AN ABSTRACT OF THE THESIS OF

Jun R. Kinoshita for the degree of Master of Arts in Applied Anthropology presented on July 9th, 2004.
Title: Little Houses on the Prairie: a Predictive Model of French-Canadian Settlement in Oregon's Willamette Valley

Abstract approved:

Redacted for privacy

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Using GIS, this study creates a predictive model of a distinct population of French-Canadian settlers, highlighting shared environmental characteristics of known sites that may have factored into their decision-making process as they chose locations for their farmsteads. While traditional historic and archaeological research has been conducted on French Prairie, the advent of GIS and readily available data sets facilitated this first multivariate, statistical, predictive model of French-Canadian settlement. This study explored theoretical and logistical issues of predictive modeling and determined that this population may be uniquely suited to predictive modeling. Here, however, substantiating a previous settlement pattern was problematic and the variables used produced a weak predictive model. One by-product of this research was the digitalization, rectification and analysis of 1852 GLO maps of the French Prairie during the development of the "known sites" data theme. As an initial attempt at modeling, this study points to the need for ongoing archeological testing and modeling efforts as development on and around French Prairie threatens archaeological resources. The study suggests other environmental and social variables for further testing.

Little Houses on the Prairie: a Predictive Model of French-Canadian Settlement in Oregon's Willamette Valley

By

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A THESIS

submitted to

Oregon State University

in partial fulfillment of

the requirements for the

degree of

Master of Arts

Presented July 9, 2004

Commencement June 2005

Master of Arts thesis of Jun R. Kinoshita presented on July 9, 2004.

APPROVED: Redacted for privacy

Major Professor, representing Applied Anthropology

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Jun R. Kinoshita, Author

ACKNOWLEDGEMENTS

I begin by thanking Lenville J. Stelle, who first "preached the gospel of anthropology" to me, for his friendship, guidance, faith, and the gift of a career. Without the friendship, support and shepherding of Karen Mills, Loretta Wardrip and Claire Younger, my time at OSU could not have been as rich and successful. Dr. Sunil Khanna, Dr. Jon Kimerling, and Dr. Anna Harding, have my appreciation for being a patient, insightful and accommodating committee. As Major Professor, Dr. David Brauner provided me with friendship and incredible opportunities. I am grateful to fellow graduate students Michelle Wilson, Rebecca Snyder, Carolyn Flizack, Scott MacAleer, and Michael Rogers who provided inspiration, insight, laughter, and the occasional kick in the pants. Jennifer "Pips" Thatcher has been a true "GIS buddy", without whose help, I could not have navigated the often arcane intricacies of GIS. Thanks to all of my friends in the "IS" who have given me no mercy over the years. I thank my extended family for the love, support and rich history has which shaped my life. I thank my sister Aiko and my brother Andy, who have provided much of the necessary encouragement and of whom I am so proud of. I am forever indebted for the love, example and support of my parents, Takuo and Waunita. Likewise, Chevon has been my muse, my disciplinarian, my counselor, and most of all, my best friend—and who married me anyway. There are many others whom, in error, I have neglected to mention here by name, but who have my gratitude as well. Although all of these wonderful people have contributed towards the completion of this project, any and all errors are my own.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

Over the last twenty years, predictive modeling using Geographic Information Systems (GIS) has received a great deal of attention in archaeological circles (Allen et al. 1990; Darsie et al. 1985; Judge and Sebastian 1988; Maschner 1996; Moon 1993; Wescott and Brandon 2000). This thesis explores the use of GIS-based predictive modeling of French-Canadian settlement on French Prairie, located at the north end of Oregon's Willamette Valley (Figure 1). It is hypothesized that a juxtaposition of environmental criteria with known sites can, within the context of a GIS, test our understanding of French-Canadian decision-making, create a series of models that will identify criteria used to select occupation sites, and finally, characterize other areas where sites may be located.

Within this introduction, the research questions are developed and the rational for using GIS is introduced along with a brief discussion of data issues. Chapter Two sets forth the archaeologically relevant theoretical foundations for this research, explores the implications of inductive and deductive reasoning for predictive modeling and, asserts that this research will contribute to both the practice of predictive modeling and the growing body of knowledge surrounding the French-Canadians. Chapter Three provides the natural and historical context for the research. Chapter Four describes the construction of the model, while Chapter Five breaks out each research question and presents the conclusions and implications of the respective models for future research.

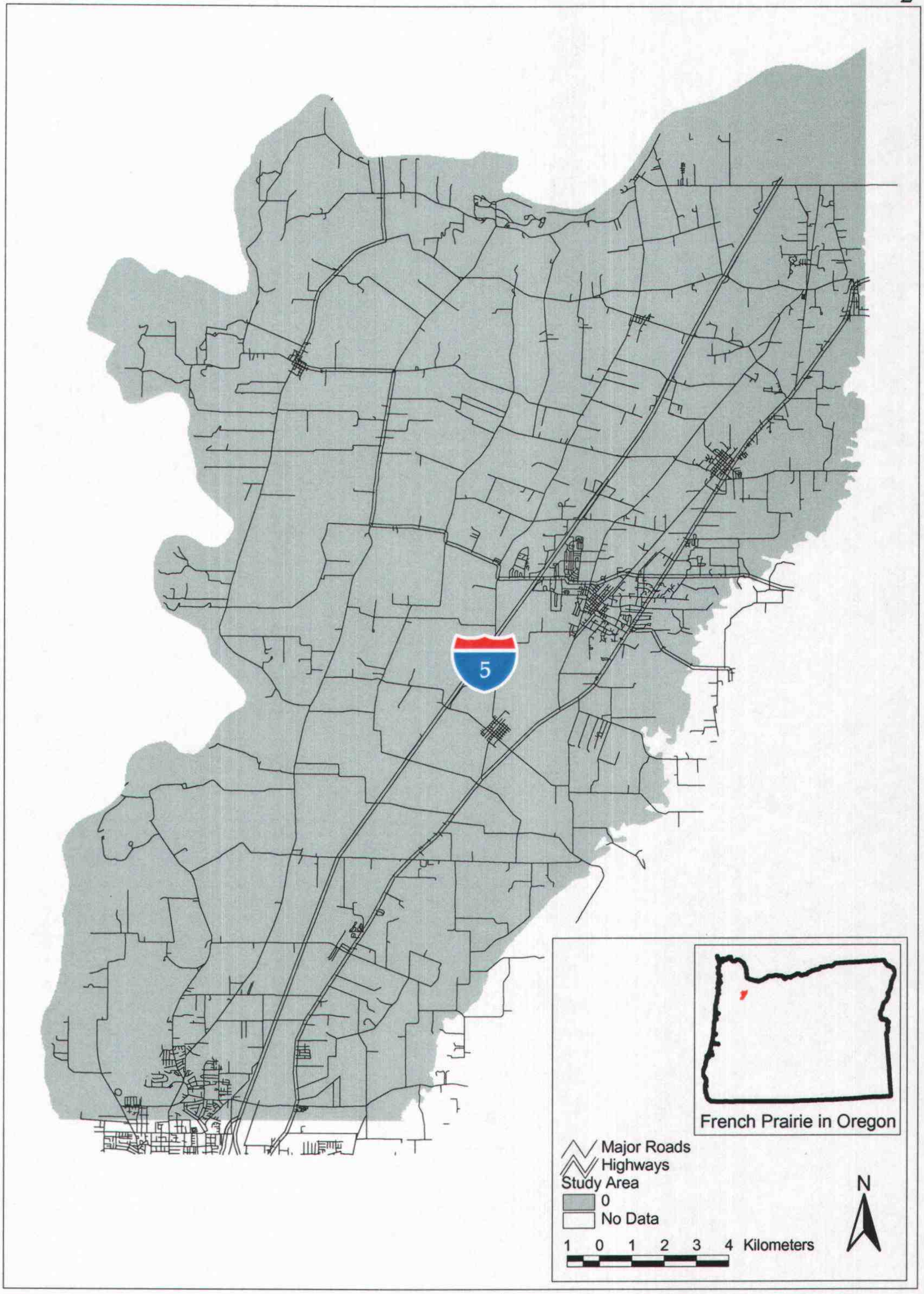

Figure 1. French Prairie research area in Oregon's Willamette Valley

While able to stand alone, conceptually this research finds greater utility as a phase in the on-going French-Canadian Archaeological Project (F-CAP), conceived and initiated by Dr. David Brauner of Oregon State University's Anthropology Department (Brauner 1989; Sanders-Chapman 1993; Speulda 1996). This researcher makes use of much of the background archival and archaeological work accomplished by Dr. Brauner and his students, incorporating many of the same definitions, and focusing on the same time frame as does the F-CAP, 1829 to 1843. In return, this researcher hopes to contribute to the growing understanding generated by the French-Canadian Archaeological Project.

Four research questions guided this work:

1) Can both inductive and deductive reasoning be used together to scientifically create a model of French-Canadian settlement;

2) does this model substantiate the settlement pattern developed in Dr. Brauner's French-Canadian Archaeological Project;

3) can patterns in environmental variables be used to characterize 1829-1843 French-Canadian settlement sites on the French Prairie of Oregon's Willamette Valley; and

4) if so, can other areas on French Prairie that share these characteristics, or some combination of these characteristics, be identified and to what degree?

These research questions drive two modeling efforts. The settlement of the French Prairie offers a unique opportunity to explore key issues in the debate surrounding the use of deductive and inductive models. The first model represents a deductive process that tests the settlement pattern developed by F-CAP, and thus our current understanding of, and to what degree, certain environmental variables did influence the settler's decision-making process (Kohler 1985). If proximity to waterways and building above the annual flood levels were of primary concern to the French-Canadians, then we would expect to see sites in locations that correspond to the intersection of those elements (Dalla Bona 2000). If our set of known sites tends to fall within areas that correspond to the intersection of those elements, we may congratulate ourselves on having identified influences that shaped the French-Canadian decision-making process, and search in areas that share those same characteristics. If not, then we must re-examine the data and our assumptions about the French-Canadian decision-making process. Conducting this analysis within the context of a GIS allows easier manipulation of variables and the supposed role they play in the decision-making process.

The second model explores whether sites, in which the house location is known through Land Grant Survey maps, archaeological survey, or existing landmarks, can be used to predict where house locations may be when only the claim boundaries are known but not the actual house location. This issue is relevant because, as will be discussed later, land claims may encompass many elevations, resource types, or other variables.

This second model represents inductive use of the archaeological record to generalize about what environmental variables characterize the record, and then locate other areas that share those same characteristics (Kohler 1985; Warren 1990a). Conducting this analysis within the context of a GIS allows more variables over a greater area to be factored in as possible influences in the decision-making process. This encourages identification of criteria that may have been missed in the historic research of F-CAP or inadvertently ignored through researcher bias.

In answering these four research questions, French Prairie exemplifies a case-study in which concerns about inductive predictive modeling are addressed, and argues that, as part of a larger scientific process, both inductive and deductive modeling are not only appropriate, but necessary. In testing the settlement pattern, this study sets the stage for discussion of the two types of models and their role in the scientific process (Warren 1990a). Both approaches can be built upon the same methodological and theoretical foundations set forth in the following chapters and are facilitated by the use of GIS.

A GIS takes advantage of advances in technology to spatially reference databases and carry out complex queries on that data (Clarke 1997; Kvamme 1989; Warren and Asch 2000). GIS has emerged as a powerful tool for archaeologists working in both Cultural Resource Management (CRM) and academic contexts by allowing the manipulation of geographically larger as well as more complex data sets, such as in the case of this study. By expanding the possibilities for archaeological research this tool encourages new perspectives and theoretical paradigms (Duncan and Beckman 2000; Wescott 2000). For this study, Environmental Systems Research Institute's (ESRI) ArcView software package was used. This was chosen for its accessibility and versatility. The criteria used to choose this package along with software-dependent definitions are discussed in more detail in Appendix A.

The successful and meaningful use of GIS depends on the quality and appropriateness of the data sets integrated into the GIS. The phrase used in programming circles, "garbage in, garbage out", is fitting. Archaeologists may accept digital data at face value while challenging the validity of the archaeological data because of the perceived authority with which it is presented (Kvamme 1990). Several aspects of the data sets used in this research were considered including, price, accuracy, precision, temporal relevancy, and issues of scale (coverage, resolution, and cell size) (GII 1997). This process is described in detail in Appendix A, section 3.

CHAPTER TWO: THEORETICAL FOUNDATIONS

"Studies of Oregon history clearly demonstrate that topography and natural resources have determined the paths of migration into the State and the locations of the settlements within it" (Hussey 1967:2).

As Kvamme points out, "the conduct of archaeology implies by its very nature, a spatial orientation; sites are distributed within regions and artifacts are distributed within sites" (Kvamme 1989:139). True to the holistic methodology of anthropology, and archaeology as a sub-discipline, the theory utilized in spatial analysis is based in diverse schools of thought such as economics (Clarke 1977). Clarke identified four theoretical approaches to understanding spatial relationships in archaeological analysis. "Anthropological spatial theory maintains that archaeological remains are spatially patterned as the result of the patterned behavior of the members of an extinct society, thus the spatial structure is potentially informative about the way the society organized itself" (Clarke 1977:18). Economic spatial theory "makes the assumption that over a span of time and experience, people move to choices and solutions which minimize costs and maximize profits" (Clarke 1977:19). "Social physics theory goes back to nineteenth-century speculations that although individual human actions may be unpredictable, nevertheless the resultant of the actions of large numbers of individuals may form predictable empirical regularities which the researcher may utilize" (Clarke 1977:19). Statistical mechanics theory purports "that the most probable state of any system at a given time is the one which satisfies the known constraints and which maximizes its entropy, where maximum entropy is achieved by that state which can be arrived at in the maximum number of ways" (Clarke 1977:20). Taken together, these four theoretical pillars form the basis of ecological and settlement archaeology which in turn support predictive modeling.

Using environmental variables in spatial analysis can be traced back through the emergence in Europe of environmental functionalism. Out of a systemic perspective of culture that rejected culture history without explanation developed the study of the role of environment as one influence in the development of a cultural whole (Trigger 1989). The limits placed on culture by ecological factors were examined (Trigger 1989). In the United States, the ecological approach and settlement archaeology gained currency from the influence of Steward and the work of Willey (Thomas 1990; Trigger 1989). Willey went beyond diagramming the relationship between the environment and a society and viewed the settlement pattern as a sum of multiple systems. A wider implication of this perspective was that sites previously studied individually now became integrated parts of a larger whole, placing an emphasis on collecting data from sites that before might have been deemed less important or valuable (Thomas 1990; Trigger 1989).

The emergence of the New Archeology and its emphasis on environmental influence and statistics prompted early attempts at quantifying settlement patterns and predictive modeling. Trigger points out that the New Archeology viewed change as a response to outside factors such as environmental shifts (Trigger 1989). As the primary proponent of the New Archeology, Lewis Binford argued "the correlations used to infer human behavior from archaeological data had to be based on the demonstration of a constant articulation of specific variables in a system" (Trigger 1989:300-301).

Thomas identified four approaches to settlement patterns (Thomas 1990). Of those four, Brauner used the ecological determinants approach to argue that French-Canadian settlement was in response to a suite of environmental variables including elevation, distance to water, vegetation and soil type (Brauner 1989; Thomas 1990). The predictive modeling effort used by this study builds upon this argument. At the scale used for this study, the site catchment approach may also present a possible option for later investigation based on the settler's proximity to one another (Thomas 1990).

Settlement patterns serving as informal predictive tools have been increasingly replaced by models with more predictive power (Warren and Asch 2000). Facilitated by an increase in computing power and sophistication of software applications, increased arrays of environmental variables are being used. This has been accompanied by a broadening of the physical area that a researcher can examine. Warren and Asch argue that these trends have led to a regional as opposed to a site-level perspective in analysis, and an increase in the application of probability models (Warren and Asch 2000).

"Predictive models are tools for projecting known patterns or relationships into unknown times or places" (Warren and Asch 2000:6). Archaeologists have been exploring this tool for years (Allen et al. 1990; Judge and Sebastian 1988; Moon 1993;

Wescott 2000). Out of that exploration, two types of models have been the focus of a great deal of debate (Dalla Bona 2000; Ebert 2000). Most archaeological predictive models have been inductive, or correlative, which use empirical relationships between environmental variables and site locations to predict areas likely to contain undiscovered sites (Kvamme 1990; Warren 1990b; Warren and Asch 2000). Deductive, or explanatory models from a positivist view, test theories about which and to what degree human behavior is influenced by environmental variables, thus predicting where evidence of that behavior may be found (Dalla Bona 2000; Fritz and Plog 1970; Kohler 1985; Sebastian and Judge 1988).

Several aspects of this research into the French-Canadians make it a unique opportunity to address concerns about predictive modeling. In particular, this research explores the use of both inductive and deductive reasoning, each fulfilling its unique role within the scientific inquiry into the French-Canadian world. As discussed, most current research has utilized inductive models while few others focus on deductive models. Instead, this research argues that each has a role in the scientific method (Fritz and Plog 1970; Thomas 1989; Warren 1990a). Deductive research must begin with a hypothesis to be tested. That hypothesis may come from abduction or, in this case, a pattern observed in a prior study (Fritz and Plog 1970).

For this study, the deductive model uses variables identified as influential in the F-CAP settlement pattern, weights them according to a hypothesis about the decision-making process also identified from the settlement pattern and predicts where other areas are according to that hypothesis. With deductive modeling there may be a return to the emphasis placed "on inferring patterns of social behavior and its (settlement archaeology) rejection of ecological determinism" (Trigger 1989:285). The inductive models identify correlation between known sites and variables, establishing a set of shared characteristics. They then identify other areas that share those characteristics. Thus, in this scheme, the deductive model leads into and is tested by the inductive model (Fritz and Plog 1970). It is hoped that the two models will be able to meet in the explanatory middle (Kohler 1985).

At the same time, by addressing some of the weaknesses of inductive modeling, this project may present a case study in which inductive modeling is appropriate. A large part of the criticism of inductive models in archaeology has focused on their use to economize inventory survey without any analytical contribution to understanding or explanatory theory (Ebert 2000). While Binford has argued that with the "demonstration of a constant articulation of variables" explanation and prediction are both achieved, more recent work has challenged that view (Dalla Bona 2000; Ebert 2000; Trigger 1989:301).

As stated earlier, while this study stands on its own, it finds most utility as a phase in the continuing French-Canadian Archaeological Project. The inductive model is not intended to replace intensive survey but rather to focus the search and act as a launching point for the research that will ultimately result in a greater theoretical base. Indeed, this model claims to predict only a very narrowly defined type of site and will not accurately predict prehistoric sites or those used by the French-Canadians for purposes other than as a residence. Thus, the need for systematic, thorough survey is not reduced. Through historical sources we know to expect at least 97 occupation sites. While there may certainly be more than the historic sources suggest, this figure provides the model with a more accurate population than surface survey or other sampling techniques (Kvamme 1988; Warren and Asch 2000). These sites are in danger of being destroyed by encroaching development along the I-5 corridor and it is argued that site preservation and protection along with developing theory should be of concern of the archaeologist. Accelerating the discovery of sites and focusing the study can preempt the accidental destruction of these sites.

Bias in survey techniques may color an inductive predictive model (Kohler 1985; Wescott and Kuiper, 2000). As discussed above, the use of historical sources, in juxtaposition with other sources, eliminates some bias out of the sample. These same historical references also document that French Prairie was part of a larger system; the economy surrounding the fur trade, and the resulting reliance on the Hudson Bay Company (HBC) at Fort Vancouver, of the French-Canadians. With that understanding, this research hopes to isolate that known system out of their decision-making process and identify that which remains.

Inductive models may often be limited to correlation of extant sites with modern environmental variables (Ebert 2000). However, for the inductive model created for this study, temporal distance between the data gathered today and the landscape that the French-Canadians encountered is not so great as to threaten the integrity of the model (Church et al 2000). The historical resources that are used for information about the French-Canadians also reach back in time to provide environmental data. For example, the vegetation data are based on the 1852-1856 General Land Office Township Survey Plats rather than modern vegetation. While this may introduce new sources of bias, (as discussed in appendix D) the vegetation data are at most, only twenty years removed from what the French-Canadians would have encountered, in comparison to modern vegetation data sets that would reflect over 150 years of agriculture, fire suppression and development.

Inductive models tend to focus on the "site" as the unit of analysis, applying an arbitrary boundary, neglecting its participation in numerous peripheral systems, multiple cultural affiliations, and encompassing multiple definitions of "site" (Ebert 2000:131). For example, previous inductive predictive modeling efforts may have tried to predict sites such as "lithic processing", "seasonal hunting", or "ceremonial" sites to which were ascribed labels reflecting perceived predominate usage. Certainly, however, if these sites were being used as predominately "hunting" camps, daily living activities took place as well. Additionally, these sites may have represented use by different cultural groups over the course of hundreds of years.

Rather than try to create a model that predicts many different types of sites, this research takes advantage of the documented, agrarian lifestyle that the French-Canadians were trying to adopt, and focuses on this particular type of site with known cultural affiliations, within a tightly defined, narrow, 14 year temporal context. While acknowledging the existence and participation in larger systems, this research uses the occupation sites, or home sites of the French Canadians, as the basic unit of analysis (Ebert 2000). It is assumed that these are points of substantial impact, year-round occupation within the period defined even if the settlers were supplementing their income by traveling with the fur brigades. The historical references do indicate that although native resources were being used, economic emphasis had shifted to agriculture. While proximity to outside systems was important, immediate access to the good soils may have been more important. Of course, French Prairie had already been chosen for its abundant, good soils but within the area there may have been those sites considered preferable. As budding agriculturalists, (if you pardon the pun) the French-Canadians needed to be located near their fields. For the French-Canadians, ownership meant proximity. They set up their land claims so that they would be proximal to their abodes. The fact that they were receiving their seed and equipment from the HBC on credit, and that credit could be paid back with agricultural product, certainly encouraged them to succeed in their attempt at agriculture (Hussey 1967).

Once again, this research acknowledges that it attempts to trade the ability to predict a wider variety of sites for a more focused, hopefully more accurate look at French-Canadian sites. From the historic sources we know that the particular settlement we are interested in was limited to a period of less than twenty years, limiting the need to allow for temporal change in the model (Church et al. 2000).

Predictive modeling research in archaeology has focused on prehistoric archaeological sites (Duncan and Beckman 2000; Wescott and Kuiper 2000). As the discussion above has revealed, there are instances where historic site location models, with their ability to refer to, or build upon historic sources, facilitates the ability of the inductive model to predict site location.

The line between historic and prehistoric sites is notoriously gray, inviting the possibility of incrementally bridging the gap between the two through modeling (Fontana 1978). A greater understanding of settlement patterns in historic sites may allow extension of that understanding to prehistoric sites. Archaeological use of GIS in predictive modeling has focused on either an inductive or deductive approach (Kvamme 1989). The use of both inductive and deductive modeling with historic sites may not only predict where sites occur but also contribute meaningfully to the understanding of why sites are located where they are.

From an anthropological perspective, this study bridges the gap between the adaptive strategy of Cultural Materialism and the ideational strategy of Critical Theory (Thomas 1990). The predictive model is dependent on the adaptive interaction that people have with their environment (Thomas 1990). This theoretical stance is particularly useful because manifestations of this interaction are present in the archaeological record (Thomas 1990). Yet on the ideational side, our understanding of the historic decision-making process is tested and challenged by the application of Critical Theory (Thomas 1990). While acknowledging the influence of the environment, the project asks both: to what degree did those environmental factors shape the French-Canadian settlement and what social factors may have played a part (Thomas 1990)? At the same time, Critical Theory demands that the study ask questions of itself such as: why these variables, and how will this model be used (Thomas 1990)?

In answering the four research questions outlined in chapter 1, this research will achieve three goals. First, it is hoped that the process of building this model will illuminate the culture of this first group of Oregon settlers. The model will ultimately identify those criteria that the French-Canadians used to select their homesteads, allowing researchers to locate similar sites. At the same time, sites that do not follow the model's prediction may signify diversity within the cultural group, identifying areas for later research (Altschul 1990). Thus, this study will be of interest to archaeologists, historians and ethnographers working in the region.

Secondly, it will demonstrate that a GIS-driven predictive model is feasible for historic populations in the Willamette Valley. Some of the issues encountered in previous predictive modeling efforts elsewhere will be addressed and issues unique to predictive modeling in the historic Willamette Valley will be identified. For archaeologists, technicians and theoreticians focused on the application of predictive modeling and/or GIS technology, this project will provide a valuable case study.

Finally, as can be seen in Figure 1, French Prairie sites, many of which are on private land, are threatened by development in the valley. Predictive modeling can locate sites in a timely and cost-effective manner because the laboratory setting eliminates travel and access costs (Duncan and Beckman 2000). For this study, all the data was acquired at no explicit cost to the researcher. The research was completed over the course of three and a half years of graduate work in which the process was studied. A researcher already versed in the creation of a predictive model could have produced the model in significantly less time and at minimal cost, potentially preventing the destruction of sites. It is crucial to remember, however, that this study is designed not to replace traditional survey techniques, but to augment, guide, and test them. The model must be verified by ground-truthing as well as through statistical methods (Wescott and Kuiper 2000). Thus, although the model stands on it's own it finds greater utility as a phase in the on-going French-Prairie Archaeological Project (Brauner 1989).

CHAPTER THREE: SETTING

Environmental Setting

The Willamette Valley, nestled between Oregon's Coastal and Cascade ranges, suffers a mild climate and rich natural resources that even today, draws much of the state's population (Brauner1989; Jewell, 1996).

French Prairie, like much of the Willamette Valley, is sheltered by the Coastal Range but still benefits from the warm Pacific Ocean resulting in warm, dry summers and wet winters while temperatures below zero Fahrenheit and above 100 are rare (Balster and Parsons 1968; Bowen 1978). The annual precipitation ranges from 30 to 50 inches, falling mostly during the winter (Bowen 1978:6; Brauner 1989:6). Burnett, (1880) described the climate as such:

> ...during most of the rainy season the rains are almost continuous. Sometimes the sun would not be seen for twenty days in succession. It would generally rain about three days and nights without intermission, then cease for about the same period (still remaining cloudy), and then begin again. These rains were not very heavy, but cold and steady, accompanied with a brisk, driving wind from the south.

The valley was formed between the volcanic basalt deposits of the Cascade Range and the tectonic uplifting of the Coastal Range (Balster and Parsons 1968). The floor of the valley slopes towards the north, gradually flattening out near Salem (Figure 1). Rising prairies are cut deeply by the Willamette River here before dropping sharply at Oregon City (Balster and Parsons 1968:3). At least twice, ice-age lakes filled the valley depositing silt and gravel that form the foundation of rich soils (Hussey 1967). Edwards (1842) described these soils:

> The soil is generally of a siliceous nature, and bears little resemblance to the dark vegetable mould which we of the west are used to prefer. It produces well without the application of manure; but I have never known any country in which its happy effects are so palpable. Even the ashes deposited from the burning of stubble or other remains of the previous year's produce, effect a marked improvement in the crops. The silt is deep and its productive qualities durable, but little if any deterioration being yet perceptible in the oldest fields.

Drainage from the sides and upper valley join to form the Willamette River, which in turn empties into the Columbia River east of Portland. Along the flood plain of the Willamette and Champoeg Creek, seasonal flooding has historically deposited the well-drained silty clay loams. Higher up on the flood plain are the gravel-rich silt loams. These were deposited over gravel substrata by intermittent flooding. Other areas within French Prairie are characterized by Senecal and Calapooyia Series soils which did not undergo flooding (Balster and Parsons 1968). Poorly drained, Calapooyia soils are silt loams with greater clay content than the moderately drained Senecal series (Brauner 1989).

The research area lies on the boundaries of two eco-tones, between the denser forests of the lower Willamette and the open areas of the upper Willamette Valley (Hussey 1967).

> In the lowlands the dominant trees were Douglas fir, Oregon maple, yew, ash, white oak, alder, willow and balm. Occasionally found on the valley floor but generally growing on the hills or mountain slopes were fir, pine, spruce, hemlock, cedar, larch and madrone. Beneath the trees there was a dense undergrowth, which included ferns from 6 to 12 feet high [Hussey 1967:2].

The open mixed prairie and oak savannah of the valley floor reflected the management of the land by the native Kalapuya Indians through annual fall fires (Brauner 1989; Habeck 1961; Hussey 1967; Jewell 1996). Floral resources that the Native Americans used include camas, skunk cabbage, lupine, bracken fern, cattail, hazelnuts, berries of many varieties and tarweed (Hussey 1967). There was also plentiful timber for fuel and shelter (Brauner 1989; Hussey 1967).

The diverse environment yielded diverse fauna. Beaver was what first brought Europeans to the Willamette Valley and was still being trapped when they began to settle (Hussey 1967). Other animals trapped for fur included ermine, lynx, muskrat, otter, rabbit, and wolf (Brauner 1989). Bear, deer, elk, cougar, and fox filled the forests and grazed the prairies (Hussey 1967). Native Americans, and later the fur traders, hunted these large animals, but also relied heavily on smaller game such as beaver, rabbits, and squirrels (Hussey 1967). Migratory waterfowl were exploited seasonally (Brauner 1989). Although salmon were not found above the falls at present-day Oregon City, trout and other fish could be found in the numerous tributaries of the Willamette River (Hussey 1967).

Cultural Context

The native peoples of the Willamette Valley were the Kalapuya, decimated by small pox and venereal diseases introduced by the trappers and traders to the point that the Willamette Valley was sparsely populated when Europeans began to explore and settle (Brauner 1989; Hussey 1967; Jackson 1995). Early explorers recognized potential in the void left by the Kalapuya. "This valley would be competent to the maintenance of 40 or 50 thousand souls if properly cultivated and is indeed the only desirable situation for a settlement which I have seen on the West side of the Rocky mountains" (M. Lewis, as quoted in Hussey 1967:21).

Within this rich valley is the area called French Prairie, after the influence of its first settlers. This study borrows the definition used by Dr. Brauner's French-Canadian Archaeological Project (1989). Thus, the study area is bounded by the Willamette River on the north and west sides, and the Pudding River to the east. The now-drained Lake Labish, (Lac La Bich) demarcates the limits of French Prairie to the south. Using these boundaries, French Prairie is 18 miles north to south and 15 miles wide east to west (Brauner 1989; Hussey 1967).

French-Canadian contributions to early American history are long and significant, yet often marginalized (Jackson 1995). Even Meriweather Lewis described his stake within the new Louisiana Purchase in terms of "Arpents"- a French unit of land measure (Ambrose 1996:450). Several members of the Lewis and Clark expedition were of French-Canadian fur-trade ancestry, coloring the roster with names like Drouillard and Charbonneau (Jackson 1995). Charbonneau's most famous contribution to the expedition was to bring along his Shoshone wife, Sacagawea (Ambrose 1996; Jackson 1995). Pierre Cruzatte and Francis Labiche, also of the expedition, were *Métis*, examples of the mixing of European and Native American blood that marked the opening of the American west (Ambrose 1996; Jackson 1995).

More often than not, the fur trade was responsible for the early exploration that brought French-Canadians to the frontier (Brauner 1989). Although they are called French-Canadian, some of these men were of mixed blood, offspring of *voyageurs* and their Algonquin, Iroquois, or other Native American group wives (Jackson 1995). This study will use the term "French-Canadian" as a convenient label for a complex cultural affiliation. *Métis* will be used in instances where Native American heritage is known and relevant to the discussion. As the fur trade moved west and the original *voyageurs* were required to spend years on the frontier, it is only natural that they sought intimacy with the Native American women that they encountered (Jackson 1995). Often, these relationships served to cement economic bonds as well (Jackson 1995). Their *Métis* sons and daughters were raised in the fur trade forts as it moved west, taking up their fathers' loads. Thus, while growing up in a somewhat European fashion, they were schooled in the ways of the local Native American groups as well, by their mothers and other relatives (Brauner 1989; Jackson 1995). Native American ties extended across the region as new assignments forced women away from their families' tribes and customs (Jackson 1995). With the resulting conglomeration of cultures, the dominant cultural impact on their children may have been that of the French-Canadian fathers.

In 1806 the North West Company belatedly attempted to address the issue of an estimated 1500 family members trailing along by banning their employees from keeping Native American wives at company expense (Jackson 1995). The fur companies employed these *voyageurs* from Montreal to transport and support their ventures. Freemen, many former employees of the Pacific Fur or North West Companies, now provided hired services to the HBC (Brauner 1989; Hussey 1967). HBC Governor George Simpson described the situation created by the Freemen as such: "These Freemen are a pest in this country, having much influence on the natives, which they exert to our disadvantage by inciting them against us" (Jackson 1995:39, 60). A portion of employees and a larger percentage of Freemen were *Métis*, further earning social scorn (Jackson 1995).

From the American side, interest in the Oregon territory and the fur trade was stoked by the success of the Lewis and Clark expedition (Ambrose 1996). Meriweather Lewis had hoped that his famous expedition would open western trade routes for the United States and that his accounts of the rich agricultural potential would set off a wave of settlers that would silence debate about ownership between Britain and the United States (Ambrose 1996). Access to the fur trade and river routes of economic exchange, such as the Columbia River, were the source of great tension between Britain and the United States (Ambrose 1996; Jackson 1995). The value of the Pacific Northwest was calculated in economic terms for both nations and the fur companies were the primary economic forces in the region, responsible for putting people on the ground (Jackson 1995).

In 1811 the American John Jacob Astor's Pacific Fur Company established Fort Astoria on the Columbia River and began exploring the interior (Bowen 1978; Brauner 1989; Hussey 1967; Jackson 1995). Britain's North West Company was also working the area around the Columbia River. The Willamette Valley was first explored by French-Canadians in 1811, led by David Stuart of Astor's Pacific Fur Company. He was joined by Regis Bruguier, a Freeman and first of a wave of French Canadians to follow (Brauner 1989; Hussey 1967). The Astorians began a fur-trade tradition by using the Willamette Valley as a source of food for their hungry fort (Brauner 1989; Hussey 1967). In 1813 the Astorians, influenced by the War of 1812, sold their interests to the North West Company which had begun operations in the Willamette as well (Bowen 1978; Brauner 1989; Hussey 1967). November of that year saw the North West Company founding Willamette Post on what would eventually become the town of Champoeg (Brauner 1989:23). In 1821 the North West Company merged with Hudson's Bay Company under Dr. John McLaughlin, manager of the Columbia Department (Bowen 1978; Hussey 1967). The HBC built Fort Vancouver in 1824 as the regional hub for their operations and the de-facto center of the French-Canadian's economic and social universe (Bowen 1978; Brauner, 1989; Hussey 1967). Between 1825 and the early 1840's, Hudson's Bay Company expeditions pushed south up the Willamette Valley (Hussey 1967; Jackson 1995; Brauner 1989). Thus, "there were few on the Willamette (River) from 1821 to about 1835 whose conduct was not shaped within the framework established by the 'Honourable Company'." (Hussey 1967:41).

Several early fur company establishments are known. Hussey documents the existence of a post that surfaces in records between 1826- 1828 as "McKay's Fort" on the "...Willamette River between the present Champoeg and the present Newberg which may have been a North West Co. post 2 miles upstream from the present

Champoeq State Park on the top of a low ridge in the prairie about 1300 feet south of the river" (Hussey 1967:28, 33-34). William Wallace's post near Salem, built between 1812 and 1813, served as the launching point for North West Company hunters (Hussey 1967; Brauner 1989).

An 1818 convention left the Oregon Territory accessible to citizens of both Britain and the United States (Hussey 1967). In 1827 the U.S. and Great Britain agreed to "extend the joint occupation of Oregon for an indefinite period" (Hussey 1967; Jackson 1995:88). The Hudson's Bay Company was actively involved in shaping policy regarding the Oregon Territory. In 1824 the HBC was actively moving its southern assets to north of the Columbia to bolster their claim to that area (Hussey 1967; Jackson 1995). Although the Willamette Valley was the more attractive area from an agricultural standpoint, it lay south of the Columbia River, the assumed dividing line along which the border would eventually fall (Jackson 1995). With the beaver trapped out in the lower Willamette Valley, HBC Governor Simpson saw it only as "a convenient route of travel and supply for parties operating in the more distant and richer fields of the Snake Country and the Umpqua, regions which Simpson desired to denude of furbearing animals so as to make them unattractive to American Rivals" (Hussey 1967:34). That policy was reversed by HBC authorities on January 16, 1828 when it was realized that a stronger presence in the disputed areas could bolster the negotiating leverage of Britain and in turn the HBC (Hussey 1967). As late as 1838, the HBC's monopoly was renewed by the British Parliament with the understanding that the company would counter American claims by encouraging and facilitating British settlement in the contested areas (Jackson 1995:91).

Chief Factor McLoughlin, realizing that a territory occupied by indebted friends was preferable to being surrounded by antagonistic, resentful Americans and ex-patriots, was also reluctant to subject employees to the "great hardships" of moving their families east (Hussey 1967:51; Jackson 1995). Employees of the company were bound by a strict contract, lived in close proximity to the forts or post and were required to return to the east on their retirement (Hussey 1967; Jackson 1995). The Hudson's Bay Company had declared after 1833 "that no Officer or Servant be permitted to remain in the Country after the expiration of his engagement, without our sanction or that of Governor Simpson" (Hussey 1967:94). Freemen, on the other hand, had more latitude with respect to where they lived and were not bound to return to the east (Hussey 1967). Both found themselves familiar with the bounty and diversity of the Pacific Northwest, and both found themselves drawn to the rich farmlands along the Willamette River (Brauner 1989).

Beginning in the late 1820's, as many as 100 French Canadians and their families, began to settle in and farm the Willamette River flood plain (Brauner 1989). As the fur trade declined, farming on the fertile prairie began to look like a promising occupation for traders who still needed to feed their families (Jackson 1995). The process of settlement probably began with semi-permanent (one to three years) trapping encampments from which they ranged (Brauner 1989). Hussey (1967) documents some of the French-Canadians farming horses and possibly tending family gardens by the late 1820's. Brauner summarizes the archaeological information about this early settlement:

> Little detail about pre-1829 settlement exists in the literature. We can assume that occupation of a year or more at one location required the erection of a single log cabin, probably employing the *Piece sur piece* building technique typically associated with French-Canadian construction. Less elaborate log buildings suitable for short-term occupation, storage, or some other function may also have been associated with these isolated cabin sites. Hand wrought square nails were being manufactured at Fort Vancouver in small quantities, but were probably not used in the Willamette Valley before the early 1830s. Window glass was not used in regional construction until the mid-1830s. Brick was similarly not used in Willamette Valley construction until the late 1830s. Archaeologically, little architectural evidence will ever be found relative to the pre-agricultural period of French-Canadian usage of the valley. We also have little evidence relative to the location of these pre-1829 occupation sites. Several French-Canadians, including Lucier, had cabins in the Champoeg area and there was a short-term occupation site at the mouth of the Pudding River (Hussey, 1967). Beyond that, little is known. The occupation sites selected by the first permanent French-Canadian settlers from 1829 to 1831 may well have been their place of residence for several years prior to receiving formal permission form the Hudson's Bay Company to settle in the valley [Brauner 1989:25].

The Hudson's Bay Company continued to exert substantial economic influence over the region through lines of credit extended to former employees and Freemen settling and switching to farming (Bowen 1978; Brauner 1989; Jackson 1995). This influence extended to social and political realms as well (Brauner 1989).

Within French Prairie, Champoeg was the focus of much activity and later came to play a pivotal role in the new Oregon government. Champoeg was the gateway to French Prairie for several reasons. Traveling overland was shorter as the river bent, became shallower and the current strengthened. Overland routes from the

Columbia and Fort Vancouver-both of central economic importance, emptied out onto Champoeg at "Dupatti's" (Hussey 1967:57-58, 73). There is no clear definition of where the name "Champoeg" came from let alone which area people are referring to (Hussey 1967). Hussey documents the use of McKay's Old Fort near Champoeg as the launching point for southern-bound expeditions (1967). The location was convenient for those coming overland, bypassing difficult terrain along the lower Willamette River, provided an accessible beach and consequently, horses could be bought from Freemen and traders living in the area or extra and injured animals left in their care (Hussey 1967). Because of its convenient location, access and grazing, the HBC pastured horses on the prairie (Jackson 1995). Gradually, the French-Canadians and their families increased their dependence on their gardens and livestock and decreased their use of wild game and plants (Brauner 1989). In contrast to the fur trade posts, who depended on their own orchards and gardens for produce, many of the early French-Canadian settlers used resources that they would have become familiar with through their own heritage or their Native-American wives knowledge (Brauner 1989). This utilization of resources traditionally used by Native-Americans may have shaped the location and extent of their land claims, as well (Brauner 1989).

That these people shifted economic gears and settled is not surprising given the emphasis on land at that time (Ambrose 1996). Ownership of land implied wealth and, indeed, provided wealth through its resources in an economy short on viable cash. As the fur trade declined they were forced to search out alternative livelihoods (Jackson

1995). As was pointed out, they were probably well aware of the difficulty that they and their spouses faced if they tried to integrate into eastern society (Jackson 1995).

On the French Prairie, their farms were forgiving of their lack of experience and produced well with moderate investments of labor while accommodating continued participation in the fur trade economy.

> James A. O'Neil, whose farm on the west side of the river near the Methodist Mission was described by one visitor in 1841 as 'the best we have seen, in every respect,' was considered to be a highly industrious farmer, yet he reported that he found it necessary to work only one month in the year to make a living. 'The rest of the time he may amuse himself,' reported the perhaps somewhat envious observer [Hussey 1967:117]

There were certainly cultural advantages for the men. Their Native American wives were a source of labor that they readily took advantage of (Hussey 1967). They also took advantage of the local Native Americans who they employed but who were akin to slaves in treatment (Hussey 1967). Thus, although life was certainly not easy, the French-Canadians had chosen well.

> A few of the French-Canadians lived in substantial hewn log or frame houses, neatly painted, surrounded by thrifty orchards, and generally displaying an air of 'rude plenty'. But most of the settlers, both Canadians and Americans, lived during this early period in small, unpainted log houses of various styles and shapes. For most prairie farmers, fireplaces were made of sticks plastered with clay. There were few stoves. Cooking generally was done over the coals or in kettles swung on cranes in the fireplaces [Hussey 1967:117].

There were Americans on the French Prairie, some associated with the fur trade, others with the Methodist mission (Bowen 1978). The French-Canadians aided these earliest American settlers with knowledge and resources (Bowen 1978; Brauner

1989). Later, as American rule was more certain, contention between French-Canadians and the growing population of Americans over issues of self-government foreshadowed the marginalization of the French-Canadians (Hussey 1967).

As the political and social influence shifted, the French-Canadians were eclipsed by the Americans through racism, nationalism, politics and religion (Brauner 1989). As Brauner (1989) points out, the French-Canadians, as voyagers or employees of the fur trade, were subject to prejudice even before they settled on French Prairie. Once they settled, they became targets of the increasing American population. Brauner (1989) documents this well in his discussion of the hidden legacy of the French-Canadians and argues convincingly for the necessity of archaeological investigation.

Even within the fur trade forts, the *Métis* were mistrusted, expendable before other employees and faced limited opportunities (Jackson 1995). Early on, the idea of melding the Native Americans into the European stock in order to exert control through familial ties and enculturation enjoyed some entertainment. "Breeding the Indians out of existence was a novel humanitarian concept in a society that was generally willing to kill them" (Jackson 1995:219). Unfortunately, that concept could not overcome the deep, ingrained prejudice that resulted from concepts of racial purity that stretched back to European sources (Jackson 1995). Those with Native American wives risked social ostracizing or labeling as Indian sympathizers if they attempted to defend the honor of their wives (Jackson 1995). Hussey states of John Ball; "In his opinion, the white residents had adopted too many of the habits and customs of the natives" (1967:66).

As Catholics, the French-Canadians felt pressure from the Protestant Americans (Jackson 1995). "Only four of the fifty-two voting for organization were Catholic" (Jackson 1995:183). The Catholic French Prairie settlers asked for religious representation in response to pressure from the Methodist Mission (Jackson 1995). Later, this Catholic base supported the longevity of some French-Canadian family lines (Jackson 1995). Religion, and its associated education, acted in other ways to exclude the *Métis*. The Oregon Institute constitution limited education to non-whites only "if he has good moral character and can read write and speak the English language intelligibly", a requirement that few *Métis* children could fulfill (Jackson 1995:219). Although the French-Canadians had been an integral part of the growing community, "cultural differences augmented by religious division quickly led to the development of a closed ethnic community, isolated from the main stream of frontier society and politics" (Bowen 1978:11).

One result of tension between the French-Canadians and the influx of Americans was the low price at which some *Métis* sold their claims (Jackson 1995). Some were drawn to the promise of gold, others to the cash that newly wealthy gold field emigrants offered (Jackson 1995). Some French-speaking families did withstand or integrate into the new American society (Jackson 1995). However, Native American wives, and those settlers who were more Indian than French-Canadian, retreated to reservations (Jackson 1995).

Attempts to push out the French-Canadians legally took the form of a congressional debate in 1850 over excluding British subjects in the land grant

(Jackson 1995). The influx of American settlers were perturbed to see the premier sites held by "the French-speaking, Catholic *Métis*" (Jackson 1995:225).

Today, the French-Canadians present a challenging study because the contemporary American accounts - from which we draw much of our information, reflect contemporary biases (Brauner 1989). Because many of the French-Canadians were illiterate, few left journals and letters. Because there was no government, the only official documents we have for the earliest settlers are from North West Company and HBC archives—which tend to focus on economic issues and reflect the biases of the day (Brauner 1989). Thus, French-Canadians appear in histories of Oregon or the Willamette Valley only sparingly and often without due reference to their historical contribution (Jewell 1996). And so, as Brauner argues, "If we are to understand French-Canadian lifestyles, settlement patterns and their ultimate contributions to the early settlement of the Willamette Valley we must turn away from the written historical accounts and rely on the archaeological record" (1989:19).

CHAPTER FOUR: BUILDING THE MODELS

Defining the Models

As illustrated in Chapter 3, predictive modeling, as it has developed in archaeology, depends on the idea that human settlement is directly and/or indirectly shaped by combinations of environmental variables (Altschul 1988; Duncan and Beckman 2000; Warren 1990b; Warren and Asch 2000). Today's predictive models examine the relationships of layered environmental, and possibly cultural, variables in order to discern patterns in human behavior (Kincaid 1988).

> Models are selective abstractions, which of necessity omit a great deal of the complexity of the real world. Those aspects of the real world selected for inclusion in a model are assumed to be significant with respect to the interests and problem orientation of the person constructing the model (Sebastian and Judge 1988:1). The archaeologists' goal is to correctly identify important aspects of the natural or social environment that influenced the location of human activities, and to interpret the archaeological record as the result of a set of functional, temporal, spatial, and behavioral responses to a varied environment (Kincaid 1988:550). [Moon 1993:3]

For this study, the deductive model drew its variables from descriptions of the decision-making process found in historical references and identified by Dr. Brauner's F-CAP. Brauner discerns two distinct episodes, differentiated by their land claim shape and date, of French Canadian settlement (Brauner 1989). The earlier episode focused on the Willamette River for transportation, while staying above the normal flood levels. While well-drained, fertile soils were important, these early agriculturalists may have hedged their bet with access to native resources and productive trapping grounds.

The later episode was more reliant on a developing overland transportation network, the security of an increasing network of neighbors, and building upon the agricultural experience of the first episode. The later episode still remained above annual flood levels, shifted to smaller watercourses, and may have placed less emphasis on the location of native resources. Thus for the deductive model, elevation above the normal flood level, distance to water for both transport and consumption, soils suitable for farming, and access to overland transport routes were specifically identified by F-CAP (Brauner 1989). For some settlers, availability of native resources and good trapping grounds may have also been attractive.

The variables used in the inductive model represent those identified by previous researchers as possible factors in the decision-making process, either overtly, or as a prerequisite to another factor. The rationale for including each variable is discussed in the descriptions below.

Dalla Bona points out that many variables overlap in usage and questions why particular variables are chosen over others for consideration (2000). For example, vegetation can be considered a product of elevation, hydrology, soil, aspect and slope (Altschul 1990). This phenomenon can be argued to "inflate the models apparent power" (Altschul 1990:231). Chou points out that, "incorporating correlated variables into a spatial model induces inflated parameter variances and should be avoided" (Chou 1997:266). This quandary is in part addressed in the analysis by using the pair-wise test of conditional independence and its implications are discussed in the conclusions.

Proximity to Ft. Vancouver for trade and its social network was certainly a consideration of the French-Canadians (Hussey 1967). Within the radius of one or two day's travel of Ft. Vancouver, however, they chose French Prairie as the locus of their settlement. At this level the need for good agricultural soils, temperate weather and good drainage appear to dominate. Within French Prairie however, those environmental variables, which dictated where homes would be, are the focus of this research. For this model, elevation, slope, aspect, vegetation, distance-to-water and soil were chosen primarily based on criteria identified in the historical record. For example, having worked in the region for many years, the French-Canadians must have been aware of the seasonal flood levels and may have chosen higher ground, or ground beyond a natural dike. Flatter areas would have been more suitable for agriculture. South-facing homes would have been warmer and south-facing fields would receive more sun. Areas characterized by wetlands would have been less suitable for farming while those covered by thick stands of mature forest would have required labor-intensive clearing. Access to water for drinking, cooking, washing and transportation would have also been considered.

Describing the Data Sets

The following sections include descriptions of each data set used in this research and the basic manipulations used on the data. These manipulations were executed using ArcInfo, ArcView, and the ArcView extensions, Spatial Analyst, X-

Tools and Arc-Spatial Data Modeler (Arc-SDM). Table 1 lays out the raw data sets and their sources.

Table 1. Data sets and sources

Theme	Source	Projection	Datum	Type
Elevation	OGDC www.sscgis.state.or.us/data/ themes.html	UTM	NAD27	ASCII DEM-grid
Slope	Derived from elevation	UTM	NAD27	grid
Aspect	Derived from elevation	UTM	NAD27	grid
Vegetation	www.orst.edu/Dept/pnw-erc/	UTM	NAD27	
Hydrology (reach)	www.streamnet.org/pnwr/ fileaccess.html	Lambert	NAD27	shape
Hydrology (reach)	www.streamnet.org/pnwr/ fileaccess.html	Lambert	NAD27	E00
Hydrology (lakes)	www.streamnet.org/pnwr/ fileaccess.html	Lambert	NAD27	
Soils	ftp://soils.css.orst.edu/pub/ webdocs/marion.html	UTM	NAD27	E00
GLO tifs	Scanned	UTM	NAD27	
Sites	Tabular	UTM	NAD27	shape
Updated Sites	Digitized after comparison between "Sites" theme and 1852 GLO maps	UTM	NAD27	
Claims	Digitized	UTM	NAD27	
Highways (Marion)	www.sscgis.state.or.us/data/ themes.html (TIGER Files)	Lambert	NAD83	E00
Roads (Marion)	www.sscgis.state.or.us/data/ themes.html (TIGER Files)	Lambert	NAD83	E00
Railroads (Marion)	www.sscgis.state.or.us/data/ themes.html (TIGER Files)	Lambert	NAD83	E00

Several data sets required projection. These were projected in ArcInfo by J. Thatcher using the parameters in Table 2 (2001: Pers. comm.).

After each of these data sets were projected and imported into the ArcView GIS, a few other manipulations were required. Several of the data sets such as the hydrology, soils, vegetation, roads, highways and city limits extended beyond the defined limits of the study area. While in the case of the roads, highways and city limits, the spillover of data presented only minor aesthetic concern, some of the basic analysis on soils, vegetation and hydrology would depend on a uniform demarcation of study boundaries.

Table 2. Projection parameters

Projection	UTM, Zone 10
1st standard parallel	42 20 0.0
2nd standard parallel	48 40 0.0
Central meridian	-117 0 0.0
Latitude of origin	41 0 0.0
False easting (meters)	914401.82880
False northing (meters)	0.0
Datum	NAD 27

Using the boundary defined by the F-CAP, a polygon was created on a separate theme in ArcView by tracing the Willamette and Pudding Rivers. To the east, the longitude line 122° 45' was used where the Pudding River extends beyond the limits of the elevation data. On the north and west sides there are two French-Canadian sites located on the opposite banks of the river. It was decided to include these two sites in the study area because of their cultural affiliation and relative proximity. Thus, the study area boundary extends out in these two areas to encompass these sites. On the south end of the prairie, the 45° latitude line corresponding to the limits of the elevation data was used to demarcate the southern boundary. All of the data sets described above were clipped using the ArcView extension "X-Tools" to the study area polygon. This clipping process resulted in a new series of Shape files. These new Shape files could be queried allowing discussions such as site frequencies to a particular attribute in relation to that attribute's frequency in the study area. Arc-SDM requires that the study area theme be a grid and so the study area SHP file was converted to a new grid theme with an output cell size of 30 meters. A detailed discussion of the processing and manipulation of the data is included in Appendix A.

Elevation

A Digital Elevation Model (DEM) is a digital data set that stores elevation data with corresponding location data in raster format. Varying surfaces can be generated from this data set (Robinson et al. 1995). Even in cases such as for this research area where GIS-ready DEMs are available, understanding the source and processes involved in producing such data are critical to assessing the accuracy of the resulting predictive model (Hageman and Bennett 2000:113; Kvamme 1990:113; Robinson et al. 1995).

For this study, nine DEMs were downloaded from the Oregon Geographic Data Clearinghouse (OGDC). The metadata for these DEMs along with the processes used to prepare them for use can be found at the same web address. Because this study uses slope and aspect which are derived from the DEM, the metadata for the DEMs was examined especially in regard to the number of sample points taken, their distribution, the accuracy with which they were collected both in terms of the equipment and the operator's competency, and the implications of the particular interpolation process used (Hageman and Bennett 2000; Kvamme 1989; Robinson et al. 1995).

The DEMs were joined in ArcInfo to create a new grid. The process and ArcInfo command Mosaic is discussed in Appendix B. This new grid was brought into ArcView, clipped to reflect the study area, and reclassified (Figure 3). This reclassification reflects the input resolution of the DEMs at roughly 30 meters. The re-classification creates 16 equal-interval classes (excluding the "no-data" class), in thirty-meter increments. Clipping using the study area eliminated several classes of elevation below 40 meters and above 520 meters.

Aspect

One of the benefits of using digital data sets is that complex calculations can be carried out relatively quickly over large areas to derive new data sets (Kvamme 1989). Deriving aspect from elevation data was done in ArcView using the joined and clipped DEM grid. A new grid was created using the Spatial Analyst command "Derive Aspect". The resulting floating-point grid was reclassified into five 90 degree classes, including one class dedicated to values of "-1" which indicated a flat area with no aspect (Figure 3). The act of reclassifying transformed the floating-point grid to an integer grid, as required by Arc-SDM.

Slope

Slope was also derived from the joined elevation data in ArcInfo. Once again, the output was in the form of a grid and was reclassified in ArcView (Kvamme 1989). This classification used 7 classes in 10-degree increments (Figure 4).

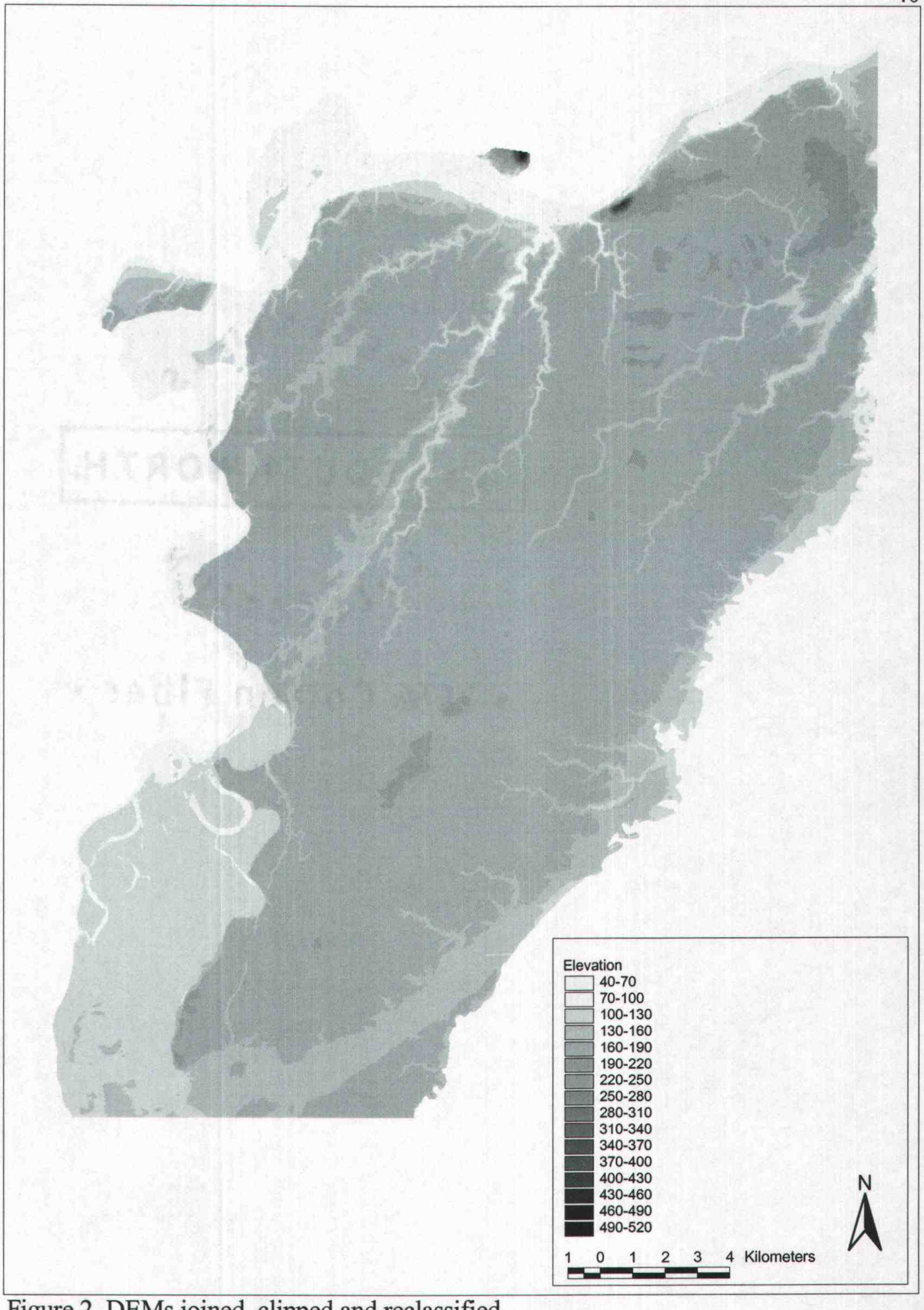

Figure 2. DEMs joined, clipped and reclassified

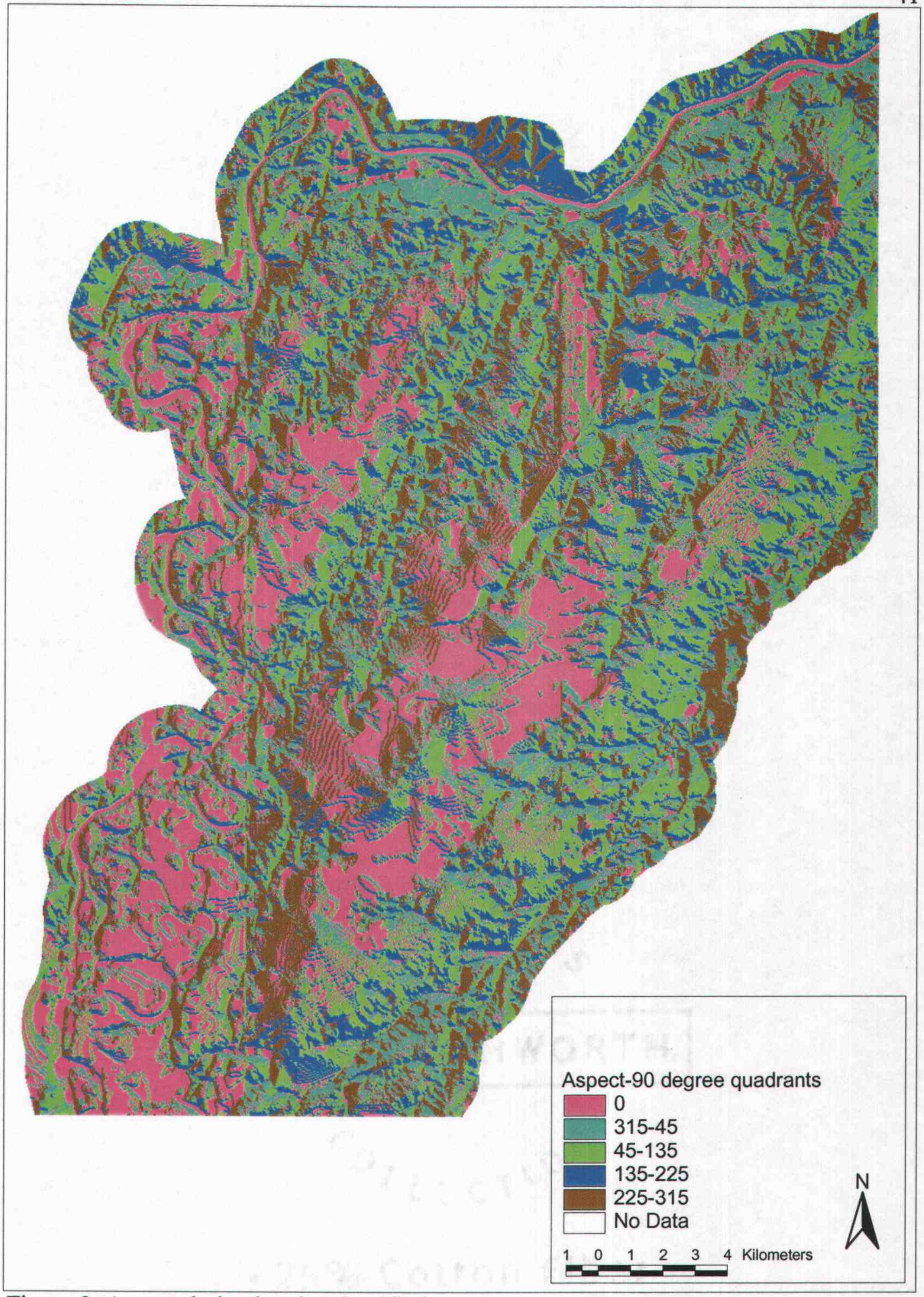

Figure 3. Aspect derived and reclassified

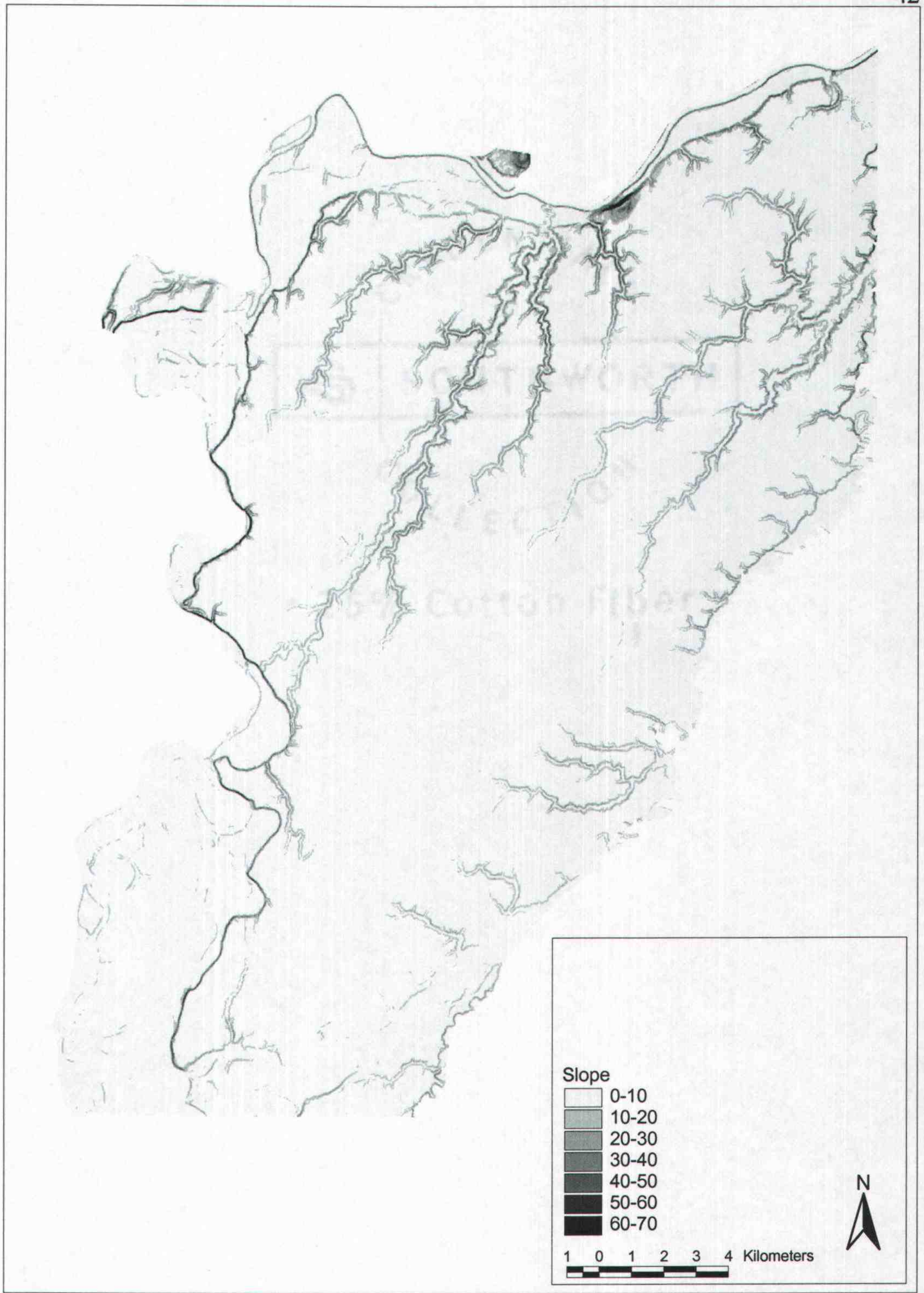

Figure 4. Slope derived and reclassified

Historic Vegetation

Modern vegetation data reflects almost a hundred and fifty years of intense agriculture and development in the most widely populated area of the state (Habeck 1961). That data are therefore suspect when searching for a possible correlation between French-Canadian settlement and vegetation. Although settlement had intensified, 1852-1856 General Land Office Township Survey Plats for the Willamette Valley offer the closest representation of what the French-Canadians were most likely to have encountered (Habeck 1961).

In 1961 Habeck reviewed existing work on historic vegetation that included the GLO surveys. Taking into account surveyor's methods, the surveyor's notes were used to compile a description of historic vegetation (Habeck 1961). This description is particularly relevant as it focuses on a transect of townships immediately south of the French Prairie (Habeck 1961). The five vegetation types described by Habeck include Oak opening, Oak forest, Douglas fir forest, bottomland forest, and Prairie (Habeck 1961).

Habeck used densities calculated by average distance to witness trees in the surveyor's notes to establish the boundary between Oak opening and Oak forest when the surveyors were not explicit (Habeck 1961). For example, Oak openings were those in which oak trees were separated by 50 feet or more (Habeck 1961). Oak opening, predominately Garry oak (*Quercus Garryana*) with the occasional Douglas fir, could be found in every township within Habeck's transect to varying degrees (Habeck 1961). Habeck assumes that the understory of the Oak opening included those mixed grasses found in the prairie as well as "forbs, and shrubs" and "ferns", "hazel", and "young oaks" (Habeck 1961:73).

Oak forest, on the other hand, occupied a much smaller area than Oak opening (Habeck 1961:73). This forest was filled out with Douglas fir, red alder (*Alnus rubra*), and laurel (Umbellularia californica) (Habeck 1961:73).

The dense Douglas fir forest was found primarily on the upper sides of the valley and "in ravines and on the floodplain of the Willamette River" (Habeck 1961:74). Mixed in with the fir were the occasional big-leaf maple, hemlock (*Tsuga heterophylla*), dogwood (*Conus Nuttallii*), vine maple (*Acer circinatum*), Garry oak, laural, and cedar (*Thuja plicata*) (Habeck 1961).

Bottomland forest areas included equal amounts of white ash, black cottonwood (*Populus trichocarpa*), Douglas fir, and big-leaf maple, and less of Garry oak, laurel, alder, cherry (*Prunus emarginata*), and willow (*Salix sp.*) (Habeck 1961). Beneath these trees the surveyors described Oregon grape (*Berberis aquifolium* and *B. nervosa*), salmonberry (*Rubus spectabilis*), elderberry (*Sambucus glauca*), rose (*Rosa sp.*), hardhack (*Spiraea Douglasii*), ninebark (*Physocarpus capitatus*), and cascara (*Rhamnus Purshiama*) (Habeck 1961). This vegetation type was found along the floodplain of the Willamette River and its tributaries (Habeck 1961).

Prairie grasses, whose mix was not described well by the GLO surveyors, covered much of the Willamette Valley uplands and some low lands (Habeck 1961). The surveyors do record the presence of hazel (*Corylus californica*), Oregon grape, rose and ninebark (Habeck 1961). Habeck cites Nelson (1919) who identified native grasses that might have been found in the wet areas around French Prairie to include *Agrostis exarata, Alope curus aequalis, Beckmannia syzigachne, Deschampsia caespitosa, D. danthonio ides, Eragrostis hypnoides, Glyceria leptostachya, G. occidentalis, G. pauciflora, Leersia oryzoides, Panicum capillare* var. *occidentalis, occidentalis, Pleuropogoa refractus, Poa triflora,* and *Trisetum cernuum*. Dryer areas might have supported: *Agrostis Halli, Agropyron pauciflorum, Bromus carinatus, B. vulgaris, Danthonia californica, Elymus glaucus, Festuca octoflra, F. californica, F. rubra, F. occidentalis, F. sublata, F. idahoensis, hierochloe occidentalis, Panicum Scribnerianum, P. pAcificum, Poa scabrella, P. Howellii, Sitanion jubatum, Stipa Lemmoni,* and *Trisetum canescens*.

More recently, vegetation data was interpolated from the surveyor's notes and digitized by The Nature Conservancy under contract for the Oregon Division of State Lands. John Christy and Jon Hak of The Nature Conservancy were kind enough to provide digital copies of those coverages along with the digital transcripts of the surveyor's notes from which the coverages were created. Because the surveyors moved along section lines, data reflects vegetation encountered along those lines and what was observed from those lines. (J. Christy, pers. comm. May 2000). This data set is presented in Figure 5. Metadata for this coverage is presented in Appendix D.

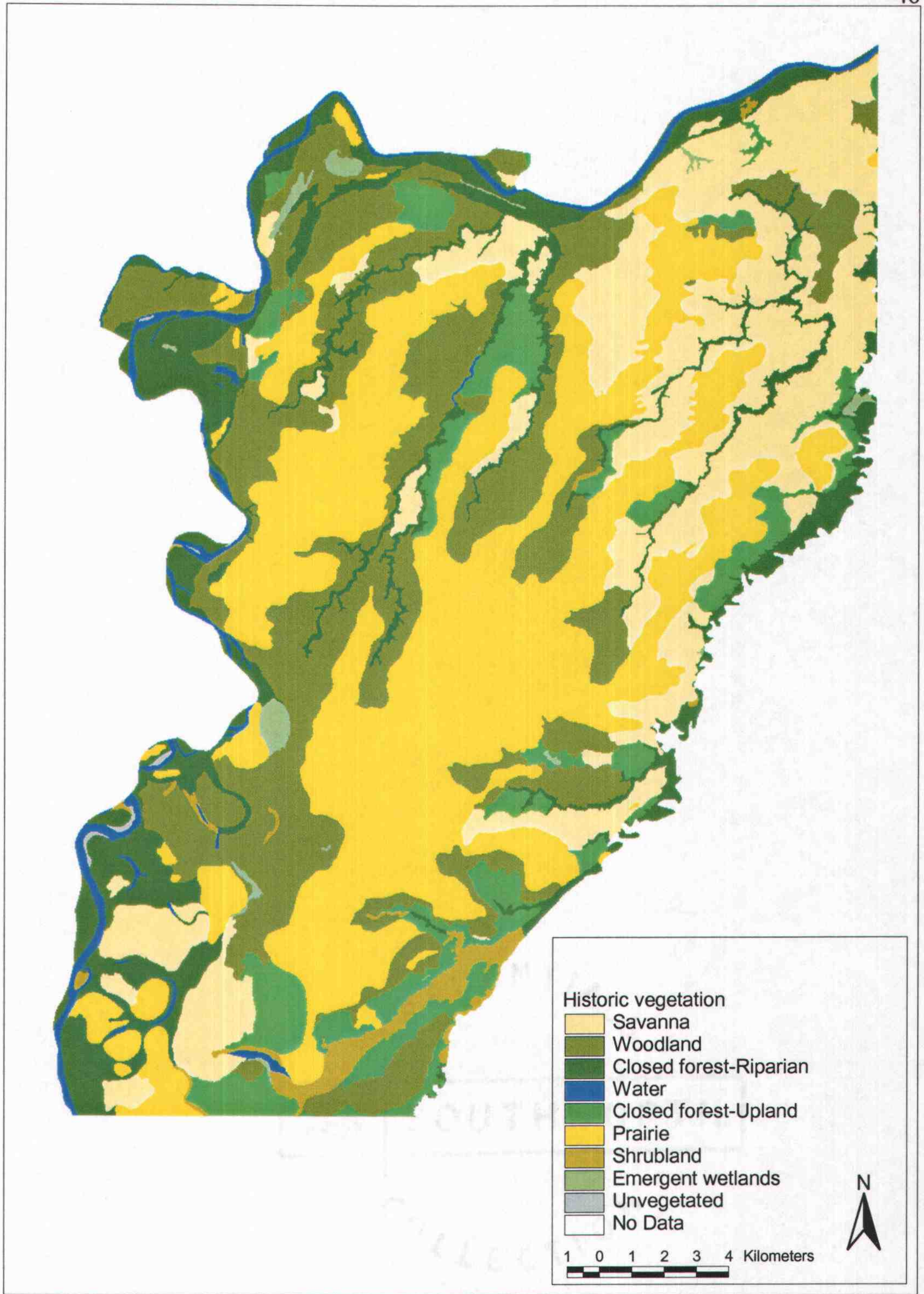

Figure 5. Historic vegetation on French Prairie

Soils

Although 150 years of agriculture, especially deep plowing, have impacted the soils found on French Prairie by churning in clays from the B-horizon, their general classes have probably not changed (Brauner 1989). What change has occurred may have resulted from shifts in flooding patterns, reported to be regular occurrences by the 1850s GLO surveyors, more recently altered by human damming of the Willamette's tributaries (Habeck 1961).

The bedrock underneath the floor of the Willamette Valley date to the Eocene and Miocene and were carved by erosion (Balster and Parsons 1968). This bed is buried under Quaternary alluvium (Balster and Parsons 1968). Balster and Parsons identified six geomorphic surface units within the area of French Prairie (1968).

The Looney unit is described as "a complex group of valleys and intervening ridges that compose a completely dissected, predominantly steeply sloping terrain" (Balster and Parsons 1968:5). The diverse soil series associated with this unit include: Apt, Honeygrove, Peavine, McCully, Kinney, and Chehulpum (Balster and Parsons 1968:10). Apt soils, which can be found on slopes between 3 to 50 percent, are Haplohumults that developed from Eocene sandstones (Balster and Parsons 1968:10). Honeygrove soils share much in common with Apt soils but are found on more coherent slopes of 5 to 40 percent. Chehulpum soils are Haploxerolls that developed on 3 to 40 percent slopes "over a IIR horizon composed of sedimentary bedrock" (Balster and Parsons 1968:10).

> Witzel soils are commonly found on buttes and other steep, active slopes... ...gravelly silty clay loam A and B horizons which overlie, at depths of 15 to 20 inches, a IIR horizon composed of fractured basalt bedrock. Kinney soils are well-drained, cobbly very acid Haplumbrepts developed in till or colluvium over basic igneous rocks on slopes of 3 to 70 percent at elevations of 1000 to 3500 feet in the Cascade Mountains. McCully soils are well-drained, fine-textured haplumbrepts developed in colluvium or alluvium-colluvium over basic igneous rocks on slopes of 4 to 30 percent in the Cascade Mountains. Peavine soils are haplohumults with a silty clay loam A horizon over a clay or silty clay B2t horizon which overlies weathered sedimentary rocks. These soils are mapped extensively in the Coast Range but also occur on the Eola unit along the edges of the Willamette Valley [Balster and Parsons 1968:11].

Little relief and unorganized drainage describe the Calapooyia unit which is "the product of deposition of a thin mantle of materials on a valley floor surface that was eroded from earlier materials, predominantly Willamette Silts" (Balster and Parsons 1968:7). In the French Prairie area, poorly drained, Ochraqualf, Concord soils are associated with the Calapooyia unit (Balster and Parsons 1968).

The Senecal unit represents continued alteration and improved drainage of the Calapooyia unit. Primarily Woodburn and Aloha soils are associated with this unit. Along with the Concord series described above, Willamette, Amity and Holcomb soils may also be found in the Senecal unit. On French Prairie, Woodburn soils are most common in the unit. These are somewhat well-drained Argixerolls on 0-3 percent slopes. Aloha soils are not as well drained.

Continuing alteration of the Calapooyia and Senecal units, along with greater dissection results in the Champoeg unit (Balster and Parsons 1968). As a result of a period of "downcutting" following the Calapooyia unit, "small pediment-like landforms" dominate the Champoeg unit (Balster and Parsons 1968:8). Soils found in the Champoeg unit include Amity, Woodburn, Briedwell, Quatama and Aloha. The predominate soils, Amity, are poorly drained Argialbolls on 0-4 percent slopes (Balster and Parsons 1968). While Woodburn and Amity soils can be found on Senecal, Champoeg, and Quad units, Balster and Parsons argue that sufficient difference in relief between these units warrant their division (1968).

The Winkle unit is characterized by remnant flood plains of aggrading watercourses which "suggest a braided, overloaded stream channel in some localities and generally reflect the size of the channel of the stream that was responsible for their formation" (Balster and Parsons 1968:8). Lake Labish, on the southern margin of French Prairie "represent(s) the final stages of the formative processes of the Winkle surface" (Balster and Parsons 1968:8). Salem soils predominate in this unit along with Labish, Malabon, Coberg, Awbry, Sifton, Clackamas, and Courtney. Salem soils are Pachic Ultic Argixerolls found on 1 to 3 percent slopes with "very gravelly substrata marking discontinuities within the soil" (Balster and Parsons 1968:14).

Finally, the Ingram unit, the oldest in the Willamette valley, encompasses an upper terrace of the Willamette River and its tributaries. (Balster and Parsons 1968). It is characterized as "undulating with a maximum of 8 feet of relief...the result of corrugation developed by overbank channeling, and a crude directional orientation of ridges and intervening channels is perceptible" (Balster and Parsons 1968:9). Although the Willamette River intermittently inundates the lower portions of this surface unit, the upper ridges are rarely flooded, necessitating a change in nomenclature of the unit from floodplain to terrace (Balster and Parsons 1968:9). The Ingram unit includes the Chehalis, McBee, Wapato, and Cloquato soil series (Balster and Parsons 1968). Chehalis soils, indicative of this unit, are well drained Haploxerolls on 0-3 percent slopes (Balster and Parsons 1968).

Soils data for this study was acquired from the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) web site. Soil series description sheets also from the above internet site were consulted for the soils found in the study area in order to classify the soils into well-drained, moderately-drained and poorly-drained classes (Figure 6). These classes are presented in Table 3a.

Table 3a. Soil classes

Soil Name	**Class**
Amity silt loam	Poorly-drained
Bashaw clay	Poorly-drained
Camas gravelly sandy loam	Well-drained
Chehalis silty clay loam	Well-drained
Cloquato silt loam	Well-drained
Concord silt loam	Poorly-drained
Dayton silt loam	Poorly-drained
Holcomb silt loam	Poorly-drained
Labish silty clay loam	Poorly-drained
McBee silty clay loam	Moderately-drained
Newberg silt loam	Well-drained
Newberg fine sandy loam	Well-drained
Semiahmoo muck	Poorly-drained
Wapato silty clay loam	Poorly-drained
Willamette silt loam 0-3 percent slopes	Well-drained
Willamette silt loam 3-12 percent slopes	Well-drained
Woodburn silt loam 0-3 percent slopes	Moderately-drained
Woodburn silt loam 3-12 percent slopes	Moderately-drained
Woodburn silt loam 12-20 percent slopes	Moderately-drained

Additionally, four relevant land features were classed as well (Table 3b).

Table 3b. Land feature classes

Feature	Class
Water	Poorly-drained
Alluvial land	Well-drained
Terrace escarpments	Well-drained
Pits	Poorly-drained

Hydrology

As Ambrose (1996) points out, men, information and trade operated on a much slower time frame than which we are accustomed to today. Travel depended heavily on the waterways. Indeed, the American expedition of Lewis and Clark held as its primary objective to find the best water route down the Columbia and to the Pacific. President Thomas Jefferson's instructions to the Lewis and Clark expedition held high hopes for the existence of a trans-Missouri-Columbia waterway specifically to encourage American commerce in that area (Ambrose 1996). Impetus for the expansion stemmed from the threat that Britain, Spain and France might be extending their influence into the region (Ambrose 1996). The French-Canadians, inadvertently caught in British interests, were thus on the front lines of this struggle and their dependence on the waterways is reflected in the legends of their prowess with canoes, moving great loads of furs back east.

The Willamette River in the French Prairie area is represented by the USGS cataloguing unit # 1709007. The hydrology theme was acquired from the USGS Pacific Northwest River Reach (PNWR) data layer. The separate "streams" and

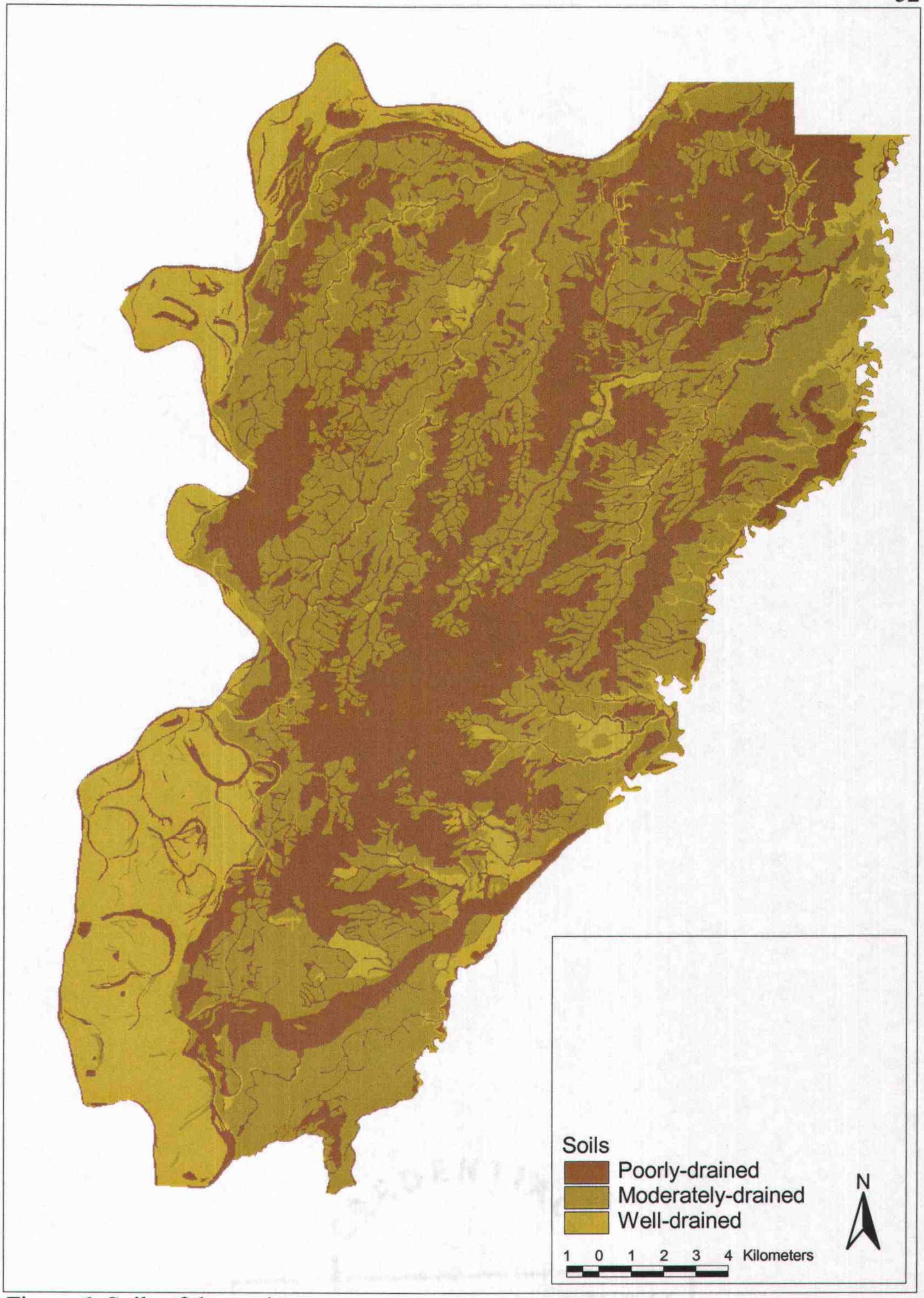

Figure 6. Soils of the study area

"bodies" data sets were merged to create one hydrology theme (Figure 7). Metadata for this data set is available at the web address http://www.

The hydrology data set was then buffered creating a distance to water data set at 100 meter intervals (Kvamme 1989). The resulting grid was clipped to the study area and reclassified in ArcView to 21 classes (Figure 8).

1852 GLO Survey Images

To augment and verify the modern data sets, photographic reproductions of 1852 GLO Survey maps were used. The process by which these images were scanned and brought into the GIS as images (Figure 9) is detailed in Appendix F. These images aided in locating known sites and claims. Some of the homes, fields and claims of the French-Canadians were recorded in the 1852 survey. Also, as a backdrop to the other modern themes such as hydrology, the images may indicate changes that have occurred over the last hundred and fifty years. Alternately, it is acknowledged that discrepancy may be the result of more accurate surveying and mapping techniques. The extent of these discrepancies and their impact on the model will be evaluated in the analysis. When compared with the hydrology theme, as in Figure 10, it is apparent that the watercourses are little changed.

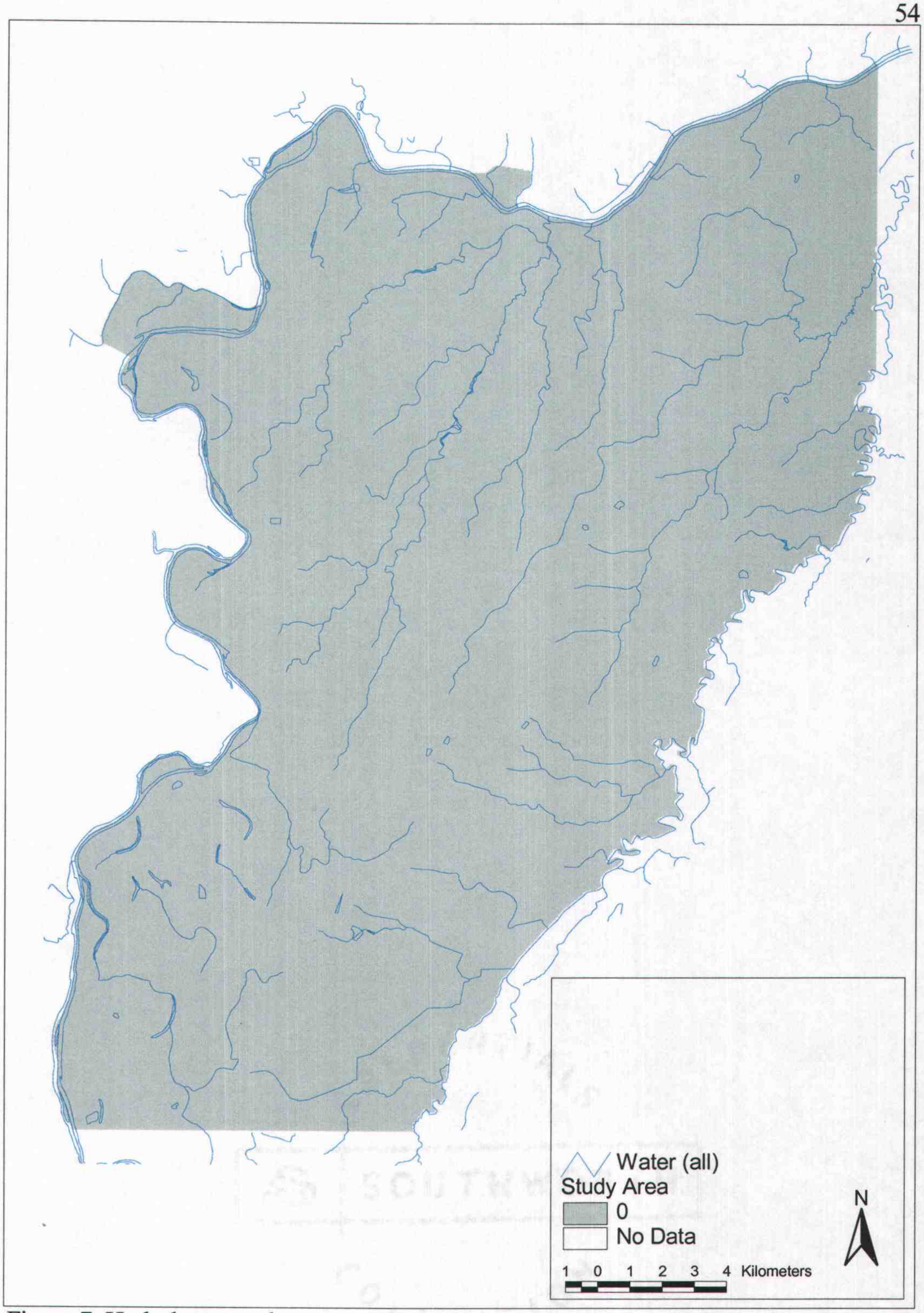

Figure 7. Hydrology overlay

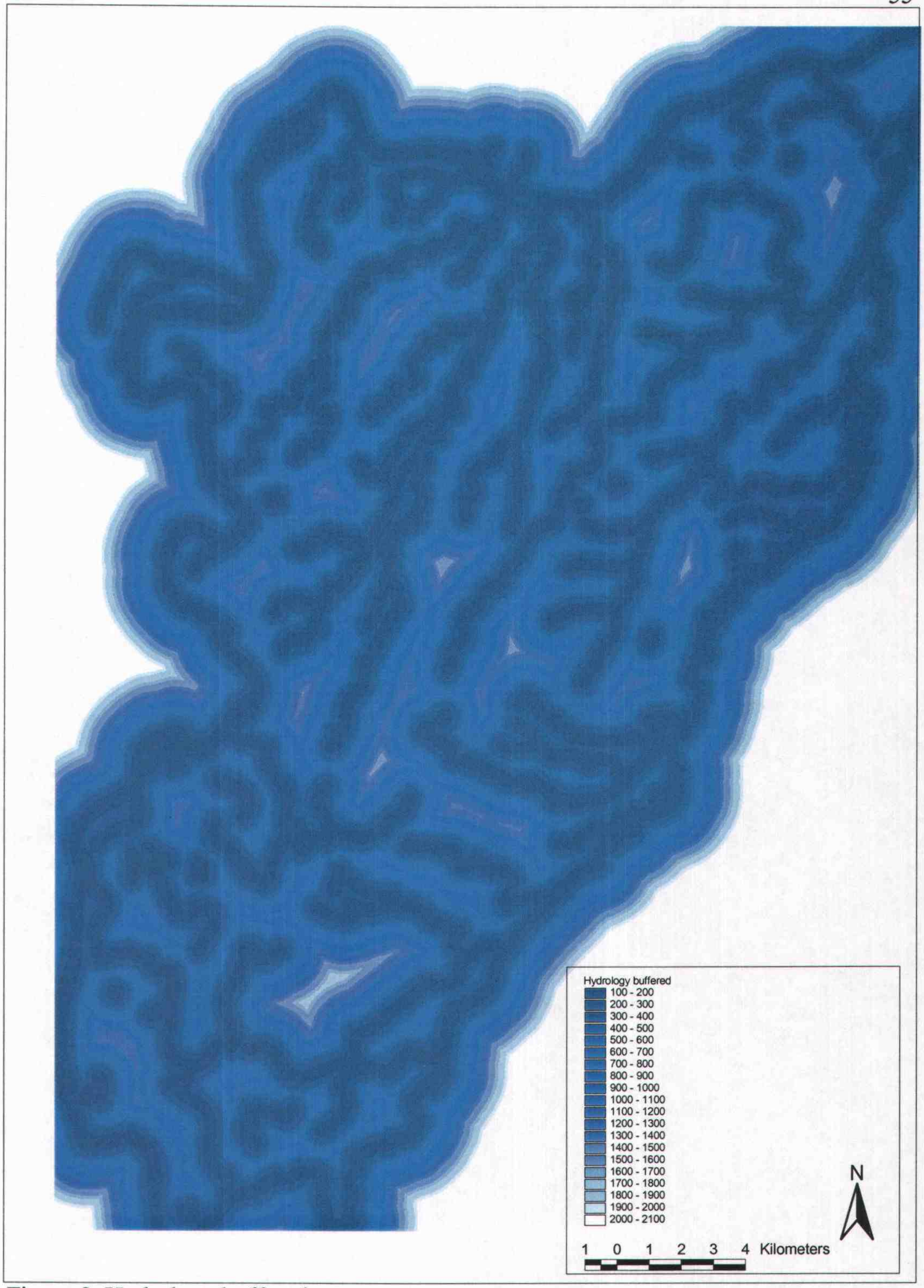

Figure 8. Hydrology buffered

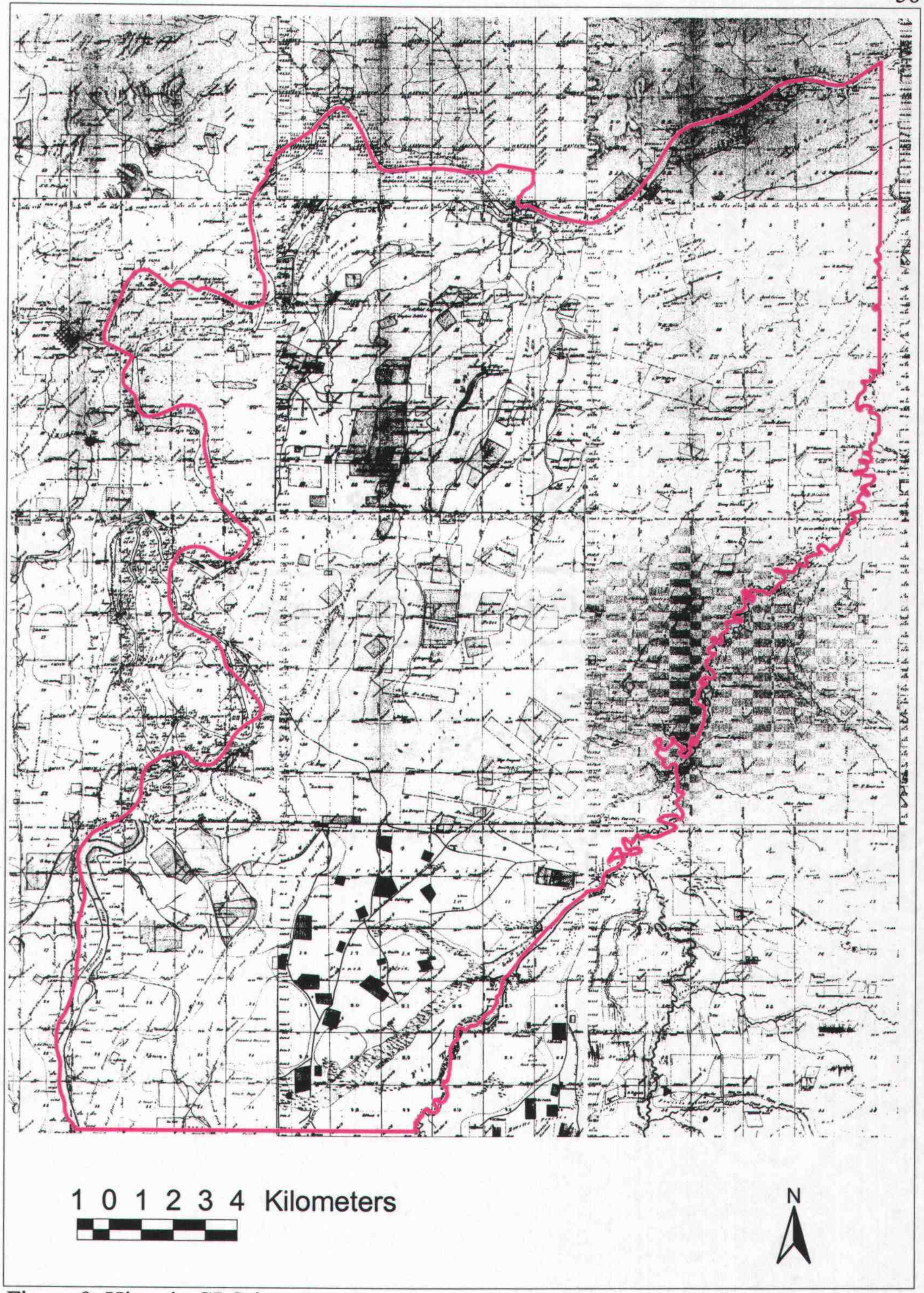

Figure 9. Historic GLO images

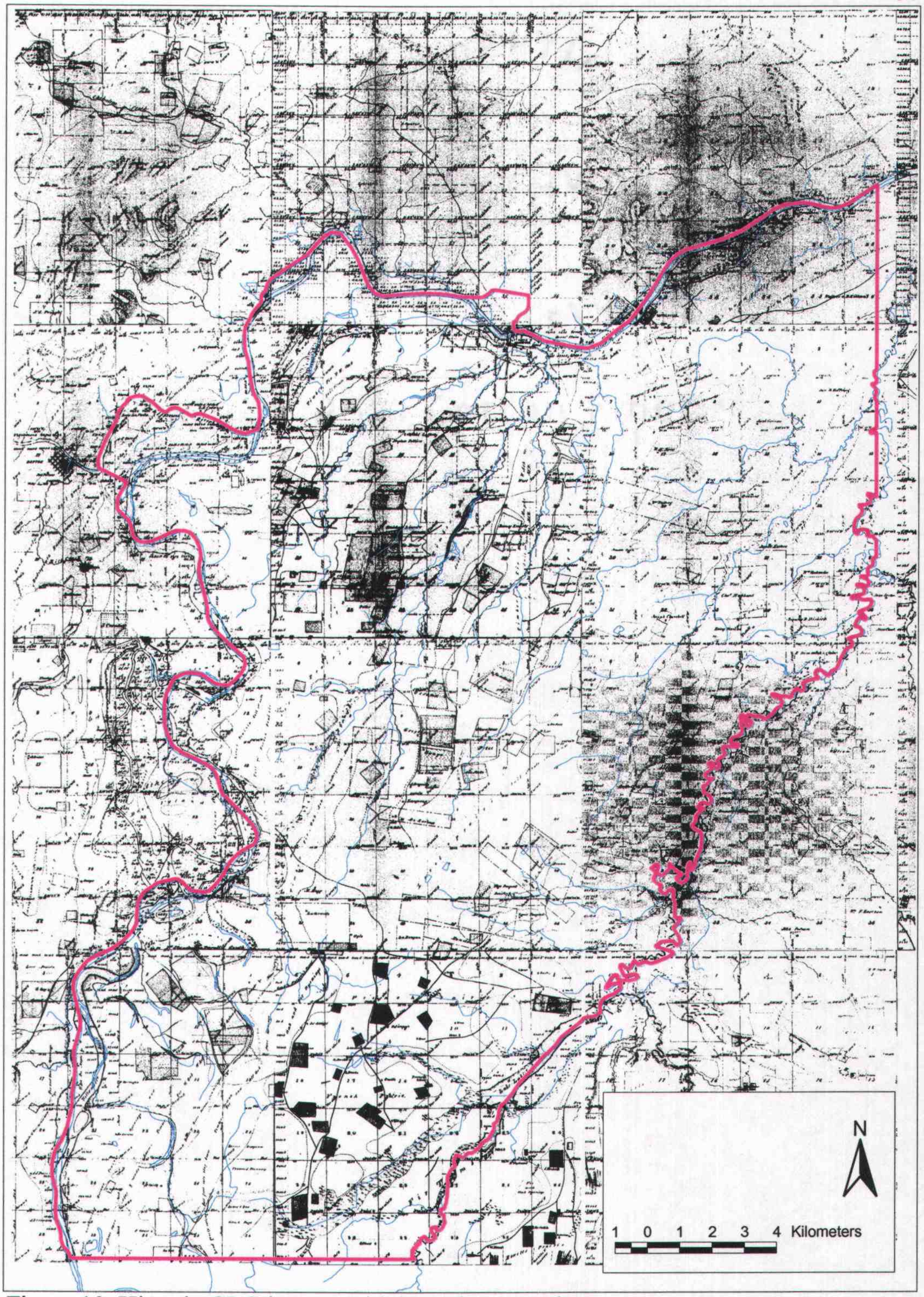

Figure 10. Historic GLO images with hydrology overlay

Known Sites

Dr. Brauner's 1989 French Canadian Archaeological Project identified 97 French-Canadian heads of households settling on French Prairie between 1829 and 1843 (Brauner 1989). The cut-off date, 1843, represents the arrival of the first wagon train of immigrants including some French-Canadians who were not associated with the fur trade in the Pacific Northwest (Brauner 1989).

As discussed in Chapter 2, using known sites drawn from historical references eliminates some bias that might be introduced in surveys where only surface indicators of sites are used (Kvamme 1988; Warren and Asch 2000). This research thus utilizes the research of the F-CAP. Brauner discerns two distinct waves of French-Canadian settlement based on their land claim shape that can also be temporally differentiated (1989). The first wave, between 1829 and 1832, consisted of only 8 settlers, of which the homesteads of 6, (Joseph Gervais, Joseph Despard, Andre Longtain, Joseph Delard, Pierre Bellique and Etienne Lucier) are known. The land claim of Lois Labonte is known while Jean Babtiste Desportes McKay is only known to have been between the mouth of Champoeg Creek and the Willamette River (Brauner 1989). According to Brauner, the land claims of these early settlers encompassed native and fur resources to supplement their income and diets (Brauner 1989). For example, the trapping opportunities that Skookum Lake held may have prompted Lucier to embrace it within his claim (Brauner 1989). The settlers and their wives would have found camas among the edible tubers and bulbs in the low areas. They would have found plentiful timber, pastures for their livestock, and rich, well-drained soils for growing produce (Brauner 1989). This early wave all set their homes high on the natural levees above the Willamette River yet as close to the river as possible. These were also along the existing rudimentary trail system.

The second wave (1833-1843) of French-Canadians all chose distinctive historical French "long lot" shaped land claims. Of the second wave, twenty-four occupation sites and the land claims of another fifteen are known. In the case of French Prairie the land claims were oriented to a road system rather than the water system as they were historically in France. For this second wave of settlers, the proximity or abundance of native resources was not a primary factor in the orientation or limits of the land claim (Brauner 1989). Rather, they may have focused more intently on agriculture (Brauner 1989). This division between the two waves may have significance for this study's predictive model in that the possible shift in economic emphasis may be reflected in house site location as well as claim shape.

Of the 97 known households, the residence sites of 30 were "narrowly defined" while the land claim boundaries of another 16 were identified (Brauner 1989:4, 26). UTM coordinates for the 30 residence sites were obtained from USGS 7" maps based on Brauner's 1989 French-Canadian Archaeological Project. This coverage consists of tabular data of 49 known sites imported into ArcView and converted into a "Known Sites" Shape file (Figure 11). The precision of these coordinates directly impacts the legitimacy of the predictive models and thus a source of verification was sought.

The sites identified by F-CAP were located on the basis of historical record research and did not have the advantage of digital access to the 1852 GLO maps.

Therefore, within the GIS, the "Known Sites" theme was overlaid on the 1852 images and a point-by-point comparison was done to see how closely structures identified on the 1852 images corresponded with points identified by F-CAP. In several instances, sites identified only by claim boundary by F-CAP corresponded closely to structures on the 1852 GLO images. In certain cases, when the name of the corresponding French-Canadian was listed next to a structure on the 1852 images, the "known sites" theme was updated to reflect that location. In at least one case, the French-Canadian name (M. La Frambois) on the 1852 image did not match that (Despard) identified by the F-CAP.

After verifying that the discrepancy was not a result of the data entry process, it was theorized that the discrepancy reflected a possible sale of a claim between the cutoff date of F-CAP and the GLO survey in 1852 (Brauner, pers. comm. 2001). In a few cases, the point identified by F-CAP closely mirrored that of an unidentified structure on the 1852 images. These structures were assumed to be possible abandoned homes of the corresponding French-Canadians and the "Updated Sites" theme was updated accordingly. Additionally, previously unknown sites or claims (LaChapelle, for example) were identified using the 1852 images. The nineteen changes made to the "Known Sites" theme to create the "Updated Sites" theme presented in Figure 12, are detailed in Appendix F. Once the data sets had been brought together into the GIS, analysis could proceed.

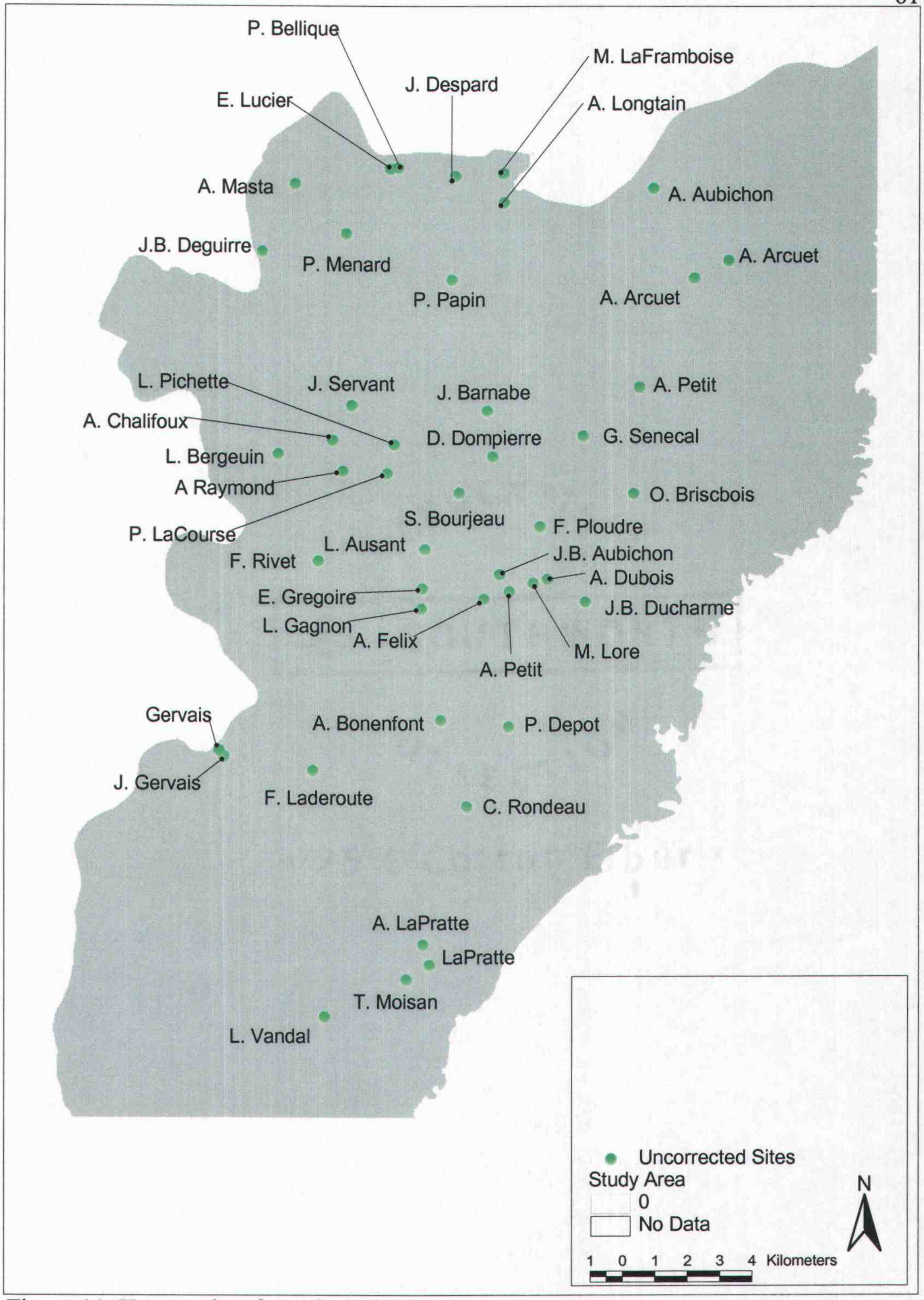

Figure 11. Known sites from the F-CAP

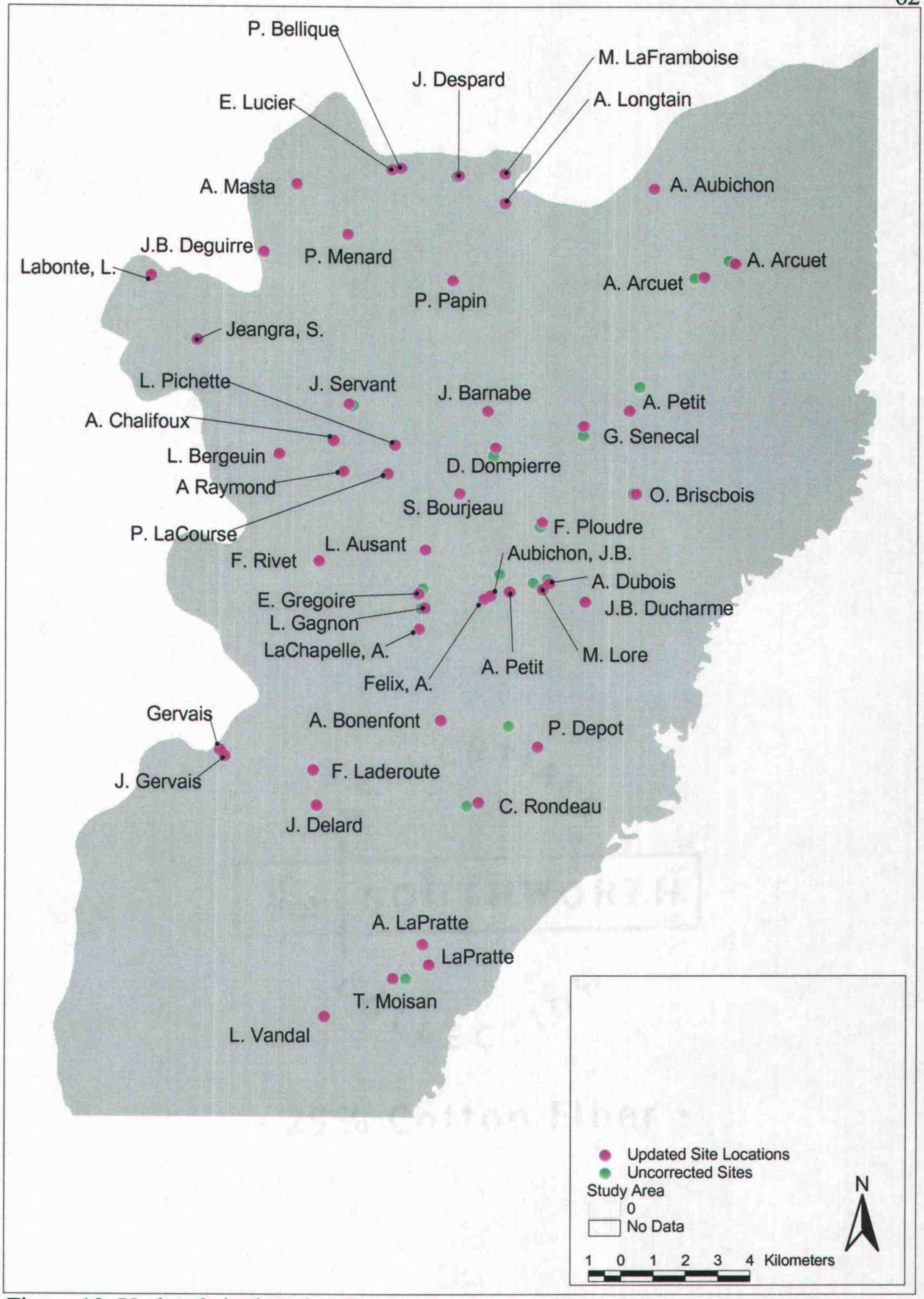

Figure 12. Updated site location theme

CHAPTER FIVE: ANALYSIS

The Deductive Model

This research used the data sets described above to create two models. The first, a deductive model, tests the settlement pattern identified by the French-Canadian Archaeological Project. Simple "select by theme" queries in ArcView were used to identify areas that conformed to the criteria outlined in the F-CAP Settlement Pattern.

A deductive modeling effort as described by Kohler and Parker (1986) and re-examined by Dalla Bona (2000), must examine the process and goal of a human decision. As previously discussed, the French-Canadian decision-making process was based upon years of experience and observation of natural processes in the area, while the end goal was economic viability through maintaining ties to the HBC, and to each other.

Through this process, variables are identified in the decision-making process for a given temporally or functional set of sites. The hydrology theme was used to select areas progressively further from watercourses (Brauner 1989). While Brauner identified sites on an alluvial flat beyond natural levees above "natural flood levels", it appears from examination of the elevation data set that these levees fall short of the resolution of the Digital Elevation Model and do not appear in the visualization (Brauner, 1989:29). Instead, it can be argued that a distance from water greater than 100 meters would include that levee (Brauner 1989:29, pers. comm.). Emphasizing a distance greater than 100 meters seems counter-intuitive given the need for proximity to water until we are reminded that a historically higher water table accessed via shallow wells could meet daily water needs (Brauner 1989). Thus, emphasis on proximity to water for transportation was tempered by the desire to remain above flooding.

The buffer function included in ArcSDM was used to buffer the vector hydrology theme, resulting in a grid (raster) theme of area greater than 100 meters from water (Figure 13). Next, the Map Query function under the Analysis menu was used to identify areas in this subset that contained well-drained soils such as Chehalis, McCulley, Willamette, or Kinney (Figure 14).

Finally, a deductive model must suggest a methodology for quantifying or qualifying said variables, in a way that predictions about the decision-making process could be seen in the archeological record. By selecting the "True" cells, or those well-drained soils greater than 100 meters from water, and saving them as a shape file, the "Select by theme" query was used to highlight those French-Canadian sites that intersect the subset. Only seven sites fell within areas of well-drained soil greater than 100m from water (Figure 15). Because of this disappointing return, the map query was expanded to include well and moderately-drained soils greater than 100 meters from water. Again, a "Select by theme" was used to identify the 21 sites of the known 49 that fall within this second selection (Figure 16).

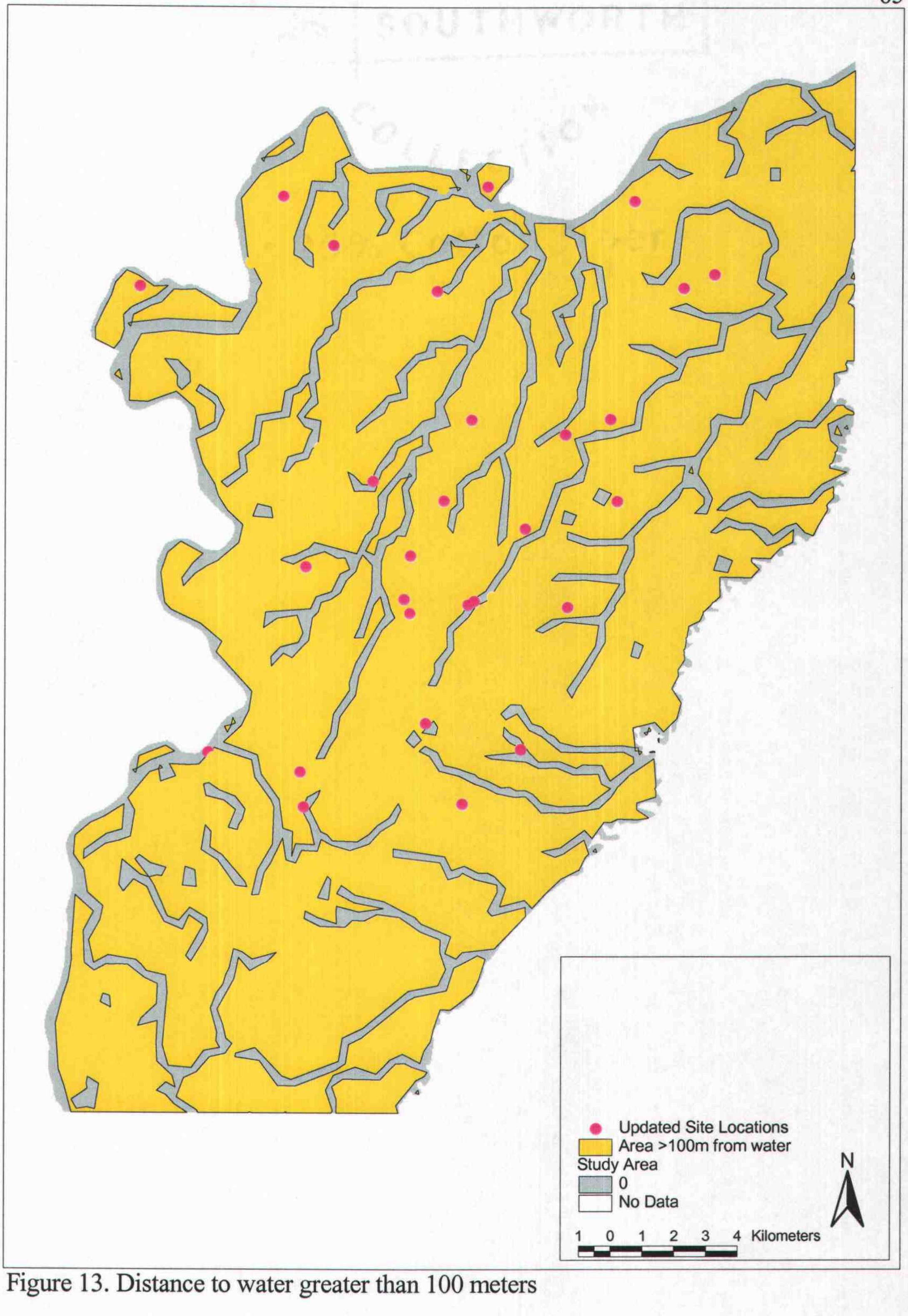

Figure 13. Distance to water greater than 100 meters

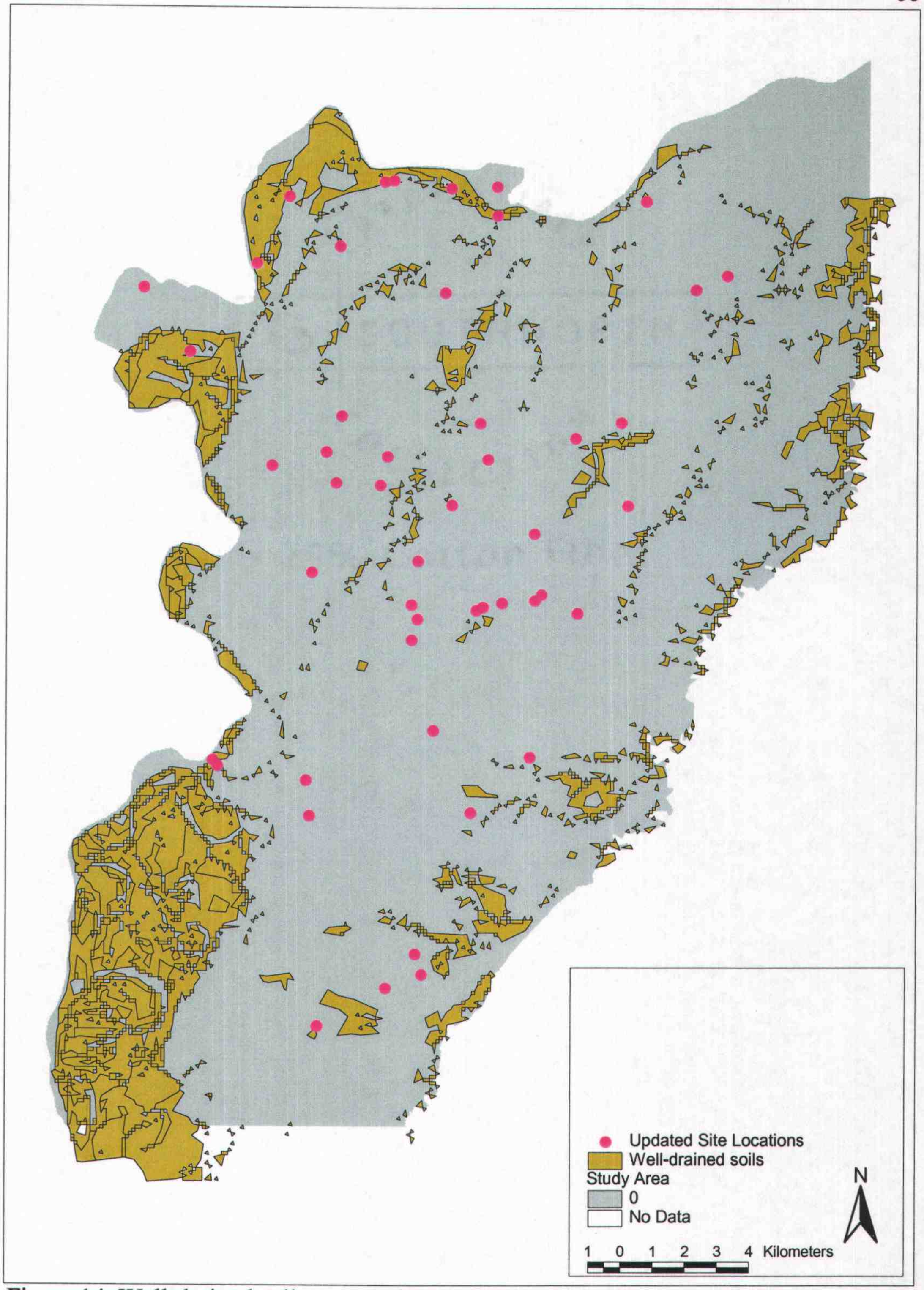

Figure 14. Well-drained soils greater than 100 meters from water

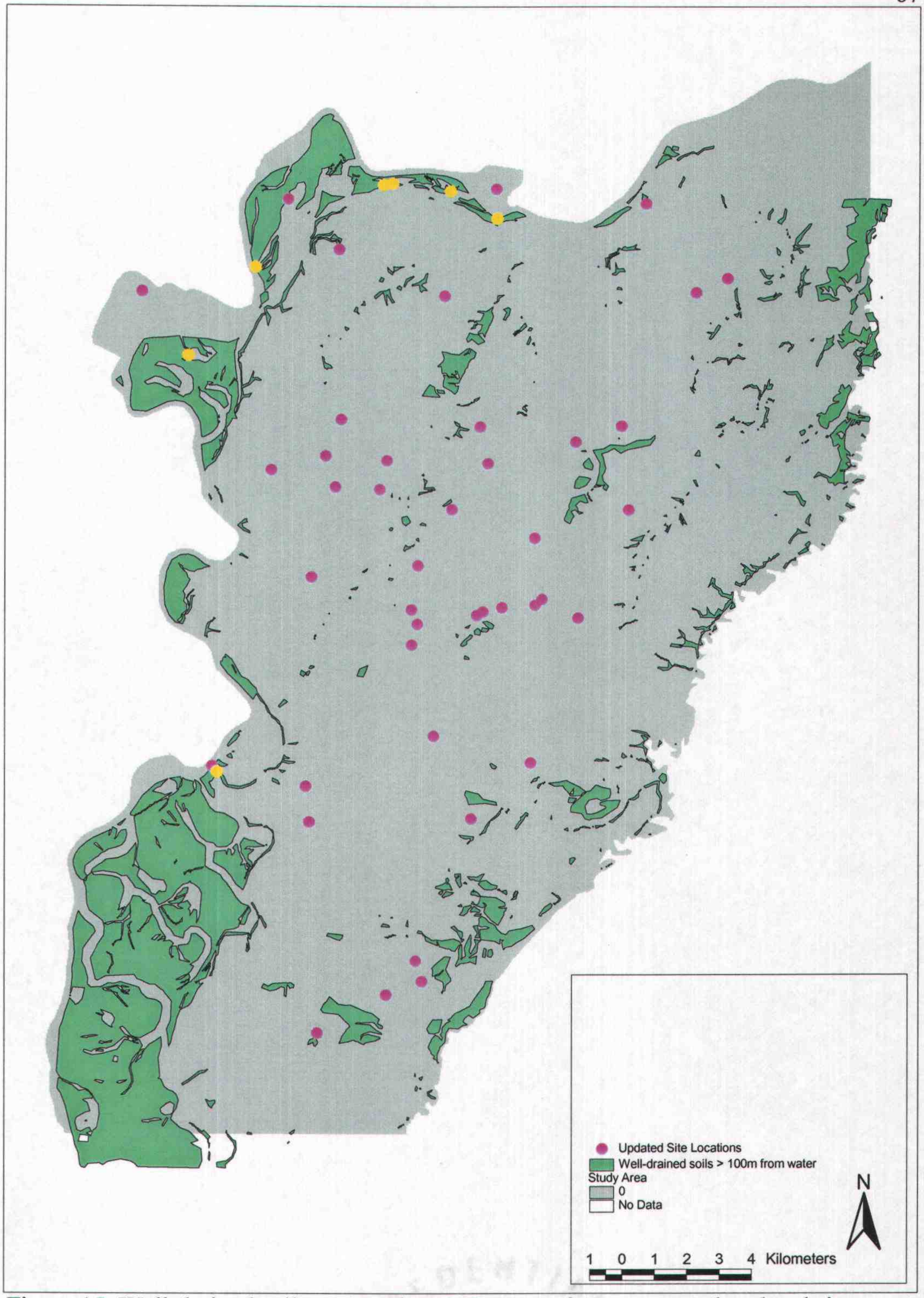

Figure 15. Well-drained soils greater than 100 meters from water and updated sites

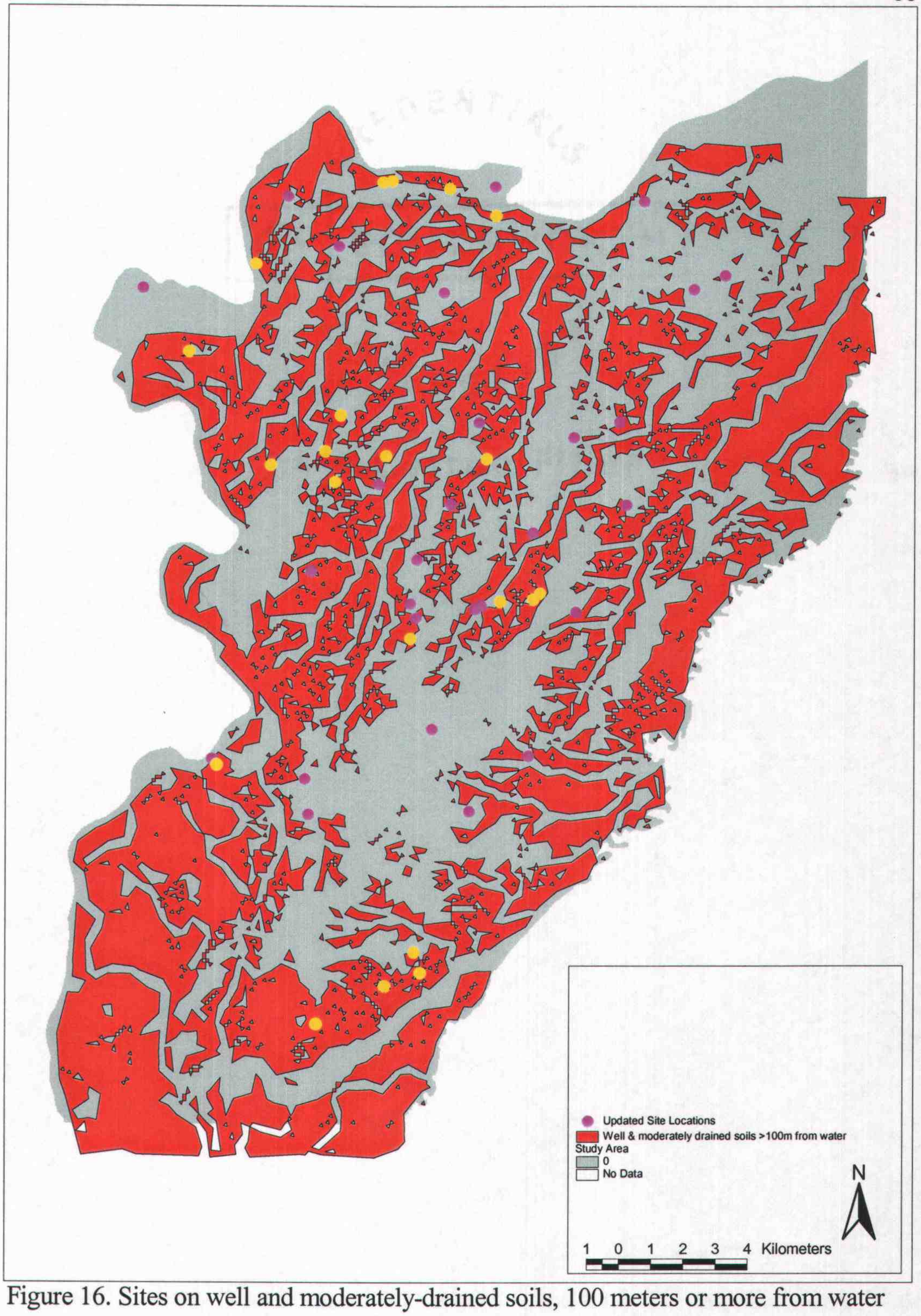

Figure 16. Sites on well and moderately-drained soils, 100 meters or more from water

The Inductive Model

The second model, an inductive model, seeks out correlation between the location of known sites and each of the independent variables through logistic regression carried out using *Arc-Spatial Data Modeler* (Arc-SDM), an ArcView extension that works in conjunction with the "Spatial Analyst" extension. Logistic Regression has been used in many inductive predictive models because of its robust nature and versatility in multi-variable analysis (Chou 1997:283; Kvamme 1989; Warren and Asch 2000).

> "In archaeological applications, logistical regression creates a prediction formula that uses independent environmental variables of virtually any scale to predict the probability that a site occurs on any given parcel of land. The formula defines an S-shaped probability curve of group membership that is oriented along an axis of intergroup discrimination. The axis comprises an interaction of environmental variables that best discriminates site locations from non-site locations." [Warren and Asch 2000:8].

The "S-shaped curve" described above is illustrated in Figure 17.

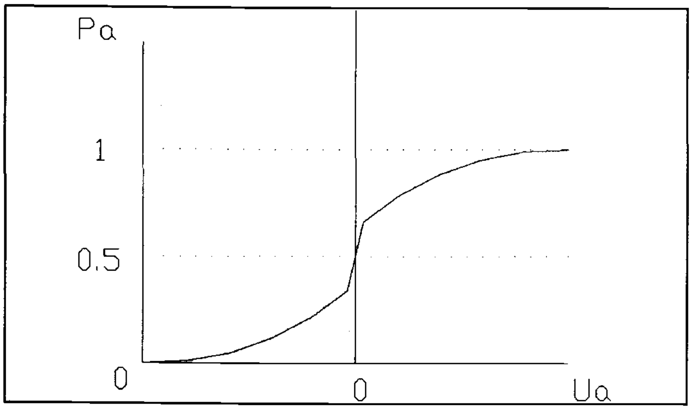

Figure 17. Graph of logistic regression (Adapted from Chou 1997:284).

For this study, "Properties" under the "Analysis" menu were set as in Figure 18.

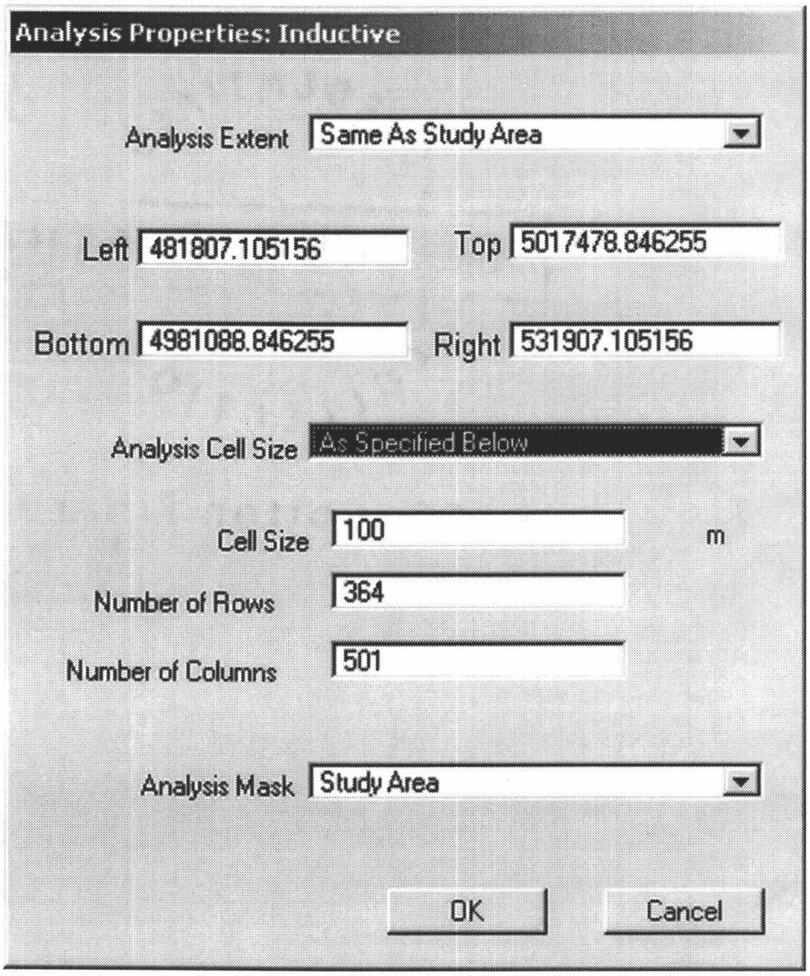

Figure 18. “Analysis Properties” settings.

Under the Spatial Data Modeler menu, “Analysis Parameters” were set as in Figure 19.

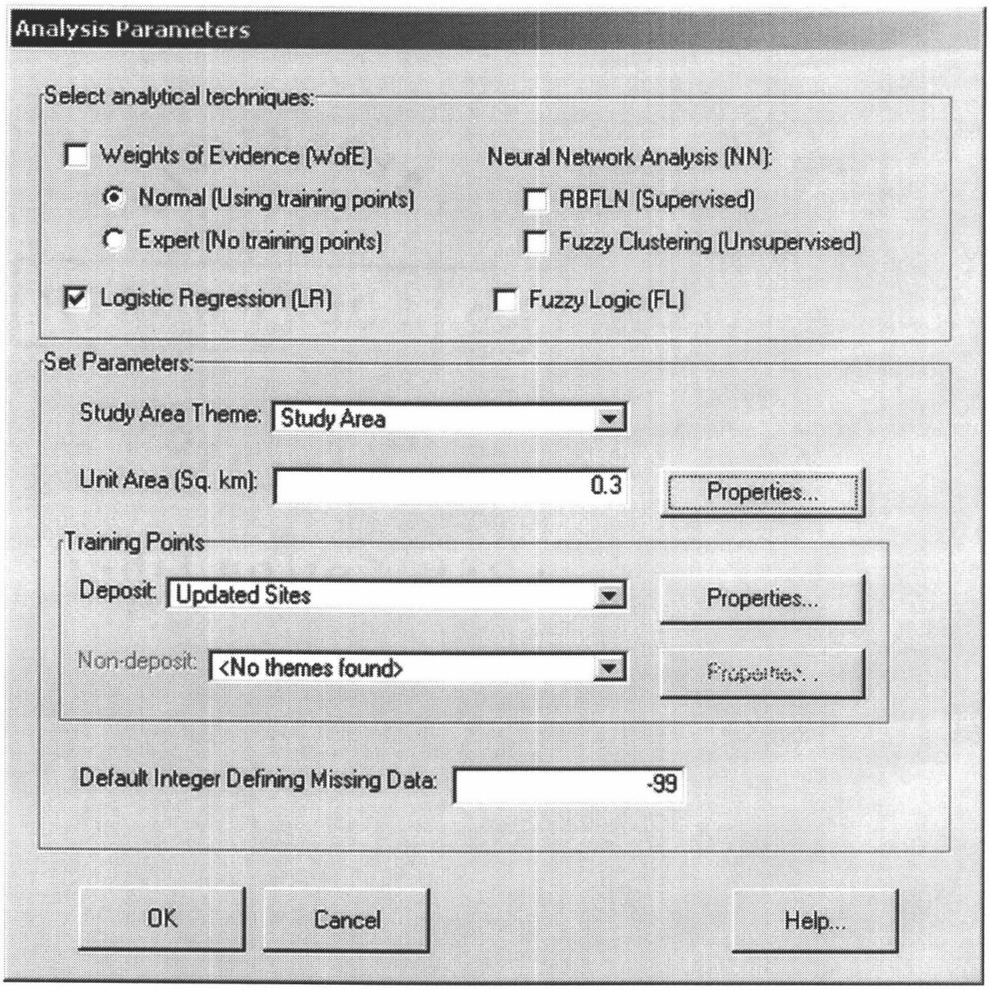

Figure 19. Arc-SDM "Analysis Parameters".

For logistic regression, Arc-SDM treats missing data areas by assigning a value that is the area-weighted mean of the known values in the study area for each evidential theme. Within Arc-SDM, logistic regression does not require a set of non-site locations-a data set that archaeologists do not tend to collect.

Because logistic regression requires ordinal data, Arc-SDM calculates free multi-class data sets by expanding a unique conditions grid to a series of binary themes (Kemp 2001).

Table 4. Data types

Evidential Theme	Data Type
Elevation	Ordered
Slope	Ordered
Aspect	Free
Historic Vegetation	Free
Hydrology buffered	Ordered
Soil	Ordered

The "S"-shaped curve described above produces values between 1 and 0, with values approaching 1 indicating a higher probability of site presence and values approaching 0 indicating less probability of site presence. The logistic regression calculations for each of the 5298 grid cells for the study area produced values between 0 and 0.20644. The resulting grid is presented in Figure 20, visualized in seven classes.

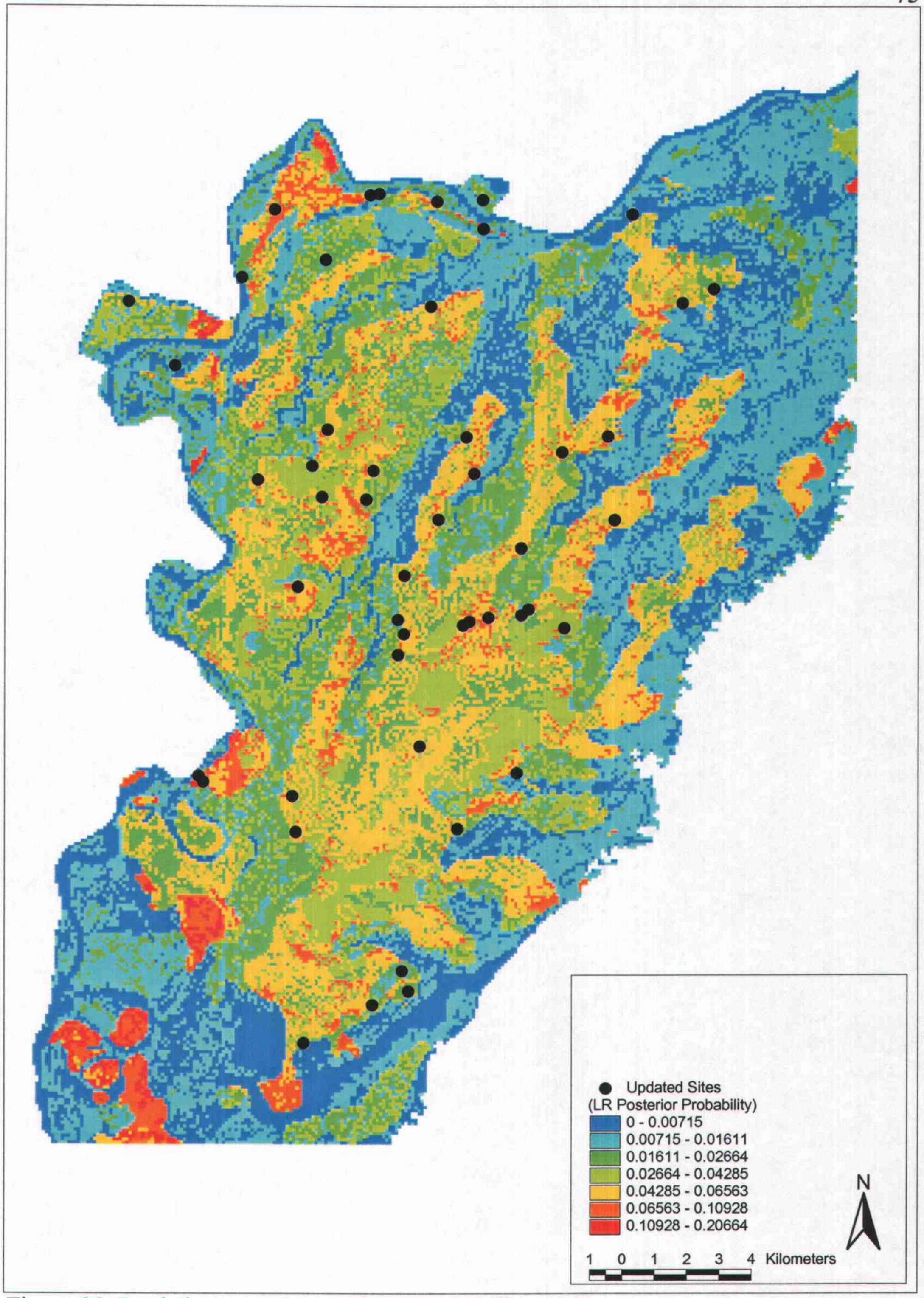

Figure 20. Logistic regression posterior probability grid

CHAPTER SIX: CONCLUSIONS

Four research questions drove this project. Each is broken out here for discussion.

1) Can both inductive and deductive reasoning be used together to scientifically create a model of French-Canadian settlement?

Today's site location models can benefit from a dual approach to predictive modeling, testing the assumptions archeologists have made at many levels and highlighting new locations to evaluate. Both models may identify new areas in which sites are likely to be found. The deductive model may be weakened by a researcher's bias and the inductive model may serve to counter that bias by subjecting a greater number of variables to statistical testing. Conversely, an inductive model may be tainted by bias in survey techniques. If, for example, the majority of site locations had been identified in the process of clearing for highway development, and that highway had been placed upon a natural levee, the resulting data might lead researchers to assume that settlers preferred a particular elevation or landform.

Comparing the results of the two models may highlight weaknesses in one or both. Additionally, comparison between the two models may highlight where environmental variables have changed over time, especially in the background historical work that this deductive modeling is based upon. As will be seen below, the background work conducted by F-CAP identified a lowering water table which has implications for French-Canadian settlement.

In this study, the inductive model benefits from the more carefully defined site data set that the F-CAP developed. The deductive process has narrowed down the cultural and temporal parameters of the study, and serves as a reminder that understanding the French-Canadian thought-process is the ultimate goal, rather than simply recovering their artifacts.

On a more practical note, data sets require an investment of time and money first to collect and then to ready them in the GIS for analysis. That "cost" is reduced each time the data sets are used, and the convenience of GIS facilitates multiple uses, as will be demonstrated for the next research question. Use of deductive reasoning can highlight differences between temporally or functionally discrete sites. Initial attempts at a deductive model can identify the need to exclude or include variables or classes of variables. For example, observations from the F-CAP were used to narrow down choices of environmental variables included in both models. The question of deductive in opposition to inductive is misleading. As the remaining research questions are addressed, these themes will be revisited with specific examples of how these two approaches are, and must be, complimentary.

2) Does this model substantiate the settlement pattern developed in Brauner's French-Canadian Archaeological Project?

This question is addressed by the deductive model. Observation of the F-CAP settlement pattern in the model is problematic. As illustrated in Figure 15, only 7 known French-Canadian sites fell within the area of well-drained soils greater than 100 meters from water. An attempt to understand why the model does not appear to support the settlement pattern invites a series of increasingly involved questions. Are there common characteristics of French-Canadian settlement sites on Oregon's Willamette Valley French Prairie? As discussed, the F-CAP settlement pattern differentiated between two episodes of settlement and proposed that site location may be at the junction of several requirements.

However, can we assume some cultural continuity between the two episodes of settlement that Brauner identifies, since they were sharing a fur trade heritage and had switched to a lifestyle of farming? The differences observed between the two groups may be real enough to be observed in the model, which would suggest a high level of sensitivity in the model. Of the seven that fell into the area of well-drained soils greater than 100 meters from water, 5, (Bellique, Despard, Gervais, Longtain and Lucier) are from the initial phase of settlement identified by Brauner (1989). Gervais does have two claims on French Prairie, both dating from the early settlement episode but only one on well-drained soils, suggesting the possibility that they may have had differing functions. Initially, there may be a perceivable difference between waves.

Were the French-Canadians farming? They were certainly beginning to farm although their commitment to the process may have varied. Hussey found several Freemen settled on or near French Prairie by 1826 although they probably continued to trap and hunt, and added herding horses to their resumes. For example, Lucier was dealing in horses around Champoeg (Hussey 1967). Additionally, the degree to which they were taking advantage of native resources may only be visible in the archeological record (Brauner 1989, Hussey 1967). Camas, a Native American staple, prefers moist lowlands and thus may have shaped their claims in ways unexpected. Certainly, the later wave was more committed to an agrarian lifestyle than the first (Brauner 1989).

Although it appears that the F-CAP settlement pattern best fits the early wave of French-Canadian settlement, there may be other reasons for this fit. If well-drained soils truly played a part in an agriculturalist's decision-making process, well and moderately-drained soils greater than 100 meters from water should capture most of the sites.

This query, as visualized in Figure 16, captures only 21 of the 49 known sites. This weak return suggests that soil drainage characteristics were not at the fore of French-Canadian decision-making processes. One weakness of both of these queries is the connection between the natural levee and 100 meters from water. More computing power may facilitate a higher resolution examination of the data, allowing the natural levee to be more accurately depicted and thus taken into account. Another possible explanation for weakness in the model is that the soils data reflects changes over 150 years of agriculture and a lowering water table. Further examination of the soils data may eliminate this possibility and strengthen the implications of the deductive model.

Finally, other considerations may have played a part in the French-Canadian decision-making process. For example, the early wave may have chosen to situate their living sites directly on the well-drained soils that they intended to till. As settlement increased and agriculture intensified, later settlers may have situated their living quarters on moderately and poorly-drained soils, reserving the well-drained soils for tilling. Ultimately, the modeling process has challenged our assumptions about the French-Canadian identity and their decision-making process, and because the sites do not neatly fit our model, humbly reminds us of our lack of understanding and encourages further research with fresh perspectives.

The third and fourth research questions are addressed by the inductive model. 3) Can patterns in environmental variables be used to characterize 1829-1843 French-Canadian settlement sites on the French Prairie of Oregon's Willamette Valley; and 4), if so, to what degree can other areas on French Prairie that share these characteristics, or some combination of these characteristics, be identified?

The third research question is answered by breaking out and discussing each variable in turn. For example, can Elevation be used to characterize French-Canadian sites on French Prairie? The elevation over the French Prairie ranges only between 40 and 520 feet while the interval selected for the study is 30 feet. Within this small range, 524.07 square kilometers, or over 98% of the study area (529.97 square kilometers) falls between 70 and 220 feet. Not surprisingly then, all 49 known French-Canadian sites fall within this range as well. French-Canadians may or may not have viewed differences in elevation as significant. If they did, however, the 30-foot interval may not provide enough resolution to tease out significant landform subtleties.

Again, this study has focused on predicting the residential "site" location. In cases when the location of the residence isn't known, a "site", rather than representing the home or some other improvement even, may represent some other desired elevation within the claim. Indeed, many of these claims reflected a desire to have access to resources such as timber and beaver that may have been found in the lowlands, along with grasslands that may have been higher.

Can Slope be used to characterize French-Canadian sites on French Prairie? In the same way that elevation may reflect an artificial characteristic of a residential "site", a steep slope may have been incorporated into a claim and inadvertently tagged with a known French-Canadian “site” designation. For this study, slope was divided into 10-degree intervals. 47 of the 49 known sites were located on flat to 10-degree slopes, 1 was located on a 10 to 20-degree slope and 1 on a 20 to 30-degree slope. These three classes, however, made up 521.47 square kilometers or over 98% of the study area.

Can Aspect be used to characterize French-Canadian sites on French Prairie? Here, in the northern latitudes, a south-facing field will receive more sunlight than a north facing slope. Like elevation and slope, it is possible, however unlikely, to incorporate multiple aspects into a claim. Interestingly enough, the 49 known sites were distributed fairly evenly around the compass. Nine of the known sites were found on flat (no aspect) ground (121.8 square kilometers or almost 23% of the study area). Ten known sites were found on aspects of 315 to 45 degrees (89.61 square kilometers or almost 17% of the study area). Eleven known sites were found on aspects between 45 and 135 degrees (122.81 square kilometers or over 23% of the study area). Ten known sites were found between 135 and 225 degrees (92.18 square kilometers or over 17% of the study area). Finally, 9 known sites were found on aspects of 225 to 315 degrees (103.46 square kilometers or over 19% of the study area). Thus, like elevation, and slope, aspect does not appear to strongly predict French-Canadian site location.

Can Hydrology be used to characterize French-Canadian sites on French Prairie? Distance to water was primarily a factor for transportation since a high water table provided sufficient drinking water. Most of the 49 known sites are spread fairly evenly between water and 800 meters distant. Only 2 known sites, those of A. Arcuet and L. Vandal, are located more than 1100 meters from a water course. Both of these French-Canadians are associated with the later phase of settlement, when, as Brauner (1989) has pointed out, overland transportation routes had gained precedence. Again, in cases where the claim is known but residential location not known, the "site" may be tempered by the inclusion of waterways for other purposes such as habitat for game and fur-bearing animals. For example, Delard may have forgone proximity to the Willamette River in favor of having access to lacustrian resources (Brauner 1989).

Can Vegetation be used to characterize French-Canadian sites on French Prairie? For this study vegetation is problematic as a cultural indicator because it reflects 150 years of intense development and agriculture that even the 1852 data does not eliminate completely. As described in the metadata, the 1852 GLO vegetation coverage is an interpolation from the surveyor's notes. These notes represent the surveyor's impressions of the vegetation peering in from the section line and are thus further suspect (Christy 2000). Additionally, vegetation tends to be dictated by other factors including elevation, slope, aspect and hydrology.

Can soil type be used to characterize French-Canadian sites? Only 7 of the known French-Canadian sites are located on well-drained soils, which make up 17% (90.26 square kilometers) of the study area. The majority of known sites occur on moderately-drained soils which make up almost 38% (or 200.66 square kilometers) of the study area. Nineteen sites were located on poorly drained soils which make up almost 40% (211.63 square kilometers) of the study area and 2 sites fall in areas of no data which make up only 5% (27.31 square kilometers) of the study area.

Can a combination of elevation, slope, aspect, hydrology, soil and vegetation be used to characterize French-Canadian sites French Prairie? It appears that individually, these environmental variables are either weak indicators in French-Canadian decision-making, that some other criteria overshadowed their role, or that the resolution of the data is inadequate. It does not appear that the French-Canadians were selecting their sites based on a scheme that required a combination of these variables/resources be available in these particular proportions (Moon 1993:3). The values returned for the logistic regression calculation for each of the 5298 cells fall between "0" for low probability, and "1" for high probability. The highest value returned for a cell is 0.2, indicating weak predictive power for the model.

Models are by definition simplifications of the real world and those elements omitted from consideration represent assumptions about what is not critical to understanding the shape or flavor of the real world. To that end, the use of environmental variables is questionable to the extent that it can be demonstrated that environmental variables did effect site selection among the French-Canadians (Moon

1993). Variables can be evaluated for their level of statistical significance. (Kvamme 1988; Rose and Altschul 1988; Warren 1990b; Warren & Asch 2000). ArcSDM calculated a pair-wise test for conditional independence on variables used in the inductive model of this study, returning a ratio of .81, indicating that one or more of the variables may depend on another. This in turn may explain the weak predictive power of the model.

Finally then, can other areas on French Prairie that share these characteristics be identified and to what degree? As seen in Figure 19, areas that appear to have a higher probability for French-Canadian sites have been identified. The ability to present the results of this predictive model as an informative, accurate map strengthens the utility of the study in that this map can be taken out into the field on reconnaissance surveys or combined with other data sets such as property maps. There are also dangers in presenting this information through the use of computer-aided mapping. Interpretations of the map can be overly authoritative if users don't understand the process behind the production of the map. Specifically, "a map of potential or a predictive model is not a final result; it is just a map, and all maps require interpretation and study" (Dalla Bona 2000:94).

Interpretation of the map requires an understanding of the reliability of the map. For example, how high is the probability that a site will be located in a given area and how reliable is that probability? The reliability of a model can be tested in several ways. Comparing known sites against areas of high probability is ineffective since these sites were used to create the model. Another method is to test it against sites independent from the model, either because they were unknown at the time of building the model or removed before the model was run (Warren and Asch 2000). "Another way to assess the performance of a predictive model is to measure its gain in accuracy over a random or null classification (Kvamme 1992)" (Warren and Asch 2000:20). It is hoped that the results of this model be tested through statistical means beyond the scope of this research, and through further archeological testing.

One measure of the utility of a GIS model is the number of applications that it can be applied to. For example, another model may be run using these data sets to determine if land claims made by the encroaching American settlers, can be predicted. One of the strengths of this study is that it focuses on a unique cultural group in a defined temporal context and does not predict prehistoric or historic sites that represent use or settlement by other groups. These sites represent continuous, multi-task, multi-season occupations unlike many other predictive models-which focus on seasonal occupations, inherently emphasizing one resource over another (Duncan and Beckman 2000). At the same time, the French-Canadians were, by their own reckoning, taking advantage of a wide variety of resources simultaneously.

Additionally, this study focuses on French-Canadian occupation sites and does not claim to predict cultural impact on the land of farriers or blacksmiths, if these activities took place on French Prairie. This database could also be used, however, to predict these types of sites or the location of prehistoric sites—disparately represented on French Prairie where few prehistoric sites have been documented.

Another direction for future research might be to extend the study area boundary to the regional level in hopes of identifying a set of characteristics that made the French Prairie more attractive than other areas in the region. A database could be built for other areas in which Hudson Bay Company expatriates also settled, in hopes of identifying shared characteristics.

Allen points out that Iroquois horticulturalists did not always select the best soils, possibly because access to other resources, and protection from hostile groups were also critical to village site selection (Allen 2000). The French Canadians were already in the area because of suitable soils. Likewise, proximity to Ft. Vancouver might have been a factor but they were quite capable of living without that resource—although it certainly eased the transition from trapping to farming and factored strongly into their sense of identity. It is possible that site locations near the boundary of the study area were influenced by variables outside of the study area.

Finally, the division in land claim shape between the two settlement episodes may be indicative of a growing sense of identity within the French-Canadians who, even though they would not forsake their Native American wives, may have realized the hard truth that "Indian-ness" would hobble their inclusion in the growing complexity of local society and government. The "French" label may have been a compromise between “American” and “Indian” and may have allowed slightly more freedom than being labeled “Indian”. Another research foray using portions of the results of this study may be into the exploration of the archeological record of the primary influence on the identity of their offspring. Did they encourage their sons and daughters to be more "French" than "Indian"? In this way, the process of modeling, rather than provide a literal map of French-Canadian decision-making, has tested and found lacking our generalized assumptions about these marginalized and complex people. In a broader sense, it forces the question; if we cannot understand or see the factors influencing a cultural expression only 150 years removed from our own experience, what makes us think we can understand those cultures 500 years, 1000 years or 10,000 years removed?

As illustrated by the above discussion then, perhaps the greatest import of this study is the amalgamation of diverse schools of thought, to lay the theoretical foundation for future research.

While this project may guide archeological exploration and illuminate aspects of French-Canadian culture that were not previously visible, it does so with the understanding that it is only a model, no matter how accurately it represents the real world. To that end, it must ultimately be tested through archaeological investigation.

"All those...moments will be lost... in time, like tears... in rain."

-Roy Batty in *Blade Runner*

based on the novel "Do Androids Dream of Electric Sheep",

by Philip K. Dick

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APPENDICIES

Appendix A: Discussion of GIS and Data Sources

A tool as complex as GIS requires that the user, and the reader, be comfortable with a suite of complex concepts and techniques. This appendix begins by elucidating the selection of the GIS software used and concludes with a discussion of relevant definitions and concepts used in the construction of these models.

While there are numerous GIS software packages available, Oregon State University (OSU) has a site license with the Environmental Systems Research Institute (ESRI), which produces the popular ArcView and ArcINFO packages. Because of this license agreement, these packages were available for use in several of the computer labs on the OSU campus. This fact was central to the decision to use ArcView and ArcInfo for several reasons. First, the size of many of the data files necessitated the use of a fast internet connection for downloading. Secondly, these packages can be prohibitively expensive even with a student discount. ArcInfo is not offered with a student discount and it was discovered that this more powerful (and more complex) package was necessary for several data manipulations. Finally, the license encourages many users at OSU, which meant a larger pool of informal technical support in the immediate neighborhood. Also considered was the fact that ESRI dominates the GIS market, which meant greater third party support, greater availability of data in ESRI-friendly formats, and several internet user-groups which provided technical answers.

ArcView and ArcInfo accept both raster and vector data formats making them versatile. Use of these respective formats has implications during analysis. Raster files organize data in grids while vector stores data as a direction and distance (Clarke 1997; Kvamme 1989; Robinson 1995). In the raster format, data are stored in grid cells which means that each cell has a resolution, or the cell size in ground units (Kvamme 1989). Raster data format is good for representing continuous surfaces such as elevation or soil types, conducive to spatial analysis and good at localized topology (Kvamme 1989). Lines stored as raster cells however, appear to widen or as stair steps. Data stored in vector format can represent points or lines-which can be used in turn to build polygons. Thus, network features such as rivers and street features are suited to vector format (Kvamme 1989). Vector format allows precise locations as coordinates rather than depending on cell size (Kvamme 1989). For this study, data in both formats was used. Which data sets used which format is included in later descriptions of each data set.

There are a few software-dependent definitions that will facilitate discussion of the methodology used in this study.

- ArcView uses layers, or "themes" to display geographic information of a given type in "views" (ESRI 1996; GII 1997). The data in a theme may be stored in one of many formats including shape files, images or grids.
- A shape file is ArcView's format for a file containing "the location, shape, and attribute information of geographic features" (GII 1997).
- A "coverage" is the ArcInfo data format comparable to "theme", which can also be exported from ArcInfo and imported into ArcView using the Import71 extension (ESRI 1996:48; GII 1997).
- A "layout" is ArcView's production function in which maps are designed, printed and exported (ESRI 1996).

- An ArcView "project" is a file that archives accessed data sets and processes (ESRI 1996:6 GII 1997). Rather than copying large data sets, a Project file stores information about which data sets have been accessed, where they were accessed from and what processes have been used on them. When a project is opened, ArcView refers back to those data and applies changes to the presentation of those sets. Some processes, such as derivations of slope or aspect from elevation, result in the creation of new data sets.
- "Extensions" are add-on software applications with specific functions run within ArcView (ESRI 1996). For example, Spatial Analyst is an extension used in this research.

Although ArcView was the primary software package utilized for this research, several others were necessary for formatting, transforming, moving, and analyzing the data.

- PKZip is a shareware compression software utility. Many of the data files were large and compressing them made downloading and transfer easier. Most data files came "zipped".
- TransNAD by Wessex Inc. is a shareware utility that changes data stored as a ArcView Shapefile and projected using the North American Datum 1927 to or from the North American Datum 1983.
- SDTS2DEM is a shareware utility that translates from the Spatial Data Transfer Standard to an Ascii file Digital Elevation Model.

- DEMmatch is a shareware utility that reads Digital Elevation Map (DEM) files and tells the user whether the file units are feet or meters. This utility will also convert specified DEM files from one unit to the other.
- Arc-Spatial Data Modeller (Arc-SDM) and DataXplore are an analysis extension that complement Spatial Analyst. Downloaded from the ESRI web site, they were created by Laura Kemp at the Geological Survey of Canada and Gary Raines of the USGS. Originally designed for use in modeling mining probabilities, the statistical calculations can be applied to this study.

For this study, data was acquired from several sources with the intent of keeping the model reliable, readily available and cheap (Kvamme 1989). Some of the data sets, such as the DEMs, were downloaded from the internet site of the Oregon Geospatial Data Clearinghouse (OGDC), formerly known as the State Service Center for GIS. These were data sets in turn collected from other agencies such as the United States Geological Survey (USGS), the Environmental Protection Agency (EPA), and the Department of Environmental Quality (DEQ).

Acquiring existing data available on the internet has some advantages. These files were downloaded are available to the public at no cost beyond having internet access and the capability of handling these large data sets. This makes them much cheaper than in-house digitizing of the data from what would probably be the same source (Kvamme 1989). Within the GIS community there is a push to make digital data available to as many users as possible, in theory increasing the cost benefit ratio on the benefit side with each new user. The formats at the OGDC are uniform, all as

ArcInfo export files and in Lambert Projection. The DEMs, however may also, as in the case of this research, be downloaded as raw ASCII files. The fact that the USGS stores elevations in feet or meters for their DEMs, and ODGC does not compensate for that discrepancy, is discussed in Appendix B. The availability of these data sets to other researchers who wish to duplicate these models strengthens the potential contribution that this research can make to the science of predictive modeling.

Existing data available on the internet does have some disadvantages. While more and more data are being made available, there are many instances where specialized research is hampered by limited choices. In these cases, it becomes necessary to create the required data sets or compromise and use the existing data set. Fortunately, in the case of this research no such compromise needs to be made. Because data may be from multiple sources, metadata may not be complete, complicating the evaluation of each data set and thus the overall model. Different resolutions of each data set, which are described in the following sections, may have implications for the analysis.

This study required the in-house generation of only one specialized data set-that of known sites (Kvamme 1989). Fortunately, this set required only minimal data entry of UTM coordinates of 52 sites into an Excel file.

Evaluating the model requires considering several aspects of the data being used. Metadata are information provided with data sets that relays scale, data acquisition processes, and sources, among other relevant factors, about the data and allows determinations of the accuracy, precision, and integrity of the data (Duncan and

Beckman 2000; GII 1997). Evaluation of any model requires the ability to identify error and recreate the model. To facilitate this, the metadata for each data set used in this study is included in the appendices. The following are factors that must be considered from the metadata.

Accuracy is "the validity of data measured with respect to an independent source of higher reliability and precision" (Clarke 1997; Robinson et al. 1995:248). Precision is "the number of digits used to record a measurement or which a measuring device is capable of providing" (Clarke 1997; Robinson et al. 1995:248).

Distortion is a by-product of displaying the curved surface of the earth on flat media (GII 1997; Robinson et al. 1995). Different projections distort the data in different ways, which may have implications for the types of analysis that are possible (GII 1996; Robinson et al. 1995). In the case of this research, the area being examined was small enough that distortion caused by projection was negligible. However, there were other considerations regarding projection.

ArcView allows the user to change the projection of a view but only themes stored in decimal degrees will reflect that view's projection when displayed. Images, such as the Digital Elevation Models (DEMs) stored as ArcINFO grids or the GLO survey tiffs are displayed in the projection in which they are stored and will not reflect the set projection of a view (ESRI 1996). After trying to reference the images using latitude/longitude coordinates, it was discovered that because ArcView does not project images, the images were skewed horizontally. In this case, because the data came from varying sources, it came in several different projections. Most of the data was available in UTM projection using the North American Datum of 1927 (NAD27). Other data, such as the hydrology data set from the Pacific Northwest Reach web site, was in Lambert Conic Conformal projection. ArcInfo was used to change the projection of the data set. The study area falls within one UTM zone. Therefore, a UTM projection was chosen as the project projection in order to minimize distortion and facilitate multiple data sources

The metadata can assist in evaluation of the time relation of the data to the subject (Duncan and Beckman 2000; GII 1997). The 1852 GLO data better represents the vegetation that the French-Canadians would have observed on the ground. The more modern data reflects over 100 years of development and agriculture in one of the most heavily populated regions of the state. The scanned images of the 1852 survey maps offer an opportunity to examine possible changes in the landscape even though the survey at that time may not have been as robust as modern techniques.

Allen organizes the issue of scale by identifying three types; "scales of analysis, data scales, and data resolution" (Allen 2000:102). Data scale and data resolution can be determined by looking at the metadata. These two are closely related in the digital realm. On paper, data, or map, scale is fixed. ArcView allows the user to zoom in or out to varying scales. At a smaller scale, a site is represented as a point whose symbol, a dot, may cover several real-world meters. On paper, that dot remains the same size no matter how close to the eye it is held. As the user zooms in using ArcView, however, that point remains the same size on the screen, perhaps covering only a few real-world centimeters. "The original base maps from which GIS data are derived contain finite amounts of information and are constructed at some level of accuracy. At some point decreases in cell size will fail to yield increases in information content" (Kvamme 1989:152). This concept applies to vector systems as well.

Data resolution refers to the level of detail that is provided in the data. (GII 1996:5-8, 5-10). For example, in the hydrology data set, is width or depth conveyed if the symbol used to portray the feature a simple line? In this research, it was acceptable to portray sites as points because the analysis did not depend on accurately portraying the shape of the house or other structures.

Cell size is another issue raised by Allen. In the case of the soils data set where soils are described over a large area, cell size becomes less of an issue. Allen argues that cell size should reflect the size of the unit of study-in this case that of an occupation site (Allen 2000). Specifics relating to data scale and data resolution of each data set are discussed in the following sections that describe each data set. The quality of each data set is evaluated later in the discussion of each set based on descriptions of data collection processes included in the metadata (Allen 2000). The next considerations are those that are tied to the research design.

Based on a review of the literature, Allen's discussion of scale of analysis identifies "regional to refer to studies of roughly 5500km squared, and local to refer to studies of approximately 100km or less" (Allen 2000:102). French Prairie, at roughly 437 square kilometers, is a local study in that "particular resources available in the immediate vicinity of the site can be identified and assessed for their importance to particular location choice" (Allen 2000:102). This study focuses on residential sites that share a common occupational pattern, a common cultural background and are scattered across a large local area, not clumped in villages. Thus the unit of investigation is a familial unit, rather than a village or larger group of people. Of course, historical records indicate that there were cases in which employees or partners, both French-Canadian and Native American, were living with the settlers but the primary unit that decided where to live was the family (Hussey 1967).

The French Canadians chose French Prairie almost exclusively from the Pacific Northwest. There were two other settlements but French Prairie, in part because of it's proximity to Ft. Vancouver, was the most predominant site. A small-scale model might include a regional analysis to better understand why these three areas were chosen rather than why particular sites within one area were chosen. Historical sources tell us that the settlers were drawn to the rich resources on French Prairie. This might negate any benefit in allowing the model to overlap outside French-Prairie. The scale of analysis is driven not only by the research problem, but by the availability of the data as well (Allen 2000). Fortunately, data for this area is readily available at a scale that permits the research questions.

Because the variables being examined are part of larger systems, how much can we isolate those variables from their system that lays outside the area defined as French Prairie (GII 1996)? Should data extend beyond the boundaries of the French Prairie? For example, if a large camas field lies just outside of the area we have defined as French Prairie but still within a half-hour walk of a homestead, camas may not correlate with site presence. For this study the data sets were either large enough to incorporate areas beyond our definition of French Prairie or several adjoining data sets could be merged to produce to cover areas outside French Prairie. Analysis was limited to that area defined as the "study area" however, and future research may examine the possibility that resources immediately outside the study area may aid the model.

Other variables such as solar insolation may prove to be more accurate indicators of site location. For this study however, limited computing power and time dictated that a limited set of variables be used.

Metadata often includes the data dictionary (GII 1996:5-10). Attribute data are often coded. Where applicable, the data dictionary for each data set is included with the metadata in the appendices.

Appendix B: Metadata for the DEM.

The nine USGS DEMs in raw ASCII format were downloaded from the OGDC at: http://www.sscgis.state.or.us/

Metadata for the DEMs are also available from the above website. Three of the DEMs (5123A1DF, 5123B1DF and 5123C1DG) used meters as elevation units while the other six used feet. This prevented displaying and analyzing the DEMS together. DEMmatch, a shareware application, was used to convert those DEMs from meters to feet. In ArcInfo's Grid module, the command "DEMgrid" was used to change the newly uniform raw ASCII DEMs into grids. From the same module, the "Mosaic" command was used to join the nine-contiguous DEMs as one creating a new seamless grid. The Elevation, Aspect and Slope grids were created as floating point grids. The extension used for the analysis, Arc-SDM requires that grids be integer grids. To solve this problem, the ArcView map calculator was used to multiply the value for each cell of each grid by 100.and the resulting calculations were saved as grids using the "Convert to grid" command under the Theme menu. The grids were reclassified so that the classes are designated as 1/100th of their value.

Appendix C: Metadata for the Hydrology Theme

The Hydrology theme, oreghydi.tar, and metadata were downloaded from the Pacific Northwest Reach web site at:

http://www.streamnet.org/pnwr/fileaccess.html

This tar file contained all of the reaches in Oregon of which only three covered French Prairie. These were identified by their Hydrologic Unit Codes (HUC). For each unit, there were two files, one containing the centerline of the watercourses, and one depicting the outer boundaries of water bodies. Thus, the six files used in this research are: b709007, b709008, b709009, s709009, s709008, and s709007. These files were available in a Lambert projection with NAD27, and were projected into UTM coordinates.

Appendix D: Metadata for the Vegetation Theme

As discussed in the body of this paper, modern vegetation data reflects over 150 years of agriculture and development. Vegetation data that more realistically represents what the French-Canadians encountered was derived from the 1852 GLO Survey maps and notes, and then digitized by The Nature Conservancy under contract for the Oregon Division of State Lands. The metadata for that coverage, taken from the web site:

http://www.orst.edu/Dept/pnw-erc/

is presented below.

(Permission to use the data and metadata was received from John Christy as outlined in the following e-mail.)

{ beginning of e-mail from John Christy}

< "Jun" <rafe20@home.com> Wrote:

|

| I was wondering if there

| was an associated metadata file? There wasn't one in the

| zip file.

Jun --

Check at the web site: <http://www.orst.edu/Dept/pnw-erc/>, under Datasets -- data layers -- 1851 Vegetation. There should be at least a skeletal metadata file there. We don't have anything more detailed here.

John

{End of e-mail}

Data along section lines are generally accurate, although some survey lines were abandoned after subsequent resurveys. Vegetation in the interiors of sections was delineated using secondary sources, and these coverages will not meet current map standards. Surveyors township plat maps, while accurately depicting points along survey lines, provide only sketches of features in the interiors of sections, and do not meet map standards. The same holds true for modern soil maps, which depict approximate boundaries of given soil types, based on limited sampling and interpretation of topography. We estimate map accuracy of position be within 10 meters along section lines, if section corners are the same as at the time of survey, and 100-300 meters in the interiors of sections, depending on topographic features.

Data_Set_Credit

Data should be credited to: John A. Christy, Edward R. Alverson, Molly P. Dougherty and Susan C. Kolar, Oregon Natural Heritage Program, The Nature Conservancy of Oregon. GIS processes should be credited to Oregon State University Department of Fisheries and Wildlife, Department of Corrections, and Oregon Division of State Lands.

Appendix E: Metadata for the Soils Theme.

Soils data for this study was acquired from the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) web site. This data set is derived from the USDA NRCS SSURGO data set. Metadata for this data set is also available at this web site.

Appendix F: Creating the Known Sites Theme.

UTM coordinates for sites known from Dr. David Brauner's French-Canadian Archaeological Project (F-CAP) were obtained from a series of USGS 7.5 minute maps on which the site locations had been hand-plotted by township, range, section and quarter section, and marked with push-pins. Because a hole left by a push-pin translated to approximately 100m on the ground, there was some concern over the accuracy of these UTM coordinates. In addition, the UTM coordinates were hand-read by this researcher using a transparent UTM overlay key, also potentially a source of error. Mitigations for these sources of possible error are discussed below. These coordinates were entered and stored in a Microsoft Excel file. These points were then brought into ArcView as an event theme and saved as a point shape file.

Photographic copies of the 1852-1856 General Land Office Township Survey Plats for the Willamette Valley maps archived in the Oregon State University Valley Library were scanned by Corvallis Blueprint at 400dpi at a cost of $2.00 per sheet. The resulting images were stored as compressed CCITT Group 4 (2d) Fax tiff files. Although ArcView supports this format with its Tiff6.0 extension, the display time for one of these images was prohibitive. The images were brought into Kodak Imaging software, decompressed. The decompressed tiff files are rendered in ArcView much quicker. UTM coordinates, presented in Table 5 were obtained for the township and range corners using Maptech Terrain Navigator v. 4. The individual TIF images were then geo-referenced in ArcInfo using the "register" command. The images were clipped and rectified using the ArcInfo "rectify" command.

UTM coordinates for Township and Range corners are in the format outlined below using UTM Zone 10, NAD 27.

UTM x-coordinate UTM y-coordinate 1852GLO index # = Township, Range UTM x-coordinate UTM y-coordinate

Table 5. UTM coordinates for the township and range corners of the 1852 GLO images.

			529843.7 5021269.4
491130.1 5021211.8 **30= T3S, R3W**	500779.4 5021246.1 **31= T3S, R2W**	510444 5021203.9 **32= T3S, R1W**	520167.8 5021266.4 **33= T3S, R1E** 529906.1 5011644.7
491111.5 5011553.9 **38= T4S, R3W**	500771.3 5011577.2 **39= T4S, R2W**	510453.4 5011603.9 **40= T4S, R1W**	520182.9 5011601.7 **41= T4S, R1E** 529953 5001975.8
491076.8 5001841.1 **46= T5S, R3W** 491023.7 4992329.3	500777.3 5001949.8 **47= T5S, R2W**	510475.5 5001942.7 **48= T5S, R1W**	520245 5001964.2 **49= T5S, R1E** 530021.1 4992320.2
491279.7 4992321.3 **54= T6S, R3W**	500939.2 4992314.2 **55= T6S, R2W**	510487.7 4992324.5 **56= T6S, R1W**	520283.2 529952.5 4992287.9 4992316.1 **57= T6S, R1E** 529980.7 4982670
491262.5 4982663 **60= T7S, R3W**	500924.3 4982615.3 **61= T7S, R2W**	510626.2 4982604.6 **62= T7S, R1W**	520307.2 4982601.9 **63= T7S, R1E** 530000.6 4972988.7
491231.5 4972945.3	500916.6 4972991	510631.7 4972913.9	520343.3 4972945.3

The point file of known sites was laid over the 1852 GLO maps and examined. Because the hydrology theme and many of the sites corresponded closely with features and structures identified on the 1852 maps, it was judged that the 1852 maps accurately portrayed locations of structures. Several of the sites for which site location was known through the prior research of the F-CAP closely coincided with locations of structures noted by the 1852 surveyors, albeit with misspellings typical of that period. Several were close enough that it was judged that they represented the same structure. In cases where there was some discrepancy, the data was examined in order to determine whether the discrepancy represented a later, newer, occupation, a moved structure or data entry error. The 1852 maps do represent a 9 year departure from the end of the period that this study focuses on, providing ample time for claims to be bought and sold, structures to be torn down and built, and families to move. Using the 1852 GLO survey images, the "Known Sites" theme a new theme, "Updated Sites" was created to reflect the more accurate positions. The changes made are discussed here. Numbers in parentheses following the names of the French-Canadians refer to numbers given to each site in figure 4 of the F-CAP report (Brauner 1989).

Amable Arcuet appears on the 1852 GLO map as "Armable Arcouette" between two structures within one claim boundary that closely correspond to two points (#'s 9, 10) from the F-CAP. The "Known Sites" theme was updated to reflect the location of these structures.

This case raises an important issue that is encountered frequently in this study. Spelling of names falls over a wide spectrum of possibilities between the French-

Canadians and the American surveyors. Given that some of the French-Canadians may not have been able to read or write or that the surveyors were recording names remembered by neighbors when confronted with abandoned structures, it is not surprising to see alternate spellings based on the phonetic pronunciation of the French-Canadian names.

Similarly, Amable Petit appears in the 1852 survey as "Armable Petite" along with two structures. One structure is closer to the name and is thus the focus of this discussion. Although the F-CAP point (# 11) is further removed from the 1852 structure, the "Known Sites" theme was updated to reflect this structure.

After careful consideration, this researcher accepts that the structure next to the name "Greg__re" (where the middle one or two letters are obscured) is indeed the more accurate position for the F-CAP point for E. Gregoire (# 33). The "updated Sites" theme reflects this change.

L. Gagnon is represented on the 1852 GLO map by a structure under the name "Gunyo". This structure falls close to the F-CAP-determined point (# 34) and so the "Updated Sites" reflects the position of this structure.

Although I was unable to determine an F-CAP point for A. LaChapelle (# 35), his name and a structure appear on the 1852 map. "Updated Sites" reflects the location of this structure.

There is a structure under a name that appears to be "I. Gregoi__" (where the last one or two letters are obscured) in the area that according to the F-CAP report figure 4, should have been owned by A. Felix (F-CAP # 36). It is possible that Felix sold his claim to Gregoire. However, there is also another structure immediately below that with the name "Langeray". This structure could also be associated with Felix. Although Felix appears on Figure 4 of the F-CAP report, this researcher was unable to obtain a set of UTM coordinates for the "Known Sites" theme. On the "Updated Sites" theme, that entry remained blank.

In the "Known Sites" theme, the name Felix is attached to the location of the F-CAP "French House" (# 32). It is assumed that this is a result of data entry error and the correction is made in the "Updated Sites" theme. "French House" presents an interesting dilemma. The F-CAP point falls in the middle of the northern boundary of a field labeled "Petee" (# 31- Petit?). There does not appear to be any structure immediately associated with that field except for a structure across the road/river. This structure however, seems to be associated with another field labeled "Obershones" (#29 Aubichon?). Petit (# 31) may be represented by a structure labeled "Roy" on the 1852 map. Due to this ambiguity, both the Petit (# 31) and French House points are unchanged from the "Known Sites" theme to the "Updated Sites" theme. The "Known Sites" point for J.B. Aubichon (# 29) is corrected to reflect the structure described above. It is highly possible that Aubichon moved his house across the field in the intervening ten years between the cutoff of the F-CAP and the 1852 survey. Field testing of both sites is highly recommended.

The "Known Sites" points taken from the F-CAP for both E. Lucier (# 3) and P. Bellique (# 4), are closely associated with unidentified structures, on the 1852 GLO map. Indeed, Lucier's point overlaps the structure and requires no change. The "Updated Sites" theme reflects the location of the unnamed structure for Bellique.

As discussed previously, the point marking the F-CAP coordinates for J. Despard (# 5) coincides closely with the name "M. La Frambois" and a structure on the 1852 map. A F-CAP point for M. La Frambois does occur north-east and across the Willamette River. After careful consideration, taking into account the almost ten intervening years between the end of the period covered by the F-CAP and the GLO survey, it is possible that Despard sold his claim to La Frambois. A deed search may shed new light on this discrepancy.

J. Servant's name does not appear on the 1852 GLO map but the F-CAP point (# 18) coincides with two unnamed structures. The structure closest to the F-CAP point was chosen to represent Servant on the "Updated Sites" theme.

Both "Known Sites" and "Updated Sites" themes can contribute to the possible location of sites. For example, the F-CAP point for P. Papin (# 49) falls on the edge of a field labeled "P_bot" and containing a structure on the opposite edge of the field. Archaeological excavation may be required in each location to determine which of those points, if either, was the actual location of Papin's house.

The name of "Andrew Longtaine" (Andre Longtain) appears on the 1852 GLO map along with a series of structures, one of which falls almost directly underneath the F-CAP point (# 7). Thus, no changes were made to the "Updated Sites" theme for Longtain.

A house identified only as "French House" in the 1852 survey coincides with the point identified by F-CAP as the home site of A. LaPratte (# 43). The "Updated Sites" theme was updated to reflect the location of this structure. A second F-CAP point for LaPratte (# 44) does not coincide with any visible name or structure and so was not altered.

T. Moisan (# 45) is closely associated with a structure and name of "T. Moj__" the last few letters of which are obscured. The "Updated Sites" theme was changed to reflect the location of this structure.

The F-CAP site location for C. Rondeau (# 39) corresponds to "Londo" and a structure on the 1852 image. This presents a strong argument for changing the location of Rondeau for the "Updated Sites" theme.

On the 1852 image, the name "De Poe" and its' associated structure appear. This miss-spelling of the French-Canadian name "Depot" is located within the same claim boundary line as the F-CAP point for P. Depot (# 38). The "Updated Sites" theme was adjusted to reflect the location of the "De Poe" structure.

A name "Bonifort" can be made out on the 1852 image which may correspond with the nearby F-CAP point for A. Bonnenfont (# 37). There is also an unidentified structure near the F-CAP point. No claim boundary lines or other connections are apparent so the entry remains unchanged in the "Updated Sites" theme.

The F-CAP points for D. Dompierre (# 22) and F. Laderoute (# 40) are each close to a structure and the names "Dupier" and "Lateroute" respectively on the 1852 map, suggesting that they are the same. The "Updated Sites" theme records the location of these structures.

Similarly, F-CAP points for A. Dubois (# 27), F. Ploudre (# 50), and M. Lore (# 28) are near structures and the corresponding names on the 1852 GLO map although the names are spelled "DuBois", "Ploord" and "Lore" respectively. These structures probably represent more accurate locations for Dubois, Ploudre and Lore and are thus used in the "Updated Sites" theme.

The F-CAP point for O. Briscbois (# 25) is located very near an unidentified structure on the 1852 images. The "Updated Sites" theme reflects the location of this structure.

L. Ausant (# 30) appears near a field labeled "Oss_au", where the fourth letter is unclear. There is an unidentified structure on the opposite side of the field from the F-CAP point but it appears to be outside a claim boundary and there is enough distance between the two that the "Updated Sites" theme entry was unchanged for Ausant.

G. Senecal (# 23) is possibly the name "Snagall" which appears on the 1852 map along with two structures. The name appears to be associated with the southern and smaller of the two structures and it is the location of this structure that is used to update the "Updated Sites" theme.

"Jam_ McKay's _ _ Mill" appears on the 1852 map where the last letters of the first name and the word(s) after "McKay" and before "Mill" are obscured. This name may correspond to J. B. D. Mckay, a French-Canadian not included in the F-CAP. The name may also be "Tom_ _" however. While no structure is clear, the general center of the area under the beginning of the "M" is used as a location on the "Updated Sites" theme.

The "Updated Sites" theme is based on the following table-which lists the location information, F-Cap reference number, whether a structure or claim is identified by the F-Cap, what appears on the 1852 GLO maps and the date in which it was presumably established. This table also includes those French-Canadians identified by F-CAP as living on French-Prairie for whom location data are not yet available.

Table 6. List of known French-Canadian Settlers (from Brauner 1989:21, 28).

Zone	Easting	Northing	Name	FCAP #	FCAP	1852GLO	Date
			Allard, M.				
			Ambrose, J.				
10	515159.18	5009125.52	Arcuet, A.	9	S/C	S & N (shared)	1837
10	514198.62	5008694.24	Arcuet, A.	10		S & N (shared)	1837
10	512640	5011420	Aubichon, A.	8	S/C	S?	1840
10	507607.2	4998873.73	Aubichon, J.B.	29	S/C	S & N	1839
10	505580	5000300	Ausant, L.	30	S/C	N?	1840
			Bargeau, C.				

Zone	Easting	Northing	Name	FCAP #	FCAP	1852GLO	Date
10	507510	5004570	Barnabe, J.		C		1841
10	504773.21	5012061.55	Bellique, P.	4	S/C	S	1836
			Bergevin, F.				
10	501000	5003240	Bergevin, L.		C		1843
10	506070	4995040	Bonenfont, A.		S/C		1842
			Bourbonnais, A.				
10	506640	5002030	Bourjeau, S.		C		1841
10	512117.06	5002013.71	Briscbois, O.	25	S/C	S	1843
			Brouillet, H.				
			Brunelle, J.				
			Caloman, B.				
10	502700	5003670	Chalifoux, A.		C		1838
			Chamberlain, A.				
			Champaigne, F.				
			Chappell, P.				
			Crochiere, J.				
			Daprai, F.				
			Decan, J.				
			Degie, P.				
10	500490	5009480	Deguirre, J.B.	47	C	N	1840

Zone	Easting	Northing	Name	FCAP #	FCAP	1852GLO	Date
10	502200	4992400	Delard, J.		S/C		1832
			Delcoure, J. B.				
10	509087.53	4994216.46	Depot, P.	38	S/C	S & N	1839
			Derouche, F.				
10	506574.42	5011825.42	Despard, J.	5	S/C	S	1830
			Diamare, C.				
10	507755.28	5003445.08	Dompierre, D.	22	C	N ? & S	1837
			Dorian, J. B.				
10	509443.79	4999261.95	Dubois, A.	27	S/C	N & S	1840
			Dubruille, J. B.				
10	510560	4998680	Ducharme, J.B.		C		1841
			Duperre, J.				
			Dupre, N.				
10	507410	4998770	Felix, A.		C		1843
			Forcier, L.				
10			French House				
			Gagnon, F.				
10	505563.29	4998499.51	Gagnon, L.	34		S & N?	1843
10	499170	4994120	Gervais				1830
10	499320	4993940	Gervais, J.		S/C		1830

Table 6. List of known French-Canadian settlers (Continued)

Zone	Easting	Northing	Name	FCAP #	FCAP	1852GLO	Date
			Gingas, Jean				
			Gingas, Joseph				
			Gobin, J. B.				
10	505378.55	4998939.87	Gregoire, E.	33	C	S & N	1837
			Guilbeau, F.				
			Jacquet, P.				
10	498420	5006760	Jeangra, S.				1843
10	496970	5008730	Labonte, L.		C		1830
10	505388.15	4997850.41	LaChapelle, A.	35	S/C	S & N	1841
10	504390	5002640	LaCourse, P.		S/C		1843
			LaFantasie, C.				
10	502090	4993500	Laderoute, F.	40	S/C	S & N	1838
10	508000	5011880	LaFramboise, M.	S/C			1838
			Lalcoure, J. B.				
			Lambue, A.				
			LaPlante, L				
			LaPointe, C.				
10	505720	4987490	LaPratte				1842
10	505520	4988120	LaPratte, A.		S/C		1842
			Lartie, F.				

Table 6. List of known French-Canadian settlers (Continued)

Zone	Easting	Northing	Name	FCAP #	FCAP	1852GLO	Date
			Lavigeur, H.				
			Leno, J.				
10	508020	5010980	Longtain, A.	7	S/C	N & Ss?	1837
10	509226.68	4999078.44	Lore, M.	28		N & S	1842
			Lucic, B.				
10	504490	5012020	Lucier, E.	3	S/C	S	1829
10	501510	5011560	Masta, A.		S		1839
			Matte, J.				
			McKay, J. B. D.				
10	503110	5010020	Menard, P.		C		1842
Zone	Easting	Northing	Name	FCAP #	FCAP	1852GLO	Date
10	504597.83	4987067.21	Moisan, T.	45	S/C	S & N?	1842
			Moloire, F.				
			Montour, N.				
			Mongrain, D.				
10	508720	5010850	Newell, R.				
10	506400	5008600	Papin, P.		S/C		1843
			Perrault, J. B.				
10	508200	4999000	Petit, A.	31	C	N	1842

Zone	Easting	Northing	Name	FCAP #	FCAP	1852GLO	Date
10	511901.88	5004586.11	Petit, A.	11	C	N & S	1842
			Picard, A.				
10	504610	5003530	Pichette, L.		S/C		1842
			Plante, C.				
			Plouffe, J.				
			Plourdre, A.				
10	509213.76	5001146.16	Plourdre, F.	50	S/C	N & S	1841
			Porteous, W.				
			Quintall, L.				
10	503010	5002710	Raymond, A.		C		1841
10	502260	4999940	Rivet, F.		C		1839
10	507243.87	4992499.02	Rondeau, C.	39	S/C	N & S	1837
			Sanders, J.				
10	510488.98	5004104.43	Senecal, G.	23	S/C	N? & S	1842
10	503181.98	5004786.12	Servant, J.	18	S/C	S	1841
			Toupin, J. B.				
10	502460	4985890	Vandal, L.		S/C		1843

In addition, several structures appear on the 1852 map listed simply as "House" or "Cabin". These may represent abandoned homes of French-Canadians and warrant further investigation. Their locations are recorded here but are withheld from the "Updated Sites" theme. Although these structures are not included in the "Updated Sites" theme, their locations are recorded here in table 7. with the hope that later archaeological or historical research may elucidate their ownership, age and function.

Table 7. Coordinates for unidentified structures on 1852 GLO images.

Easting	Northing	Designation
508548.24	4991724.16	"House"
506241.31	4991630.46	"House"
506564.87	4990082.90	"House"
509913.66	4991451.97	"House"
506698.02	4989704.93	"House"
504037.50	4994313.33	"Cabin"
505385.43	4989596.97	"House"
506349.23	5012871.18	"Cabin"
503913.86	4998083.53	"Fabia Mel_ay"

The Microsoft Excel file "Updated Sites" was saved as a Dbase IV file and brought into ArcView as a table. It was then added to a view as an Event theme and saved as a Shape file.