulis</i>		Up to 16 inches (40 cm)	-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Barbarea vulgaris</i>		Stems 3-8 dm long, fruit 2-4 cm long	-
<i>Geum canadense</i>		Stems up to 1 m long	-
<i>Satureja vulgaris</i>		-	-
<i>Monarda fistulosa</i>		-	-
<i>Osmorhiza longistylis</i>		-	-
<i>Podophyllum peltatum</i>		-	-
<i>Trillium grandiflorum</i>		-	-
<i>Lithospermum canescens</i>		-	-
<i>Taraxacum officinale</i>		Up to 12 inches (30 cm)	-
<i>Anura</i> sp.		9.5 to 20.3 cm (3.7 to 8 inches)	-
<i>Emydoidea blandingii</i>		Adult carapace length: 15.2 to 27.4 cm (6 to 10.8 inches)	-
<i>Chrysemys picta</i>		Adult carapace length: 9 to 25 cm (3.5 to 9.8 inches)	-
<i>Chelydra serpentina</i>		Adult carapace length: 20.3 to 50.3 cm (8 to 19.8 inches)	Female avg. weight: 6.4 kg (14 lbs.); Male avg. weight:
<i>Nerodia sipedon</i>		Adult Length: 61 to 140.5 cm (24 to 55.3 in.)	-
<i>Thamnophis</i> sp.		Adult Length: 46 to 137 ch (18 to 54 inches)	-
<i>Trionyx</i> sp.		Adult male carapace length: 24 to 48 cm (9.4 to 18.9 inches); adult female carapace length: 12.7 to 24 cm (5 to 9.4 inches)	-
<i>Amblema costata</i>			-
<i>Elliptio dilatatus</i>			-
<i>Fusconaia flava</i> (Raf.)			-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Quadrula pustulosa</i> (Lea)			-
<i>Pleurobema (cordatum) coccineum</i> (Conrad)			-
<i>Cyclonaias tuberculata</i>			-
<i>Lasmigona costata</i> (Raf.)			-
<i>Strophitus rugosus</i> (Swain.)			-
<i>Lampsilis siliquoidea</i> (L)			-
<i>Obovaria subrotunda</i> (Raf.)			-
<i>Ligumia (Recta) lattissima</i> (Raf.)			-
<i>Actinonaias carinata</i> (Barnes)			-
<i>Discus cronkhitei</i>			-
<i>Anguispira kochi</i>			-
<i>Anodonta grandis footiana</i> (Say) Goodrich		Up to 6 inches long	-
<i>Micromya (Villosa) Iris</i> (Lea) Goodrich			-
<i>Amblema costata</i> (Rafinesque) Goodrich			-
<i>Ligumia recta</i> (Lamarck) Goodrich			-
<i>Valvata tricarinata</i> (Say)			-
<i>Goniobasis livescens</i> (Say)			-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
<i>Somatogyrus</i> sp.		Shell large, greatest diameter more than 12 mm; lip usually thickened	-
<i>Amnicola lustrica</i> (Pilsbry)			-
<i>Lymnaea columella</i> (Say)			-
<i>Helisoma Campanulatum</i>			-
<i>Stenotrema monodon</i> (Racket)			-
<i>Mesodon thyroidus</i> (Say)			-
<i>Triodopsis albolabris</i> (Say)			-
<i>Triodopsis multilineata</i> (Say)			-
<i>Anguispira alternata</i>			-
<i>Anguispira solitaria</i> (Say)			-
<i>Helicodiscus parallelus</i> (Say)			-
<i>Haplotrema concavium</i> (Say)			-
<i>Mesomphix cuprea</i> (Say)			-
<i>Amnicola Limosa</i> (Say)			-
<i>Pomatiopsis lapidaria</i> (Say)		5 to 10 mm long	-
<i>Lymnaea (Staginicola) palustris</i> (Say)			-
<i>Helisoma trivolvis</i> (Say)			-
<i>Retinella rhoadsi</i>			-

Table 28. (cont'd)			
Species	Avg. Caloric Return	Avg. Size	Avg. Weight
(Pilsbry)			
<i>Succinea ovalis</i> (Say)			-
<i>Campeloma decisum</i> (Say)		-	-
<i>Helisoma anceps</i> (Conrad)			-
<i>Zonitidae</i>			-
<i>Pelecypoda</i>			-

Table 29. Resource habitat, distribution, density			
Species	Habitat/Resource Community	Distribution	Density
<i>Cervus canadensis</i>	Mixture of woodlands, shrubs, and open lands.	Prehistoric (post-glacial up to early days of settlement) distribution covers the whole Lower Peninsula.	4.4 per sq. mi.
<i>Odocoileus virginianus</i>	Boreal conifer-hardwood forest; temperate hardwood forest	Large geographic range in the Americas; boreal, temperate, tropical environments, international; found prehistorically in Michigan	1 animal per 6.4-8.0 acres
<i>Procyon lotor</i>	Lakeshores, inland forests, hardwoods	All counties in both Upper and Lower Michigan, dating even back to postglacial period, Woodland period	1 animal per 10-16 acres
<i>Ursus americanus</i>	Northern hardwood and conifer forests of the Canadian biotic province; southeastern hardwood forests of the Carolinian biotic province.	Temperate and boreal North America	1 animal per 10-16 acres
<i>Castor canadensis</i>	Semiaquatic areas; must be associated with proper vegetative growth	Extensive North American geographic range; found on all major waterways in Michigan as well as swamps, marshes, and lakes.	Variable depending on bodies of water; up to about 15 per square mile

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Ondatra zibethicus</i>	Semi-aquatic; marshes, waterways, swamps	Northern North America from tree line in the Arctic southward to the Gulf Coast on the east and to near the Mexican border; widely distributed all over Michigan.	15-16 per mile
<i>Canis sp. (lupus, familiaris)</i>	The ray wolf, in presettlement Michigan, was probably a forest creature that frequented openings, lakeshores, and riparian growth along streams.	Arctic and down south into the United States and Central Mexico, although unwelcome near human settlement, so species is not often seen in the southern part of its North American range.	1 individual per 5.2 to 10.5 sq. mi
<i>Martes americana</i>	Boreal coniferous forests	Prehistoric distribution: marten may have been in all counties of Michigan, but they may have preferred northern regions.	0.5 to 6.2 individuals/sq. mi.
<i>Marmota monax</i>	Fertilized pasturage; basically areas of human occupation.	Occurs in most of North America; the animal is widespread in both peninsulas of Michigan.	30-40 per 640 acres
<i>Mustela vison</i>	Streams, rivers, lakes, ponds, marshes.	Temperate, boreal North America; In Michigan, Upper and Lower Peninsulas, almost all counties.	Hunting season: 8.5-22 per sq. mi; Other times, 3-4 per sq. mi.
<i>Lynx rufus</i>	Hardwood forests, mountains, deserts; usually needs woody cover.	Temperate hardwoods, like those in Michigan.	1 per sq. mile
<i>Erethizon dorsatum</i>	Northeastern North America; deciduous, coniferous forests; hemlock, pine habitats	Boreal North America, coniferous forest NE US	30 per sq. mi.
<i>Lontra canadensis</i>	Abundant Aquatic habitats	Arctic, boreal, temperate North America	1 per 2.2 mi of waterway

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Martes pennanti</i>	Northern coniferous, mixed conifer-hardwood, and hardwood stands	Northern coniferous and hardwood forests across North America	1 to 4 per sq. mi.
<i>Sciurus</i> sp.	Woods areas; mature groves of nut-bearing oaks, hickories, and beeches, maples, hemlock-hardwoods.	Eastern North America, extending westward to the prairies	Avg. 2 per acre
<i>Leporidae</i> sp. (<i>Sylvilagus</i>)	Areas of cleared/covered with second-growth shrubs, vines, and low trees; forests of southern Michigan are preferred habitats for the cottontail; snowshoe hare lives in woody protection, northern swamps, and bushy understory of trees.	In Michigan, mixed woodlots, cultivated and fallow fields, and fence-row/roadside vegetation.	High densities, up to 100 rabbits in a two-acre orchard
<i>Vulpes fulva</i>	Fallow and cultivated fields, meadows, bushy fence lines, woody stream borders, and low shrub cover along the fringes of woods and along beaches bordering larger lakes; the fox has been a longtime resident of Michigan.	In North America, the red fox occurs from the Arctic Ocean and some of the islands in the Canadian Archipelago south to the Gulf coast and west to California; In Michigan, the red fox lives in every county of the state and on several of the larger islands in lakes Michigan, Superior, and Huron.	One fox family (~7 individuals) per 2,471 acres.
<i>Alces alces</i>	Northern boreal forests	Within the northern boreal forests of North America; broadly across Alaska and Canada; boreal parts of northern US, and most of Michigan except for the southern and southwestern parts of the	One moose per square mile in average boreal habitat, and three moose per square mile in most favorable

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
		Lower Peninsula.	habitat.
<i>Blarina sp.</i>	Varied living conditions – swamps, bogs, moist lowlands to dry uplands, sand dunes; however, moist, litter-strewn forested areas are considered prime living places.	In Michigan, species occurs in all counties and most terrestrial communities.	Most common of all mammals in the Upper Great Lakes Region; in the LP of Michigan, at least 4 shrews per acre.
<i>Tamias sp.</i>	Deciduous hardwoods of both the Upper and Lower Peninsulas	At home in both Upper and Lower Peninsulas, occurring in all counties on several islands in Lake Michigan.	20 or more per acre
<i>Muridae sp.</i>	Rats are attracted towards human settlement areas; mice are the same way, where they are attracted to human habitations where scrap food, stored grains, and poorly cached garbage provides nourishment.	Mice in most Michigan environments except dense woodlands, marshes, and northern swamps; rats prefer to concentrate where food supplies and cover sites are abundant.	Stationary in environment; number is variable
<i>Peromyscus sp.</i>	Woodlands and brushlands; active on litter-strewn forest floor.	US as far west as the Great Plains; Occurs throughout the Lower Peninsula of Michigan, as well as southwestern parts of the Upper Peninsula.	Anywhere from 0.9 to 9.7 per acre
<i>Microtus sp.</i>	Grass and mixed grass and weeds where vegetation is rank and lush.	Southwestern Michigan	10 individuals per acre

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Acipenser fulvescens</i>	Quiet waters of large rivers and streams	Hudson Bay, Great Lakes, Mississippi and Missouri drainages southeast to Alabama; in Michigan, lakes Superior, Michigan, Huron and a few large tributary streams	n/a
<i>Perca flavescens</i>	Lakes and streams preferring clear open water	Widely introduced throughout northern US and southern Canada; common throughout Michigan	n/a
<i>Amia calva</i>	Deep waters associated with weedbeds in warm water lakes and rivers; feeds in shallow weeds	Mississippi River east through St. Lawrence drainage, south from Texas to Florida; common throughout the Lower Peninsula of Michigan	n/a
<i>Aplodinotus grunniens</i>	Slow-to-moderate current areas of rivers and streams; shallow lakes, often with mud or sand bottoms; prefers turbid (cloudy) water	Canada south through Midwest into eastern Mexico to Guatemala; in Michigan, rare inland, common in lakes St. Clair, Erie, and Michigan, and in Saginaw Bay	n/a
<i>Monroe chrysops</i>	Migratory in large, open rivers, impoundments, and lakes; often in large schools at the surface.	In Great Lakes- St. Lawrence dr.	n/a
<i>Micropterus salmoides</i>	Shallow, fertile, weedy lakes and river backwaters; weedy bays and extensive weedbeds of larger lakes	Southern Canada through US into Mexico, widely introduced; common throughout Michigan, including the Upper Peninsula where it is a recent introduction	n/a
<i>Micropterus dolomieu</i>	Clear, swift-flowing streams and rivers; clear lakes with gravel or rocky shorelines	Extensively introduced throughout North America; common throughout Michigan, in both the Upper and Lower Peninsula	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Esox lucius</i>	Lakes, ponds, streams and rivers; often found near weeds; small pike tolerate water temperatures up to 70 degrees but larger fish prefer cooler water, 55 degrees F or less	Northern Europe, Asia and North America; common throughout Michigan and in the shallows of all three Great Lakes	n/a
<i>Stizostedion vitreum</i>	Lakes and streams, abundant in very large lakes	Originally the northern states and Canada, now widely stocked in the U.S.; common in all but the south-western part of Michigan	n/a
<i>Ictalurus punctatus</i>	Prefers clean, fast-moving streams with deep pools; stocked in many lakes can tolerate turbid water	Southern Canada through the Midwest into Mexico and Florida; introduced through much of the US; known from all Great Lake drainages in the southern half of Michigan	n/a
<i>Lepisosteus oculatus</i>	Floodplain lakes and backwaters of large rivers	Central US through the Mississippi drainage south into Mexico; in Michigan, common in all Lower Peninsula drainages	n/a
<i>Salvelinus namaycush</i>	Cold (less than 65 degrees), oxygen-rich waters of deep, clear, infertile lakes	Great Lakes north through Canada, to northeaster US, stocked in the Rocky Mountains; deep, cold lakes in the northwest corner of the lower Peninsula, lakes Superior and Michigan	n/a
<i>Ictalurus melas</i>	Shallow, slow-moving streams and backwaters; lakes and ponds-tolerates extremely turbid (cloudy) conditions	Southern Canada through the Great Lakes and the Mississippi River watershed into Mexico and the Southwest; common throughout Michigan	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Ictalurus natalis</i>	Warm, weedy lakes and sluggish streams	Southern Great Lakes through the eastern half of the U.S. To the Gulf and into Mexico; introduced in the West; common in Michigan's Lower Peninsula, rare in the Upper Peninsula	n/a
<i>Ictalurus nebulosus</i>	Warm, weedy lakes and sluggish streams	Southern Canada through the Great Lakes down the eastern states to Florida, introduced in the West; most common in southern Michigan but represented throughout the state including the Upper Peninsula	n/a
<i>Moxostoma</i> sp. (<i>macrolepidotum</i>)	Clean streams and rivers with sand, gravel or rocky bottom; found in a few clear lakes	Great Lake states to New England south to the Gulf; clear, clean streams and a few lakes throughout Michigan	n/a
<i>Pomoxis</i> sp.	Quiet, clear water of streams and mid-sized lakes; often associated with weed growth but may roam deep, open basins and flats, particularly during winter	Southern Manitoba through the Atlantic and southeastern states, introduced in the West; common in all three Michigan drainages	n/a
<i>Catostomus</i> sp. (<i>catostomus</i> , <i>commersoni</i>)	Primarily shallow waters of large, cold lakes and streams; sometimes found in deeper water	Siberia across Canada through Great Lakes to the eastern US; in Michigan, lakes Superior, Huron, Michigan, and their tributaries	n/a
<i>Centrarchidae</i>	Avg. warm, clear, moderately weedy waters	Common throughout Michigan	n/a
<i>Lepomis</i> cf. <i>macrochirus</i>	In vegetated lakes and quiet streams. Weedy bays or shorelines	Mississippi drainage; Great Lakes – St. Lawrence – Champlain drainage. All of Michigan area.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Pomoxis nigromaculatus</i>	Chiefly in clear, weedy lakes, usually in larger streams, lakes, and impoundments.	Great Lakes- St. Lawrence to L. Champlain; all of Michigan area.	n/a
<i>Stizostedion canadense</i>	Most often in somewhat silty rivers and large lakes.	Great Lakes- St. Lawrence drainage (rare)	n/a
<i>Lota lota lacustris</i>	In medium to large streams and cold, deep lakes. Builds and inhabits trenches at the bottom of Great Lakes. Also in larger streams, preferring patches of plants and debris when young, stony riffles when half-grown, and undercut banks when adult.	N America south to Columbia, Missouri, Mississippi, Hudson Bay, Ungava Bay, Great Lakes – St. Lawrence, Delaware, and Ohio drainages.	n/a
<i>Ectopistes migratorius</i>	Hardwood growths; large nesting or roosting sites located in or near areas of abundant hardwood timber. Trees such as beech, maple, birch, oak, tamarack, cedar, hemlock, pine were used often for nesting.	Formerly eastern North America, from Hudson Bay southward, and west to the Great Plains, straggling thence to Nevada and Washington. Breeding range mainly restricted to portions of Canada and northern border of the United States as far west as Manitoba and the Dakotas. Now extinct.	During nesting season, up to 110 birds per tree in a 100,000 acre area.
<i>Anas discors</i>	Marshes, grassy ponds and sluggish streams; partial to regions where wild rice grows. Often nests on the ground in meadows or prairies.	North America in general, but chiefly eastward; north to Alaska, and south to the West Indies, Lower California, and northern South America. Casual in California. Breeds from Kansas and Illinois northward. The most abundant summer duck found in Michigan	Flocks of up to 30 are often seen through fall

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Anas americana</i>	Open waters	North America, from the Arctic Ocean south, in winter to Guatemala and Cuba. Breeds chiefly north of the United States, and west of the Mississippi. Not the most common duck in the state of Michigan.	Dozens to hundreds seen by bodies of water
<i>Anas platyrhynchos</i>	Typical marsh or shallow water duck. Often visits stubble fields and meadows long distances from water; also found on islands, marshy ponds.	Northern parts of Northern Hemisphere; in America south to Panama and Cuba, breeding southward to southern United States; less common in the east; common throughout the state of Michigan. The most abundant species of duck found in the state.	Near bodies of water, avg. of up to 50 mallards per day
<i>Aythya collaris</i>	Prefers inland waters, ponds, and marshy streams rather than the open waters.	North America; breeding far north and migrating south to Guatemala and the West Indies (throughout Michigan)	Dozens to hundreds seen by bodies of water
<i>Mergus merganser</i>	Occurs in the spring and fall on all the waters of the state, the smaller ponds and streams as well as the shores of the Great Lakes. It nests from the Saginaw Valley northward.	Generally distributed throughout the state of Michigan. North America generally breeding south in the United States to Pennsylvania and the mountains of Colorado and California.	Up to hundreds seen near bodies of water
<i>Mergus serrator</i>	Ponds and streams in the interior and as well as on the Great Lakes.	Northern portions of the Northern Hemisphere; south in winter throughout the United States (so, throughout Michigan)	50-hundreds seen near bodies of water and flocks in flight

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Gavia immer</i>	Streams ponds and lakes of the state. Nesting takes place on the mainland, islands in inland lakes, or at the edge of a pond.	Generally distributed throughout Michigan; hardly a stream or pond on which Loons are not seen each season. Northern part of Northern Hemisphere. In North America breeds from the northern tier of states northward; ranges in winter south to the Gulf of Mexico and lower California.	Found in small numbers, like pairs
<i>Podilymbus podiceps</i>	Nests abundantly in every suitable place in the state, building a floating nest; therefore, during nesting it keeps to marshes and rank vegetation along the borders of streams and ponds for cover.	British Provinces southward to Brazil, Argentine Republic and Chile, including the West Indies and Bermuda; breeding nearly throughout its range. In Michigan, very generally distributed and absent only during the winter months.	Density unclear; reportedly 15-60 grebes seen in a single marshy area
<i>Meleagris gallopavo</i>	Along wooded river valleys	United States from Chesapeake Bay to the Gulf coast, and west to the Plains, along wooded river valleys; formerly north to southern Maine, southern Ontario, and up the Missouri River to North Dakota. Formerly was an abundant bird at least as far north as Saginaw Valley of Michigan.	Have been spotted in flocks of 30 in the Lower Peninsula

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Lophodytes cucullatus</i>	Alongside streams of the Lower Peninsula, as well as in the northern parts of the state; nests in hollows of trees. Partial to the smaller and more rapid streams, and remains in the winter wherever open running water supplies food.	North America generally, south to Mexico and Cuba, breeding nearly throughout its range.. Casual in Europe. A common migrant throughout Michigan.	Small amounts in spring; 1-50 in a flock; in fall, up to 50 in a flock
<i>Corvus brachyrhynchos</i>	Distributed throughout various habitats	North America, from the Fur Countries to the southern border of the United States. Locally distributed in the West. In Michigan, the crow is an abundant bird during the larger part of the year, and some even stay during severe winters.	Being a common summer resident, there are larger numbers in areas during the summer; flocks of up to around 50-100 birds
<i>Botaurus lentiginosus</i>	Wades in bodies of water; nests on the ground in marshy places	Temperate North America, south to Guatemala, Cuba, Jamaica, and Bermuda; occasional in the British Islands. Abundant throughout Michigan.	Said to be one of the most abundant in Michigan, but no number estimates are given.
<i>Ardea herodias</i>	Found especially near bodies of water; rivers, streams, lakes, shores, swamps, marshes	North America from the Arctic regions southward to the West Indies and northern South America; Bermuda's; Galapagos; present throughout Michigan.	Colonies can consist of tens to hundreds of pairs of great blue herons
<i>Grus canadensis</i>	Found in wet places; pastures, marshes, swamps	Southern half of North America; now rare near the Atlantic coast, except in Georgia and Florida; however, found throughout Michigan.	Flocks can consist of up to 15-20 cranes; can be made up of notably smaller groups too

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Aythya marila</i>	Remains in the open waters of the state.	North America, breeding far north. South in winter to Guatemala.	According to Wood, up to thousands can be seen in one area while they are in Michigan.
<i>Bubo virginianus</i>	The great horned owl appears to be resident wherever found and wherever any considerable patches of timber remain.	Generally distributed throughout the state of Michigan.	1 pair of great horned owls to ever 2 square miles.

Table 29. (cont'd)

Species	Habitat/Resource Community	Distribution	Density
<i>Chenopodium</i>	Shores, streambanks, and disturbed areas; Southern Mesic, Beech-Maple Community; Nothern and Southern Mesic, Beech-Hardwood-Pine Community; Southern Mesic, Beech-Maple Community; Nothern and Southern Mesic, Hardwood Community; Southern and Northern Dry-Mesic, Hardwood Community; Nothern and Southern Mesic, Hardwood Community; Nothern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community; Southern and Northern Dry-Mesic, Hardwood Community	West Minnesota, Wisconsin, mostly Lower Peninsula of Michigan	51,451.2/km ² (Modern: 121,939.3)
<i>Zea mays</i>			n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Iva annua</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Carex sp.</i>	Floodplain forests and backwater areas	Common in LP of Michigan	n/a
<i>Cyperus</i>	Wet sandy or mucky shores and wet meadows; ditches, floating mats, muddy shores, wet cultivated fields	Found throughout Michigan	n/a
<i>Zizania aquatica</i>	Shallow water (up to 1 m deep) or mud of streams, rivers, lakes, ponds; where water is slightly flowing and not stagnant; soils vary from muck to silt, sand, or gravel, with best establishment of plants on a layer of soft silt or muck several cm thick.	Minnesota, Wisconsin, Michigan (both peninsulas)	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Quercus</i>	Southern and Northern Dry-Mesic, Hardwood Community; Northern and Southern Mesic, Hardwood Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community; Northern and southern Wet-Mesic, Hardwood Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Southern Mesic, Beech-Maple Community; Northern Mesic to Wet-Mesic, Lowland Swamp Community		2,213.1 Sp D/km ² ; 220,283.1 Modern
<i>Carya</i>	Nothern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hardwood; Northern and Southern Mesic, Hardwood community; Southern Mesic, Hardwood; Northern and Southern Wet-Mesic, Hemlock and Hardwood; Northern and Southern Mesic, Beech-Hardwood-Pine; Southern Mesic, Beech-Maple Community		176.82/km ² (Modern Density 101,453.5)

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>J. cinerea</i>	Northern and Southern Wet-Mesic, Hardwood Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Southern Mesic, Beech-Maple Community; Northern and Southern Mesic, Hardwood Community		59.6 Sp D/km ² ; 3,737.9 Modern
<i>Juglans nigra</i>	Northern and southern Wet-Mesic, Hardwood Community; Southern and Northern Dry-Mesic, Hardwood Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Southern Mesic, Beech-Maple Community; Northern and Southern Mesic, Hardwood Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community		12.7 Sp D/km ² ; 1,296.7 Modern
<i>Corylus americana</i>	Characteristic of open sites in dry and moist situations: roadsides, fence rows, edges of woods, old fields. Shade-intolerant.	Common to abundant in the southern half of the Lower Peninsula; rare in the Upper Peninsula.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Castanea dentata</i>	Characteristic of dry-mesic sites and oak-hickory forests where it tolerates droughty soils and periodic fires; associated with black, white and red oaks, pignut and shagbark hickories, white ash, black cherry.	Rare in southeastern Michigan; formerly native as far north as St. Clair Co. and abundant in Monroe and Wayne Co. Reaching the northwestern limit of its range in southeastern Michigan. Planted trees, more or less healthy, are widespread throughout the Lower Peninsula.	n/a
<i>Cucurbita pepo</i>	Floodplain forests, wet deciduous forests, streambanks, thickets and waste ground.	Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a
<i>Amphicarpaea bracteata</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Geranium maculatum</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Pyrus sp.</i>	North woods, high altitudes and cool swamps	Great Lakes region, especially in the northern portions	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Physalis</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Convolvulaceae</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Brassicaceae</i> sp.	Variety of habitats, especially where shaded. Floodplain forests, rocky shores, wet woods	Both UP and LP of Michigan	n/a
<i>Fragaria virginiana</i>	Southern and Northern Dry-Mesic, Hardwood Community		8,006.0/ sq. km; (Modern: 796,889.2)
<i>Galium aparine</i>	Swamps, streambanks, thickets, marshes, wet meadows, calcareous fens; moist meadows, moist prairies.	Common throughout Michigan	n/a
<i>Helianthus divaricatus</i>	Wet meadows, low prairie, sedge headrows, fens, floodplain forests, streambanks	Common throughout Michigan, especially the LP	n/a
<i>Polygala senega</i>	Sandy or mucky lakeshores, wet areas between dunes	Common in the LP of Michigan	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Rubus occidentalis</i>	Southern and Northern Dry-Mesic, Hardwood Community; Northern Mesic to Wet-Mesic, Lowland swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		25,085.6/Sp. D km ² ; (Modern:2,496,929.5)
<i>Celtis occidentalis</i>	Northern and Southern Mesic, Hardwood Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Southern Mesic, Beech-Maple Community; Northern and Southern Wet-Mesic, Hardwood Community; Southern and Northern Dry-Mesic, Hardwood Community. Characteristic of banks of small streams, river floodplains and moist, fertile bottomlands with calcareous soils. Not typical of the often-flooded bottoms where the maple, red ash, and American elm thrive. Also grows on limestone outcrops and on dry,	Occasional in the southern half of the Lower Peninsula, north to Newaygo, Midland, and Arenac Co.	221.0 Sp D/km ² ; 523.8 modern

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
	gravelly or rocky slopes where the soil is circumneutral to basic and rich in lime.		
<i>Vitis sp.</i>	Floodplain forests, moist sandy woods, streambanks, thickets; also on sand dunes. Northern and Southern Mesic, Beech-Hardwood-Pine Community; Southern and Northern Dry-Mesic, Hardwood Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community	Minnesota, Wisconsin, mostly LP of Michigan, common in northeast Illinois and northwest Indiana.	4,872.8 Sp D/km ² ; 17,152.3 Modern;
<i>Crataegus sp.</i>	Northern and Southern Mesic, Hardwood Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Southern Mesic, Beech-Maple Community; Northern and Southern Wet-Mesic, Hardwood Community; Southern and Northern Dry-Mesic, Hardwood Community		8.84 Sp D/km ² ; 21.0 Sp Density Modern
<i>Viburnum sp.</i>	Southern and Northern Dry-Mesic, Hardwood Community		8,006.0/ sq. km; (Modern: 796,889.2)

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Rhus sp</i>	Frequent in the understory of open, oak-hickory forests on dry, sandy calcareous soils in the southern part of the Lower Peninsula; rare in the northern half of the Lower Peninsula and in the Upper Peninsula.	Southern Lower Peninsula; rare in northern half of the Lower Peninsula and in the Upper Peninsula	n/a
<i>Polygonum pennsylvanicum</i>	Streambanks, exposed shores, marshes, fens, ditches and cultivated fields. Northern and Southern Mesic, Beech-Hardwood-Pine Community; Southern Mesic, Beech-Maple Community; Northern and Southern Mesic, Hardwood Community; Southern and Northern Dry-Mesic, Hardwood Community; Northern and Southern Wet-Mesic Hardwood Community	Mostly south Minnesota, Wisconsin, Michigan, common in northeast Illinois and northwest Indiana.	49,602.5 Sp D/km ² ; 209,800.8 modern
<i>Prunus spp.</i>	Northern and southern Mesic, Beech-Hardwood-Pine Community; Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Mesic, Hardwood Community	Common throughout Michigan	11.9 Sp D/km ² ; 746.3 Modern

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Sambucus canadensis</i>	Floodplain forests, swamps, wet forest depressions, thickets, shores, meadows, roadsides, fencerows	Central and south Minnesota, Wisconsin, Michigan (all), northeast Illinois and northwest Indiana.	n/a
<i>Prunus serotina</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Mesic, Hardwood Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Southern Mesic, Beech-Maple Community; Northern and Southern Wet-Mesic, Hardwood Community; Southern and Northern Dry-Mesic, Hardwood Community		119.2 Sp D/km ² ; 7,475.9 Modern
<i>Amelanc (Amelanchier Medikus)</i>	Conifer swamps, open bogs, thickets.	North Minnesota, Michigan Upper Peninsula (somewhat uncommon in the Lower Peninsula)	n/a
<i>Aster cordifolius</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)

Table 29. (cont'd)

Species	Habitat/Resource Community	Distribution	Density
<i>Sassafras albidum</i>	Characteristic of disturbed sites in dry-mesic and mesic forests; most abundant along fence rows and in old fields where it forms small clones. Associates include black, white, and red oaks, white ash, black cherry, black walnut, aspens, red and sugar maples beech, and hop-hornbeam.	Common in the southern half of the Lower Peninsula, becoming rare northward to Manistee and Grand Traverse Co. A southern species reaching the northern limit of its range in the Lower Peninsula of Michigan.	n/a
<i>Hypericum</i>	Streambanks	Found in Michigan, Wisconsin, Minnesota	n/a
<i>Cornus rugosa</i>	Lakeshores, streambanks, swamps, thickets, marshes, moist woods, low prairie.	Common in Michigan.	n/a
<i>Gaylussacia baccata</i>	Open bogs, usually with tamarack and leatherleaf; more common in dry, acid, sandy or rocky habitats.	Common in Michigan	n/a
<i>Lamiaceae</i>	Marshes, swamps, moist to wet areas	LP of Michigan, mostly	n/a
<i>Rosa palustris</i>	Open bogs, conifer swamps, thickets, shores and streambanks; increasing in disturbed wetlands.	Central and eastern Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a
<i>Pinus</i>	Cold, poorly drained swamps, bogs and wet lakeshores.	North and central Minnesota, Wisconsin, Michigan, extreme northeast Illinois and northwest Indiana.	n/a
<i>Fraxinus alba</i>	Floodplain forests, swamps, shores, streambanks	Common throughout Michigan	n/a

Table 29. (cont'd)

Species	Habitat/Resource Community	Distribution	Density
<i>P. resinosa</i>	Characteristic of well drained, dry, highly acid, sandy soils of outwash plains and gravelly ridges; associated with jack pine, white pine, oaks, aspens, white birch. Also common on rock outcrops and sand dunes. Not competitive with hardwoods on the better, heavier textured soils; does not tolerate a high water table or frost pockets.	Common to frequent in the Upper Peninsula and the northern half of the Lower Peninsula, south to Ottawa Co. on the west and St. Clair Co. on the east. Vigorous as an ornamental tree farther south.	n/a
<i>P. strobus</i>	Grows well on a wide variety of sites; moraines of moderately well drained loams and silt loams; well drained, dry, highly acid, infertile, sandy soils and dunes; small ridges or mounds in swamps and poorly drained sites; floodplains; rock ridges and outcrops	Abundant in the Upper Peninsula and the northern half of the Lower Peninsula; south to Berrien, St. Joseph, Oakland, and formerly Wayne Co.; often-planned and vigorous as an ornamental tree.	n/a
<i>Ulmus rubra</i>	Characteristics of mixed hardwood forests with mesic sites and moist, fertile soils: lower slopes, river terraces, bottomlands; also found on drier slopes with soils of high lime content.	Frequent in the southern half of the Lower Peninsula; occasional in the northern half of the Lower Peninsula; absent in the Upper Peninsula. Approaching the northern limit of its range in Michigan.	n/a

Table 29. (cont'd)

Species	Habitat/Resource Community	Distribution	Density
<i>Ulmus</i> sp.	Floodplain forests, streambanks and moist, rich woods; less common now than formerly due to losses from Dutch elm disease.	Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a
<i>Cercis canadensis</i>	Characteristic understory tree of forests of stream borders and moist, fertile bottomlands. Associates include American elm, basswood, silver maple, red ash, red mulberry, northern hackberry.	Rare in the southern tiers of counties to the valley of the Grand River on the west and the Raisin River on the east. Tree of widespread distribution south of Michigan, reaching its northernmost limit in the relatively mild and protected river valleys of Southern Michigan.	n/a
<i>Tilia americana</i>	Characteristic of mesic deciduous forests with moist, nutrient-rich, well drained to somewhat poorly drained soils; lake and stream borders, bottomlands. Associates include sugar maple, beech, yellow birch, red maple, American elm, white ash, black walnut, butternut, red and white oaks.	Common in deciduous forests of the Lower Peninsula; frequent in deciduous forests of the Upper Peninsula.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Q. nigra</i>	Characteristic of xeric and dry-mesic oak-hickory forests and oak-pine forests with well to very well drained, upland soils, especially sandy to gravelly textures; intolerant of high water tables; associated with white, red, northern pin, and scarlet oaks, pignut and shagbark hickories, white ash, black cherry, bigtooth aspen, white and red pines, red maple.	Common in the southern half of the Lower Peninsula, occasional in the northern half; not known from the Upper Peninsula.	n/a
<i>Q. bicolor</i>	Characteristic of low, wet, somewhat poorly to poorly drained soils; borders of swamps and along streams; moist flats and bottomlands; associated with silver maple, American elm, bur oak, red ash, basswood, tuliptree, yellow birch. Adapted to conditions of poor aeration and high water tables but not abundant in deciduous swamps having a continually high water table.	Occasional in the southern half of the Lower Peninsula. A species of predominantly Midwestern range reaching one segment of its northern limit in southern to central Michigan.	9.6 Sp D/km ² ; 955.5 Modern

Table 29. (cont'd)

Species	Habitat/Resource Community	Distribution	Density
<i>Q. rubra</i>	Characteristic of mesic forests throughout the state on moist, cool, well drained sites; also occurring in dry-mesic forests of southern Michigan with white and black oaks, shagbark and pignut hickories, white ash, black cherry. Found on sandy, well drained soils of the northern Lower Peninsula and Upper Peninsula with white and red pines, aspens, and red maple; locally frequent near the shores of the Great Lakes and on rock outcrops. More demanding of moisture than black and white oaks; tolerating a colder climate than black or white oaks.	Common in the southern half of the Lower Peninsula; frequent in the northern half and the Upper Peninsula; frequent along Lakes Michigan and Superior. Most northerly distributed of Michigan oaks; approaching its northern range limit in the Upper Peninsula.	2,213.1 Sp D/km ² ; 220,283.1 Modern
<i>Populus tremuloides</i>	Characteristic of warm, humid river floodplains; associated with black willow, sandbar willow, silver maple, red ash, American elm, northern hackberry, box-elder	Common in the southern half of the Lower Peninsula	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Carya laciniosa</i>	Characteristic of river floodplains and moist woodland soils that are deep, fertile, neutral or slightly alkaline, and of a loam or silt loam texture. Requires moister, more fertile soils than shagbark or pignut hickories.	Rare. Occurs in the southernmost 2 tiers of counties of the Lower Peninsula; reaches its northernmost Midwestern limit in southern Michigan.	n/a km ²
<i>Carya ovata</i>	Characteristic of dry-mesic, oak-hickory forests; associated with black, red, and white oaks, pignut hickory, white ash, black cherry. Occasional on mesic sites; associated with sugar maple, beech, basswood, red oak, butternut hickory. Also occurs in the drier parts of river floodplains. Tolerant of drought but not of prolonged high water table.	Common in the Lower Peninsula as far north as Roscommon and Missaukee Co.; primary range south of Michigan, reaching its northernmost Midwestern limit in the southern half of the Lower Peninsula.	59.6 Sp D/km ² ; 3,737.9 Modern
<i>Cornus racemosa</i>	Lakeshores, streambanks, swamps, thickets, marshes, moist woods, low prairie.	Common; Minnesota, Wisconsin, Michigan Lower peninsula, northeast Illinois and northwest Indiana.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Fagus americana</i>	Characteristic of mesic beech-maple forests with well drained to somewhat poorly drained soils of a wide range of textures, from loamy sand to clay loam. Associated with sugar maple, basswood, red oak, white ash, American elm, tuliptree, eastern hemlock. Tolerates acidic or basic conditions.	Common in the Lower Peninsula; locally common in the eastern half of the Upper Peninsula, west to Marquette and Dickinson Co.	n/a
<i>Ostrya virginiana</i>	Characteristic of the understory of dry-mesic, oak-hickory forests on well-drained, upland sites; associated with black, white and red oaks, shagbark and pignut hickories, white ash, black cherry. Also occurs in mesic beech-maple forests on moist, fertile slopes; associated with sugar maple, beech, basswood, red oak. Not found on poorly drained sites.	Common throughout the state of Michigan.	n/a
<i>Fraxinus sp</i>	Floodplain forests, swamps, shores, streambanks	Common throughout Michigan	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Fagus grandifolia</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hardwood Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Southern Mesic, Beech-Maple Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community		2,265.3 Sp D/km ² ; 142,072.8 Modern
<i>Acer spp.</i>	Floodplain forests, streambanks, shores; also drier woods and disturbed areas; Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Mesic, Hardwood Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Southern Mesic, Beech-Maple Community; Southern and Northern Dry-Mesic, Hardwood Community	Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	10,134.2 Sp D/km ² ; 635,586.6 Modern
<i>Betula spp.</i>	Hummocks in swamps and on wetland margins	Eastern Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Morus rubra</i>	Northern and Southern Mesic, Hardwood Community; Northern and Southern Mesic, Beech-Hardwood-Pine Community; Southern Mesic, Beech-Maple Community		8.84 Sp D/km ² ; 21.0 Sp Density Modern
<i>Platanus occidentalis</i>	Riverbanks, floodplain forests and lakeshores. Characteristic of river floodplain and bottomland forests with moist, alluvial soils; also lake shores. Tolerates flooding, silting, high water tables, and soils with slow drainage.	Occasional in south Wisconsin and south Michigan; northeast Illinois and northwest Indiana. Occasional in the Lower Peninsula, rare north to Newaygo and Midland Co. Primarily a Midwestern and southern species, reaching a portion of its northernmost range in Michigan.	n/a
<i>Picea</i>	White spruce: Moist to sometimes wet forests; absent from wetlands where water is stagnant. Black spruce: Cold, acid, sphagnum bogs, swamps, and lakeshores; often where water is slow-moving and low in oxygen; less common in calcium-rich, well-aerated swamps dominated by northern white cedar.	LP , north and central Michigan (rarer in southern Michigan)	n/a
<i>Typha</i>	Wetland; marshes, lakeshores, streambanks, ditches, pond margins, usually in shallow water. Cattail Marsh Communities;	Common in Minnesota, Wisconsin, Michigan, NE Illinois and NW Indiana, S Canada to central Alaska, throughout USA and into Mexico	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Rumex spp.</i>	Floodplain forests and openings, cultivated fields and disturbed areas	Common in Michigan	n/a
<i>Panicum spp.</i>	Floodplain forests, alder thickets, ditches, especially where sandy.	Central and south LP of Michigan	n/a
<i>Silphium terebinthinaceum</i>	Low prairie, fens; especially where calcium-rich.	Fairly common; south Wisconsin, south Lower Peninsula of Michigan (local in central Upper Peninsula), northeast Illinois and northwest Indiana; south Ontario and Ohio to Wisconsin, south to GA and Miss.	n/a
<i>Smilacina racemosa</i>	Open bogs, conifer swamps, thickets.	North and east central Minnesota, north and central Wisconsin, common throughout Michigan.	n/a
<i>Smilacina stellata</i>	Open bogs, conifer swamps, thickets.	North and east central Minnesota, north and central Wisconsin, common throughout Michigan.	n/a
<i>Maianthemum canadense</i>	On hummocks in swamps, open bogs and thickets; also common in moist to dry woods.	Very common across most of our region. Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a
<i>Onoclea Sensibilis</i>	Swampy woods and low places in forests, wet meadows, calcareous fens, and roadside ditches, wet or moist wheel ruts; sometimes weedy.	Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a
<i>Poa pratensis</i>	Wet meadows, marshes, shores, streambanks, ditches and low prairie; also moist woods.	Common to occasional; Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a

Table 29. (cont'd)

Species	Habitat/Resource Community	Distribution	Density
<i>Smilax lasioneura</i>	Characteristic of open, moist habitats or lightly shaded woods, stream and lake environs, dunes, roadsides, fence rows, old fields, edges of woods, banks, cutover forests. Moderately shade-tolerant.	Common in the Lower Peninsula; rare in the Upper Peninsula.	n/a
<i>Solidago</i> Sp.	Wet meadows, streambanks, swamps, floodplain forests, thickets, marshes, calcareous fens, ditches; also in moist to dry open woods and roadsides.	Common in Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a
<i>Thalictrum dioicum</i>	Wet to moist meadows, low prairie, swamps, thickets, and streambanks.	Common in Michigan	n/a
<i>Viola pensylvanica</i>	Moist hardwood forests; occasionally in swamps, floodplain forests and along rocky streambanks.	Common in Minnesota, Wisconsin, northeast Illinois and northwest Indiana.	n/a
<i>Viola sororia</i> (Sens. Lat.) (Glabrous plants like this one have been referred to <i>V. Papilionacea</i>)	Moist hardwood forests; occasionally in swamps, floodplain forests and along rocky streambanks.	Common in Minnesota, Wisconsin, northeast Illinois and northwest Indiana.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Zanthoxylum americanum</i>	Characteristic of open, disturbed, moist sites or lightly shaded woods, especially stream banks and floodplains. Moderately shade-tolerant. Typical of fence rows and forest edges.	Common throughout the Lower Peninsula of Michigan	n/a
<i>Lilium michiganense</i>	Wet meadows, along streams, and in flood-plain forests of the Great Lakes region.	Common throughout Michigan.	n/a
<i>Lysimachia ciliata</i>	Usually shaded wet areas, such as shores, streambanks, wet meadows, ditches, floodplains, wet woods and thickets.	Minnesota, Wisconsin, Michigan, northeast Illinois and NW Indiana.	n/a
<i>Carex blanda</i>	Floodplain forests and backwater areas	Common in LP of Michigan	n/a
<i>Carex lupulina</i>	Wet woods, swamps, wet meadows and marshes, ditches and shores.	Common throughout Michigan	n/a
<i>Carex pensylvanica</i>	Floodplain forests and backwater areas	Common in LP of Michigan	n/a
<i>Smilax cirrata</i>	Characteristic of open, moist habitats or lightly shaded woods, stream and lake environs, dunes, roadsides, fence rows, old fields, edges of woods, banks, cutover forests. Moderately shade-tolerant.	Common in the Lower Peninsula; rare in the Upper Peninsula.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Toxicodendron radicans</i>	Characteristic of open areas and the understory, or climbing on tree trunks. Of open woodlands on virtually any kind of soil; stream banks, lake margins, fence rows, and where birds are likely to disperse the seeds.	Common to locally abundant in the southern half of the Lower Peninsula.	n/a
<i>Apocynum androsaemifolium</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Aquilegia canadensis</i>	Cedar and tamarack swamps, thickets, fens, shores.	Michigan UP and occasional in north and central LP	n/a
<i>Aralia nudicaulis</i>	Moist ravines and mixed woods	Great Lakes region	n/a
<i>Barbarea vulgaris</i>	Rocky shores, swamps and wet woods	Northeast and eastern central Minnesota, Wisconsin, and eastern UP and LP of Michigan.	n/a
<i>Geum canadense</i>	Swamps, wet forests, wet meadows, marshes, calcareous fens, ditches and roadsides.	Minnesota, Wisconsin, Michigan, northeast Illinois and northwest Indiana.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Satureja vulgaris</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Monarda fistulosa</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Osmorhiza longistylis</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Podophyllum peltatum</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Trillium grandiflorum</i>	Wet meadows, along streams, and in flood-plain forests of the Great Lakes region.	Common throughout Michigan.	n/a
<i>Lithospermum canescens</i>	Wet meadows, along streams, and in flood-plain forests of the Great Lakes region.	Common throughout Michigan.	n/a
<i>Taraxacum officinale</i>	Northern Mesic to Wet-Mesic, Lowland Swamp Community; Northern and Southern Wet-Mesic, Hemlock and Hardwood Community; Northern and Southern Wet-Mesic, Hardwood Community		33,921.9/Sp D/km ² ; (Modern 3,463,933.6)
<i>Anura</i> sp.	Any still, permanent body of water including backwaters, sloughs, lakes, farm ponds, impoundments, marshes, and shallow Great Lakes bays. Places with abundant submerged and emergent vegetation are preferred.	Occurs throughout Michigan.	n/a
<i>Emydoidea blandingii</i>	Shallow, weedy waters like ponds, marshes, swamps, lake inlets and coves. Sometimes found in rivers; they like logs, grass clumps, sloping banks, or other perches to bask on.	In the Great Lakes basin, they are found throughout southern Ontario, along both shores of Lake Erie, In Michigan (Lower and central Upper Peninsula), northern Ohio, Indiana, Eastern Illinois, and Wisconsin.	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Chrysemys picta</i>	Slow-moving or quiet permanent waters with a soft-bottom substrate, abundant aquatic plant life, and basking sites. Sometimes they occupy ponds, ditches, and can tolerate certain levels of organic pollution.	Range encompasses much of the US, including the LP of Michigan.	n/a
<i>Chelydra serpentina</i>	Snapping Turtles inhabit most permanent bodies of water in the region, including shallow, weedy inlets and bays in the Great Lakes themselves. Quiet, mud-bottomed ponds, lakes, sloughs and slow streams with dense aquatic vegetation support the largest populations.	Present in nearly all of the United States east of the Rocky Mountains, including all of the Great Lakes region, omitting the area in Canada north of Lake Superior.	n/a
<i>Nerodia sipedon</i>	The Northern water snake lives on or near most permanent bodies of water, including rivers, streams, sloughs, lakes, ponds, bogs, marshes, swamps, and impoundments.	Occurs throughout the Great Lakes region, except for the northern and western portions of the Lake Superior Drainage basin; The Lake Erie Water Snake is found on certain islands of western Lake Erie in Ontario and Ohio.	n/a
<i>Thamnophis sp.</i>	Found in nearly every natural habitat in the region; especially grassy places near the edges of ponds, lakes, ditches, and streams.	Common garter snakes are generally common and locally abundant and are the most frequently encountered snake in the Great Lakes region (through all of Michigan)	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Trionyx sp.</i>	Rivers, larger streams, inland lakes, reservoirs, protected bays and rivermouth areas. Tolerate a fairly swift current but prefer a sand or mud bottom and usually avoid streams with sharp-edged rocks or coarse gravel.	Ranges across the Lower Great Lakes region from the southern and western shores of Lake Ontario through southern Ontario and much of Michigan's Lower Peninsula, adjacent Ohio and Indiana, to the western Lake Michigan basin (north to Green Bay).	n/a
<i>Amblema costata</i>	Small to large rivers	Eastern half of the United States	n/a
<i>Elliptio dilatatus</i>	Rarely found in bodies of freshwater deeper than 6 feet	Tributaries of the Mississippi River and lesser drainage systems in the eastern half of North America	n/a
<i>Fusconaia flava</i> (Raf.)	Drainages	Common and generally distributed in eastern half of the United States	n/a
<i>Quadrula pustulosa</i> (Lea)	Drainages	Mississippi drainage as far west as Minnesota and Texas	n/a
<i>Pleurobema (cordatum) coccineum</i> (Conrad)	Drainages	Mostly in the southeastern states, but a few drainages in the northeastern quarter of the United States	n/a
<i>Cyclonaias tuberculata</i>			
<i>Lasmigona costata</i> (Raf.)		Eastern half of the United States	n/a
<i>Strophitus rugosus</i> (Swain.)		Widely distributed	n/a
<i>Lampsilis siliquoidea</i> (L)	Drainages	Mississippi and St. Lawrence drainages, and southeastern states	n/a
<i>Obovaria subrotunda</i> (Raf.)		Generally distributed in eastern half of the United States	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Ligumia (Recta) lattissima</i> (Raf.)	Most abundant in the shallows, especially in water less than 2 m deep, but in larger rivers and some lakes, they can occur as deep as 7 m.	Generally distributed in eastern half of the United States	n/a
<i>Actinonaias carinata</i> (Barnes)		Eastern half of the United States	n/a
<i>Discus cronkhitei</i>			
<i>Anguispira kochi</i>			
<i>Anodonta grandis footiana</i> (Say) Goodrich	Most abundant in the shallows, especially in water less than 2 m deep, but in larger rivers and some lakes, they can occur as deep as 7 m.	Fresh-water bivalves occur in all types of unpolluted habitats but they are most abundant and varied in the larger rivers and large drainage lakes.	n/a
<i>Micromya (Villosa) Iris</i> (Lea) Goodrich	Most abundant in the shallows, especially in water less than 2 m deep, but in larger rivers and some lakes, they can occur as deep as 7 m.	Fresh-water bivalves occur in all types of unpolluted habitats but they are most abundant and varied in the larger rivers and large drainage lakes.	n/a
<i>Amblema costata</i> (Rafinesque) Goodrich	Most abundant in the shallows, especially in water less than 2 m deep, but in larger rivers and some lakes, they can occur as deep as 7 m.	Fresh-water bivalves occur in all types of unpolluted habitats but they are most abundant and varied in the larger rivers and large drainage lakes.	n/a
<i>Ligumia recta</i> (Lamarck) Goodrich	Most abundant in the shallows, especially in water less than 2 m deep, but in larger rivers and some lakes, they can occur as deep as 7 m.	Generally distributed in eastern half of the United States	n/a

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
<i>Valvata tricarinata</i> (Say)	Found in both shallow and deep water	Generally distributed in a variety of habitats, but especially in large lakes.	n/a
<i>Goniobasis livescens</i> (Say)	Near lake shores and in rapid rivers	Most common in rivers of Tennessee and Alabama, but extending north to Great Lakes, St. Lawrence River basin, and western tributaries of the Mississippi River.	n/a
<i>Somatogyrus</i> sp.	Many species in all types of habitats, but most commonly found in quiet waters	Widely distributed	n/a
<i>Amnicola lustrica</i> (Pilsbry)	Common in a variety of habitats, but rare west of the Continental Divide	Widely distributed	n/a
<i>Lymnaea columella</i> (Say)	Muddy bottoms of fresh bodies of water, marshes	Found from coast to coast across the United States.	n/a
<i>Helisoma</i> <i>Campanulatum</i>	Many species in all types of habitats, but most commonly found in quiet waters	Found from coast to coast across the United States; widely distributed.	n/a
<i>Stenotrema monodon</i> (Racket)			
<i>Mesodon thyroidus</i> (Say)			
<i>Triodopsis albolabris</i> (Say)			
<i>Triodopsis multilineata</i> (Say)			
<i>Anguispira alternata</i>			
<i>Anguispira solitaria</i>			

Table 29. (cont'd)			
Species	Habitat/Resource Community	Distribution	Density
(Say)			
<i>Helicodiscus parallelus</i> (Say)			
<i>Haplotrema concavium</i> (Say)			
<i>Mesomphix cuprea</i> (Say)			
<i>Amnicola Limosa</i> (Say)	Common in a variety of habitats, but rare west of the Continental Divide	Widely distributed	
<i>Pomatiopsis lapidaria</i> (Say)	Usually amphibious but often found on submerged substrates	Found within the Midwest	n/a
<i>Lymnaea (Staginicola)</i> <i>palustris</i> (Say)	Muddy bottoms of fresh bodies of water, marshes	Found from coast to coast across the United States.	n/a
<i>Helisoma trivolvis</i> (Say)	Many species in all types of habitats, but most commonly found in quiet waters	Found from coast to coast across the United States; widely distributed.	n/a
<i>Retinella rhoadsi</i> (Pilsbry)			
<i>Succinea ovalis</i> (Say)			
<i>Campeloma decisum</i> (Say)	Most common in lakes and streams	Generally distributed from the Mississippi Valley to the Atlantic coast	n/a
<i>Helisoma anceps</i> (Conrad)	Many species in all types of habitats, but most commonly found in quiet waters	Found from coast to coast across the United States; widely distributed.	n/a
<i>Zonitidae</i>			
<i>Pelecypoda</i>			

Table 30. Resource schedule detail – January to June						
Species	January	February	March	April	May	June
<i>Cervus canadensis</i>	-	-	-	-	Birth	Birth
<i>Odocoileus virginianus</i>	-	-	-	-	Birth	Birth
<i>Procyon lotor</i>	Winter dormancy	Breeding	Breeding	Litter production	Litter production	-
<i>Ursus americanus</i>	Winter dormancy, birth?	Winter dormancy, birth?	Winter dormancy	Winter dormancy	-	-
<i>Castor canadensis</i>	-	-	-	-	-	-
<i>Ondatra zibethicus</i>	-	-	-	Litter production	Litter production	Litter production
<i>Canis sp. (lupus, familiaris)</i>	-	Courtship/mating	Courtship/mating	Litter production	Litter production	-
<i>Martes americana</i>	Birth	Birth	Birth	Birth	-	-
<i>Marmota monax</i>	Hibernation	Hibernation	Mating	Mating, litter production, active midday	Litter production, Active midday	Active midday
<i>Mustela vison</i>	-	Mating	Mating	Mating, Litter production	Litter production	-
<i>Lynx rufus</i>	Courtship	Breeding	Breeding	-	Litter production	-
<i>Lontra canadensis</i>	-	Litter production	Litter production	Litter production	-	-
<i>Erethizon dorsatum</i>	-	-	-	Birth	Birth	Birth

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Martes pennanti	-	-	Courtship, mating, birth (352 days, gestation)	Courtship, mating, birth (352 days, gestation)	-	-
Sciurus sp.	Mating	Mating	Litter production	Litter production	Mating	Mating
Leporidae sp. (Sylvilagus)	-	Mating	Mating	Mating/birth	Mating/birth	Mating/birth
Vulpes fulva	Mating	Mating	Mating/Litter production	Litter production	-	-
Alces alces	-	-	-	-	Birth	Birth
Blarina sp.	-	-	Mating	Mating/pregnancies	Mating/pregnancies/litters	Mating/pregnancies/litters
Tamias sp.	-	Mating	Litter production; species now a common member of wildlife community starting in March	Litter production	-	Mating
Muridae sp.	-	-	-	-	-	-
Peromyscus sp.	Little to no activity	Mating	Birth of litter	Birth of litter	-	Reduction of population
Microtus sp.	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Acipenser fulvescens	-	-	-	Spawn	Spawn	Spawn
Perca flavescens	-	-	-	-	-	-
Amia calva	-	-	-	-	-	-
Aplodinotus grunniens	-	-	-	-	Eggs laid	Eggs laid
Monroe chrysops	-	-	Spawn	Spawn	Spawn	Spawn
Micropterus salmoides	-	-	-	-	Nest/eggs laid and fertilized	Nest/eggs laid and fertilized
Micropterus dolomieu	-	-	-	-	Nesting	Nesting
Esox lucius	-	-	Spawn	Spawn	-	-
Stizostedion vitreum	-	-	-	-	-	-
Ictalurus punctatus	-	-	-	-	-	Nesting/eggs laid
Lepisosteus oculatus	-	-	-	-	-	-
Salvelinus namaycush	-	-	-	-	-	-
Ictalurus melas	-	-	-	Spawn	Spawn	Spawn
Ictalurus natalis	-	-	-	-	-	Spawn/nest
Ictalurus nebulosus	-	-	-	-	-	Spawn
Moxostoma sp. (macrolepidotum)	-	-	-	-	Spawn	Spawn
Pomoxis sp.	-	-	-	-	Spawn	Spawn

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Catostomus sp. (catostomus, commersoni)	-	-	-	Crowd tributaries/Spawn	Crowd tributaries/Spawn	-
Centrarchidae	-	-	-	-	Spawn	Spawn
Lepomis cf. macrochirus	-	-	-	Spawn	Spawn	Spawn
Pomoxis nigromaculatus	-	-	-	Spawn	Spawn	Spawn
Stizostedion canadense	-	-	-	Spawn	Spawn	Spawn
Lota lota lacustris	Spawn	Spawn	-	-	-	-
Ectopistes migratorius	-	-	-	Migrating into Michigan	Nesting	Nesting/eggs hatched
Anas discors	-	-	-	Arrives in Michigan	-	Nesting/eggs laid
Anas americana	-	-	Arrives in Michigan	Leaves Michigan, heads north	-	-
Anas platyrhynchos	-	-	Migrates into Michigan	-	Eggs laid	Ducklings hatch
Aythya collaris	-	-	Migrates into Michigan	Migrates into Michigan	-	-
Mergus merganser	-	-	-	-	Found on small ponds and streams, shores	Found on small ponds, streams, shores
Mergus serrator	-	-	-	Migrates back into Michigan	-	-

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Gavia immer	-	-	-	-	-	-
Podilymbus podiceps	Absent	Absent	-	-	-	-
Meleagris gallopavo	-	-	-	-	-	-
Lophodytes cucullatus	Open running waters	Open running waters	-	-	-	-
Corvus brachyrhynchos	-	Migrate into Michigan	Nesting	Nesting	Offspring hatched	Offspring leave the nest
Botaurus lentiginosus	-	-	Migrates into Michigan	-	-	-
Ardea herodias	-	-	Migrates into Michigan, lays eggs	Lays eggs	Lays eggs	-
Grus canadensis	-	-	-	Nesting/lays eggs	Nesting/lays eggs	Nesting/lays eggs
Aythya marila	-	-	-	-	-	-
Bubo virginianus	Nesting	Nesting	Eggs laid	Eggs laid/ hatched	-	-
Chenopodium	-	-	-	-	-	-
Zea mays						
Iva annua	-	-	-	-	-	-
Carex sp.	-	-	-	-	-	x
Cyperus	-	-	-	-	-	-
Zizania aquatica	-	-	-	-	-	-

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Quercus	-	-	-	-	Flowers	Flowers
Carya	-	-	-	-	Flowers	Flowers
J. cinerea						
Juglans nigra						
Corylus americana	-	-	Flowers	Flowers	-	-
Castanea dentata	-	-	-	-	-	Flowers
Cucurbita pepo	-	-	-	-	-	-
Amphicarpaea bracteata	-	-	-	-	-	-
Geranium maculatum	-	-	-	-	-	-
Pyrus sp.						
Physalis	-	-	-	-	-	-
Convolvulaceae	-	-	-	-	-	-
Brassicaceae sp.	-	-	-	-	-	Fruit
Fragaria virginiana						
Galium aparine	-	-	-	-	-	Fruit
Helianthus divaricatus	-	-	-	-	-	Fruit
Polygala senega	-	-	-	-	-	-
Rubus occidentalis						
Celtis occidentalis	-	-	-	-	Flowers	-
Vitis sp.	-	-	-	-	Fruit	Fruit
Crataegus sp.						
Viburnum sp.	-	-	-	-	x	x

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Rhus sp	-	-	-	Flowers	Flowers	-
Polygonum pennsylvanicum	-	-	-	-	-	x
Prunus spp.	-	-	-	-	-	-
Sambucus canadensis	-	-	-	-	-	-
Prunus serotina						
Amelanc (Amelanchier Medikus)	-	-	-	-	x	x
Aster cordifolius	-	-	-	-	-	-
Sassafras albidum	-	-	-	-	Flowers	-
Hypericum	-	-	-	-	-	-
Cornus rugosa	-	-	-	-	x	x
Gaylussacia baccata	-	-	-	-	x	x
Lamiaceae	-	-	-	-	-	-
Rosa palustris	-	-	-	-	-	-
Pinus	-	-	-	-	-	-
Fraxinus alba	-	-	-	x	x	-
P. resinosa	-	-	-	Pollen/seed cones	Pollen/seed cones	-
P. strobus	-	-	-	-	-	Pollen cones/Seed cones
Ulmus rubra	-	-	Flowers	Flowers	Fruit	-
Ulmus sp.	-	-	-	-	-	-
Cercis canadensis	-	-	-	Flowers	Flowers	Fruit/Legume

Table 30. (cont'd)						
Species	January	February	March	April	May	June
<i>Tilia americana</i>	-	-	-	-	-	Flowers
<i>Q. nigra</i>	-	-	-	-	Flowers	-
<i>Q. bicolor</i>	-	-	-	-	Flowers	Flowers
<i>Q. rubra</i>	-	-	-	-	Flowers	Flowers
<i>Populus tremuloides</i>	-	-	-	Flowers	Flower, fruits	Fruit
<i>Carya laciniosa</i>	-	-	-	-	Flowers	Flowers
<i>Carya ovata</i>	-	-	-	-	Flowers	Flowers
<i>Cornus racemosa</i>	-	-	-	-	-	x
<i>Fagus americana</i>	-	-	-	Flowers	Flowers	-
<i>Ostrya virginiana</i>	-	-	-	Flowers	Flowers	-
<i>Fraxinus</i> sp.	-	-	-	x	x	-
<i>Fagus grandifolia</i>						
<i>Acer</i> spp.						
<i>Betula</i> spp.	-	-	-	x	x	-
<i>Morus rubra</i>						
<i>Platanus occidentalis</i>	-	-	-	-	x	-
<i>Picea</i>	-	-	-	-	-	-
<i>Typha</i>	-	-	-	-	-	x
<i>Rumex</i> spp.	-	-	-	-	x	x
<i>Panicum</i> spp.	-	-	-	-	-	x
<i>Silphium terebinthinaceum</i>	-	-	-	-	-	-
<i>Smilacina racemosa</i>	-	-	-	-	x	x
<i>Smilacina stellata</i>	-	-	-	-	x	x
<i>Maianthemum</i>	-	-	-	-	x	x

Table 30. (cont'd)						
Species	January	February	March	April	May	June
canadense						
Onoclea sensibilis	-	-	-	-	-	-
Poa pratensis	-	-	-	-	-	x
Smilax lasioneura	-	-	-	-	-	Flowers
Solidago Sp.	-	-	-	-	-	-
Thalictrum dioicum	-	-	-	-	-	x
Viola pensylvanica	-	-	-	x	x	x
Viola sororia (Sens. Lat.) (Glabrous plants like this one have been referred to V. Papilionacea)	-	-	-	x	x	x
Zanthoxylum americanum	-	-	-	Flowers	Flowers	-
Lilium michiganense	-	-	-	-	-	x
Lysimachia ciliata	-	-	-	-	-	x
Carex blanda	-	-	-	-	-	x
Carex lupulina	-	-	-	-	-	x
Carex pensylvanica	-	-	-	-	-	x
Smilax cirrata	-	-	-	-	-	Flowers
Toxicodendron radicans	-	-	-	-	Flowers	Flowers

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Apocynum androsaemifolium	-	-	-	-	-	-
Aquilegia canadensis	-	-	-	-	x	x
Aralia nudicaulis	-	-	-	-	-	-
Barbarea vulgaris	-	-	-	-	-	x
Geum canadense	-	-	-	-	-	x
Satureja vulgaris	-	-	-	-	-	-
Monarda fistulosa	-	-	-	-	-	-
Osmorhiza longistylis	-	-	-	-	-	-
Podophyllum peltatum	-	-	-	-	-	-
Trillium grandiflorum	-	-	-	-	-	x
Lithospermum canescens	-	-	-	-	-	x
Taraxacum officinale	-	-	-	-	-	-
Anura sp.	-	-	-	-	Breeding	Breeding
Emydoidea blandingii	Hibernation	Hibernation	Hibernation	Hibernation/Mating	Mating	Mating (when most nesting occurs)
Chrysemys picta	Dormant	Dormant	Dormant	Dormant	pCourtship/ Mating /Basking	Courtship/ Mating /Basking

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Chelydra serpentina	Dormant	Dormant	Dormant	Dormant	Mating	Mating/ Active mostly in morning and early evening; even nocturnal.
Nerodia sipedon	-	-	-	Courtship and mating	Courtship and mating	Courtship and mating
Thamnophis sp.	Hibernation	Hibernation	Hibernation	Mating/Hibernation	Mating	-
Trionyx sp.	-	-	-	Mating	Mating	Eggs laid
Amblema costata	-	-	-	-	-	-
Elliptio dilatatus	-	-	-	-	-	-
Fusconaia flava (Raf.)	-	-	-	-	-	-
Quadrula pustulosa (Lea)	-	-	-	-	-	-
Pleurobema (cordatum) coccineum (Conrad)	-	-	-	-	-	-
Cyclonaias tuberculata	-	-	-	-	-	-
Lasmigona costata (Raf.)	-	-	-	-	-	-
Strophitus rugosus (Swain.)	-	-	-	-	-	-
Lampsilis siliquoidea (L)	-	-	-	-	-	-

Table 30. (cont'd)						
Species	January	February	March	April	May	June
Obovaria subrotunda (Raf.)	-	-	-	-	-	-
Ligumia (Recta) lattissima (Raf.)	-	-	-	-	-	-
Actinonaias carinata (Barnes)	-	-	-	-	-	-
Discus cronkhitei	-	-	-	-	-	-
Anguispira kochi	-	-	-	-	-	-
Anodonta grandis footiana (Say) Goodrich	-	-	-	-	-	-
Micromya (Villosa) Iris (Lea) Goodrich	-	-	-	-	-	-
Amblema costata (Rafinesque) Goodrich	-	-	-	-	-	-
Ligumia recta (Lamarck) Goodrich	-	-	-	-	-	-
Valvata tricarinata (Say)	-	-	-	-	-	-
Goniobasis livescens (Say)	-	-	-	-	-	-
Somatogyrus sp.	-	-	-	-	-	-
Amnicola lustrica (Pilsbry)	-	-	-	-	-	-
Lymnaea	-	-	-	-	-	-

Table 30. (cont'd)						
Species	January	February	March	April	May	June
columella (Say)						
Helisoma Campanulatum	-	-	-	-	-	-
Stenotrema monodon (Racket)	-	-	-	-	-	-
Mesodon thyroidus (Say)	-	-	-	-	-	-
Triodopsis albolabris (Say)	-	-	-	-	-	-
Triodopsis multilineata (Say)	-	-	-	-	-	-
Anguispira alternata	-	-	-	-	-	-
Anguispira solitaria (Say)	-	-	-	-	-	-
Helicodiscus parallelus (Say)	-	-	-	-	-	-
Haplotrema concavium (Say)	-	-	-	-	-	-
Mesomphix cuprea (Say)	-	-	-	-	-	-
Amnicola Limosa (Say)	-	-	-	-	-	-
Pomatiopsis lapidaria (Say)	-	-	-	-	-	-
Lymnaea (Staginicola)	-	-	-	-	-	-

Table 30. (cont'd)						
Species	January	February	March	April	May	June
palustris (Say)						
Helisoma trivolvis (Say)	-	-	-	-	-	-
Retinella rhoadsi (Pilsbry)	-	-	-	-	-	-
Succinea ovalis (Say)	-	-	-	-	-	-
Campeloma decisum (Say)	-	-	-	-	-	-
Helisoma anceps (Conrad)	-	-	-	-	-	-
Zonitidae	-	-	-	-	-	-
Pelecypoda	-	-	-	-	-	-

Table 31. Resource schedule detail July – December

Species	July	August	September	October	November	December
<i>Cervus canadensis</i>	-	Courtship	Rutting season	Rutting season	-	-
<i>Odocoileus virginianus</i>	-	-	Mating	Mating	Mating	-
<i>Procyon lotor</i>	-	-	-	-	-	Winter dormancy
<i>Ursus americanus</i>	-	-	(Mating? 210 day gestation)	-	-	Winter dormancy
<i>Castor canadensis</i>	-	-	-	-	-	-
<i>Ondatra zibethicus</i>	Litter production	Litter production	Litter production	-	-	-
<i>Canis sp. (lupus, familiaris)</i>	-	-	-	-	-	-
<i>Martes americana</i>	Courtship	Courtship/birth	Birth	Birth	Birth	Birth
<i>Marmota monax</i>	Active morning, afternoon (mother is rid of offspring)	Active morning, afternoon		-	-	Hibernation
<i>Mustela vison</i>	-	-	-	-	-	-
<i>Lynx rufus</i>	-	(?) Breeding	-	-	-	-
<i>Erethizon dorsatum</i>	-	-	-	-	Courtship, mating	Courtship, mating
<i>Lontra canadensis</i>	-	-	-	-	-	-
<i>Martes pennanti</i>	-	-	-	-	-	-
<i>Sciurus sp.</i>	Litter production	Litter production	-	-	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>Leporidae sp.</i> (<i>Sylvilagus</i>)	Mating/birth	Birth	-	-	-	-
<i>Vulpes fulva</i>	-	-	Autumn movement	Autumn movement	-	Mating
<i>Alces alces</i>	-	-	Rutting/ mating	Rutting/ mating	Rutting/ mating	Rutting/ mating
<i>Blarina sp.</i>	Mating/ pregnancies/ litters	Mating/ pregnancies/ litters	Mating/ pregnancies/ litters	-	-	-
<i>Tamias sp.</i>	Litter production; Less common in the wildlife community	Litter production, less common in the wildlife community	-	-	Retreat to winter quarters	-
<i>Muridae sp.</i>	-	-	-	-	-	-
<i>Peromyscus sp.</i>	Reduction of population	Reduction of population	Mating	Birth of litter	-	Little to no activity
<i>Microtus sp.</i>	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding
<i>Acipenser fulvescens</i>	-	-	-	-	-	-
<i>Perca flavescens</i>	-	-	-	-	-	-
<i>Amia calva</i>	-	-	-	-	-	-
<i>Aplodinotus grunniens</i>	-	-	-	-	-	-
<i>Monroe chrysops</i>	-	-	-	-	-	-
<i>Micropterus salmoides</i>	-	-	-	-	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>Micropterus dolomieu</i>	-	-	-	-	-	-
<i>Esox lucius</i>	-	-	-	-	-	-
<i>Stizostedion vitreum</i>	-	-	-	-	-	-
<i>Ictalurus punctatus</i>	Nesting/eggs laid	-	-	-	-	-
<i>Lepisosteus oculatus</i>	-	-	-	-	-	-
<i>Salvelinus namaycush</i>	-	-	-	-	-	-
<i>Ictalurus melas</i>	-	-	-	-	-	-
<i>Ictalurus natalis</i>	Spawn/nest	Spawn/nest	Spawn/nest	-	-	-
<i>Ictalurus nebulosus</i>	Spawn	-	-	-	-	-
<i>Moxostoma</i> sp. (<i>macrolepidotum</i>)	-	-	-	-	-	-
<i>Pomoxis</i> sp.	-	-	-	-	-	-
<i>Catostomus</i> sp. (<i>catostomus</i> , <i>commersoni</i>)	-	-	-	-	-	-
<i>Centrarchidae</i>	Spawn	Spawn	-	-	-	-
<i>Lepomis</i> cf. <i>macrochirus</i>	-	-	-	-	-	-
<i>Pomoxis nigromaculatus</i>	-	-	-	-	-	-
<i>Stizostedion canadense</i>	-	-	-	-	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>Lota lota lacustris</i>	-	-	-	-	-	Spawn
<i>Ectopistes migratorius</i>	Nesting/eggs hatched	Nesting/eggs laid	Migrating out of Michigan	Migrating out of Michigan	-	-
<i>Anas discors</i>	-	-	Migrates out of Michigan	-	-	-
<i>Anas americana</i>	-	-	Returns to Michigan	-	-	Leaves Michigan to go south
<i>Anas platyrhynchos</i>	-	-	Migrates south out of Michigan	Migrates south out of Michigan	-	-
<i>Aythya collaris</i>	-	-	Migrates south out of Michigan	Migrates south out of Michigan	-	-
<i>Mergus merganser</i>	-	-	Found on ponds, streams, shores	Found on ponds, streams, shores	-	-
<i>Mergus serrator</i>	-	-	Migrates south into middle or our of Michigan	Migrates south into middle or out of Michigan	-	-
<i>Gavia immer</i>	-	-	-	-	-	-
<i>Podilymbus podiceps</i>	-	-	-	-	-	Absent
<i>Meleagris gallopavo</i>	-	-	-	-	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>Lophodytes cucullatus</i>	-	-	-	-	-	Open running waters
<i>Corvus brachyrhynchos</i>	-	-	-	-	Migrate out of Michigan	-
<i>Botaurus lentiginosus</i>	-	-	-	-	-	Migrates out of Michigan
<i>Ardea herodias</i>	-	-	-	-	Migrates out of Michigan	Migrates out of Michigan
<i>Grus canadensis</i>	-	-	-	-	-	-
<i>Aythya marila</i>	Nesting	Nesting	-	-	Migration south	Migration south
<i>Bubo virginianus</i>	-	-	-	-	-	-
<i>Chenopodium</i>	-	x	x	x	-	-
<i>Zea mays</i>						
<i>Iva annua</i>	-	x	x	x	-	-
<i>Carex sp.</i>	x	x	x	-	-	-
<i>Cyperus</i>	x	x	x	-	-	-
<i>Zizania aquatica</i>	x	x	x	-	-	-
<i>Quercus</i>	-	-	Fruit/nut	Fruit/nut	-	-
<i>Carya</i>	-	-	-	Fruit/nut	-	-
<i>J. cinerea</i>						
<i>Juglans nigra</i>						
<i>Corylus</i>	-	Nut	Nut	-	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>americana</i>						
<i>Castanea dentata</i>	Flowers	Nut	Nut	Nut	-	-
<i>Cucurbita pepo</i>	-	Fruit	Fruit	-	-	-
<i>Amphicarpaea bracteata</i>	-	Fruit	Fruit	Fruit	-	-
<i>Geranium maculatum</i>	-	Fruit	Fruit	Fruit	-	-
<i>Pyrus sp.</i>						
<i>Physalis</i>	-	Fruit	Fruit	Fruit	-	-
<i>Convolvulaceae</i>	-	Fruit	Fruit	Fruit	-	-
<i>Brassicaceae sp.</i>	Fruit	Fruit	-	-	-	-
<i>Fragaria virginiana</i>						
<i>Galium aparine</i>	Fruit	Fruit	-	-	-	-
<i>Helianthus divaricatus</i>	Fruit	Fruit	Fruit	Fruit	-	-
<i>Polygala senega</i>	Fruit	Fruit	Fruit	-	-	-
<i>Rubus occidentalis</i>						
<i>Celtis occidentalis</i>	-	-	Nut	Nut	-	-
<i>Vitis sp.</i>	Fruit	-	-	-	-	-
<i>Crataegus sp.</i>						
<i>Viburnum sp.</i>	x	-	-	-	-	-
<i>Rhus sp</i>	Fruit	Fruit	-	-	-	-
<i>Polygonum pennsylvanicum</i>	x	x	x	-	-	-
<i>Prunus spp.</i>	-	x	x	x	-	-
<i>Sambucus</i>	x	x	-	-	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>canadensis</i>						
<i>Prunus serotina</i>						
<i>Amelanc</i> (<i>Amelanchier</i> <i>Medikus</i>)	x	x	-	-	-	-
<i>Aster cordifolius</i>	-	x	x	x	-	-
<i>Sassafras albidum</i>	-	-	Fruit	Fruit	-	-
<i>Hypericum</i>	x	x	x	-	-	-
<i>Cornus rugosa</i>	x	-	-	-	-	-
<i>Gaylussacia</i> <i>baccata</i>	-	-	-	-	-	-
<i>Lamiaceae</i>	x	x	x	-	-	-
<i>Rosa palustris</i>	x	x	-	-	-	-
<i>Pinus</i>	-	-	-	-	-	-
<i>Fraxinus alba</i>	-	-	-	-	-	-
<i>P. resinosa</i>	-	-	-	-	-	-
<i>P. strobus</i>	-	-	-	-	-	-
<i>Ulmus rubra</i>	-	-	-	-	-	-
<i>Ulmus</i> sp.	-	-	-	-	-	-
<i>Cercis canadensis</i>	Fruit/Legume	-	-	-	-	-
<i>Tilia americana</i>	Flowers	-	-	Nut	-	-
<i>Q. nigra</i>	-	-	-	Fruit/nut	-	-
<i>Q. bicolor</i>	-	-	Fruit/nut	Fruit/nut	-	-
<i>Q. rubra</i>	-	-	Fruit/nut	Fruit/nut	-	-
<i>Populus</i> <i>tremuloides</i>	-	-	-	-	-	-
<i>Carya laciniata</i>	-	-	-	Fruit/nut	-	-
<i>Carya ovata</i>	-	-	-	Fruit/nut	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>Cornus racemosa</i>	x	-	-	-	-	-
<i>Fagus americana</i>	-	-	Nut	Nut	-	-
<i>Ostraya virginiana</i>	-	-	-	-	-	-
<i>Fraxinus sp</i>	-	-	-	-	-	-
<i>Fagus grandifolia</i>						
<i>Acer spp.</i>						
<i>Betula spp.</i>	-	-	-	-	-	-
<i>Morus rubra</i>						
<i>Platanus occidentalis</i>	-	-	-	Fruit	-	-
<i>Picea</i>	-	-	-	-	-	-
<i>Typha</i>	-	-	-	-	-	-
<i>Rumex spp.</i>	x	x	x	-	-	-
<i>Panicum spp.</i>	x	-	-	-	-	-
<i>Silphium terebinthinaceum</i>	x	x	x	-	-	-
<i>Smilacina racemosa</i>	-	-	-	-	-	-
<i>Smilacina stellata</i>	-	-	-	-	-	-
<i>Maianthemum canadense</i>	x	-	-	-	-	-
<i>Onoclea Sensibilis</i>	-	-	-	-	-	-
<i>Poa pratensis</i>	x	x	x	-	-	-
<i>Smilax lasioneura</i>	-	-	-	Fruit	Fruit	-
<i>Solidago Sp.</i>	x	x	x	-	-	-
<i>Thalictrum dioicum</i>	x	-	-	-	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>Viola pensylvanica</i>	-	-	-	-	-	-
<i>Viola sororia</i> (Sens. Lat.) (Glabrous plants like this one have been referred to <i>V. Papilionacea</i>)	-	-	-	-	-	-
<i>Zanthoxylum americanum</i>	-	Fruit	Fruit	-	-	-
<i>Lilium michiganense</i>	x	-	-	-	-	-
<i>Lysimachia ciliata</i>	x	x	-	-	-	-
<i>Carex blanda</i>	x	x	x	-	-	-
<i>Carex lupulina</i>	x	x	x	-	-	-
<i>Carex pensylvanica</i>	x	x	x	-	-	-
<i>Smilax cirrata</i>	-	-	-	Fruit	Fruit	-
<i>Toxicodendron radicans</i>	-	Fruit	Fruit	-	-	-
<i>Apocynum androsaemifolium</i>	-	x	x	x	-	-
<i>Aquilegia canadensis</i>	x	-	-	-	-	-
<i>Aralia nudicaulis</i>	x	x	-	-	-	-
<i>Barbarea vulgaris</i>	x	-	-	-	-	-
<i>Geum canadense</i>	x	-	-	-	-	-
<i>Satureja vulgaris</i>	-	x	x	x	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>Monarda fistulosa</i>	-	x	x	x	-	-
<i>Osmorhiza longistylis</i>	-	x	x	x	-	-
<i>Podophyllum peltatum</i>	-	x	x	x	-	-
<i>Trillium grandiflorum</i>	x	-	-	-	-	-
<i>Lithospermum canescens</i>	x	-	-	-	-	-
<i>Taraxacum officinale</i>	-	x	x	x	-	-
<i>Anura</i> sp.	Breeding	Tadpoles	-	-	-	-
<i>Emydoidea blandingii</i>	Mating	Mating- most hatchlings emerge	Mating – most hatchlings emerge	Mating/Hibernation	Mating/Hibernation	Hibernation
<i>Chrysemys picta</i>	Courtship/Mating Basking	Courtship/ Mating /Basking	Courtship/ Mating /Basking	Dormant	Dormant	Dormant
<i>Chelydra serpentina</i>	Mating/ Active mostly in morning and early evening; even nocturnal.	Mating/ Active mostly in morning and early evening; even nocturnal.	Mating	Mating	Dormant	Dormant
<i>Nerodia sipedon</i>	-	Litter production	Litter production	-	-	-

Table 31. (cont'd)						
Species	July	August	September	October	November	December
<i>Thamnophis sp.</i>	-	Litter production	Litter production	Hibernation	Hibernation	Hibernation
<i>Trionyx sp.</i>	Eggs laid	Hatchlings emerge	Hatchlings emerge	-	-	-

Table 32. Resource schedule summary												
Resource	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Nuts												
Chestnut										X		
Shagbark hickory										X		
Hazel								X	X			
Beech										X		
Black walnut										X		
Butternut										X		
Oak									X	X		
Bush fruit												
Juneberry							X	X				
Wild strawberry					X	X						
Teaberry								X	X			
Black huckleberry							X	X				
Mayapple							X	X				
Currant, gooseberry							X	X	X			
Raspberry, blackberry, dewberry							X	X				
Elderberry									X	X		
Red berried elder						X	X					
False Solomon's seal								X	X	X		
Blueberry							X	X	X			
High bush cranberry, sheepberry								X	X			
Grape								X	X	X		
Tree fruit												
Hackberry									X	X		
Hawthorn									X	X		
Black cherry								X	X			
Tubers												

Table 32. (cont'd)												
Resource	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Wild onion				X					X	X		
Wild leek				X				X	X			
Meadow garlic					X	X						
Groundnut				X	X							
Rosary root				X	X							
Jack-in-the-pulpit				X	X				X	X		
Spring beauty				X	X	X						
Pepperroot				X	X							
Cow parsnip				X	X							
Crow potato									X	X		
American lotus					X				X	X		
Pond lily									X	X		
Solomon's seal								X	X			
Arrowhead, Wapato									X	X		
Wapato									X	X		
Bulrush				X				X	X			
False Solomon's seal								X	X			
Greenbriar						X	X	X				
Skunk cabbage								X	X			
Cattail								X	X			
Greens												
Common Milkweed				X	X	X						
Aster						X	X					
Butterflyweed				X	X	X						
Marsh marigold				X	X							
Goosefoot, etc.					X	X						
Cow parsnip				X	X							
Wood sorrels				X	X	X						
Cress					X	X						
Bulrush					X	X						

Table 32. (cont'd)												
Resource	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Sedge				?	?	?						
Weed seeds											X	X
Pigweed, etc.										X	X	
Tree sap												
Sugar Maple			X	X								
Mussel					X	X	X	X	X			
Aquatic Turtle					X	X	X	X	X			
Waterfowl	X	X										
Squirrel	X	X	X	X	X	X	X	X	X	X	X	X
Rabbit	X	X	X	X	X	X	X	X	X	X	X	X
Pigeon				X	X				X	X		
Fish	X	X	X	X	X	X	X	X	X	X	X	X
Bear	X	X	X	X	X	X	X	X	X	X	X	X
Beaver	X	X	X	X	X	X	X	X	X	X	X	X
Deer	X	X	X	X	X	X	X	X	X	X	X	X
Elk	X	X	X								X	X
Raccoon												
Muskrat	X	X	X	X	X	X	X	X	X	X	X	X
Woodchuck	X	X	X	X	X	X	X	X	X	X	X	X

Table 33. Resource usability modified from (Egan 1993)		
Resource	% Useable	Reference
Bear	70	estimate
Beaver	70	White (1953)
Deer	65	Footo (1965, Binford (1978)
Elk	65	-
Fish	88	Hoygaard (1941)
Fisher	70	estimate
Muskrat	70	White (1953)
Passenger Pigeon	75	estimate
Raccoon	70	White (1953)
Squirrel	70	White (1953)
Turtle	50	Clark and Southall (1920)
Waterfowl	80	Hoygaard (1941)
*Estimates of White have been increased to account for complete use of the animal, including the viscera (However, note Stewart and Stahl 1977).		
*Figures for deer and elk are based on caribou.		

Appendix C: Archaeology

Archaeology

Sites Summary

Table 34. Sites						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Lalone	20AC20	Arenac	Standish	Lake Huron	Late Archaic	base camp
Lalone	20AC20	Arenac	Standish	Lake Huron	Middle Woodland	camp
Potts	20AC61	Arenac	Deep River	Lake Huron	Late Archaic	undetermined
	20AC123	Arenac	Standish	Lake Huron	Late Archaic	camp
Schmidt 2-4/KERR 7	20BY1	Bay	Bangor	Lake Huron	Early Woodland	undetermined
Schmidt 2-4/KERR 7	20BY1	Bay	Bangor	Lake Huron	Late Archaic	undetermined
Schmidt 2-4/KERR 7	20BY1	Bay	Bangor	Lake Huron	Middle Woodland	undetermined
Schmidt 1-4 (Iamokia)	20BY3	Bay	Pinconning	Lake Huron	Late Archaic	village
Schmidt 1-1/Kerr 19/Lamoka	20BY16	Bay	Kawkawlin	Lake Huron	Late Archaic	camp
Schmidt 2-3/Behmlander	20BY17	Bay	Kawkawlin	Lake Huron	Late Archaic	undetermined
Schmidt 2-3/Behmlander	20BY17	Bay	Kawkawlin	Lake Huron		unknown
Fletcher/Marquette Viaduct/Defoe Park	20BY28	Bay	Bay City	Saginaw	Early Woodland	Village
Fletcher/Marquette Viaduct/Defoe Park	20BY28	Bay	Bay City	Saginaw	Late Archaic	Village

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Fletcher/Marquette Viaduct/Defoe Park	20BY28	Bay	Bay City	Saginaw	Middle Woodland	village
Butterfield/ Schmidt 5-1/ Paul Wendeloski/ 20BY5/ 20BY74	20BY29	Bay	Pinconning	Lake Huron	Late Archaic	camp
Kantzler	20BY30	Bay	Bay City	Saginaw	Early Woodland	fishing camp
Kantzler	20BY30	Bay	Bay City	Saginaw	Late Archaic	fishing camp
Kantzler	20BY30	Bay	Bay City	Saginaw	Middle Woodland	hunting camp
Boy Scout Cabin	20BY35	Bay	Monitor	Lake Huron	Early Woodland	undetermined
Boy Scout Cabin	20BY35	Bay	Monitor	Lake Huron	Late Archaic	undetermined
Boy Scout Cabin	20BY35	Bay	Monitor	Lake Huron	Middle Woodland	undetermined
Schmidts 1-5	20BY46	Bay	Kawkawlin	Lake Huron	Late Archaic	undetermined
Surath's Junk Yard	20BY77	Bay	Bay City	Saginaw	Middle Woodland	camp
Third Street Bridge	20BY79	Bay	Bay City	Saginaw	Late Archaic	fall camp
Third Street Bridge	20BY79	Bay	Bay City	Saginaw	Middle Woodland	undetermined
Schmidt 2-9	20BY84	Bay	Kawkawlin	Lake Huron	Late Archaic	unknown
Schmidt 2-9	20BY84	Bay	Kawkawlin	Lake Huron		undetermined
W.N. Schmidt	20BY92	Bay	Beaver	Lake Huron	Late Archaic	camp
W.N. Schmidt	20BY92	Bay	Beaver	Lake Huron	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Meier/PFUND	20BY94	Bay	Monitor	Saginaw	Late Archaic	camp
McMillan	20BY96	Bay	Monitor	Lake Huron	Late Archaic	camp
McMillan	20BY96	Bay	Monitor	Lake Huron	Early Woodland	camp
Kerr 20	20BY133	Bay	Kawkawlin	Lake Huron	Late Archaic	camp
Kerr 20	20BY133	Bay	Kawkawlin	Lake Huron	Late Archaic	cremation
Crow Island West	20BY153	Bay	Frankenlust	Saginaw	Late Archaic	camp
Ubu's Booboo/ Tobico #84	20BY314	Bay	Bangor	Lake Huron	Middle Woodland	camp
Doan/ Schuman	20BY159	Bay	Bangor	Lake Huron	Late Archaic	camp
Jahrman Ranch	20BY161	Bay	Hampton	Saginaw	Early Woodland	camp
Jahrman Ranch	20BY161	Bay	Hampton	Saginaw	Late Archaic	camp
Dutch Creek	20BY200	Bay	Frankenlust	Saginaw	Middle Woodland	camp
	20BY219	Bay	Frankenlust	Saginaw	Late Archaic	unknown
Parish West	20BY246	Bay	Kawkawlin	Lake Huron	Late Archaic	camp
Schmidt Trail	20BY247	Bay	Kawkawlin	Lake Huron	Late Archaic	camp
Tobico #63	20BY263	Bay		Lake Huron	Middle Woodland	camp
Halm's Find	20BY292	Bay	Kawkawlin	Lake Huron	Middle Woodland	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Expatriot/ Tobico #78	20BY308	Bay	Bangor	Lake Huron	Middle Woodland	camp
Joel's Jagged Edge/ Tobico #82	20BY312	Bay	Bangor	Lake Huron	Middle Woodland	camp
Viaduct South	20BY387	Bay	Bay City	Saginaw	Early Woodland	camp
Viaduct South	20BY387	Bay	Bay City	Saginaw	Late Archaic	camp/ cemetery
	20BY388	Bay	Frankenlust	Saginaw	Early Woodland	camp
	20BY388	Bay	Frankenlust	Saginaw	Late Archaic	camp
	20BY400	Bay	Frankenlust	Saginaw	Early Woodland	camp
Kelley	20CL2	Clinton	Duplain	Grand	Late Archaic	camp
Cobbs Farm	20CL3	Clinton	Duplain	Grand	Middle Woodland	mound group
Beckworth Site No. 21	20CL56	Clinton	Victor	Grand	Late Archaic	base camp
Beckworth Site No. 21	20CL56	Clinton	Victor	Grand	Middle Woodland	base camp
Hinkley	20CL75	Clinton	Duplain	Grand	Late Archaic	undetermined
Hinkley	20CL75	Clinton	Duplain	Grand	Middle Woodland	undetermined
Leonard LGR-79-5	20CL95	Clinton	Victor	Grand	Late Archaic	camp
Bean 1 LGR-79-6	20CL96	Clinton	Watertown	Grand	Late Archaic	activity area
Lerg LBR-79-9	20CL99	Clinton	Dewitt	Grand	Early Woodland	base camp
Lerg LBR-79-9	20CL99	Clinton	Dewitt	Grand	Late Archaic	base camp
Oliver 1 LGR-79-10	20CL100	Clinton	Watertown	Grand	Early Woodland	base camp
Oliver 1 LGR-79-10	20CL100	Clinton	Watertown	Grand	Late Archaic	base camp
Oliver 1 LGR-79-10	20CL100	Clinton	Watertown	Grand	Middle Woodland	base camp
Openlander LGR-79-12	20CL102	Clinton	Watertown	Grand	Late Archaic	activity area
Baker LGR-79-17	20CL105	Clinton	Victor	Grand	Late Archaic	camp
Baker LGR-79-17	20CL105	Clinton	Victor	Grand	Middle Woodland	camp
Bower LGR-79-25	20CL110	Clinton	Bath	Grand	Late Archaic	activity area

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
High Grass	20CL147	Clinton	Dewitt	Grand	Early Woodland	undetermined
High Grass	20CL147	Clinton	Dewitt	Grand	Late Archaic	undetermined
Lerg	20CL148	Clinton	Olive	Grand	Late Archaic	camp
Cloddy	20CL153	Clinton	Olive	Grand	Late Archaic	undetermined
Steinhardt	20CL224	Clinton	Dewitt	Grand	Early Woodland	undetermined
Steinhardt	20CL224	Clinton	Dewitt	Grand	Late Archaic	undetermined
Hufnagel	20CL231	Clinton	Bingham	Grand	Late Archaic	undetermined
Thelen	20CL235	Clinton	Westphalia	Grand	Late Archaic	undetermined
Thelen	20CL235	Clinton	Westphalia	Grand		undetermined
Smith	20CL236	Clinton	Riley	Grand	Late Archaic	undetermined
Goerge Find spot	20CL241	Clinton	Lebanon	Grand	Late Archaic	undetermined
Bull Dog 1	20CL276	Clinton	Greenbush	Grand	Late Archaic	camp
Bull Dog 2	20CL277	Clinton	Greenbush	Grand	Late Archaic	camp
Badder	20CL284	Clinton	Eagle	Grand	Late Archaic	undetermined
Badder	20CL284	Clinton	Eagle	Grand	Middle Woodland	undetermined
Badder	20CL284	Clinton	Eagle	Grand		undetermined
James Stout	20GS101	Genesee	Montrose	Flint	Late Archaic	undetermined
Butler	20GS104	Genesee	Grand Blanc	Flint	Late Archaic	undetermined
Hachtel D	20GS107	Genesee	Grand Blanc	Flint	Late Archaic	undetermined
Harmon	20GS109	Genesee	Thetford	Flint	Early Woodland	undetermined
Harmon	20GS109	Genesee	Thetford	Flint	Late Archaic	undetermined
Harmon	20GS109	Genesee	Thetford	Flint	Middle Woodland	undetermined
Pine Grove Cemetery	20GS28	Genesee	Davison	Flint	Late Archaic	camp
Mott Lake	20GS30	Genesee	Genesee	Flint	Late Archaic	camp
Gainey	20GS49	Genesee	Grand Blanc	Flint	Late Archaic	undetermined
Warner School	20GS6	Genesee	Flint	Flint	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
No Name	20GS63	Genesee	Fenton	Shiawassee	Late Archaic	cemetery
Kozel	20GS76	Genesee	Flushing	Flint	Late Archaic	habitation
Van Sickle	20GS77	Genesee	Fenton	Shiawassee	Late Archaic	undetermined
No Name	20GS78	Genesee	Argentine	Shiawassee	Late Archaic	cemetery
No Name	20GS84	Genesee	Montrose	Flint	Middle Woodland	undetermined
Barber	20GS91	Genesee	Montrose	Flint	Late Archaic	undetermined
Barber	20GS91	Genesee	Montrose	Flint		undetermined
Kish	20GS93	Genesee	Montrose	Flint	Late Archaic	camp
No Name	20GS96	Genesee	Montrose	Flint	Late Archaic	undetermined
No Name	20GS97	Genesee	Montrose	Flint	Middle Woodland	undetermined
No Name	20GS98	Genesee	Montrose	Flint	Middle Woodland	undetermined
Dehaan	20GW3	Gladwin	Hay	Tittabawassee	Late Archaic	undetermined
Kantiz GR-1	20GR13	Gratiot	Arcada	Tittabawassee	Middle Woodland	camp
Sutherland GR-11	20GR23	Gratiot	Sumner	Tittabawassee	Middle Woodland	undetermined
Pine River Park, Conservation Park GR-13	20GR33	Gratiot	Arcada	Tittabawassee	Late Archaic	winter camp
MLP2-20	20GR105	Gratiot	Wheeler	Shiawassee	Early Woodland	camp
MLP2-20	20GR105	Gratiot	Wheeler	Shiawassee	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Louis Thaller	20GR163	Gratiot	Seville	Tittabawassee	Late Archaic	camp
Powelson 3	20GR183	Gratiot	Hamilton	Shiawassee	Early Woodland	undetermined
Powelson 3	20GR183	Gratiot	Hamilton	Shiawassee	Late Archaic	camp
Powelson 4	20GR184	Gratiot	Hamilton	Shiawassee	Late Archaic	lithic scatter
Burk 8E	20GR200	Gratiot	Elba	Shiawassee	Early Woodland	camp
Burk 8E	20GR200	Gratiot	Elba	Shiawassee	Late Archaic	camp
Burk 8E	20GR200	Gratiot	Elba	Shiawassee	Middle Woodland	undetermined
Burk 8W	20GR201	Gratiot	Elba	Shiawassee	Early Woodland	camp
Burk 8W	20GR201	Gratiot	Elba	Shiawassee	Late Archaic	camp
Burk 65	20GR210	Gratiot	Elba	Shiawassee	Late Archaic	undetermined
	20GR230	Gratiot	Hamilton	Shiawassee	Middle Woodland	
	20GR250	Gratiot	Elba	Shiawassee	Late Archaic	findspot
	20GR254	Gratiot	Layfayette	Shiawassee	Late Archaic	lithic scatter

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
A. Derry Burk 96	20GR258	Gratiot	Hamilton	Shiawassee	Late Archaic	lithic scatter
Burk 116	20GR267	Gratiot	Hamilton	Shiawassee	Late Archaic	lithic scatter
Bay Port village	20HU1	Huron	Fairhaven	Lake Huron	Early Woodland	undetermined
Bay Port village	20HU1	Huron	Fairhaven	Lake Huron		village
	20HU4	Huron	Fairhaven	Lake Huron	Early Woodland	camp
	20HU107	Huron	Fairhaven	Lake Huron	Early Woodland	camp
Oak Point	20HU149	Huron	Caseville	Lake Huron	Late Archaic	undetermined
Melssner-Aumann	20HU150	Huron	Sebewaing	Sebewaing	Late Archaic	camp
Jahr 2	20HU152	Huron	Sebewaing	Sebewaing	Late Archaic	camp
Goodwin-Gresham	20IS8	Iosco	Oscoda	Au Sable	Middle Woodland	fishing village
Brandt 1	20IS46	Iosco	Oscoda	Au Sable	Late Archaic	cemetery
Shellenbarger/ Probably part of 20IS23	20IS66	Iosco	Au Sable	Au Sable	Late Archaic	undetermined
Shellenbarger/ Probably part of 20IS23	20IS66	Iosco	Au Sable	Au Sable		undetermined
	20IS67	Iosco	Tawas	Lake Huron	Late Archaic	undetermined
Semeyn III/ USFS 09-04-06-076	20IS84	Iosco	Oscoda	Au Sable	Late Archaic	camp
	20IS87	Iosco	Oscoda	Au Sable	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
	20IS93	Iosco	Oscoda	Au Sable	Late Archaic	undetermined
	20IS98	Iosco	Oscoda	Au Sable	Late Archaic	camp
Cooke South-1-25	20IS125	Iosco	Oscoda	Au Sable	Middle Woodland	camp
Foote South-1-7	20IS140	Iosco	Oscoda	Au Sable	Middle Woodland	camp
Old Orchard Park	20IS173	Iosco	Oscoda	Au Sable	Middle Woodland	camp
	20IS175	Iosco	Oscoda	Au Sable	Late Archaic	undetermined
	20IS178	Iosco	Oscoda	Au Sable	Middle Woodland	camp
Eagle Hill	20IS241	Iosco	Oscoda	Au Sable	Late Archaic	undetermined
Van Etten Creek	20IS242	Iosco	Oscoda	Lake Huron	Middle Woodland	camp
USFS 09-04-06-185	20IS246	Iosco	Oscoda	Au Sable	Late Archaic	camp
USFS 09-04-06-185	20IS246	Iosco	Oscoda	Au Sable	Middle Woodland	camp
Zeigler	20IB29	Isabella	Nottawa	Tittabawassee	Late Archaic	findspot
	20LP6	Lapeer	Goodland	Flint	Late Archaic	undetermined
	20LP6	Lapeer	Goodland	Flint		undetermined
Wim Hughes	20LP7	Lapeer	Goodland	Flint	Late Archaic	camp
Hodge	20LP8	Lapeer	Goodland	Flint	Late Archaic	camp
Hodge	20LP8	Lapeer	Goodland	Flint		camp
	20LP9	Lapeer	Burnside	Flint	Late Archaic	camp
	20LP11	Lapeer	North Branch	Flint	Late Archaic	camp
Horeck 1	20LP12	Lapeer	North Branch	Flint	Late Archaic	camp
Swoish	20LP13	Lapeer	North Branch	Flint	Late Archaic	camp
Swoish	20LP13	Lapeer	North Branch	Flint		camp
Slobodnski	20LP14	Lapeer	North Branch	Flint	Late Archaic	camp
	20LP17	Lapeer	Burnside	Flint	Late Archaic	camp
Kesselring	20LP19	Lapeer	North Branch	Flint	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Wilbur 1	20LP22	Lapeer	Goodland	Flint	Late Archaic	camp
Wilbur 1	20LP22	Lapeer	Goodland	Flint		camp
Ankley	20LP23	Lapeer	Burnside	Flint	Late Archaic	camp
	20LP28	Lapeer	Burnside	Flint	Late Archaic	undetermined
Leo Csaike	20LP30	Lapeer	Burnside	Flint	Late Archaic	camp
Ditmas Younge	20LP38	Lapeer	Burnside	Flint	Late Archaic	camp
	20LP52	Lapeer	Burnside	Flint	Late Archaic	camp
Holland 2	20LP65	Lapeer	North Branch	Flint	Late Archaic	undetermined
Holland 2	20LP65	Lapeer	North Branch	Flint		undetermined
	20LP67	Lapeer	Goodland	Flint	Late Archaic	undetermined
	20LP67	Lapeer	Goodland	Flint		undetermined
Dutch Smith	20LP86	Lapeer	Goodland	Flint	Early Woodland	camp
Helwig	20LP100	Lapeer	Lapeer	Flint	Late Archaic	undetermined
Rozanski	20LP291	Lapeer	Attica	Flint	Late Archaic	undetermined
Rozanski	20LP291	Lapeer	Attica	Flint	Middle Woodland	undetermined
Bowie	20LP16	Lapeer	Burnside	Flint	Late Archaic	camp
Ira Brown	20LP26	Lapeer	North Branch	Flint	Early Woodland	undetermined
Ira Brown	20LP26	Lapeer	North Branch	Flint	Late Archaic	undetermined
Ira Brown	20LP26	Lapeer	North Branch	Flint		undetermined
	20LP94	Lapeer	Arcadia	Flint	Late Archaic	undetermined
Giddings-upton	20LP97	Lapeer	Burlington	Flint	Late Archaic	camp
Buckingham B	20LP283	Lapeer	Attica	Flint	Late Archaic	undetermined
Stones Throw	20LP284	Lapeer	Oregon	Flint	Middle Woodland	undetermined
	20LP296	Lapeer	Lapeer	Flint	Late Archaic	camp
Brown	20LV53	Livingston	Cohoctah	Shiawassee	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Brown	20LV53	Livingston	Cohoctah	Shiawassee		undetermined
Emery Lii	20LV55	Livingston	Cohoctah	Shiawassee	Middle Woodland	undetermined
Bailey/ LCS-4	20LV108	Livingston	Hartland	Shiawassee	Late Archaic	undetermined
Wilkinson Viii/ LCS-18	20LV111	Livingston	Hartland	Shiawassee	Early Woodland	undetermined
Kuyda/ LCS-94	20LV133	Livingston	Howell	Shiawassee	Late Archaic	undetermined
Wilkinson Xvi/ LCS-26	20LV138	Livingston	Oceola	Shiawassee	Late Archaic	undetermined
Sartwell I/ LCS-46	20LV141	Livingston	Oceola	Shiawassee	Early Woodland	undetermined
Sartwell I/ LCS-46	20LV141	Livingston	Oceola	Shiawassee	Late Archaic	chipping station
1--13--019	20LV318	Livingston	Hartland	Shiawassee	Early Woodland	findspot/ ovate biface
1—13--020	20LV319	Livingston	Howell	Shiawassee	Middle Woodland	camp
Peterson Preserve Collection/ Alyce Peterson Farm	20MC78	Mecosta	Mecosta	Muskegon	Early Woodland	camp
Peterson Preserve Collection/ Alyce Peterson Farm	20MC78	Mecosta	Mecosta	Muskegon	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Peterson Preserve Collection/ Alyce Peterson Farm	20MC78	Mecosta	Mecosta	Muskegon	Middle Woodland	camp
Pomranky/ part of Cornelius' Midland 5	20MD3	Midland	Midland	Tittabawassee	Early Woodland	undetermined
Pomranky/ part of Cornelius' Midland 5	20MD3	Midland	Midland	Tittabawassee	Late Archaic	cemetery
Pomranky/ part of Cornelius' Midland 5	20MD3	Midland	Midland	Tittabawassee	Middle Woodland	undetermined
Windover Collection/ Cornelius' Midland 3, Tanner 3, County Farm	20MD13	Midland	Midland	Tittabawassee	Early Woodland	undetermined
Windover Collection/ Cornelius' Midland 3, Tanner 3, County Farm	20MD13	Midland	Midland	Tittabawassee	Late Archaic	undetermined
CNC Arboretum	20MD19	Midland	Midland	Tittabawassee	Late Archaic	undetermined
CNC Arboretum	20MD19	Midland	Midland	Tittabawassee	Early Woodland	undetermined
Orchard	20MD20	Midland	Midland	Tittabawassee	Late Archaic	undetermined
Orchard	20MD20	Midland	Midland	Tittabawassee		undetermined
Sumac Bluff	20MD25	Midland	Midland	Tittabawassee	Early Woodland	camp
Sumac Bluff	20MD25	Midland	Midland	Tittabawassee	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Area N-B/ part of Cornelius' Homer 7	20MD29	Midland	Homer	Tittabawassee	Early Woodland	camp
Naugle/ Area "N"-A, part of Cornelius' Homer 7	20MD30	Midland	Homer	Tittabawassee	Early Woodland	camp
Naugle/ Area "N"-A, part of Cornelius' Homer 7	20MD30	Midland	Homer	Tittabawassee	Late Archaic	camp
Area 2/ part of Cornelius' Homer 7	20MD31	Midland	Homer	Tittabawassee	Early Woodland	undetermined
Oxbow South 2	20MD34	Midland	Midland	Tittabawassee	Late Archaic	camp
Sias Gravel	20MD42	Midland	Midland	Tittabawassee	Early Woodland	undetermined
Coin Farm Cache	20MD45	Midland	Midland	Tittabawassee	Late Archaic	turkey tail cache
Currie West Burial/ Cornelius' Midland 12	20MD52	Midland	Midland	Tittabawassee	Late Archaic	camp
Currie West Burial/ Cornelius' Midland 12	20MD52	Midland	Midland	Tittabawassee	Middle Woodland	cemetery
Sias Flats-East	20MD57	Midland	Midland	Tittabawassee	Late Archaic	camp
Sias Flats-East	20MD57	Midland	Midland	Tittabawassee		camp
Pomranky NW/ part of Cornelius' Midland 5	20MD60	Midland	Midland	Tittabawassee	Early Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Pomranky NW/ part of Cornelius' Midland 5	20MD60	Midland	Midland	Tittabawassee	Late Archaic	camp
	20MD69	Midland	Midland	Tittabawassee	Early Woodland	undetermined
Tittabawassee River Road/ IRA SMITH, STEVENS 29	20MD74	Midland	Homer	Tittabawassee	Late Archaic	camp
Tittabawassee River Road/ IRA SMITH, STEVENS 29	20MD74	Midland	Homer	Tittabawassee		undetermined
Riggie/ Cornelius' Homer 4	20MD77	Midland	Homer	Tittabawassee	Late Archaic	undetermined
Riggie/ Cornelius' Homer 4	20MD77	Midland	Homer	Tittabawassee		undetermined
Francis Shore North B	20MD89	Midland	Edenville	Tittabawassee	Late Archaic	undetermined
Francis Shore North B	20MD89	Midland	Edenville	Tittabawassee		undetermined
Paul Shaffer/ Cornelius' Lee 11	20MD90	Midland	Lee	Tittabawassee	Late Archaic	burial
Berlin	20MD95	Midland	Lee	Tittabawassee	Early Woodland	undetermined
Berlin	20MD95	Midland	Lee	Tittabawassee	Middle Woodland	undetermined
Geneva 1	20MD100	Midland	Geneva	Tittabawassee	Early Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Geneva 1	20MD100	Midland	Geneva	Tittabawassee	Late Archaic	camp
Geneva 1	20MD100	Midland	Geneva	Tittabawassee	Middle Woodland	camp
	20MD110	Midland	Porter	Tittabawassee	Late Archaic	camp
Big Mapleton	20MD116	Midland	Ingersoil	Tittabawassee	Late Archaic	camp
Porter 1	20MD124	Midland	Porter	Tittabawassee	Early Woodland	camp
Porter 1	20MD124	Midland	Porter	Tittabawassee	Late Archaic	camp
	20MD141	Midland	Larkin	Tittabawassee	Middle Woodland	undetermined
	20MD151	Midland	Jerome	Tittabawassee	Middle Woodland	undetermined
	20MD151	Midland	Jerome	Tittabawassee		undetermined
	20MD152	Midland	Jerome	Tittabawassee	Early Woodland	undetermined
	20MD152	Midland	Jerome	Tittabawassee	Middle Woodland	undetermined
Piggot Farm/ Cornelius' Jerom 2	20MD154	Midland	Jerome	Tittabawassee	Late Archaic	undetermined
Geisler	20MD164	Midland	Midland	Tittabawassee	Early Woodland	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Pine River Bridge/ Tanner 6	20MD189	Midland	Homer	Tittabawassee	Early Woodland	undetermined
Pomranky 2/ part of Cornelius' Midland 5	20MD191	Midland	Midland	Tittabawassee	Middle Woodland	undetermined
	20MD223	Midland	Ingersoil	Tittabawassee	Middle Woodland	undetermined
Smiths Crosing/ STEVENS 4	20MD234	Midland	Ingersoil	Tittabawassee	Late Archaic	camp
Turner Sand	20MD239	Midland	Mount Haley	Tittabawassee	Late Archaic	undetermined
Heritage Arms Apartments	20MD241	Midland	Midland	Tittabawassee	Early Woodland	undetermined
Maxwell ridge	20MD244	Midland	Hope	Tittabawassee	Early Woodland	undetermined
Edenville/ Fred Stevens' 11	20MD258	Midland	Edenville	Tittabawassee	Late Archaic	camp
Sias River East/ 85 West	20MD263	Midland	Midland	Tittabawassee	Middle Woodland	camp
Porter 18	20MD275	Midland	Porter	Tittabawassee	Early Woodland	undetermined
Porter 22	20MD278	Midland	Porter	Tittabawassee	Early Woodland	undetermined
Porter 22	20MD278	Midland	Porter	Tittabawassee	Middle Woodland	undetermined
	20MD299	Midland	Jerome	Tittabawassee	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
	20MD300	Midland	Jerome	Tittabawassee	Early Woodland	undetermined
Prarie Creek/ Cornelius' Lee 3	20MD322	Midland	Lee	Tittabawassee	Middle Woodland	undetermined
Grose/ Cornelius' Lee 5, Bear Track rock	20MD323	Midland	Lee	Tittabawassee	Early Woodland	undetermined
Grose/ Cornelius' Lee 5, Bear Track rock	20MD323	Midland	Lee	Tittabawassee	Late Archaic	habitation
Grose/ Cornelius' Lee 5, Bear Track rock	20MD323	Midland	Lee	Tittabawassee	Middle Woodland	undetermined
H. Mashue Collection/ Cornelius' Lee 6	20MD324	Midland	Lee	Tittabawassee	Late Archaic	undetermined
H. Mashue Collection/ Cornelius' Lee 6	20MD324	Midland	Lee	Tittabawassee		undetermined
Lee 9	20MD325	Midland	Lee	Tittabawassee	Late Archaic	camp
Denet Sand	20MD363	Midland	Midland	Tittabawassee	Early Woodland	undetermined
Coin Farm 2/ Tanner 1, Cornelius' Greendale 3	20MD364	Midland	Midland	Tittabawassee	Late Archaic	camp
Kaiser/ Tanner 16	20MD379	Midland	Midland	Tittabawassee	Middle Woodland	undetermined
	20MD394	Midland	Ingersoil	Tittabawassee	Late Archaic	camp
Noack Copper/ Eugene Knapp, Cornelius' Lee 15	20MD443	Midland	Lee	Tittabawassee	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Mount Haley 4	20MD448	Midland	Mount Haley	Tittabawassee	Late Archaic	undetermined
Smith	20MD453	Midland	Edenville	Tittabawassee	Middle Woodland	camp
Aldrich	20MD478	Midland	Porter	Tittabawassee	Late Archaic	camp
East Oxbow	20MD490	Midland	Midland	Tittabawassee	Late Archaic	camp
East Oxbow	20MD490	Midland	Midland	Tittabawassee		camp
	20MD536	Midland	Edenville	Tittabawassee	Late Archaic	unknown
	20MD536	Midland	Edenville	Tittabawassee		unknown
Lincoln Pines	20ML52	Montcalm	Pierson	Muskegon	Late Archaic	undetermined
Lloyd Vergin	20OK312	Oakland	Springfield	Shiawassee	Late Archaic	undetermined
Lloyd Vergin	20OK312	Oakland	Springfield	Shiawassee	Early Woodland	undetermined
Groveland Valley	20OK372	Oakland	Groveland	Flint	Middle Woodland	undetermined
Henry	20OL22	Osceola	Osceola	Muskegon	Late Archaic	camp
Henry	20OL22	Osceola	Osceola	Muskegon	Late Archaic	camp
Zimowske	20OD5	Oscoda	Big Creek	Au Sable	Late Archaic	undetermined
Zimowske	20OD5	Oscoda	Big Creek	Au Sable	Middle Woodland	undetermined
Riopel	20OD6	Oscoda	Mentor	Au Sable	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Recreation Area/ USFS 09-04-05-122	20OD61	Oscoda	Mentor	Au Sable	Early Woodland	undetermined
Long Point	20RO39	Roscommon	Richfield	Tittabawassee	Middle Woodland	camp
Taymouth Dustin 7-6	20SA78	Saginaw	Taymouth	Flint	Late Archaic	village
Taymouth Dustin 7-6	20SA78	Saginaw	Taymouth	Flint	Early Woodland	village
French 1 Lutz 27	20SA709	Saginaw	Bridgeport	Cass	Late Archaic	camp
French 1 Lutz 27	20SA709	Saginaw	Bridgeport	Cass		camp
Simons 63	20SA720	Saginaw	Spaulding	Flint	Late Archaic	camp
Rose	20SA721	Saginaw	Spaulding	Flint	Late Archaic	camp
Rose	20SA721	Saginaw	Spaulding	Flint		camp
Clunie	20SA722	Saginaw	James	Tittabawassee	Late Archaic	undetermined
Clunie	20SA722	Saginaw	James	Tittabawassee	Middle Woodland	camp
	20SA748	Saginaw	Bridgeport	Cass	Late Archaic	camp
Pine Grove	20SA752	Saginaw	Bridgeport	Cass	Late Archaic	undetermined
Leach 3, CAI-15, 20SA2026, Leach Garden, Riverbank	20SA759	Saginaw	Taymouth	Flint	Late Archaic	camp
Leach 4, 20SA202A, CAI-14, North of Barn	20SA760	Saginaw	Taymouth	Flint	Late Archaic	camp
Sheppard 1, Simons 38-B	20SA764	Saginaw	Birch Run	Flint	Late Archaic	camp
William Kulhanck	20SA796	Saginaw	Albee	Shiawassee	Late Archaic	camp
Ernest Adams	20SA797	Saginaw	Spaulding	Flint	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Andrews	20SA8	Saginaw	saginaw	Tittabawassee	Late Archaic	camp
Foster 2	20SA82	Saginaw	Taymouth	Flint	Late Archaic	village
Foster 2	20SA82	Saginaw	Taymouth	Flint	Late Archaic	burial
Kunik Farms	20SA88	Saginaw	Albee	Flint	Late Archaic	camp
Fischer A Findspot	20SA801	Saginaw	Bridgeport	Cass	Late Archaic	undetermined
Gill	20SA807	Saginaw	Spaulding	Shiawassee	Late Archaic	base camp
Weinecke & Weiss	20SA808	Saginaw	saginaw	Tittabawassee	Middle Woodland	undetermined
Boese 1, RAI-2	20SA816	Saginaw	Spaulding	Cass	Early Woodland	undetermined
Boese 1, RAI-2	20SA816	Saginaw	Spaulding	Cass	Late Archaic	undetermined
Vogelaar 2	20SA847	Saginaw	St. Charles	Shiawassee	Middle Woodland	camp
Menapace-Deindorfer	20SA860	Saginaw	saginaw	saginaw	Late Archaic	camp
Niagara St. Garden	20SA866	Saginaw	saginaw	saginaw	Late Archaic	undetermined
Dick, 20SA301	20SA867	Saginaw	St. Charles	Shiawassee	Early Woodland	undetermined
Dick, 20SA301	20SA867	Saginaw	St. Charles	Shiawassee	Late Archaic	undetermined
Dick, 20SA301	20SA867	Saginaw	St. Charles	Shiawassee	Middle Woodland	undetermined
Brabant, Burk 41	20SA878	Saginaw	St. Charles	Shiawassee	Early Woodland	camp
Brabant, Burk 41	20SA878	Saginaw	St. Charles	Shiawassee	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 41N	20SA879	Saginaw	St. Charles	Shiawassee	Early Woodland	camp
Burk 41N	20SA879	Saginaw	St. Charles	Shiawassee	Middle Woodland	camp
Burk 41E	20SA880	Saginaw	St. Charles	Shiawassee	Late Archaic	undetermined
Burk 41E	20SA880	Saginaw	St. Charles	Shiawassee	Early Woodland	camp
Fry	20SA881	Saginaw	saginaw	Tittabawassee	Early Woodland	camp
Fry	20SA881	Saginaw	saginaw	Tittabawassee	Late Archaic	camp
Simons Map 10	20SA887	Saginaw	saginaw	Flint	Late Archaic	undetermined
Simons Map 4	20SA888	Saginaw	saginaw	Flint	Middle Woodland	undetermined
Trinklein VI	20SA896	Saginaw	saginaw	Cass	Late Archaic	camp
	20SA9	Saginaw	saginaw	Tittabawassee	Early Woodland	camp
	20SA9	Saginaw	saginaw	Tittabawassee	Late Archaic	camp
	20SA9	Saginaw	saginaw	Tittabawassee	Middle Woodland	camp
Pickleman	20SA910	Saginaw	saginaw	Cass	Late Archaic	camp
Pickleman	20SA910	Saginaw	saginaw	Cass		camp
Little, Dustin 2-4, Saginaw Plate Glass	20SA4	Saginaw	saginaw	Tittabawassee	Middle Woodland	camp
Jerome, Dustin 6-61, Simons 68, 20SA779	20SA42	Saginaw	saginaw	Cass	Early Woodland	village

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Toth, Lutz 13	20SA400	Saginaw	saginaw	Cass	Late Archaic	camp
Toth, Lutz 13	20SA400	Saginaw	saginaw	Cass		camp
Trinklein	20SA401	Saginaw	saginaw	Cass	Late Archaic	undetermined
Anderson	20SA402	Saginaw	saginaw	Cass	Late Archaic	undetermined
Jerome	20SA403	Saginaw	saginaw	Cass	Late Archaic	undetermined
Vamey, Puisk North	20SA404	Saginaw	saginaw	Cass	Early Woodland	undetermined
Vamey, Puisk North	20SA404	Saginaw	saginaw	Cass	Late Archaic	undetermined
Watson Cache	20SA420	Saginaw	saginaw	Tittabawassee	Late Archaic	cache
Sawatzki	20SA421	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Schramke 2	20SA422	Saginaw	saginaw	Shiawassee	Late Archaic	camp
	20SA447	Saginaw	saginaw	Tittabawassee	Middle Woodland	camp
Leuenberger 2	20SA449	Saginaw	saginaw	Tittabawassee	Late Archaic	camp
	20SA465	Saginaw	saginaw	Tittabawassee	Late Archaic	camp
Intersection	20SA471	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Riverside, Dustin 2-5	20SA5	Saginaw	Saginaw	Tittabawassee	Early Woodland	village
Riverside, Dustin 2-5	20SA5	Saginaw	Saginaw	Tittabawassee	Late Archaic	village
Gray, Dustin 6-123, 20SA706	20SA55	Saginaw	saginaw	Cass	Late Archaic	village

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Gray, Dustin 6-123, 20SA706	20SA55	Saginaw	saginaw	Cass	Middle Woodland	village
Kinney, Dustin 2-83, 20SA418	20SA56	Saginaw	saginaw	Tittabawassee	Late Archaic	camp
Solms, Dustin 2-82	20SA57	Saginaw	saginaw	Tittabawassee	Middle Woodland	camp
Center St. Bridge	20SA514	Saginaw	saginaw	saginaw	Middle Woodland	camp
Sturm	20SA580	Saginaw	saginaw	Cass	Late Archaic	undetermined
Weber I, Dehmel Road	20SA581	Saginaw	saginaw	Cass	Late Archaic	seasonal camp
Dale Irish, MLP-10, Simons 94	20SA585	Saginaw	saginaw	Flint	Late Archaic	camp
Mlp2-13	20SA594	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Wellpoint, MLP2-15, Ebenhoh	20SA596	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Wellpoint, MLP2-15, Ebenhoh	20SA596	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
MLP-16, MLP2-17	20SA597	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
MLP-16, MLP2-17	20SA597	Saginaw	saginaw	Shiawassee	Late Archaic	undetermined
MLP-16, MLP2-17	20SA597	Saginaw	saginaw	Shiawassee	Middle Woodland	undetermined
Bayou, Dustin 2-6	20SA6	Saginaw	saginaw	Tittabawassee	Early Woodland	undetermined
Bayou, Dustin 2-6	20SA6	Saginaw	saginaw	Tittabawassee	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Swan Creek, Dustin 5-4	20SA67	Saginaw	saginaw	Tittabawassee	Late Archaic	village
Swan Creek, Dustin 5-4	20SA67	Saginaw	saginaw	Tittabawassee	Middle Woodland	village
Albert Miller	20SA600	Saginaw	saginaw	saginaw	Late Archaic	camp
Fort Road 1, Lutz 1, Circle 1	20SA604	Saginaw	saginaw	Cass	Late Archaic	camp
Fort Road 1, Lutz 1, Circle 1	20SA604	Saginaw	saginaw	Cass		camp
Fort Road 2, Lutz Circle 2, Lutz 1	20SA605	Saginaw	saginaw	Cass	Late Archaic	camp
Fort Road 2, Lutz Circle 2, Lutz 1	20SA605	Saginaw	saginaw	Cass		camp
Hoffman Hills, Lutz 2	20SA606	Saginaw	saginaw	Cass	Early Woodland	camp
Hoffman Hills, Lutz 2	20SA606	Saginaw	saginaw	Cass	Late Archaic	camp
Sheridan Hills, Lutz 6, 20SA616	20SA615	Saginaw	saginaw	Cass	Early Woodland	undetermined
Washington Terrace 2, Lutz 7	20SA617	Saginaw	saginaw	Cass	Late Archaic	undetermined
Washington Terrace 2, Lutz 7	20SA617	Saginaw	saginaw	Cass		undetermined
Bridgeport Wastewater, Lutz 9, Water Plant; Bridgeport Township	20SA620	Saginaw	saginaw	Cass	Early Woodland	warm season camp
Bridgeport Wastewater, Lutz 9, Water Plant; Bridgeport Township	20SA620	Saginaw	saginaw	Cass	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Bridgeport Wastewater, Lutz 9, Water Plant; Bridgeport Township	20SA620	Saginaw	saginaw	Cass	Middle Woodland	warm season camp
Popp A, Lutz 10	20SA621	Saginaw	saginaw	Cass	Late Archaic	camp
Popp B, Lutz 10	20SA622	Saginaw	saginaw	Cass	Late Archaic	camp
Cooks Mill, Lutz 12	20SA623	Saginaw	saginaw	Cass	Late Archaic	camp
Cooks Mill, Lutz 12	20SA623	Saginaw	saginaw	Cass	Middle Woodland	camp
Schmidt Field E, Dorwood, Lutz 19	20SA627	Saginaw	saginaw	Cass	Late Archaic	camp
Schmidt Field A-2, Lutz 15	20SA629	Saginaw	saginaw	Cass	Late Archaic	camp
Schmidt Field A-2, Lutz 15	20SA629	Saginaw	saginaw	Cass		undetermined
Schmidt Field C-1, Lutz 17	20SA631	Saginaw	saginaw	Cass	Late Archaic	camp
Schmidt Field C-1, Lutz 17	20SA631	Saginaw	saginaw	Cass		undetermined
Schmidt Field C-2, Lutz 17	20SA632	Saginaw	saginaw	Cass	Late Archaic	camp
Schmidt Field C-2, Lutz 17	20SA632	Saginaw	saginaw	Cass		undetermined
Homer Burk, Burk 1	20SA635	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Homer Burk, Burk 1	20SA635	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Homer Burk West, Burk 1W	20SA636	Saginaw	saginaw	Shiawassee	Early Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Homer Burk West, Burk 1W	20SA636	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Clifford McQuiston East, Burk 2	20SA637	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Clifford McQuiston East, Burk 2	20SA637	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
McQuiston, Burk 2W, Main McQuiston	20SA638	Saginaw	saginaw	Shiawassee	Early Woodland	camp
McQuiston, Burk 2W, Main McQuiston	20SA638	Saginaw	saginaw	Shiawassee	Late Archaic	camp
McQuiston South, Burk 2S	20SA639	Saginaw	saginaw	Shiawassee	Late Archaic	camp
McQuiston South, Burk 2S	20SA639	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
La Belle, Simons 109	20SA642	Saginaw	saginaw	Flint	Early Woodland	camp
La Belle, Simons 109	20SA642	Saginaw	saginaw	Flint	Late Archaic	camp
La Belle, Simons 109	20SA642	Saginaw	saginaw	Flint	Middle Woodland	camp
Meyer, Simons 112	20SA646	Saginaw	saginaw	Flint	Late Archaic	camp
Gosen 4, Simons 96	20SA651	Saginaw	saginaw	Flint	Late Archaic	camp
Winterstein 1, Simons 97A	20SA652	Saginaw	saginaw	Flint	Late Archaic	camp
Winterstein 2, Simons 97B, 97C, 97D, 97E	20SA653	Saginaw	saginaw	Flint	Late Archaic	camp
Simons 185, Tom In The Woods, Kunik	20SA658	Saginaw	saginaw	Flint	Late Archaic	camp
Hemker 1, Simons 106	20SA660	Saginaw	saginaw	Flint	Late Archaic	camp
Simons 160	20SA672	Saginaw	saginaw	Flint	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Simons 34	20SA691	Saginaw	saginaw	Cass	Late Archaic	camp
	20SA696	Saginaw	saginaw	Cass	Middle Woodland	camp
Burk 2B	20SA917	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 3	20SA918	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
Burk 3	20SA918	Saginaw	saginaw	Shiawassee	Middle Woodland	undetermined
Burk 5	20SA920	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 5	20SA920	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 5	20SA920	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 6A	20SA922	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 6A	20SA922	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 6A	20SA922	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 6B	20SA923	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 6B	20SA923	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 6D	20SA925	Saginaw	saginaw	Shiawassee	Middle Woodland	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 6H	20SA926	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 6H	20SA926	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 7A	20SA927	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 7A	20SA927	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 11	20SA931	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
Burk 11	20SA931	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 11	20SA931	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 12	20SA932	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 12	20SA932	Saginaw	saginaw	Shiawassee	Middle Woodland	undetermined
Burk 18B	20SA937	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 18B	20SA937	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 18C	20SA938	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 18C	20SA938	Saginaw	saginaw	Shiawassee	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 19A	20SA939	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 19A	20SA939	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 19A	20SA939	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 19B	20SA940	Saginaw	saginaw	Shiawassee	Late Archaic	lithic scatter
Burk 19B	20SA940	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 19C	20SA941	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 19N	20SA942	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 20N	20SA943	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
Burk 20N	20SA943	Saginaw	saginaw	Shiawassee	Late Archaic	undetermined
Burk 20S	20SA944	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 20S	20SA944	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 21A	20SA945	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 21B	20SA946	Saginaw	saginaw	Shiawassee	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 22	20SA947	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 23	20SA948	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 23	20SA948	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 24	20SA949	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 24	20SA949	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 25	20SA951	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 25	20SA951	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 25	20SA951	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 28N	20SA954	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 33B	20SA958	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 35	20SA959	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 38	20SA962	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 38	20SA962	Saginaw	saginaw	Shiawassee	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 38N	20SA963	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 38W	20SA964	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
Burk 38W	20SA964	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 39E	20SA965	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 39W	20SA966	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 39W	20SA966	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 40	20SA968	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 40	20SA968	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 42	20SA969	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 42	20SA969	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 43	20SA970	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
Burk 43	20SA970	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 45	20SA972	Saginaw	saginaw	Shiawassee	Early Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 45	20SA972	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 46	20SA973	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
Burk 46	20SA973	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 46	20SA973	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 46B	20SA974	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
Burk 46B	20SA974	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 46B	20SA974	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 48	20SA975	Saginaw	saginaw	Shiawassee	Middle Woodland	
Burk 49	20SA976	Saginaw	saginaw	Shiawassee	Early Woodland	undetermined
Burk 49	20SA976	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 51	20SA978	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 51	20SA978	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 51	20SA978	Saginaw	saginaw	Shiawassee	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 53	20SA980	Saginaw	Saginaw	Shiawassee	Early Woodland	camp
Burk 53	20SA980	Saginaw	Saginaw	Shiawassee	Late Archaic	camp
Burk 53	20SA980	Saginaw	Saginaw	Shiawassee	Middle Woodland	camp
Burk 54	20SA981	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 54N	20SA982	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 58	20SA987	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 58	20SA987	Saginaw	saginaw	Shiawassee	Late Archaic	undetermined
Burk 58	20SA987	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 60	20SA989	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 60	20SA989	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 61S	20SA991	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 64	20SA994	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 66	20SA995	Saginaw	saginaw	Shiawassee	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 66A	20SA996	Saginaw	saginaw	Shiawassee	Late Archaic	undetermined
Burk 66A	20SA996	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 66B	20SA997	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 66B	20SA997	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 69	20SA998	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 69	20SA998	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 70	20SA999	Saginaw	saginaw	Shiawassee	Late Archaic	findspot
Stroebe, Dustin 2-18	20SA14	Saginaw	saginaw	Tittabawassee	Early Woodland	Cemetery
Green Point	20SA1	Saginaw	saginaw	Tittabawassee	Early Woodland	village
Green Point	20SA1	Saginaw	saginaw	Tittabawassee	Middle Woodland	village
Dustin 8-5	20SA102	Saginaw	saginaw	Flint	Late Archaic	camp
Dustin 8-5	20SA102	Saginaw	saginaw	Flint		camp
Walser 4-8, Dustin 4-8, Miller 4, Burk 16B	20SA108	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Walser 4-8, Dustin 4-8, Miller 4, Burk 16B	20SA108	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Bridgeport Enclosure	20SA123	Saginaw	saginaw	Cass	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Bridgeport Enclosure	20SA123	Saginaw	saginaw	Cass	Early Woodland	undetermined
Feeheley	20SA128	Saginaw	saginaw	saginaw	Late Archaic	summer fishing camp
Hodges	20SA130	Saginaw	saginaw	Flint	Late Archaic	cremation
Vogelair (Reported in Peebles, 1978 as Vogelaar)	20SA133	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Schmidt, Dustin 6-339, Lutz 16, Schmidt Site B	20SA192	Saginaw	saginaw	Cass	Late Archaic	camp
Mahoney	20SA193	Saginaw	saginaw	Shiawassee	Late Archaic	undetermined
Mahoney	20SA193	Saginaw	saginaw	Shiawassee	Middle Woodland	seasonal camp
Bussinger	20SA194	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Bussinger	20SA194	Saginaw	saginaw	Shiawassee	Late Archaic	camp/ cemetery
Bussinger	20SA194	Saginaw	saginaw	Shiawassee	Middle Woodland	camp/ cemetery
Stadelmeyer	20SA195	Saginaw	saginaw	Tittabawassee	Late Archaic	village
Bad River	20SA197	Saginaw	saginaw	Shiawassee	Early Woodland	seasonal camp
Bad River	20SA197	Saginaw	saginaw	Shiawassee	Middle Woodland	seasonal camp
Hart	20SA198	Saginaw	saginaw	Shiawassee	Early Woodland	fishing camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Hart	20SA198	Saginaw	saginaw	Shiawassee	Late Archaic	fishing camp
Burk 73E	20SA1002	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Silver Creek	20SA1006	Saginaw	saginaw	Flint	Late Archaic	camp
Silver Creek	20SA1006	Saginaw	saginaw	Flint	Middle Woodland	camp
Malone	20SA1007	Saginaw	saginaw	Flint	Late Archaic	camp
Simons	20SA1014	Saginaw	saginaw	Shiawassee	Late Archaic	undetermined
Hafner	20SA1022	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Kulhanek	20SA1023	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Kulhanek	20SA1023	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Wright	20SA1026	Saginaw	saginaw	Flint	Late Archaic	undetermined
	20SA1031	Saginaw	saginaw	Shiawassee	Late Archaic	undetermined
	20SA1032	Saginaw	saginaw	Tittabawassee	Late Archaic	camp
Deer Creek, Shiawassee River	20SA1033	Saginaw	saginaw	Shiawassee	Early Woodland	seasonal camp
Burk 51N	20SA1045	Saginaw	saginaw	Shiawassee	Early Woodland	camp
Burk 51N	20SA1045	Saginaw	saginaw	Shiawassee	Late Archaic	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Burk 51N	20SA1045	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
Burk 16C	20SA1046	Saginaw	saginaw	Shiawassee	Late Archaic	camp
Burk 16C	20SA1046	Saginaw	saginaw	Shiawassee	Middle Woodland	camp
McCullen	20SA1058	Saginaw	saginaw	Tittabawassee	Early Woodland	undetermined
McCullen	20SA1058	Saginaw	saginaw	Tittabawassee	Late Archaic	undetermined
McCullen	20SA1058	Saginaw	saginaw	Tittabawassee	Middle Woodland	undetermined
Chipman Road	20SA1059	Saginaw	saginaw	Shiawassee	Late Archaic	findspot
Bear Creek	20SA1043	Saginaw	St. Charles	Shiawassee	Late Archaic	hunting camp
Bear Creek	20SA1043	Saginaw	St. Charles	Shiawassee	Middle Woodland	work station
Vogelaar/ Dustin 3-27; may be same as 20SA90 and SA133	20SA291	Saginaw	St. Charles	Shiawassee	Early Woodland	camp
Vogelaar/ Dustin 3-27; may be same as 20SA90 and SA133	20SA291	Saginaw	St. Charles	Shiawassee	Late Archaic	hunting camp
Vogelaar/ Dustin 3-27; may be same as 20SA90 and SA133	20SA291	Saginaw	St. Charles	Shiawassee	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Kretz	20SA380	Saginaw	Swan Creek	Tittabawassee	Late Archaic	undetermined
Kretz	20SA380	Saginaw	Swan Creek	Tittabawassee	Middle Woodland	undetermined
Yokones	20SA388	Saginaw	James	Shiawassee	Late Archaic	camp
Yokones	20SA388	Saginaw	James	Shiawassee	Middle Woodland	camp
Shiawassee #7	20SA1252	Saginaw	Spaulding	Shiawassee	Middle Woodland	undetermined
Shiawassee #3	20SA1254	Saginaw	James	Shiawassee	Late Archaic	undetermined
Shiawassee #3	20SA1254	Saginaw	James	Shiawassee	Middle Woodland	undetermined
Shiawassee #4	20SA1255	Saginaw	James	Shiawassee	Late Archaic	undetermined
Shiawassee #4	20SA1255	Saginaw	James	Shiawassee	Middle Woodland	undetermined
Shiawassee 2	20SA1251	Saginaw	James	Shiawassee	Middle Woodland	camp
Peacock II/ Shiawassee #6	20SA214	Saginaw	James	Shiawassee	Early Woodland	camp
Peacock II/ Shiawassee #6	20SA214	Saginaw	James	Shiawassee	Middle Woodland	camp
Shiawassee #13	20SA1276	Saginaw	James	Shiawassee	Middle Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Casassa/ includes 20SA587	20SA1021	Saginaw	St. Charles	Shiawassee	Early Woodland	camp
Casassa/ includes 20SA587	20SA1021	Saginaw	St. Charles	Shiawassee	Late Archaic	findspot
Casassa/ includes 20SA587	20SA1021	Saginaw	St. Charles	Shiawassee	Middle Woodland	camp
Birch Run Road/ Simons 61	20SA393	Saginaw	Taymouth	Flint	Late Archaic	camp
Schultz/ Green Point Mounds, Dustin 2-2, Stage Register #460	20SA2	Saginaw	Saginaw	Saginaw	Early Woodland	seasonal camp
Schultz/ Green Point Mounds, Dustin 2-2, Stage Register #460	20SA2	Saginaw	Saginaw	Saginaw	Late Archaic	camp
Schultz/ Green Point Mounds, Dustin 2-2, Stage Register #460	20SA2	Saginaw	Saginaw	Saginaw	Middle Woodland	seasonal camp
Satchell/ Dustin 6-4, 20SA687	20SA33	Saginaw	Frankenmuth	Cass	Early Woodland	village
Satchell/ Dustin 6-4, 20SA687	20SA33	Saginaw	Frankenmuth	Cass	Late Archaic	village
Satchell/ Dustin 6-4, 20SA687	20SA33	Saginaw	Frankenmuth	Cass	Middle Woodland	village
Herbers	20SA318	Saginaw	Brant	Shiawassee	Late Archaic	winter camp
Herbers	20SA318	Saginaw	Brant	Shiawassee	Early Woodland	camp

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Benkert	20SA1267	Saginaw	Swan Creek	Tittabawassee	Early Woodland	undetermined
Benkert	20SA1267	Saginaw	Swan Creek	Tittabawassee	Late Archaic	undetermined
Snyder	20SA1268	Saginaw	James	Tittabawassee	Late Archaic	camp
Snyder	20SA1268	Saginaw	James	Tittabawassee	Early Woodland	camp
	20SA1320	Saginaw	Zilwaukee	Saginaw	Middle Woodland	camp
Owen/ Dustin 2-101	20SA20	Saginaw	Thomas	Tittabawassee	Early Woodland	camp
Branch Flats 2/ Dustin 2-102	20SA21	Saginaw	Thomas	Tittabawassee	Middle Woodland	camp
Valley Sweets/ Dustin 1-1, A.W. Wright, Schemm Brewery	20SA24	Saginaw	Saginaw	Saginaw	Middle Woodland	village
Fisher/ Dustin 6-0	20SA29	Saginaw	Bridgeport	Cass	Late Archaic	village
Fisher/ Dustin 6-0	20SA29	Saginaw	Bridgeport	Cass	Early Woodland	village
Young/ Youngs Drive, Lutz 8	20SA209	Saginaw	Bridgeport	Cass	Late Archaic	undetermined
Kralosky	20SA211	Saginaw	Bridgeport	Flint	Late Archaic	camp
Kralosky	20SA211	Saginaw	Bridgeport	Flint	Early Woodland	camp
Hare	20SA244	Saginaw	Swan Creek	Shiawassee	Late Archaic	burial
Sass Hill/ Oscar Seidel, Miller	20SA249	Saginaw	Saginaw	Tittabawassee	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Dustin 3-36	20SA287	Saginaw	St. Charles	Shiawassee	Late Archaic	camp
Vance/ Dustin 6-3	20SA32	Saginaw	Bridgeport	Cass	Late Archaic	village
Vance/ Dustin 6-3	20SA32	Saginaw	Bridgeport	Cass	Early Woodland	village
Mershon Cache	20SA1066	Saginaw	Carrollton	Saginaw	Late Archaic	cache
Lincoln Cache	20SA1067	Saginaw	James	Saginaw	Late Archaic	cache
Leo's Gulley South/ Burk 87; Shuster #9	20SA1072	Saginaw	Chesaning	Shiawassee	Early Woodland	findspot
Rohn/ Burk 85	20SA1075	Saginaw	Brant	Shiawassee	Late Archaic	camp
Bradford/ Burk 91	20SA1078	Saginaw	Brant	Shiawassee	Late Archaic	camp
Wallen West/ Burk 92	20SA1079	Saginaw	Chapin	Shiawassee	Middle Woodland	lithic scatter
Sweeney West/ Burk 77	20SA1081	Saginaw	Brant	Shiawassee	Late Archaic	camp
J. Wickie	20SA1121	Saginaw	Chapin	Shiawassee	Late Archaic	lithic scatter
Burk #38	20SA1131	Saginaw	Brant	Shiawassee	Late Archaic	findspot
	20SA1143	Saginaw	Chapin	Shiawassee	Late Archaic	findspot
	20SA1148	Saginaw	Chapin	Shiawassee	Middle Woodland	camp
Haney #7	20SA1191	Saginaw	Brady	Shiawassee	Middle Woodland	lithic scatter

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
	20SA1196	Saginaw	Brant	Shiawassee	Early Woodland	camp
	20SA1203	Saginaw	Brant	Shiawassee	Middle Woodland	camp
Haney #1	20SA1204	Saginaw	Brant	Shiawassee	Middle Woodland	camp
Haney #3	20SA1206	Saginaw	Brant	Shiawassee	Middle Woodland	camp
Haney #14	20SA1210	Saginaw	Brady	Shiawassee	Middle Woodland	camp
Haney #11B	20SA1212	Saginaw	Brady	Shiawassee	Middle Woodland	camp
Shuster #12	20SA1229	Saginaw	Albee	Shiawassee	Early Woodland	lithic scatter
Shuster #12	20SA1229	Saginaw	Albee	Shiawassee	Late Archaic	lithic scatter
Shuster #13	20SA1230	Saginaw	Albee	Shiawassee	Middle Woodland	undetermined
Shuster #15	20SA1231	Saginaw	Albee	Shiawassee	Late Archaic	camp
Sommer 6 and 16	20SA1236	Saginaw	Bridgeport	Cass	Late Archaic	camp
Sommer 6 and 16	20SA1236	Saginaw	Bridgeport	Cass	Middle Woodland	camp
Sommer 6 and 16	20SA1236	Saginaw	Bridgeport	Cass		camp
Sommer 19	20SA1242	Saginaw	Bridgeport	Cass	Late Archaic	camp
Sommer 19	20SA1242	Saginaw	Bridgeport	Cass		camp
Sommer 2, A	20SA1243	Saginaw	Bridgeport	Cass	Middle Woodland	unknown
Sommer 2, B	20SA1244	Saginaw	Bridgeport	Cass	Middle Woodland	unknown

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Sommer 2	20SA1247	Saginaw	Bridgeport	Cass	Late Archaic	camp
Sommer 2	20SA1247	Saginaw	Bridgeport	Cass		camp
Huron/ Dustin 6-10	20SA37	Saginaw	Frankenmuth	Cass	Early Woodland	village
Schemm Cache/ Dustin 3-42	20SA315	Saginaw	James	Shiawassee	Late Archaic	cache
Schemm Cache/ Dustin 3-42	20SA315	Saginaw	James	Shiawassee		cache
Morrison	20SA317	Saginaw	Swan Creek	Shiawassee	Early Woodland	undetermined
Morrison	20SA317	Saginaw	Swan Creek	Shiawassee	Late Archaic	undetermined
Morrison	20SA317	Saginaw	Swan Creek	Shiawassee	Middle Woodland	undetermined
Gamon/ Sgamon	20SA322	Saginaw	Brant	Shiawassee	Early Woodland	camp
Gamon/ Sgamon	20SA322	Saginaw	Brant	Shiawassee	Late Archaic	camp
Souden 1	20SA325	Saginaw	Brant	Shiawassee	Late Archaic	camp, summer
Souden 2	20SA326	Saginaw	Brant	Shiawassee	Late Archaic	camp
Jurstik 2	20SA337	Saginaw	Brant	Shiawassee	Late Archaic	kill station
Jurstik 2	20SA337	Saginaw	Brant	Shiawassee	Late Archaic	camp
Gosen	20SA341	Saginaw	Swan Creek	Shiawassee	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Frede	20SA342	Saginaw	James	Shiawassee	Late Archaic	undetermined
Donovan A	20SA344	Saginaw	St. Charles	Shiawassee	Early Woodland	undetermined
Donovan A	20SA344	Saginaw	St. Charles	Shiawassee	Late Archaic	undetermined
Donovan A	20SA344	Saginaw	St. Charles	Shiawassee	Middle Woodland	undetermined
Cai-16	20SA351	Saginaw	Bridgeport	Cass	Late Archaic	camp
Cai-22	20SA357	Saginaw	Bridgeport	Cass	Early Woodland	undetermined
Trogan/ Lutz 11	20SA359	Saginaw	Spaulding	Cass	Late Archaic	undetermined
Spencer 6-23, Willie Cache. Wille Cache	20SA363	Saginaw	Spaulding	Cass	Late Archaic	camp
Spencer 6-23, Willie Cache. Wille Cache	20SA363	Saginaw	Spaulding	Cass	Middle Woodland	undetermined
	20SA365	Saginaw	Bridgeport	Cass	Early Woodland	undetermined
	20SA365	Saginaw	Bridgeport	Cass	Middle Woodland	undetermined
Marzluff 1/ SIMONS 136, see also 20SA369	20SA368	Saginaw	Albee	Flint	Middle Woodland	camp
Malone 2/ SPENCER 7-101, SIMONS 28	20SA371	Saginaw	Albee	Flint	Late Archaic	camp
Malone 2/ SPENCER 7-101, SIMONS 28	20SA371	Saginaw	Albee	Flint	Late Archaic	camp
Malone 2/ SPENCER 7-101, SIMONS 28	20SA371	Saginaw	Albee	Flint		camp
Durward 1	20SA375	Saginaw	Taymouth	Flint	Late Archaic	camp
CAI-5	20SA379	Saginaw	Swan Creek	Flint	Late Archaic	undetermined

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Cady	20SA382	Saginaw	Saginaw	Tittabawassee	Late Archaic	camp
Weigl	20SA389	Saginaw	James	Shiawassee	Late Archaic	undetermined
Weigl	20SA389	Saginaw	James	Shiawassee		undetermined
Daby-abbot/ DUBAY-ABBOTT	20SA396	Saginaw	Taymouth	Flint	Early Woodland	camp
Daby-abbot/ DUBAY-ABBOTT	20SA396	Saginaw	Taymouth	Flint	Late Archaic	camp
Daby-abbot/ DUBAY-ABBOTT	20SA396	Saginaw	Taymouth	Flint	Middle Woodland	camp
Bates/ KLINKER HILL, LUTZ 21	20SA398	Saginaw	Bridgeport	Cass	Late Archaic	camp
Dorr	20SA399	Saginaw	Bridgeport	Cass	Late Archaic	undetermined
Fisher 2	20SA703	Saginaw	Bridgeport	Cass	Early Woodland	camp
Weston #94	20SL38	Sanilac	Austin	Cass	Late Archaic	undetermined
Telfers	20SE91	Shiawassee	Owosso	Shiawassee	Early Woodland	undetermined
Telfers	20SE91	Shiawassee	Owosso	Shiawassee	Late Archaic	undetermined
Jahr	20TU6	Tuscola	Wisner	Lake Huron	Late Archaic	undetermined
Jahr	20TU6	Tuscola	Wisner	Lake Huron	Early Woodland	camp
Jahr	20TU6	Tuscola	Wisner	Lake Huron	Middle Woodland	cemetery

Table 34 (cont'd)						
Site Name	State Site File No.	County	Township	River Basin	Cultural Period	Function
Levaliey	20TU61	Tuscola	Indianfields	Cass	Late Archaic	undetermined
Lajoie & Sons	20TU65	Tuscola	Ellington	Cass	Early Woodland	camp
Salgat 2	20TU66	Tuscola	Ellington	Cass	Middle Woodland	undetermined
Gurnith Faidie	20TU68	Tuscola	Aimer	Lake Huron	Late Archaic	winter camp
Alkens	20TU74	Tuscola	Ellington	Cass	Late Archaic	undetermined
Lookwood	20TU85	Tuscola	Ellington	Cass	Middle Woodland	undetermined
Ellison 1	20TU86	Tuscola	Ellington	Cass	Early Woodland	camp
Fish Point	20TU87	Tuscola	Wisner	Lake Huron	Late Archaic	cemetery
	20TU91	Tuscola	Kingston	Cass	Late Archaic	camp
Stoick	20TU94	Tuscola	Indianfields	Cass	Late Archaic	camp
Atkins	20TU104	Tuscola	Tuscola	Cass	Early Woodland	cemetery
Schafsnitz 2	20TU111	Tuscola	Juniata	Cass	Early Woodland	undetermined
Pinkerton Road	20TU121	Tuscola	Tuscola	Cass	Late Archaic	camp
Dinsmore	20TU130	Tuscola	Gilford	Lake Huron	Late Archaic	camp
	20TU146	Tuscola	Indianfields	Cass	Middle Woodland	camp
Hancock 1	20TU147	Tuscola	Arbela	Cass	Late Archaic	cemetery
	20TU149	Tuscola	Tuscola	Cass	Late Archaic	camp
	20TU149	Tuscola	Tuscola	Cass	Middle Woodland	camp
Bearss	20TU150	Tuscola	Elmwood	Cass	Late Archaic	undetermined

Table 35. Site type ratios by county and cultural period

Function	Culture	Total	Arenac	Bay	Clinton	Genesee	Gladwin	Gratiot
Activity Area	Late Archaic	118	0%	2%	3%	2%	0%	1%
Activity Area	Early Woodland	55	0%	1%	1%	1%	0%	1%
Activity Area	Middle Woodland	74	0%	3%	2%	3%	0%	2%
Cache	Late Archaic	6	0%	0%	0%	0%	0%	0%
Cache	Middle Woodland	2	0%	0%	0%	0%	0%	0%
Camp	Late Archaic	217	1%	4%	2%	1%	0%	3%
Camp	Early Woodland	76	0%	4%	1%	0%	0%	2%
Camp	Middle Woodland	110	1%	4%	2%	0%	0%	1%
Cemetery	Late Archaic	15	0%	1%	0%	1%	0%	0%
Cemetery	Early Woodland	3	0%	0%	0%	0%	0%	0%
Cemetery	Middle Woodland	5	0%	0%	1%	0%	0%	0%
Village	Late Archaic	11	0%	1%	0%	0%	0%	0%
Village	Early Woodland	9	0%	1%	0%	0%	0%	0%
Village	Middle Woodland	8	0%	1%	0%	0%	0%	0%

Table 35. (cont'd)											
Function	Culture	Huron	Iosco	Isabella	Lapeer	Mecosta	Midland	Montcalm	Oakland	Osceola	Oscoda
Activity Area	Late Archaic	0%	1%	0%	2%	0%	3%	0%	0%	0%	1%
Activity Area	Early Woodland	1%	0%	0%	1%	0%	12%	0%	1%	0%	1%
Activity Area	Middle Woodland	0%	1%	0%	3%	0%	9%	0%	1%	0%	1%
Cache	Late Archaic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cache	Middle Woodland	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Camp	Late Archaic	1%	1%	0%	5%	0%	5%	0%	0%	1%	0%
Camp	Early Woodland	1%	0%	0%	1%	1%	4%	0%	0%	0%	0%
Camp	Middle Woodland	0%	4%	0%	2%	1%	3%	0%	0%	0%	0%
Cemetery	Late Archaic	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Cemetery	Early Woodland	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cemetery	Middle Woodland	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Village	Late Archaic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Village	Early Woodland	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Village	Middle Woodland	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%

Table 35. (cont'd)						
Function	Culture	Roscommon	Saginaw	Sanilac	Shiawassee	Tuscola
Activity Area	Late Archaic	0%	12%	0%	0%	1%
Activity Area	Early Woodland	0%	16%	0%	1%	1%
Activity Area	Middle Woodland	0%	13%	0%	0%	1%
Cache	Late Archaic	0%	1%	0%	0%	0%
Cache	Middle Woodland	0%	1%	0%	0%	0%
Camp	Late Archaic	0%	35%	0%	0%	2%
Camp	Early Woodland	0%	36%	0%	0%	2%
Camp	Middle Woodland	1%	38%	0%	0%	1%
Cemetery	Late Archaic	0%	2%	0%	0%	1%
Cemetery	Early Woodland	0%	1%	0%	0%	1%
Cemetery	Middle Woodland	0%	1%	0%	0%	1%
Village	Late Archaic	0%	2%	0%	0%	0%
Village	Early Woodland	0%	6%	0%	0%	0%
Village	Middle Woodland	0%	3%	0%	0%	0%

Table 36. Site type percentage by river basin							
Cultural Period	Function	Total	Au Sable	Cass	Flint	Grand	Lake Huron
Late Archaic	Activity Area	118	2%	5%	5%	3%	2%
Early Woodland	Activity Area	55	1%	5%	1%	1%	2%
Middle Woodland	Activity Area	74	2%	7%	10%	3%	4%
Late Archaic	cache	6	0%	0%	0%	0%	0%
Middle Woodland	cache	2	0%	1%	0%	0%	0%
Late Archaic	camp	217	1%	8%	13%	2%	3%
Early Woodland	camp	76	0%	3%	3%	1%	3%
Middle Woodland	camp	110	5%	11%	8%	2%	6%
Late Archaic	cemetery	15	0%	0%	1%	0%	1%
Early Woodland	cemetery	3	0%	1%	0%	0%	0%
Middle Woodland	cemetery	5	0%	0%	0%	1%	1%
Late Archaic	village	11	0%	1%	1%	0%	0%
Early Woodland	village	9	0%	3%	1%	0%	0%
Middle Woodland	village	8	1%	2%	0%	0%	1%

Table 36. (cont'd)							
Cultural Period	Function	Muskegon	Saginaw	Saginaw	Sebewaing	Shiawassee	Tittabawassee
Late Archaic	Activity Area	0%	200%	1%	0%	8%	5%
Early Woodland	Activity Area	0%		0%	0%	13%	15%
Middle Woodland	Activity Area	0%	100%	1%	0%	14%	18%
Late Archaic	cache	0%	200%	1%	0%	0%	1%
Middle Woodland	cache	0%		0%	0%	1%	0%
Late Archaic	camp	1%	900%	2%	1%	21%	8%
Early Woodland	camp	1%	500%	3%	0%	31%	7%
Middle Woodland	camp	1%	500%	4%	0%	40%	11%
Late Archaic	cemetery	0%	200%	1%	0%	1%	1%
Early Woodland	cemetery	0%	100%	1%	0%	1%	0%
Middle Woodland	cemetery	0%	100%	1%	0%	1%	1%
Late Archaic	village	0%	100%	0%	0%	0%	1%
Early Woodland	village	0%	100%	1%	0%	0%	1%
Middle Woodland	village	0%	200%	2%	0%	0%	2%

Relative Dates

Table 37. Relative dates						
State Site File No.	Site Name	Sample	Relative Date	Range	Cultural Period	Citation
20SA192	Schmidt	N-1781	4660	740	LA	Egan 1993, Robertson 1987
20BY30	Kantzler	UGA-3195	4290	75	LA	Larsen and Demeter 1979
20SA128	Feeheley	M-1139	3930	150	LA	Crane and Griffin 1962
20BY387	Marquette Viaduct South	Beta-181524	3840	40	LA	Lovis et al. 2002, Bev Smith
20BY28	Fletcher/Marquette Viaduct/Defoe Park	Beta-154674	3670	70	LA	Lovis et al. 2002, Bev Smith
20SA8	Andrews	M-914	3550	150	LA	
20SA133	Vogelaar	Beta-78825	3410	100	LA	Branstner and Hambacher 1995
20SA8	Andrews	M-659	3170	150	LA	Crane and Griffin 1960
20IS46	Brandt	DIC-2501	3090	45	LA	Mead and Kingsley 1994
29SA581	Weber 1	Beta-5473	2990	110	LA	Monaghan et al 1986
20BY79	Third Street Bridge or Liberty Bridge	Beta-11130	2880	70	LA	Monaghan 1993
20MD30	Naugle	CWRU-169	2850	110	LA	Ozker 1976
20GR33	Conservation Park	Beta-9646	2530	60	LA	
20SA1043	Bear Creek	Beta-56425/CAMS-3836	2510	80	LA	
20SA2-2	Schultz	M-1524	2490	130	EW	Speth 1972; Egan 1993
20SA2	Schultz	M-1525	2480	150	EW	Ozker 1982

Table 37. (cont'd)

State Site File No.	Site Name	Sample	Relative Date	Range	Cultural Period	Citation
20SA1	Green Point	M-1432	2480	120	EW	H.T. Wright 1964
20BY28	Fletcher/Marquette Viaduct/Defoe Park	Beta-17752	1830	85	MW	
20BY28	Fletcher/Marquette Viaduct/Defoe Park	Beta 26380	1740	63	MW	Stuiver and Becker 1986
20GR33	Conservation Park		787		EW	Beld 1991:71
20IA305	20IA305	Beta-171300			LA	Branstner 2004
20BY29	Butterfield/ Schmidt 5-1/Paul Wendeloski	No Dates			LA	
20SA209	Young	No Dates			LA	
20SA198	Hart	No Dates			LA	Keene
20SA380	Kretz	No Dates			LA	Keene
20BY30	Kantzler	No Dates			EW	
20BY79	Third Street Bridge	No Dates			MW	
20SA2-3	Schultz	Beta-261463			MW	Egan 1993
20GR13	Kanitz	No Dates			MW	
20BY77	Surath's Junk Yard	No Dates			MW	
20SA2-3	Schultz	No Dates			MW -E	
20BY31	Kantzler	No Dates			MW -E	
20BY32	Kantzler	No Dates			MW -H	
20SA2-4	Schultz	No Dates			MW -L	Egan 1994

Site Flora and Fauna

Table 38. Archaeological fauna and flora by site								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>
	Dates - 14CYBP					4660	3930	
Moose	<i>Alces alces</i>			1				
Deer/Elk	<i>Cervidae</i> sp.							
Elk	<i>Cervus canadensis</i>			1				
Elk	<i>Cervus elaphus</i>							
White tailed deer	<i>Odocoileus virginianus</i>	x		8		2		
White tailed deer	<i>Odocoileus virginianus</i> cf.							
Bear	<i>Ursus americanus</i>			1				
Black bear	<i>Euarctos americanus</i>							
		0	0	11	0	2	0	0
Shrew	<i>Blarina brevicauda</i>							
Domestic dog	<i>Canis</i> cf. <i>familiaris</i>							
Dog/Wolf/Coyote	<i>Canis</i> sp.			1				
Wolf	<i>Canis lupus</i>							
Red fox	<i>Vulpes fulva</i>							
Beaver	<i>Castor canadensis</i>			4				
Beaver	<i>Castor canadensis</i> cf.							
Ground squirrel	<i>Citellus spilosoma</i>							
Porcupine	<i>Erethizon dorsatum</i>			1				

Table 38. (cont'd)								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Jack rabbit	Lepus californicus							
Bobcat	Lynx canadensis			1				
Marten	Martes americana			1				
Meadow vole	Microtus sp.							
Mice, rat, gerbils	Muridae sp.							
Mink	Mustela vison							
Muskrat	Ondatra zibethicus			18		2	present	
Muskrat	Ondatra zibethicus cf.							
Otter	Lontra canadensis							
Deer Mice	Peromyscus sp.	x						
Raccoon	Procyon lotor			4		3		
Rodents - mice, rats, squirrels, porcupines, beavers, chipmunks, voles	Rodentia sp.							
Chipmunk	Tamias sp.						present	
Squirrel	Sciurus sp.				1			
Rabbit	<i>Sylvilagus floridanus</i>				1	1		

Table 38. (cont'd)

Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Misc.	Carnivora sp.							
Totals	Totals	0	0	30	2	6	0	0
Lake Sturgeon	Acipenser fulvescens				2	7		
Bowfin	Amia Calva	x	x					
Freshwater drum	Aplodinotus grunniens					1	present	
Sucker	Castomidae sp.							
Longnose sucker	Catostomus catostomus							
White sucker	Catostomus commersoni							
Sucker	Catostomus sp.							
sucker	<i>Catostomidae</i> <i>Moxostoma</i>							
Sunfish	Centrarchidae sp.							
Northern pike	Esocidae sp.							
Pike	Esox sp.							
Cod	<i>Lota lota lacustris</i>							
Channel catfish	Ictaluridae sp.							
Black bullhead	Ictalurus melas							
Yellow bullhead	Ictalurus natalis							
Brown bullhead	Ictalurus nebulosus						present	
Channel catfish	Ictalurus punctatus							

Table 38. (cont'd)								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Channel catfish	Ictalurus punctatus							
Channel catfish	Ictalurus punctatus cf.							
Catfish	Ictalurus sp.	x	x					
Gar	Lepisosteus sp.							
Longnosed gar	<i>Lepisosteus osseus oxyurus</i>	x	x					
Bluegill sunfish	Lepomis cf. macrochirus					1		
Sunfish	Lepomis/Pomoxis sp.							
Cod	<i>Lota lota lacustris</i>							
Smallmouth bass	Micropterus dolomieu		x					
Largemouth bass	Micropterus salmoides							
Bass	Micropterus sp.					1		
Striped bass	Monroe chrysops							
rock bass	Morone chrysops							
Shorthead Redhorse	Moxostoma macrolepidotum							
Shorthead Redhorse	Moxostoma sp.							
Bony fish	Osteichthyes sp.							
Yellow perch	Perca flavescens						present	

Table 38. (cont'd)								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Perch	Percichthyidae sp.							
Walleye/Sauger /Perch	Percidae							
Perch	Percidae sp.	x	x					
Crappie	Pomoxis nigromaculatus							
Crappie	Pomoxis sp.							
Crappie	Pomoxis/Lepomis sp.							
Flathead	Pylodictis		x					
Trout	Salmonidae sp.							
Lake trout	Salvelinus namaycush							
Drum	Sciaenidae sp.							
Walleye	Stizostedion sp.							
Totals	Totals	0	0	0	0	2	0	0
	Anura sp.							
Green turtle	Chelonia sp.							
	Chelydra serpentina							
	Chelydra serpentina cf.							
Painted turtle	Chrysemys picta							
Snake	Colubridae sp.							
	Cryptodira sp.							
Hidden-necked turtles	Cryptodira							

Table 38. (cont'd)								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Pond turtles	Emydidae sp.							
Blandings turtle	Emydoidea blandingii							
Blandings turtle	Emydoidea blandingii cf.							
Sliders/Cooters	Emydoidea Chrysemys sp.	x						
Northern water snake	Nerodia sipedon							
Box turtles	Terrapene sp.	x						
Garter snake	Thamnophis sp.							
Soft shell turtle	Trionyx sp.	x						
		0	0	0	0	0	0	0
Great Northern Loon	Gavia immer							
	Anas sp.	x				4		
Mallard Duck	Anas platyrhynchos							
Blue winged teal	Anas discors							
American Wigeon	Anas americana							
Ring necked duck	Aythya collaris							
redhead	Aythya americana							

Table 38. (cont'd)								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Lesser Scaup	Aythya affinis							
Small eyed duck	Anatidae sp.				1			
Greater Scaup	Aythya marila							
Great horned owl	Bubo virginianus Strigiformes							
Sandhill crane	Crus canadensis							
Passenger pigeon	<i>Ectopistes migratorius</i>					13		
Bald eagle	<i>Haliaeetus leucocephalus</i>							
Common merganser	Mergus merganser Anseriformes							
Red breasted merganser	Mergus serrator							
White-winged scoter	Melanitta deglandi							
Totals	Totals	0	0	0	1	17	0	0
	Amaranthus sp.	117	14					
Serviceberry	Amelanchier							
Hog peanut	Amphicarpa bracteata							
Aster	Aster cf. cordifolius							
Mustard family	Brassicaceae							
Hackberry	Celtis occidentalis				present			

Table 38. (cont'd)								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Goosefoot	Chenopodium spp.	198	75					
Morning-glory family	Convolvulaceae							
Round-leaved dogwood	Cornus rugosa							
Hawthorn	Crataegus sp.							
Squash/Rind	Cucurbita sp.							
Sedges	Cyperus spp.							
Sedges	Cyperaceae	69	4					
Bedstraw	Galium spp.	3	1					
Elderberry, Huckleberry	Gaylussacia baccata							
	Graminea		1					
St. John's wort	Hypericum sp.							
Sumpweed	Iva annua							
Mint family	Labiatae							
rose family	Rosaceae							
Corn	Zea mays	1						
Grass	Panicum							
Nightshade	Physalis							
Virginia creeper	Parthenocissus quinquefolia							

Table 38. (cont'd)

Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Grass family	Poaceae(large)							
Grass family	Poaceae(small)							
Knotweed	Polygonum	28	1					
Knotweed	Polygonum							
Buckwheat	Polygonum pensylvanicum							
Plums, cherries, peaches, apricots, almonds	Prunus spp.							
Pear	Pyrus sp.							
Blackberry	Rubus sp.	64	25					
Raspberries, blackberries, dewberries	Rubus spp.							
Huckleberry, American Elderberry	Sambucus canadensis							
Sassafras	Sassafras albidum	1						
	Silene sp.		1					
Cattail	Typha sp.							
	Vaccinium sp.	61						
Nannyberry	Viburnum sp.							

Table 38. (cont'd)

Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
	Viola		1					
Grape	<i>Vitis</i>							
Maize kernel	<i>Zea mays</i>							
Wild rice	<i>Zizania aquatica</i>							
Poppy								
Maple	<i>Acer</i> spp.	3	4				2	2
Aster	<i>Aster</i> cr. <i>Cordifolius</i>							
Birch	<i>Betula</i> spp.						1	1
Hazelnut	<i>Corylus americana</i>							
Hickory	<i>Carya</i> spp.	3+5	8	13	present		1	12
Hickory shell	<i>Carya</i> spp.							
Hickory	<i>Carya laciniosa</i>						10	3
Shagbark hickory	<i>Carya ovata</i>						2	6
Chestnut	<i>Castanea dentata</i>							
Hackberry	<i>Celtis occidentalis</i>							3
Redbud	<i>Cercis canadensis</i>							
Beech	<i>Fagus grandifolia</i>	6	18				11	1
Ash	<i>Fraxinus</i> spp.	9	6				4	
White ash	<i>Fraxinus alba</i>							1
Ash	<i>Fraxinus americana</i>						3	1

Table 38. (cont'd)

Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Black ash	Fraxinus nigra	6	14				5	
Ash	Juglandaceae/Walnut family						16	
Butternut	Juglans cinerea	3	3	13		13	22	
Eastern Black Walnut	Juglans nigra	4		11			2	2
Walnut family	Juglans spp.	1	1				7	
Sassafras	Lauraceae		1					
Mulberry	Morus rubra							
	Nyssa		4					
Hophornbeam	Ostrya virginiana	8	1				1	2
Spruce	Picea sp.							13
Pine	Pinus spp.	8	141				8	
Red pine	P. resinosa							
White pine	Pinus strobus				present		1	15
Sycamore	Platanus occidentalis						10	8
Aspen	Populus tremuloides							2
	Populus silex	1						
	Prunus sp.						1	
Swamp white oak	Quercus bicolor				present			6
Acorn	Quercus sp.	15	18	2	present		1	
Oak	Quercus Cotyledon						12	

Table 38. (cont'd)

Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
Acorn shell	Quercus sp.							
White oak	<i>Quercus alba</i>	29	39				13	8
Black oak	<i>Quercus nigra</i>						14	
Red oak	<i>Quercus rubra</i>	11	17					6
Sumac	Rhus						1	
Basswood	<i>Tilia americana</i>							
Elm	Ulmaceae/ Elm family	3	2				2	
Elm	<i>Ulmus</i> spp.							
American elm	<i>Ulmus cf. Americana</i>							1
Slippery elm	<i>Ulmus rubra</i>						1	
Snails and slugs	<i>Actinonaias carinata</i> (Barnes)			2				
Snails and slugs	<i>Amblema costata</i> (Raf.)			1634				
Snails and slugs	<i>Amnicola limosa</i> (Say)			present				
Snails and slugs	<i>Amnicola lustrica</i> (Pilsbry)			present				
Snails and slugs	<i>Anguispira alternata</i>			present	16			
Snails and slugs	<i>Anodonta grandis</i> <i>footiana</i> (Say) Goodrich							
Snails and slugs	<i>Anguispira kochi</i> (Baker)				5			
Snails and slugs	<i>Anguispira solitaria</i>			present				

Table 38. (cont'd)

Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			MNI	MNI	MNI	MNI	MNI
	Dates - 14CYBP					4660	3930	
	(Say)							
Snails and slugs	Campeloma decisum (Say)			present				
Snails and slugs	Cyclonaias tuberculata			12				
Snails and slugs	Discus cronkfilter anthonyi (Pilsbry)			present	7			
Snails and slugs	Elliptio dilatatus (Raf.)			798				
Snails and slugs	Fusconaia flava (Raf.)			424				
Snails and slugs	Gastropoda sp.							
Snails and slugs	Goniobasis livescens (Say)			present				
Snails and slugs	Helicodiscus parallelus (Say)			present				
Snails and slugs	Helisoma anceps (Conrad)			present				
Snails and slugs	Helisoma Campanulatum			present				
Snails and slugs	Helisoma trivolvis (Say)			present				
Snails and slugs	Haplotrema concavum (Say)			present				
Snails and slugs	Lampsilis siliquoidea (L)			89				
Snails and slugs	Lasmigona costata (Raf.)			43				

Table 38. (cont'd)								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>
	Dates - 14CYBP					4660	3930	
Snails and slugs	Ligumia (Recta) lattissima (Raf.)			14				
Snails and slugs	Lymnaea (Stagnicola) palustris (Say)			present				
Snails and slugs	Lymnaea columella (Say)			present				
Snails and slugs	Mesodon thyroidus (Say)			present				
Snails and slugs	Mesomphix cuprea (Say)			present				
Snails and slugs	Obovaria subrotunda (Raf.)			2				
Snails and slugs	Pleurobema (cordatum) coccineum (Conrad)			22				
Snails and slugs	Pomatiopsis lapidaria (Say)			present				
Snails and slugs	Quadrula pustulosa (Lea)			93				
Snails and slugs	Retinella rhoadsi (Pilsbry)			present				
Snails and slugs	Somatogyrus sp.			present				
Snails and slugs	Sphaerium			85				

Table 38. (cont'd)								
Common Name	Species	Kretz	Hart	20SA2	20SA209	20SA192	20SA128	20BY29
	Site Name	20SA380	20SA198	Schultz	Young	Schmidt	Feeheley	Butterfield/ Schmidt
	Cultural Period	LA	LA	LA	LA	LA	LA	LA
	Measurement			<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>
	Dates - 14CYBP					4660	3930	
	rhombodium							
Snails and slugs	Sphaerium striatum			40				
Snails and slugs	Sphaerium sulcatum			21				
Snails and slugs	Stenotrema monodon (Rackett)			present				
Snails and slugs	Strophitus rugosis (Swain.)			23				
Snails and slugs	Succinea ovalis (Say)			present				
Snails and slugs	Triodopsis albolabris (Say)			present				
Snails and slugs	Triodopsis multilineata (Say)			present				
Snails and slugs	Valvata tricarinata (Say)			present				
Snails and slugs	Zonitidae sp.				1			
	Pelecypoda sp.							

Table 38. (cont'd)

Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>
	C14 Dates - YBP	2990	2880	2490			2480
Moose	<i>Alces alces</i>						
Deer/Elk	<i>Cervidae</i> sp.	present		6			
Elk	<i>Cervus canadensis</i>	present					
Elk	<i>Cervus elaphus</i>						
White tailed deer	<i>Odocoileus virginianus</i>	present	2	33	3	6	
White tailed deer	<i>Odocoileus virginianus</i> cf.			1			
Bear	<i>Ursus americanus</i>			2			
Black bear	<i>Euarctos americanus</i>					1	
		0	2	42	3	7	0
Shrew	<i>Blarina brevicauda</i>					1	
Domestic dog	<i>Canis</i> cf. <i>familiaris</i>			1		1	
Dog/Wolf/Coyote	<i>Canis</i> sp.			4			
Wolf	<i>Canis lupus</i>				1	1	
Red fox	<i>Vulpes fulva</i>					2	
Beaver	<i>Castor canadensis</i>				3	2	
Beaver	<i>Castor canadensis</i> cf.						
Ground squirrel	<i>Citellus spilosoma</i>					1	
Porcupine	<i>Erethizon dorsatum</i>						
Jack rabbit	<i>Lepus californicus</i>						
Bobcat	<i>Lynx canadensis</i>						
Marten	<i>Martes americana</i>						

Table 38. (cont'd)							
Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	MNI	MNI	MNI	MNI	MNI	MNI
	C14 Dates - YBP	2990	2880	2490			2480
Meadow vole	Microtus sp.			3			
Mice, rat, gerbils	Muridae sp.			14			
Mink	Mustela vison						
Muskrat	Ondatra zibethicus	present		55		1	
Muskrat	Ondatra zibethicus cf.			2			
Otter	Lontra canadensis						
Deer Mice	Peromyscus sp.			2			
Raccoon	Procyon lotor		1	17			
Rodents - mice, rats, squirrels, porcupines, beavers, chipmunks, voles	Rodentia sp.			12			
Chipmunk	Tamias sp.						
Squirrel	Sciurus sp.						
Rabbit	<i>Sylvilagus floridanus</i>						
Misc.	Carnivora sp.			13			
Totals	Totals	0	1	123	4	9	0
Lake Sturgeon	Acipenser fulvescens	present		528	2	7	
Bowfin	Amia Calva			4	0	1	
Freshwater drum	Aplodinotus grunniens			107	2	4	
Sucker	Castomidae sp.			92			
Longnose sucker	Catostomus catostomus			13			

Table 38. (cont'd)							
Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	MNI	MNI	MNI	MNI	MNI	MNI
	C14 Dates - YBP	2990	2880	2490			2480
White sucker	Catostomus commersoni			14			
Sucker	Catostomus sp.			29			
sucker	<i>Catostomidae Moxostoma</i>						
Sunfish	Centrarchidae sp.			111			
Northern pike	Esocidae sp.			2			
Pike	Esox sp.			17			
Cod	<i>Lota lota lacustris</i>						
Channel catfish	Ictaluridae sp.			99			
Black bullhead	Ictalurus melas			14			
Yellow bullhead	Ictalurus natalis			3			
Brown bullhead	Ictalurus nebulosus			12			
Channel catfish	Ictalurus punctatus			5			
Channel catfish	Ictalurus punctatus				3	6	
Channel catfish	Ictalurus punctatus cf.						
Catfish	Ictalurus sp.			35			
Gar	Lepisosteus sp.			1519		1	
Longnosed gar	<i>Lepisosteus osseus oxyurus</i>				1	2	
Bluegill sunfish	Lepomis cf. macrochirus			2			
Sunfish	Lepomis/Pomoxis sp.			32			

Table 38. (cont'd)

Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	MNI	MNI	MNI	MNI	MNI	MNI
	C14 Dates - YBP	2990	2880	2490			2480
Cod	<i>Lota lota lacustris</i>					1	
Smallmouth bass	<i>Micropterus dolomieu</i>			2			
Largemouth bass	<i>Micropterus salmoides</i>			12	1		
Bass	<i>Micropterus</i> sp.			22			
Striped bass	<i>Monroe chrysops</i>			1			
rock bass	<i>Morone chrysops</i>						
Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>			2			
Shorthead Redhorse	<i>Moxostoma</i> sp.			4			
Bony fish	<i>Osteichthyes</i> sp.						
Yellow perch	<i>Perca flavescens</i>		2	34	2	1	
Perch	<i>Percichthyidae</i> sp.			7			
Walleye/Sauger/Perch	<i>Percidae</i>		3		1		
Perch	<i>Percidae</i> sp.			210	2	2	
Crappie	<i>Pomoxis nigromaculatus</i>			1			
Crappie	<i>Pomoxis</i> sp.						
Crappie	<i>Pomoxis/Lepomis</i> sp.						
Flathead	<i>Pylodictis</i>						
Trout	<i>Salmonidae</i> sp.			12			
Lake trout	<i>Salvelinus namaycush</i>					2	
Drum	<i>Sciaenidae</i> sp.			1			

Table 38. (cont'd)

Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>
	C14 Dates - YBP	2990	2880	2490			2480
Walleye	Stizostedion sp.			188	1	3	
Totals	Totals	0	5	2403	11	18	0
	Anura sp.			11			
Green turtle	Chelonia sp.			53			
	Chelydra serpentina			2			
	Chelydra serpentina cf.			12			
Painted turtle	Chrysemys picta		8	4			
Snake	Colubridae sp.			11			
	Cryptodira sp.						
Hidden-necked turtles	Cryptodira	present	12				
Pond turtles	Emydidae sp.						
Blandings turtle	Emydoidea blandingii			5			
Blandings turtle	Emydoidea blandingii cf.			22			
Sliders/Cooters	Emydoidea Chrysemys sp.						
Northern water snake	Nerodia sipedon			3			
Box turtles	Terrapene sp.						
Garter snake	Thamnophis sp.			11			
Soft shell turtle	Trionyx sp.						
Totals	Totals	0	20	134	0	0	0
Great Northern Loon	Gavia immer						
	Anas sp.						

Table 38. (cont'd)							
Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	MNI	MNI	MNI	MNI	MNI	MNI
	C14 Dates - YBP	2990	2880	2490			2480
Mallard Duck	Anas platyrhynchos						
Blue winged teal	Anas discors						
American Wigeon	Anas americana						
Ring necked duck	Aythya collaris						
redhead	Aythya americana						
Lesser Scaup	Aythya affinis						
Small eyed duck	Anatidae sp.						
Greater Scaup	Aythya marila				present	present	
Great horned owl	Bubo virginianus Strigiformes					present	
Sandhill crane	Crus canadensis						
Passenger pigeon	Ectopistes migratorius				present		
Bald eagle	Haliaeetus leucocephalus						
Common merganser	Mergus merganser Anseriformes					present	
Red breasted merganser	Mergus serrator					present	
White-winged scoter	Melanitta deglandi						
Totals	Totals	0	0	0	0	0	0
	Amaranthus sp.						
Serviceberry	Amelanchier			1			
Hog peanut	Amphicarpa bracteata			1			1

Table 38. (cont'd)							
Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>
	C14 Dates - YBP	2990	2880	2490			2480
Aster	Aster cf. cordifolius			1			
Mustard family	Brassicaceae			7			1
Hackberry	Celtis occidentalis						3
Goosefoot	Chenopodium spp.	181		835			5
Morning-glory family	Convolvulaceae			1			1
Round-leaved dogwood	Cornus rugosa			1			
Hawthorn	Crataegus sp.			29			4
Squash/Rind	Cucurbita sp.			1			
Sedges	Cyperus spp.	4					
Sedges	Cyperaceae						
Bedstraw	Galium spp.	21					
Elderberry, Huckleberry	Gaylussacia baccata			1			
	Graminea						
St. John's wort	Hypericum sp.			5			5
Sumpweed	Iva annua			1			
Mint family	Labiataeae						4
rose family	Rosaceae						
Corn	Zea mays						
Grass	Panicum		11				
Nightshade	Physalis	3					

Table 38. (cont'd)							
Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	MNI	MNI	MNI	MNI	MNI	MNI
	C14 Dates - YBP	2990	2880	2490			2480
Virginia creeper	Parthenocissus quinquefolia						
Grass family	Poaceae(large)			67			8
Grass family	Poaceae(small)						1
Knotweed	Polygonum		3				
Knotweed	Polygonum	10		1			
Buckwheat	Polygonum pensylvanicum	1					
Plums, cherries, peaches, apricots, almonds	Prunus spp.	15		2			
Pear	Pyrus sp.						
Blackberry	Rubus sp.						
Raspberries, blackberries, dewberries	Rubus spp.	2					
Huckleberry, American Elderberry	Sambucus canadensis	2		3			2
Sassafras	Sassafras albidum			2			
	Silene sp.						
Cattail	Typha sp.			4			
	Vaccinium sp.						

Table 38. (cont'd)

Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	MNI	MNI	MNI	MNI	MNI	MNI
	C14 Dates - YBP	2990	2880	2490			2480
Nannyberry	Viburnum sp.			1			1
	Viola						
Grape	Vitis				1		
Maize kernel	Zea mays			1			
Wild rice	Zizania aquatica			36			
Poppy							
Maple	Acer spp.						51
Aster	Aster cr. Cordifolius						
Birch	Betula spp.	1					25
Hazelnut	Corylus americana			14			
Hickory	Carya spp.	3		786	2		19
Hickory shell	Carya spp.						
Hickory	<i>Carya laciniosa</i>						
Shagbark hickory	<i>Carya ovata</i>						
Chestnut	Castanea dentata						19
Hackberry	Celtis occidentalis						36
Redbud	Cercis canadensis						
Beech	Fagus grandifolia	4					5
Ash	Fraxinus spp.	1					21
White ash	Fraxinus alba						
Ash	Fraxinus americana						

Table 38. (cont'd)							
Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	MNI	MNI	MNI	MNI	MNI	MNI
	C14 Dates - YBP	2990	2880	2490			2480
Black ash	Fraxinus nigra						
Ash	Juglandaceae/Walnut family						
Butternut	Juglans cinerea	1		153			
Eastern Black Walnut	Juglans nigra	403		378			
Walnut family	Juglans spp.	3	11	1243			63
Sassafras	Lauraceae						
Mulberry	Morus rubra						7
	Nyssa						
Hophornbeam	Ostrya virginiana	8					3
Spruce	Picea sp.						
Pine	Pinus spp.	2					1
Red pine	P. resinosa				1		1
White pine	Pinus strobus		8				3
Sycamore	Platanus occidentalis	2	11				7
Aspen	Populus tremuloides						
	Populus silex						
	Prunus sp.						
Swamp white oak	Quercus bicolor				1		
Acorn	Quercus sp.			18			22
Oak	Quercus Cotyledon				2		

Table 38. (cont'd)							
Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	MNI	MNI	MNI	MNI	MNI	MNI
	C14 Dates - YBP	2990	2880	2490			2480
Acorn shell	<i>Quercus</i> sp.						
White oak	<i>Quercus alba</i>						17
Black oak	<i>Quercus nigra</i>						
Red oak	<i>Quercus rubra</i>						22
Sumac	<i>Rhus</i>						
Basswood	<i>Tilia americana</i>						2
Elm	Ulmaceae/ Elm family						12
Elm	<i>Ulmus</i> spp.			1			23
American elm	<i>Ulmus cf. Americana</i>						38
Slippery elm	<i>Ulmus rubra</i>						6
Snails and slugs	<i>Actinonaias carinata</i> (Barnes)						
Snails and slugs	<i>Amblema costata</i> (Raf.)						
Snails and slugs	<i>Amnicola limosa</i> (Say)						
Snails and slugs	<i>Amnicola lustrica</i> (Pilsbry)						
Snails and slugs	<i>Anguispira alternata</i>						
Snails and slugs	<i>Anodonta grandis footiana</i> (Say) Goodrich				present		
Snails and slugs	<i>Anguispira kochi</i> (Baker)						
Snails and slugs	<i>Anguispira solitaria</i> (Say)						
Snails and slugs	<i>Campeloma decisum</i> (Say)						

Table 38. (cont'd)							
Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>
	C14 Dates - YBP	2990	2880	2490			2480
Snails and slugs	Cyclonaias tuberculata						
Snails and slugs	Discus cronkfilter anthonyi (Pilsbry)						
Snails and slugs	Elliptio dilatatus (Raf.)				present		
Snails and slugs	Fusconaia flava (Raf.)						
Snails and slugs	Gastropoda sp.						
Snails and slugs	Goniobasis livescens (Say)						
Snails and slugs	Helicodiscus parallelus (Say)						
Snails and slugs	Helisoma anceps (Conrad)						
Snails and slugs	Helisoma Campanulatum						
Snails and slugs	Helisoma trivolvis (Say)						
Snails and slugs	Haplotrema concavium (Say)						
Snails and slugs	Lampsilis siliquoidea (L)				present		
Snails and slugs	Lasmigona costata (Raf.)						
Snails and slugs	Ligumia (Recta) lattissima (Raf.)						
Snails and slugs	Lymnaea (Stagnicola) palustris (Say)						
Snails and slugs	Lymnaea columella (Say)						
Snails and slugs	Mesodon thyroidus (Say)						

Table 38. (cont'd)

Common Name	Species	20SA581	20BY79	20SA2	20BY30	20BY30	20SA2
	Site Name	Weber I	Third Street Bridge	Schultz	Kantzler	Kantzler	Schultz
	Cultural Period	LA	LA	EW	EW	MW Early	MW Early
	Measurement	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>MNI</i>
	C14 Dates - YBP	2990	2880	2490			2480
Snails and slugs	Mesomphix cuprea (Say)						
Snails and slugs	Obovaria subrotunda (Raf.)						
Snails and slugs	Pleurobema (cordatum) coccineum (Conrad)						
Snails and slugs	Pomatiopsis lapidaria (Say)						
Snails and slugs	Quadrula pustulosa (Lea)						
Snails and slugs	Retinella rhoadsi (Pilsbry)						
Snails and slugs	Somatogyrus sp.						
Snails and slugs	Sphaerium rhombodium						
Snails and slugs	Sphaerium striatum						
Snails and slugs	Sphaerium sulcatum						
Snails and slugs	Stenotrema monodon (Rackett)						
Snails and slugs	Strophitus rugosis (Swain.)						
Snails and slugs	Succinea ovalis (Say)						
Snails and slugs	Triodopsis albolabris (Say)						
Snails and slugs	Triodopsis multilineata (Say)						
Snails and slugs	Valvata tricarinata (Say)						
Snails and slugs	Zonitidae sp.						
	Pelecypoda sp.						

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Moose	<i>Alces alces</i>						
Deer/Elk	<i>Cervidae</i> sp.					7	
Elk	<i>Cervus canadensis</i>				1	2	2
Elk	<i>Cervus elaphus</i>						
White tailed deer	<i>Odocoileus virginianus</i>	present			7	23	4
White tailed deer	<i>Odocoileus virginianus</i> cf.						
Bear	<i>Ursus americanus</i>					6	1
Black bear	<i>Euarctos americanus</i>						
Totals	Totals	0	0	0	8	38	7
Shrew	<i>Blarina brevicauda</i>						
Domestic dog	<i>Canis</i> cf. <i>familiaris</i>				2		
Dog/Wolf/Coyote	<i>Canis</i> sp.						
Wolf	<i>Canis lupus</i>					1	1
Red fox	<i>Vulpes fulva</i>				2		
Beaver	<i>Castor canadensis</i>				1	10	2
Beaver	<i>Castor canadensis</i> cf.						
Ground squirrel	<i>Citellus spilosoma</i>				1		
Porcupine	<i>Erethizon dorsatum</i>						
Jack rabbit	<i>Lepus californicus</i>				1		

Table 38. (cont'd)							
Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Bobcat	Lynx canadensis						
Marten	Martes americana						
Meadow vole	Microtus sp.						
Mice, rat, gerbils	Muridae sp.						
Mink	Mustela vison						
Muskrat	Ondatra zibethicus					9	2
Muskrat	Ondatra zibethicus cf.						
Otter	Lontra canadensis					1	1
Deer Mice	Peromyscus sp.						
Raccoon	Procyon lotor	present				4	2
Rodents - mice, rats, squirrels, porcupines, beavers, chipmunks, voles	Rodentia sp.						
Chipmunk	Tamias sp.						
Squirrel	Sciurus sp.						
Rabbit	<i>Sylvilagus floridanus</i>	present					
Misc.	Carnivora sp.						
Totals	Totals	0	0	0	7	25	8
Lake Sturgeon	Acipenser fulvescens				4	26	2

Table 38. (cont'd)							
Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Bowfin	<i>Amia Calva</i>				1	2	1
Freshwater drum	<i>Aplodinotus grunniens</i>				3	9	2
Sucker	<i>Castomidae sp.</i>						
Longnose sucker	<i>Catostomus catostomus</i>						
White sucker	<i>Catostomus commersoni</i>						
Sucker	<i>Catostomus sp.</i>						
sucker	<i>Catostomidae Moxostoma</i>				2		
Sunfish	<i>Centrarchidae sp.</i>						
Northern pike	<i>Esocidae sp.</i>						
Pike	<i>Esox sp.</i>				2	1	1
Cod	<i>Lota lota lacustris</i>						
Channel catfish	<i>Ictaluridae sp.</i>						
Black bullhead	<i>Ictalurus melas</i>						
Yellow bullhead	<i>Ictalurus natalis</i>						
Brown bullhead	<i>Ictalurus nebulosus</i>						
Channel catfish	<i>Ictalurus punctatus</i>					4	2
Channel catfish	<i>Ictalurus punctatus</i>				8		
Channel catfish	<i>Ictalurus punctatus cf.</i>					2	
Catfish	<i>Ictalurus sp.</i>					6	

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Gar	<i>Lepisosteus</i> sp.				2		
Longnosed gar	<i>Lepisosteus osseus oxyurus</i>				2		
Bluegill sunfish	<i>Lepomis</i> cf. <i>macrochirus</i>						
Sunfish	<i>Lepomis/Pomoxis</i> sp.						
Cod	<i>Lota lota lacustris</i>						
Smallmouth bass	<i>Micropterus dolomieu</i>						
Largemouth bass	<i>Micropterus salmoides</i>				1		
Bass	<i>Micropterus</i> sp.						
Striped bass	<i>Monroe chrysops</i>						
rock bass	<i>Morone chrysops</i>					6	
Shorthead Redhorse	<i>Moxostoma macrolepidotum</i>						
Shorthead Redhorse	<i>Moxostoma</i> sp.						
Bony fish	<i>Osteichthyes</i> sp.						
Yellow perch	<i>Perca flavescens</i>				1		
Perch	<i>Percichthyidae</i> sp.						
Walleye/Sauger/Perch	<i>Percidae</i>				3		
Perch	<i>Percidae</i> sp.				3	3	1
Crappie	<i>Pomoxis nigromaculatus</i>						

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Crappie	Pomoxis sp.						
Crappie	Pomoxis/Lepomis sp.						
Flathead	Pylodictis						
Trout	Salmonidae sp.						
Lake trout	Salvelinus namaycush						
Drum	Sciaenidae sp.						2
Walleye	Stizostedion sp.				3		
Totals	Totals	0	0	0	27	22	6
	Anura sp.						
Green turtle	Chelonia sp.						
	Chelydra serpentina					1	1
	Chelydra serpentina cf.						
Painted turtle	Chrysemys picta					2	1
Snake	Colubridae sp.						
	Cryptodira sp.					3	
Hidden-necked turtles	Cryptodira						
Pond turtles	Emydidae sp.						
Blandings turtle	Emydoidea blandingii					3	2
Blandings turtle	Emydoidea blandingii cf.						

Table 38. (cont'd)							
Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Sliders/Cooters	Emydoidea Chrysemys sp.						
Northern water snake	Nerodia sipedon						
Box turtles	Terrapene sp.						
Garter snake	Thamnophis sp.						
Soft shell turtle	Trionyx sp.					4	1
		0	0	0	0	13	5
Great Northern Loon	Gavia immer						
	Anas sp.						
Mallard Duck	Anas platyrhynchos						
Blue winged teal	Anas discors						
American Wigeon	Anas americana						
Ring necked duck	Aythya collaris						
redhead	Aythya americana					3	1
Lesser Scaup	Aythya affinis					1	1
Small eyed duck	Anatidae sp.						
Greater Scaup	Aythya marila						
Great horned owl	Bubo virginianus Strigiformes						
Sandhill crane	Crus canadensis				present		
Passenger pigeon	<i>Ectopistes migratorius</i>						

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Bald eagle	<i>Haliaeetus leucocephalus</i>				present		
Common merganser	Mergus merganser Anseriformes				present		
Red breasted merganser	Mergus serrator				present		
White-winged scoter	Melanitta deglandi				present		
Totals	Totals	0	0	0	0	4	2
	Amaranthus sp.						
Serviceberry	Amelanchier						
Hog peanut	Amphicarpa bracteata						
Aster	Aster cf. cordifolius					14.30%	
Mustard family	Brassicaceae						
Hackberry	Celtis occidentalis						
Goosefoot	Chenopodium spp.			2		14.30%	
Morning-glory family	Convolvulaceae						
Round-leaved dogwood	Cornus rugosa						
Hawthorn	Crataegus sp.					14.30%	
Squash/Rind	Cucurbita sp.						
Sedges	Cyperus spp.						

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Sedges	Cyperaceae						
Bedstraw	Galium spp.						
Elderberry, Huckleberry	Gaylussacia baccata					14.30%	
	Graminea						
St. John's wort	Hypericum sp.						
Sumpweed	Iva annua						
Mint family	Labiataeae						
rose family	Rosaceae					14.30%	
Corn	Zea mays					0.1	
Grass	Panicum			27			
Nightshade	Physalis						
Virginia creeper	Parthenocissus quinquefolia					14.30%	
Grass family	Poaceae(large)						
Grass family	Poaceae(small)						
Knotweed	Polygonum						
Knotweed	Polygonum						
Buckwheat	Polygonum pensylvanicum						

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Plums, cherries, peaches, apricots, almonds	Prunus spp.						
Pear	Pyrus sp.						
Blackberry	Rubus sp.						
Raspberries, blackberries, dewberries	Rubus spp.						
Huckleberry, American Elderberry	Sambucus canadensis						
Sassafras	Sassafras albidum						
	Silene sp.						
Cattail	Typha sp.						
	Vaccinium sp.						
Nannyberry	Viburnum sp.						
	Viola						
Grape	<i>Vitis</i>						
Maize kernel	Zea mays						
Wild rice	Zizania aquatica						

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Poppy							
						Per 10 liter foot	
Maple	Acer spp.						
Aster	Aster cr. Cordifolius						
Birch	Betula spp.						
Hazelnut	Corylus americana						
Hickory	Carya spp.					12.1	
Hickory shell	Carya spp.					0.5	
Hickory	<i>Carya laciniosa</i>						
Shagbark hickory	<i>Carya ovata</i>						
Chestnut	Castanea dentata						
Hackberry	Celtis occidentalis						
Redbud	Cercis canadensis						
Beech	Fagus grandifolia					3.4	
Ash	Fraxinus spp.					8.6	
White ash	Fraxinus alba						
Ash	Fraxinus americana						
Black ash	Fraxinus nigra						

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Ash	Juglandaceae/Walnut family					1.2	
Butternut	Juglans cinerea						
Eastern Black Walnut	Juglans nigra					0.1	
Walnut family	Juglans spp.						
Sassafras	Lauraceae						
Mulberry	Morus rubra						
	Nyssa						
Hophornbeam	Ostrya virginiana			1			
Spruce	Picea sp.						
Pine	Pinus spp.					3.4	
Red pine	P. resinosa						
White pine	Pinus strobus					36.2	
Sycamore	Platanus occidentalis						
Aspen	Populus tremuloides						
	Populus silex						
	Prunus sp.						
Swamp white oak	Quercus bicolor						
Acorn	Quercus sp.			1		19	
Oak	Quercus Cotyledon						

Table 38. (cont'd)

Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Acorn shell	<i>Quercus</i> sp.					0.1	
White oak	<i>Quercus alba</i>					1.7	
Black oak	<i>Quercus nigra</i>						
Red oak	<i>Quercus rubra</i>					6.9	
Sumac	<i>Rhus</i>						
Basswood	<i>Tilia americana</i>						
Elm	Ulmaceae/ Elm family					3.4	
Elm	<i>Ulmus</i> spp.					5.2	
American elm	<i>Ulmus cf. Americana</i>						
Slippery elm	<i>Ulmus rubra</i>						
Snails and slugs	<i>Actinonaias carinata</i> (Barnes)						
Snails and slugs	<i>Amblema costata</i> (Raf.)						
Snails and slugs	<i>Amnicola limosa</i> (Say)						
Snails and slugs	<i>Amnicola lustrica</i> (Pilsbry)						
Snails and slugs	<i>Anguispira alternata</i>						
Snails and slugs	<i>Anodonta grandis footiana</i> (Say) Goodrich						
Snails and slugs	<i>Anguispira kochi</i> (Baker)						
Snails and slugs	<i>Anguispira solitaria</i> (Say)						

Table 38. (cont'd)							
Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Snails and slugs	Cameloma decusum (Say)						
Snails and slugs	Cyclonaias tuberculata						
Snails and slugs	Discus cronkfilter anthonyi (Pilsbry)						
Snails and slugs	Elliptio dilatatus (Raf.)						
Snails and slugs	Fusconaia flava (Raf.)						
Snails and slugs	Gastropoda sp.						
Snails and slugs	Goniobasis livescens (Say)						
Snails and slugs	Helicodiscus parallelus (Say)						
Snails and slugs	Helisoma anceps (Conrad)						
Snails and slugs	Helisoma Campanulatum						
Snails and slugs	Helisoma trivolvis (Say)						
Snails and slugs	Haplotrema concavium (Say)						
Snails and slugs	Lampsilis siliquoidea (L)						
Snails and slugs	Lasmigona costata (Raf.)						
Snails and slugs	Ligumia (Recta) lattissima (Raf.)						

Table 38. (cont'd)							
Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				1700	1830	1740
Snails and slugs	Lymnaea (Stagnicola) palustris (Say)						
Snails and slugs	Lymnaea columella (Say)						
Snails and slugs	Mesodon thyroideus (Say)						
Snails and slugs	Mesomphix cuprea (Say)						
Snails and slugs	Obovaria subrotunda (Raf.)						
Snails and slugs	Pleurobema (cordatum) coccineum (Conrad)						
Snails and slugs	Pomatiopsis lapidaria (Say)						
Snails and slugs	Quadrula pustulosa (Lea)						
Snails and slugs	Retinella rhoadsi (Pilsbry)						
Snails and slugs	Somatogyrus sp.						
Snails and slugs	Sphaerium rhombodium						
Snails and slugs	Sphaerium striatum						
Snails and slugs	Sphaerium sulcatum						
Snails and slugs	Stenotrema monodon (Rackett)						
Snails and slugs	Strophitus rugosus (Swain.)						
Snails and slugs	Succinea ovalis (Say)						
Snails and slugs	Triodopsis albolabris (Say)						

Table 38. (cont'd)							
Common Name	Species	20GR13	29BY77	20BY79	20BY30	20BY28	20BY28
	Site Name	Kanitz	Suraths Junk Yard	Third Street Bridge	Kantzler	Marquette Viaduct Site	Marquette Viaduct Site
	Cultural Period	MW	MW	MW	MW Hopewell	MW	MW
	Measurement		<i>MNI</i>	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>MNI</i>
	C14 Dates - YBP				<i>1700</i>	1830	1740
Snails and slugs	Triodopsis multilineata (Say)						
Snails and slugs	Valvata tricarinata (Say)						
Snails and slugs	Zonitidae sp.						
	Pelecypoda sp.					1	

Table 38. (cont'd)

Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Moose	Alces alces					
Deer/Elk	Cervidae sp.				38	40
Elk	Cervus canadensis					
Elk	Cervus elaphus					1
White tailed deer	Odocoileus virginianus			10	11	32
White tailed deer	Odocoileus virginianus cf.					18
Bear	Ursus americanus					1
Black bear	Euarctos americanus					
Totals	Totals	0	0	10	49	92
Shrew	Blarina brevicauda					
Domestic dog	Canis cf. familiaris			1	12	12
Dog/Wolf/Coyote	Canis sp.			1	11	11
Wolf	<i>Canis lupus</i>					
Red fox	<i>Vulpes fulva</i>					
Beaver	Castor canadensis			9	7	
Beaver	Castor canadensis cf.			1		
Ground squirrel	<i>Citellus spilosoma</i>					
Porcupine	Erethizon dorsatum					
Jack rabbit	Lepus californicus					
Bobcat	Lynx canadensis					

Table 38. (cont'd)						
Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Marten	Martes americana					
Meadow vole	Microtus sp.					
Mice, rat, gerbils	Muridae sp.					
Mink	Mustela vison					
Muskrat	Ondatra zibethicus			5	4	6
Muskrat	Ondatra zibethicus cf.			3		
Otter	Lontra canadensis					
Deer Mice	Peromyscus sp.					
Raccoon	Procyon lotor					2
Rodents - mice, rats, squirrels, porcupines, beavers, chipmunks, voles	Rodentia sp.					
Chipmunk	Tamias sp.					
Squirrel	Sciurus sp.					
Rabbit	<i>Sylvilagus floridanus</i>					
Misc.	Carnivora sp.					
Totals	Totals	0	0	20	34	31
Lake Sturgeon	Acipenser fulvescens			3	1	6
Bowfin	Amia Calva			2		31
Freshwater drum	Aplodinotus grunniens			1	3	9

Table 38. (cont'd)

Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Sucker	Castomidae sp.			1	2	3
Longnose sucker	Catostomus catostomus					
White sucker	Catostomus commersoni					
Sucker	Catostomus sp.			1		
sucker	<i>Catostomidae Moxostoma</i>					
Sunfish	Centrarchidae sp.			1		
Northern pike	Esocidae sp.					
Pike	Esox sp.					
Cod	<i>Lota lota lacustris</i>					
Channel catfish	Ictaluridae sp.			8	1	8
Black bullhead	Ictalurus melas					
Yellow bullhead	Ictalurus natalis					
Brown bullhead	Ictalurus nebulosus					
Channel catfish	Ictalurus punctatus					
Channel catfish	Ictalurus punctatus			1	1	3
Channel catfish	Ictalurus punctatus cf.					2
Catfish	Ictalurus sp.					
Gar	Lepisosteus sp.				1	1
Longnosed gar	<i>Lepisosteus osseus oxyurus</i>					
Bluegill sunfish	Lepomis cf. macrochirus					

Table 38. (cont'd)

Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Sunfish	Lepomis/Pomoxis sp.					
Cod	<i>Lota lota lacustris</i>					
Smallmouth bass	Micropterus dolomieu				4	11
Largemouth bass	Micropterus salmoides				1	3
Bass	Micropterus sp.			2	2	25
Striped bass	Monroe chrysops			1	1	
rock bass	Morone chrysops					
Shorthead Redhorse	Moxostoma macrolepidotum					
Shorthead Redhorse	Moxostoma sp.					
Bony fish	Osteichthyes sp.			204	158	911
Yellow perch	Perca flavescens			1		3
Perch	Percichthyidae sp.					
Walleye/Sauger/Perch	Percidae					
Perch	Percidae sp.			1	5	6
Crappie	Pomoxis nigromaculatus					
Crappie	Pomoxis sp.					2
Crappie	Pomoxis/Lepomis sp.					3
Flathead	Pylodictis					
Trout	Salmonidae sp.					

Table 38. (cont'd)

Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Lake trout	Salvelinus namaycush					
Drum	Sciaenidae sp.					
Walleye	Stizostedion sp.			13	27	104
Totals	Totals	0	0	233	201	1082
	Anura sp.					
Green turtle	Chelonia sp.					
	Chelydra serpentina					
	Chelydra serpentina cf.					
Painted turtle	Chrysemys picta					
Snake	Colubridae sp.					
	Cryptodira sp.					
Hidden-necked turtles	Cryptodira					
Pond turtles	Emydidae sp.			26	4	
Blandings turtle	Emydoidea blandingii					
Blandings turtle	Emydoidea blandingii cf.					
Sliders/Cooters	Emydoidea Chrysemys sp.					
Northern water snake	Nerodia sipedon					
Box turtles	Terrapene sp.					
Garter snake	Thamnophis sp.					

Table 38. (cont'd)

Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Soft shell turtle	Trionyx sp.					
Totals	Totals	0	0	26	4	0
Great Northern Loon	Gavia immer				4	
	Anas sp.					
Mallard Duck	Anas platyrhynchos			1	1	1
Blue winged teal	Anas discors			1	1	1
American Wigeon	Anas americana				9	9
Ring necked duck	Aythya collaris				1	1
redhead	Aythya americana					
Lesser Scaup	Aythya affinis					
Small eyed duck	Anatidae sp.				6	6
Greater Scaup	Aythya marila					
Great horned owl	Bubo virginianus Strigiformes					
Sandhill crane	Crus canadensis					
Passenger pigeon	<i>Ectopistes migratorius</i>					
Bald eagle	<i>Haliaeetus leucocephalus</i>					
Common merganser	Mergus merganser Anseriformes					
Red breasted merganser	Mergus serrator					

Table 38. (cont'd)

Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
White-winged scoter	Melanitta deglandi					
Totals	Totals	0	0	2	22	18
	Amaranthus sp.					
Serviceberry	Amelanchier					
Hog peanut	Amphicarpa bracteata					
Aster	Aster cf. cordifolius					
Mustard family	Brassicaceae	2				
Hackberry	Celtis occidentalis					
Goosefoot	Chenopodium spp.	61	2			
Morning-glory family	Convolvulaceae					
Round-leaved dogwood	Cornus rugosa	1				
Hawthorn	Crataegus sp.	22	2			
Squash/Rind	Cucurbita sp.		1			
Sedges	Cyperus spp.					
Sedges	Cyperaceae					
Bedstraw	Galium spp.					
Elderberry, Huckleberry	Gaylussacia baccata	1				

Table 38. (cont'd)						
Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
	Graminea					
St. John's wort	Hypericum sp.					
Sumpweed	Iva annua					
Mint family	Labiatae					
rose family	Rosaceae					
Corn	Zea mays					
Grass	Panicum					
Nightshade	Physalis					
Virginia creeper	Parthenocissus quinquefolia					
Grass family	Poaceae(large)	55				
Grass family	Poaceae(small)	17				
Knotweed	Polygonum	1				
Knotweed	Polygonum					
Buckwheat	Polygonum pensylvanicum					
Plums, cherries, peaches, apricots, almonds	Prunus spp.					
Pear	Pyrus sp.		1			
Blackberry	Rubus sp.					1
Raspberries, blackberries,	Rubus spp.					

Table 38. (cont'd)

Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
dewberries						
Huckleberry, American Elderberry	Sambucus canadensis	1				
Sassafras	Sassafras albidum	2				
	Silene sp.					
Cattail	Typha sp.					
	Vaccinium sp.					
Nannyberry	Viburnum sp.		1			
	Viola					
Grape	Vitis					
Maize kernel	Zea mays					
Wild rice	Zizania aquatica					
Poppy			70			
Maple	Acer spp.	92				3
Aster	Aster cr. Cordifolius					
Birch	Betula spp.	15				
Hazelnut	Corylus americana					
Hickory	Carya spp.	62	3	3		

Table 38. (cont'd)						
Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Hickory shell	<i>Carya</i> spp.					
Hickory	<i>Carya laciniosa</i>					
Shagbark hickory	<i>Carya ovata</i>					
Chestnut	<i>Castanea dentata</i>	41				
Hackberry	<i>Celtis occidentalis</i>	20				
Redbud	<i>Cercis canadensis</i>					
Beech	<i>Fagus grandifolia</i>	27		5		
Ash	<i>Fraxinus</i> spp.					23
White ash	<i>Fraxinus alba</i>					
Ash	<i>Fraxinus americana</i>					
Black ash	<i>Fraxinus nigra</i>					
Ash	Juglandaceae/Walnut family					
Butternut	<i>Juglans cinerea</i>		8			
Eastern Black Walnut	<i>Juglans nigra</i>		1			
Walnut family	<i>Juglans</i> spp.	58	145			
Sassafras	Lauraceae					
Mulberry	<i>Morus rubra</i>	14				
	<i>Nyssa</i>					
Hophornbeam	<i>Ostrya virginiana</i>	1		7		10

Table 38. (cont'd)						
Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Spruce	<i>Picea sp.</i>					
Pine	<i>Pinus spp.</i>	11		18		5
Red pine	<i>P. resinosa</i>	3				
White pine	<i>Pinus strobus</i>	16				
Sycamore	<i>Platanus occidentalis</i>	48		8		2
Aspen	<i>Populus tremuloides</i>					
	<i>Populus silex</i>					
	<i>Prunus sp.</i>					
Swamp white oak	<i>Quercus bicolor</i>					
Acorn	<i>Quercus sp.</i>	27	51			
Oak	<i>Quercus Cotyledon</i>					
Acorn shell	<i>Quercus sp.</i>					
White oak	<i>Quercus alba</i>	31		1		22
Black oak	<i>Quercus nigra</i>					
Red oak	<i>Quercus rubra</i>	24				
Sumac	<i>Rhus</i>					3
Basswood	<i>Tilia americana</i>	5				
Elm	Ulmaceae/ Elm family	10				
Elm	<i>Ulmus spp.</i>	40				12
American elm	<i>Ulmus cf. Americana</i>	17				

Table 38. (cont'd)

Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	MNI	MNI	NISP	NISP	NISP
	C14 Dates - YBP	1600			1830	1740
Slippery elm	<i>Ulmus rubra</i>	4				
Snails and slugs	<i>Actinonaias carinata</i> (Barnes)					
Snails and slugs	<i>Amblema costata</i> (Raf.)					
Snails and slugs	<i>Amnicola limosa</i> (Say)					
Snails and slugs	<i>Amnicola lustrica</i> (Pilsbry)					
Snails and slugs	<i>Anguispira alternata</i>					
Snails and slugs	<i>Anodonta grandis footiana</i> (Say) Goodrich					
Snails and slugs	<i>Anguispira kochi</i> (Baker)					
Snails and slugs	<i>Anguispira solitaria</i> (Say)					
Snails and slugs	<i>Campeloma decisum</i> (Say)					
Snails and slugs	<i>Cyclonaias tuberculata</i>					
Snails and slugs	<i>Discus cronkfilter anthonyi</i> (Pilsbry)					
Snails and slugs	<i>Elliptio dilatatus</i> (Raf.)					
Snails and slugs	<i>Fusconaia flava</i> (Raf.)					
Snails and slugs	Gastropoda sp.				2	
Snails and slugs	<i>Goniobasis livescens</i> (Say)					
Snails and slugs	<i>Helicodiscus parallelus</i> (Say)					
Snails and slugs	<i>Helisoma anceps</i> (Conrad)					

Table 38. (cont'd)						
Common Name	Species	20SA2	20BY387-1	20BY387	20BY28-1	20BY28
	Site Name	Schultz	Marquette Viaduct South	Marquette Viaduct South	Fletcher/ Marquette Viaduct/ Defoe Park	Fletcher/ Marquette
	Cultural Period	MW Late				
	Measurement	<i>MNI</i>	<i>MNI</i>	<i>NISP</i>	<i>NISP</i>	<i>NISP</i>
	C14 Dates - YBP	1600			1830	1740
Snails and slugs	Helisoma Campanulatum					
Snails and slugs	Helisoma trivolvis (Say)					
Snails and slugs	Haplotrema concavium (Say)					
Snails and slugs	Lampsilis siliquoidea (L)					
Snails and slugs	Lasmigona costata (Raf.)					
Snails and slugs	Ligumia (Recta) lattissima (Raf.)					

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