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Site/Environmental Correlations in Northeastern Minnesota

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16. Abstract (Limit: 200 words)

Mn/Model, a GIS-based model for site prediction in Minnesota, performed adequately for northeastern Minnesota; but the more numerous Woodland tradition sites used to derive the models overwhelmed the older Paleoindian/Archiac sites.

This project was designed to enhance the Mn/Model databases to better represent the landscapes of northeastern Minnesota with respect to these early sites. Researchers conducted a logistic regression analysis of 108 known sites for common environmental parameters with four variables: Distance to water, stream flow, pollen average, and height above mean elevation within 90m.

Field survey by shovel testing was restricted to 50 random points. Although locations of high, middle, and low probability for archaeological resources were tested, none of the locations had such resources. The lack of new sites in this survey is not considered an indication that the model is invalid, but more a result of the use of only randomly chosen points. The non-site data generated are useful for enhancing Mn/Model but the logistic regression model developed from the known sites still requires testing.

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Final Report

Prepared by:

Susan C. Mulholland
George Rapp
Stephen L. Mulholland
Russell Rothe
and
James K. Huber

Archaeometry Laboratory
University of Minnesota Duluth
214 RLB
10 University Drive
Duluth, MN 55812

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Office of Research Services
Mail Stop 330
395 John Ireland Boulevard
St. Paul, MN 55155

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The project is indebted to many individuals and organizations. G. Joseph Hudak (Mn/DOT) helped design the initial technical approach. Elizabeth Hobbs and Craig Johnson (Mn/DOT) played major roles in developing the work plan. The Office of the State Archaeologist supplied site licenses in a timely manner. The U.S.D.A. Forest Service Superior National Forest kindly granted an ARPA permit covering all its lands. Permissions for survey on St. Louis and Lake County lands were given expeditiously, as were those for Mn/DNR lands. Permissions also were received from Minnesota Power and Potlatch Corporation as well as several private individuals.

The State Historic Preservation Office made available its site database for northeastern Minnesota. The U.S.D.A. Forest Service Superior National Forest allowed extensive use of their site forms and records. Site data were also gathered from the Anthropology Department at the University of Minnesota Twin Cities and from private sources.

PERSONNEL

George Rapp: Principal Investigator
Susan C. Mulholland: co-Principal Investigator and Project Director
Gordon R. Peters: archaeological consultant
Stephen L. Mulholland: crew supervisor
Jennifer R. Shafer: crew supervisor
Robert C. Donahue: crew/technician
Russell Rothe: computer technician
James K. Huber: palynological consultant
Ronald Regal: statistical consultant
Tim Jones: statistical supervisor
Nick Danz: statistical technician

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EXECUTIVE SUMMARY

The objective of this project was to generate data that could enhance the effectiveness of Mn/Model in assessing cultural resources questions dealing with northeastern Minnesota (St. Louis, Lake, and Cook Counties). Currently available cultural resource site data in this region are biased toward lakeshores. Hence additional data on archaeological sites in this region were considered important to improve Mn/Model for this region, particularly in regard to the Paleoindian and Early/Middle Archaic traditions. This project was undertaken through the Center for Transportation Studies at the University of Minnesota by Archaeometry Laboratory personnel augmented by Gordon Peters, former Forest Archaeologist for the U.S.D.A. Superior National Forest.

Task 1 was to identify environmental variables common to known sites of the specified periods in the region. Regional and state databases were reviewed to identify sites of Paleoindian and Early/Middle Archaic traditions, using both diagnostic artifacts and distribution of lithic material types. The known sites cluster in two regions, the Border Lakes in the north and the Reservoir Lakes by Duluth. Environmental data for the site locations (after verification) were then assembled from various digital coverages. Some variables were derived by analysis of digital data. The variables were analyzed by logistic regression and CART procedures to identify those common to the known sites. Four variables were selected by logistic regression: distance to water, stream flow, pollen (surrogate for post-glacial vegetation), and height of site above the mean elevation when within 90 m.

Task 2 was a field survey to test the environmental variables. Mn/DOT personnel restricted the survey to randomly generated points (a 30 m grid); each point was assigned a probability based on the logistic regression model. A total of 50 points was surveyed over two field seasons, chosen based on probability, access, and ownership. Although locations with high, medium, and low potential were tested, none of the 50 locations yielded sites. Task 3 was comparison of new sites to the environmental variables; since no sites were found no comparison could be made. The lack of new sites is considered largely the result of use of only randomly generated locations for survey, a restriction stipulated by Mn/DOT program managers. Although these non-site locations can be used in Mn/Model, the correlation of early sites to the four variables remains untested.

INTRODUCTION

BACKGROUND

The idea for a study of northeastern Minnesota environmental settings of Paleoindian/Early Archaic archaeological resources evolved from discussions between G.R. Rapp (University of Minnesota Duluth, UMD) and G.J. Hudak (Minnesota Department of Transportation, Mn/DOT). The recently developed Mn/Model, a Global Information System (GIS)-based model for site prediction in Minnesota, focused on the relation of environmental correlates of site location. Mn/Model models for northeastern Minnesota performed adequately but were based on low site numbers and biased survey locations. In the three counties in this project the 44 Paleoindian/Archaic sites currently identified in the State Historic Preservation Office (SHPO) database were overwhelmed in the statistical analyses used to derive the models by the much more numerous Woodlands sites. This project was designed to enhance the Mn/Model databases to better represent the landscapes of northeastern Minnesota (Figure 1) with respect to Paleoindian/Early to Middle Archaic periods.

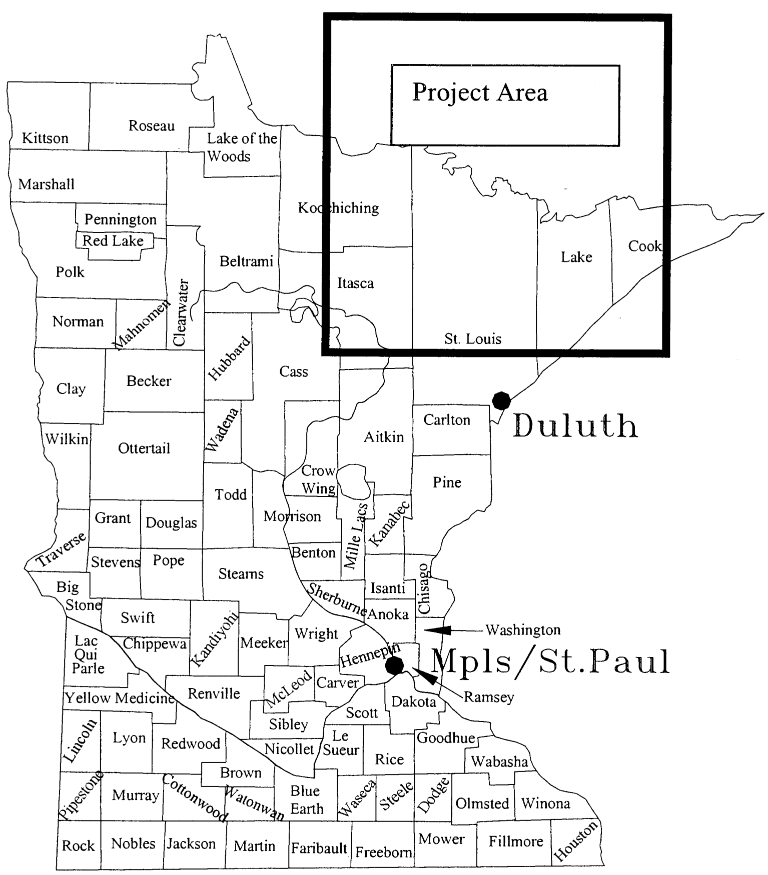

Figure 1. Project Area.

A project was proposed through the Center for Transportation Studies at the University of Minnesota to address these issues. Project personnel at the Archaeometry Laboratory initially outlined a project that focused on the determination of environmental settings around known sites of Paleoindian/Early to Middle Archaic age. There are 108 archaeological sites of known Paleoindian or Early/Middle Archaic affiliation known from the project area. The majority of these sites were discovered by Superior National Forest (SNF) personnel with others recorded by UMD Archaeometry Laboratory personnel. Only 60 of these sites are in the SHPO database available to Mn/DOT for modeling. The first task was to assemble a database of the environmental variables at the 108 sites and select the variables common to the sites. Then an initial test of the selected variables by field survey was planned within the three county area. This area (Figure 1) is the universe from which a sample of locations was to be selected.

The initial project plan, in part, focused on traditional stratification methods for archaeological survey and was designed to test the usefulness of environmental variables in predicting the location of sites. If new sites were found, the environmental variables would be considered hypotheses for further testing. Mn/DOT personnel, however, suggested that it would be more useful if the proposed work plan was modified to include a stratified survey, ensuring that some low probability areas would be tested. This was suggested because negative survey results would still be important for modeling and project results would enhance Mn/Model databases whether any sites were found. A stratified survey would also avoid codifying the existing model. Meetings between Mn/DOT and Archaeometry Laboratory personnel led to a work plan consistent with Mn/DOT=s goals and objectives. Specifically, a logistic regression model was developed from the database of Paleoindian and Archaic sites in relation to a set of measured environmental variables. The resulting regression equation was then applied to a set of random points to determine the potential of the environmental variables to indicate Paleoindian/Archaic site presence. Model values were stratified into five probability cases. Random points in all classes were surveyed with some preference given to points in higher probability classes.

The project was carried out without any bias imparted by Archaeometry Laboratory personnel being influenced by Mn/Model models for northeastern Minnesota. Archaeometry Laboratory personnel did not have access to these models because Mn/Model had not been released when the project was being done.

THE ENVIRONMENTAL SETTING

Unlike most of the rest of the state of Minnesota where glacial and fluvial geomorphic features predominate, northeastern Minnesota has landscape features often dominated by preglacial bedrock topography. In addition, the region is bordered on one side by Lake Superior, a feature that occurs no other place in the state. Large fluvial plains are largely absent and the soil cover is thin. The average relief is greater than elsewhere in the state as well.

Likewise, forests still cover a large portion of northeastern Minnesota whereas forested areas are small and discontinuous in the rest of the state; open farmland is more often the norm there, even in areas that were forested at the time of contact. The thick vegetative cover of northeastern Minnesota makes normal archaeological survey methods difficult, if not impossible, to apply. Pedestrian walkover is often not appropriate, leaving the more labor intensive shovel testing as the only possible method; shovel testing is often Ahit or miss@ as the area of surface and volume of subsurface inspection is quite low.

This region has both the highest and lowest elevations in the state, therefore the greatest relief. The highest point is Eagle Mountain in Cook County at 701 meters above sea level. The lowest is the level of Lake Superior at 183 meters. The topography is a mix of preglacial bedrock features and the product of glacial processes. Northeastern Minnesota has more bedrock outcrops than any other part of the state. These bedrocks are almost entirely of Precambrian age, i.e. greater than 560 million years old. Glacial processes have formed moraines, drumlins, and eskers as important landscape features. Glacial features range in age from about 12,000 to 25,000 years. Although there are fluvial deposits most of the sedimentary deposits in the region are of glacial origin. The fluvial deposits are younger than 15,000 years old.

The nature of the drainage varies widely because of the diverse topography. Three main drainage systems shed waters to the east through Lake Superior, to the north to Hudson Bay, and to the south through the Mississippi River. Most of the regions lakes are ponded in bedrock basins, in contrast to the rest of the state where the lakes have formed, and bottom, in the glacial drift. The fluvial systems have changed over time. For example, the Cloquet River in southern St. Louis County initially flowed into the Mississippi River. It later was captured by the St. Louis River and now connects through that system to Lake Superior.

Northeastern Minnesota is located in the transitional conifer-hardwood forest between the deciduous forest to the south and the boreal forest to the north. This area lies within the Great Lakes-St. Lawrence forest region (Rowe 1959), the Lake Forest region (Weaver and Clements 1938), or the hemlock-white pine-northern hardwoods region (Braun 1950). This area of Minnesota is composed of a mosaic of conifers and deciduous broadleaf trees interspersed with wet prairies, marshes, conifer bogs and swamps, and open muskeg.

Considerable changes have occurred in northeastern Minnesota since glacial retreat began about 15,000 years ago. Changes in river courses and drainage patterns, drying of shallow lakes, and other landscape changes as well as a series of vegetational sequences have altered the environmental conditions. Modern maps of the terrain and vegetation of the area are not exact indicators of the environmental settings of premodern archaeological resources (approximately 2,000 years and older). However, modern conditions do form the basis for reconstruction of past conditions.

Changes in the vegetation are perhaps the most widespread. Four regional pollen assemblage zones defined for the late glacial and early Holocene in Minnesota form a time-transgressive sequence in northeastern Minnesota (Cushing 1967, Bjorck 1990). A shrub tundra-like or open boreal forest developed first with limited amounts of spruce. By about 10,500 years ago, a shrub parkland dominated by birch was established. The shrub parkland was replaced by a conifer forest composed mostly of spruce and pine about 10,200 years. A transition to a mixed conifer-hardwood forest dominated by pine, birch and alder occurred about 9,000 years ago. This vegetational history is somewhat different from that of the rest of the state and differs from the vegetation recorded in the 1800s (Marschner 1974).

THE ARCHAEOLOGICAL RECORD

Given the thick vegetation cover, it is not surprising that information on the archaeology of northeastern Minnesota is less well-known than in the rest of the state. The absence of plowed fields means that the fairly easy pedestrian walkover method cannot be employed; shovel testing requires quite significantly more effort while having much less chance of finding materials. Lower modern population density also translates into less coverage by local people; the general lack of interest from archaeologists centered in the Twin Cities also has led to much less investigation.

Some work was conducted in early years by University of Minnesota archaeologists; however, it focused on the mounds in the Rainy River area to the west of the project area (Wilford 1950, 1952). Serious work started by avocational archaeologists, notably Elaine Redepenning starting in the late 1950s, eventually brought attention to the region (Harrison et al. 1995). Archaeologists at the Superior National Forest conducted intensive but selective survey within the proclamation boundaries starting in the late 1970s (Okstad et al. 2000). The Archaeometry Laboratory has focused on the Reservoir Lakes in southern St. Louis County since 1990 (Mulholland and Shafer 2000).

A search of the literature, including unpublished reports and site files, was conducted to determine where information relevant to the project is located. Two major repositories were identified. The United States Department of Agriculture (U.S.D.A.) Superior National Forest (SNF) maintains records of sites within the Proclamation Boundary of the forest. These records are largely based on work done by forest crews or commissioned under contract; however, other project reports were sporadically deposited and were consulted as well. The SHPO and the State Archaeologist maintain records of sites within the State of Minnesota and complements the SNF data within the forest. [The SNF does not routinely report sites to SHPO so both sources were consulted.] Areas outside the forest are recorded only at SHPO, which maintains an extensive collection of reports as well. A literature review was conducted for the St. Louis County Lands Department from these two sources (Mulholland, Mulholland and Rapp 1997). This review lists all prehistoric sites within the county in a database used for planning purposes.

The broad outlines of pre-Contact contexts are now known for northeastern Minnesota (Mulholland 2000). The Late Paleoindian tradition is well represented in the project area by artifacts and sites. Given the distribution of known sites, it is probable that the entire area was occupied in this period. Early Paleoindian materials are much less widespread, although present. Fluted points are sporadic across the area but the scarcity raises the possibility that the environment was too harsh for this time. Archaic materials are more abundant but tend to be mostly Late Archaic in age. The lack of Early Archaic diagnostics has been suggested to be the result of a later age for the Late Paleoindian in the upper Great Lakes with the two traditions co-existing (Mason 1981:111-115). Middle Archaic materials are just beginning to be recognized and are certainly more widespread than previously thought. Woodland tradition sites continue to be the most abundant, partly a result of the younger age, partly from the presence of pottery (which identifies sites as Woodland), and partly because the larger populations hypothesized for this time period produced more sites.

The generally thin soils in northeastern Minnesota have contributed to problems in recognizing components at archaeological sites. Mixing on multi-component sites is common, although not ubiquitous. Use of diagnostic artifacts as temporal markers is necessary but when the diagnostics are not well separated vertically or horizontally, then it is difficult to impossible to separate different occupations. In addition, when stratigraphy is present it requires excavation in much thinner levels in order to be located. Relatively few areas, such as larger river valleys, have sufficient deposition to form deep deposits. Bedrock ledges often have no to little sediment accumulation.

At this point in time, several statements about the archaeological record in northeastern Minnesota can be made. The Woodland tradition is fairly well known, although many important research questions remain to be investigated. The Paleoindian tradition is somewhat known for the later period but the earlier period is only sketchily represented. The Archaic tradition is not as well known as either the Woodland or Late Paleoindian, although that may represent a lack of detailed analysis more than lack of recovered materials. In any case, the correlation of site location to the unique environmental characteristics of the region can only enhance our understanding.

Paleoindian and Early/Middle Archaic sites are definitely present in the project area. Early Paleoindian indications are fairly rare (Mulholland et al. 1997; Higginbottom 1996). However, Late Paleoindian diagnostics are much more abundant and widespread (Florin 1996). A concentration is recorded in the Reservoir Lakes area north of Duluth (Harrison et al. 1995). Late Paleoindian sites are abundant in the Cloquet River drainage as well as the Whiteface River. Other sites have been identified in the Superior National Forest (Peters et al. 1995; Mulholland et al. 1997). Given the known concentration of Late Paleoindian and Early Archaic sites in Thunder Bay, Ontario (Ross 1997) there is a high probability that other sites of this affiliation exist in the project area. Modeling the environmental parameters of known sites will provide a guide to locating previously unknown sites from this extremely significant historic context.

RESEARCH DESIGN

OBJECTIVES

Most transportation projects must comply with Federal and State legislation regarding identification and evaluation of cultural resources. In the vast majority of these projects, archaeological survey needs to be conducted to determine whether the project will impact archaeological sites. Traditional survey methods are labor-intensive, adding time and expense to the project. Over the past three decades rapid technological progress has provided a wealth of new tools to increase the power and efficacy of archaeological survey. These techniques are just beginning to be applied widely but offer considerable potential to streamline the process.

A Minnesota application of these developments is Mn/Model, a GIS-based archaeological site predictive model recently developed by Mn/DOT. Mn/Model was constructed by analyzing known site locations and a large number of bio-physical environmental variables such as horizontal and vertical distance to water, slope, height above the surrounding ground, and vegetation diversity. Mn/Model, a composite of regional models that cover the entire state, took into account the full range of variables in Minnesota. The models developed perform better in some regions than others. It was decided that the regional model for northeastern Minnesota would be enhanced by developing a less biased sample, representing landscapes away from lakes.

Preliminary evaluation by G. Joseph Hudak and Elizabeth Hobbs of Mn/DOT indicated that Mn/Model works best for sites of Woodland and later periods because such sites predominated in the data used to build the model. Mn/Model predicts the older Paleoindian/Archaic sites less well. When sufficient Paleoindian/Archaic site data are available this time period can be treated separately to develop a superior model. One comment on our original proposal states: AAt the present time, there is no way to evaluate whether Mn/Model does or does not model Paleoindian and Early Archaic sites well. Mn/Model is based on site presence/absence (there were not enough sites assigned to any of the different cultural traditions in order to model by time period). Since it is assumed that most sites are more recent in age (i.e., Woodland, Late Prehistoric), it is also assumed that the model reflects the distribution of these sites at the expense of earlier and more rare (?) sites@ (Elizabeth Hobbs and Craig Johnson, email of 11/3/99).

We proposed to supplement Mn/Model, focusing on northeastern Minnesota. Known sites would be used to identify common environmental variables to predict site location for the Paleoindian and Early/Middle Archaic periods in the three county area (St. Louis, Lake, Cook). These predictions would then be tested by surveying new locations chosen to contain high priority variables. The results of this project might provide more data on known sites of this age for northeastern Minnesota as well as suggest environmental variables that could enhance site prediction throughout the state.

This research would benefit all transportation planners and district engineers in Minnesota by enhancing prediction of locations of certain types of prehistoric sites not accurately predicted in the current version of Mn/Model. All projects on federal lands or those federally funded or licensed are required to be reviewed for their impact on archaeological sites through the Section 106 process. The Federal Highway Administration and the State of Minnesota spends millions of dollars each year identifying, evaluating, and mitigating cultural resources that are threatened by transportation-related construction. Until recently, CRM evaluations have been carried out after initial planning has begun. Mn/Model can facilitate planning as predictions of archaeological site locations are now available from the GIS model. Specifically, this proposal was designed to:

A) provide data on site locations to enhance the Mn/Model database in northeastern Minnesota;

B) collect new data by stratified random sampling techniques;

C) identify patterns in current data collected in archaeological surveys.

METHODOLOGY

The research design was based on a thorough geomorphic and environmental examination of the known Paleoindian and Early/Middle Archaic sites in northeastern Minnesota. Analysis of the environmental variables common to the known sites indicates which variables have predictive value for identifying sites in relation to their environmental settings. The predictions would then be tested against a new set of locations. The research methodology was designed to:

A) identify known Paleoindian/Early to Middle Archaic sites in northeastern Minnesota (defined as St. Louis, Cook, and Lake Counties) from existing databases, both regional and statewide, and check location data for accuracy;

B) compare the environmental characteristics/settings of the sites by:

1) compiling environmental data for each individual site, based on GIS coverages and map data as available;

2) analyze environmental data using statistical methods to identify which characteristics predict location of known sites; and

3) predict probability of site occurrence on new locations based on the selected environmental variables;

C) conduct an archaeological survey of selected areas through shovel testing and pedestrian survey, augmented by core drilling if necessary;

D) evaluate the selected environmental variables for site prediction based on results of the survey and report the usefulness of the model for early sites in northeastern Minnesota.

TASKS

I: Data Gathering and Statistical Analysis

The first task in this project was to identify environmental parameters common to known sites associated with the Paleoindian and Early/Middle Archaic period within the project area. [For practical purposes, the project area is defined as Cook, Lake, and St. Louis Counties. Mn/Model tested more than 40 parameters, although data for many of these variables were not available for northeastern Minnesota. Some of these variables should be applicable in this project region. However, not all are relevant. Distance to water (for example) would frequently be much lower for northeastern Minnesota than most other regions of the state. In addition, no other part of the state borders on a Great Lake or has the rugged topography and vast forests typical of this area. [Other regions with vast forests in the recent past now have been largely cleared, allowing more extensive and very different methods of archaeological survey.] Therefore a review of all known sites in the target age and location is fundamental to selection of parameters.

In developing Mn/Model, it was determined that two separate models were needed. In addition to the site probability model, a survey probability model was necessary to overcome the non-random pattern of archaeological survey data. The survey probability model was necessary to predict survey bias. Since the Mn/Model report is not available, survey bias for the northeastern Minnesota region cannot be assessed. However, it is reported to be very strong (Elizabeth Hobbs, personal communication, 2001).

Several sources of information were identified as pertinent to this project. The site files of the Superior National Forest contain all known sites on USDA Forest Service land within the Proclamation Boundary of the National Forest. Some sites from other federal, state, county, municipal and private property within the boundaries are also reported. Areas outside the Forest are covered by the site files maintained by the SHPO in St. Paul. A search was made of all sites in the target counties; a review of all sites in St. Louis County had already been made for the county Land Department. Specifically, the avocational and professional collections from the Reservoir Lakes area, as represented by both reports and photographs, were reviewed. Sites were chosen if 1) a diagnostic tool (projectile point) was recovered from the sites or 2) the lithic debitage fits the pattern for Paleoindian/Early to Middle Archaic traditions in northeastern Minnesota. Stringent criteria were followed for debitage patterns (S.L. Mulholland in prep.).

Environmental data were obtained from various GIS coverages available on the Internet. Various environmental parameters were chosen. Some such as elevation, aspect, slope, geomorphic setting, and distance to waterways were included in Mn/Model. Other factors used by Mn/Model were considered either not available for northeastern Minnesota (soils) or considered not pertinent (Contact period vegetation). Some new factors such as vista (distance of sight) and pollen data (a surrogate for post-glacial vegetation) were added. As many factors as possible were assessed in order to determine which parameters were most useful in site prediction. One major constraint was the availability of coverages and the scale at which data were recorded. If data were not available or the scale was too coarse, the variable was not used.

Following the review of known archaeological sites and compilation of site environmental data, the set of environmental parameters was subjected to statistical tests to determine which have commonality among known sites and therefore diagnostic capability. The site location data and environmental parameters were entered into a database and tested by logistic regression. The resulting equation identified the variables that were most likely to be predictors of site location.

II: Field Test of Variables

Field testing of selected localities was conducted using a slightly modified standard phase I archaeological methodology. The forested environment of Northeastern Minnesota generally precludes any effective type of walk-over (pedestrian) survey for pre-contact archaeological sites. A general mosaic of forested lands punctuated by various sized areas of wetlands and generally small glades creates a vegetative mat that rarely allows for any ground visibility. The only effective means of examining this type of environment is shovel testing.

In practice, the standard phase I shovel testing survey places tests at 15 meters (50 foot) intervals in a grid pattern across the selected area. Shovel tests in northern Minnesota are normally 30-40 cm in diameter and excavated to undisturbed glacial deposits. All sediment is screened through 1/4 inch hardware mesh and returned to the test hole after examination for cultural materials. When cultural materials are encountered, tests on a shorter interval (5 to 7.5 m) may be placed in cardinal directions until site boundaries are established. Data on sediment stratigraphy and, if possible, cultural deposit extent, are recorded on shovel test forms. Area geomorphic setting and current vegetation are also recorded.

This standard methodology was modified in response to the project objectives and the area conditions. Small scale changes in environmental conditions may occur, limiting the amount of each area that fits the model. In addition, many Paleoindian and Early/Middle Archaic sites in Northeastern Minnesota are small and can be missed by a 15 m grid interval. Two modifications to the standard survey were employed. First, the grid spacing was reduced to 10 m for transects and tests. A 30x30 m grid yielding 16 shovel tests was used on all locations. Closer intervals will increase the possibility of finding small sites. Second, the test hole size was increased to 40 to 50 cm diameter. A larger test increases the sample size and possibility of recovering cultural materials.

Plan maps showing test locations (positive and negative) and surface geomorphic characteristics were to be drawn only for positive areas (areas where cultural materials were recovered). Detailed observation of the sediments, vegetation, water features (current and relic), and surface topography were to be made and association to cultural materials noted. [Since no positive areas were located, none of this information was recorded.] All information was recorded in field notebooks. Procedure modifications dependent on field conditions were made within the guidelines set.

Artifacts would be cleaned and accessioned following standard procedures. Fragile materials are cleaned by dry brushing while sturdy materials are cleaned in water. Analysis would be by type of material, based on comparison with known materials in the Archaeometry Laboratory collection. Materials would be curated at the Archaeometry Laboratory, either as part of the Superior National Forest collection or part of the Archaeometry Laboratory collection (based on land ownership). Records of the project include the original data sheets, field notebooks, electronic and paper copy of the database, and the report.

III: Evaluation and Reporting

Task III had two components. The first was to evaluate the new set of independent variables (environmental parameters) defined in Task I and field tested in Task II. This was to be done in an analogous manner to that used in Mn/Model; i.e., after assessing archaeological survey bias, site probability was tested to determine whether the new parameters place sites found in Task II in high or medium probability areas. [Mn/Model=s goal was to have 85% of sites in high and medium probability areas and for these areas to occupy no more than 33% of the landscape. About 85% of the sites statewide did fall into high and medium areas, covering 21% of the state area.]

Evaluation of the model was based on the ability to predict where sites of Paleoindian and Early/Middle Archaic affiliation are located in the defined region. Two factors must be considered for site identification. First, the recovery of cultural materials is crucial to determine if a site is present. The percentage of positive locations is a crude measure of the success of the model but shovel testing is an uncertain methodology. If material is recovered, then a site is definitely present. Conversely, shovel testing may miss small and/or scattered sites. Therefore the number of positive locations is a minimum number of sites. Second, the results from shovel testing will most likely be a few flakes for each site. Assessment of cultural affiliation is therefore necessarily preliminary and tentative.

The second component involved coordination with Mn/DOT cultural resources personnel to ensure that the results of this project are presented in digital formats that will enable Mn/DOT to enhance Mn/Model. Deliverables include any digital data generated for the project as well as a complete report using Mn/DOT standards, including the archaeological data in ArcView shapefile format so that Mn/DOT can integrate them into Mn/Model where appropriate. Note that the evaluation of the variables was dependent in large degree upon location of new archaeological sites.

REVISIONS TO ORIGINAL METHODOLOGY

Several areas of the original research design were not specified in the proposal; details were left flexible pending consultation with Mn/DOT personnel. While the project was not considered to be a Amini-Mn/Model@ for northeastern Minnesota, it was recognized that the ultimate objective was to provide information pertinent to Mn/Model revisions. To this end, it was thought prudent to tailor specifics of the project operation as much as possible to conform to Mn/Model protocols. The particular environmental variables and the statistical analyses, for example, were to be selected during consultation. This would provide the maximum conformity (and hopefully usefulness) of the project to previous Mn/Model standards. Such decisions are discussed in the next chapter.

However, one area of project specifics needs to be mentioned here. Selection of locations for the field test (Task 2) was one area where significant disagreement occurred between the UMD and Mn/DOT personnel. The original objective of the testing as proposed was to see if it was possible to find new sites using the environmental parameters selected by statistical analysis. To this end, we proposed testing as many high potential locations (those containing all the selected variables) as possible. In addition, testing was proposed to be in transects of large areas within targeted areas (where the selected variables occurred). The budget and schedule was based on this objective.

This methodology, focusing on high potential areas and covering a relatively large sections, was based on two ideas. First, the project was never considered to be a full statistical test of environmental variables. Such a test would require much more rigorous data generation, both in terms of project size and conformation to statistical principles. The project, with the relatively modest budget, was an exploration of some ideas regarding site location using the known archaeological data. Second, shovel testing is acknowledged as a Ahit or miss@ survey technique. A positive result indicates that a site is present but negative results do not indicate the lack of a site. Given the small surface area and small volume of subsurface materials tested in shovel testing, even on a close grid interval, every chance for positive results needed to be taken if new sites were to be located in the preliminary test.

The Mn/DOT perspective, however, was additional data from only high probability areas would not make a strong contribution to the already strongly biased northeastern Minnesota archaeological database. To improve the reliability of models in this region, data from all kinds of environmental situations will be required. To this end, randomly generated Apoint@ locations were provided by Mn/DOT as the sole universe for field testing. The objective of providing a preliminary test of variable usefulness in predicting new sites was rejected in favor of generating data on a variety of areas.

The points were to be assessed by the statistical equation for probability to match the known archaeological sites. The points were then divided by probability values into five categories ranging from high to low. Testing was to include a sample of points from all five categories in order to avoid survey bias by focusing on the highest probabilities. Initially 1/3 of the points were suggested to be in each of high, medium, and low probability locations. A split among the five categories was reached in consultation with Mn/DOT; although more points were allowed in the higher categories, only a few of the highest probability points could be included. These two items, testing of random points only and inclusion of points of all categories, were made a condition of the project award. Several problems originated from this stricture.

This methodology was contrary to the original objective, preliminary exploration of selected environmental variables. Only by providing the greatest chance of locating previously unknown sites can it be determined if the model is working. Restricting testing to only random locations was an attempt to provide a statistical test of the variables, effectively attempting to create a Amini Mn/Model@. Mn/DOT personnel felt this approach was necessary to reduce the already strong bias of the archaeological data in this region. In addition, from the perspective of Mn/Model both site and non-site data are equally important.

However, by testing randomly selected locations, even those with high model values, the chance of locating new sites is greatly reduced. The testing universe is drastically reduced and an effective test of the variables is impossible. Not enough points with a very high probability are present in a finite universe composed of randomly generated points to provide a reasonable chance of locating small, relatively rare sites. With shovel testing as the proposed (and only viable) field method, the chances of finding any cultural materials was greatly reduced.

Spreading survey over all categories of probability, rather than focusing on the highest probability, further reduces the already low probability of locating archaeological sites to practically none. Mn/DOT personnel were concerned that by restricting survey to only high probability areas, the Amodel will be a self-fulfilling prophecy@ when sites are found only in those areas. However, this view ignores the rare nature of early sites and the difficulty of locating small sites by shovel testing. If no sites are located when testing is diffused by looking at lower probability locations, then there are no conclusions about the model that can be reached.

However, as stated above, for Mn/Model information about where sites are not located (non-site data) is as important as information about where sites are located (site data). The testing design imposed by Mn/DOT personnel did ensure that some of this information was generated in the project. When no sites are located, the surveyed areas become non-sites. The greater the variety of non-sites, the lower the degree of bias in the archaeological database. As this bias is reduced, predictive models developed from the database can be considered more reliable. Mn/DOT personnel, therefore, effectively changed the testing portion of the project (Task II) from a preliminary test designed to see if the environmental variables worked under ideal conditions to one that generated non-site data for increasing reliability of Mn/Model. These two approaches have great consequences for interpretation of the survey results.

As shown below, the 50 point locations in the proposal were uniformly negative in survey results. Additional problems with the project methodology became evident during Task I and are discussed more fully in the conclusions. Aspects such as coarseness of computer coverage data, lack of known archaeological site data from many areas of the counties, and changes in land use over time contributed to the negative findings. The explicit focus on random sampling for field testing provided data that will improve confidence in future models of this region. In this sense, as well as the increase in known sites, Mn/Model will benefit from this project.

However, a randomly generated sample for field testing without revision of the project objectives (and budget) provided constraints on the project that did not test the selected environmental variables for usefulness in predicting new site locations. A full test of the variables with a large number of surveyed areas and a statistically valid sampling design was outside the scope (particularly the budget) of the project. Instead, an initial test of selected locations within the project area was envisioned; such a test would not prove that the model worked (as it could be a self-fulfilling prophecy) but if sites were located it would suggest that the model should be tested further. Locations were to be selected based on the environmental variables from the logistic regression model. Instead of points (30 m grids) larger areas would be selected where all variables coincide. Areas of lower probability would be in or adjacent to the highest probability areas, thus including different probabilities within the survey.

Such a selection process would have provided the first test of whether the selected variables were useful in prediction of sites. If no new sites were found from survey of the highest probability areas, then the case could be made that the model was seriously flawed. Either the known sites were too clustered to predict sites in the rest of the project area or the variables chosen were not correct because the data were insufficient or the statistics were inappropriate. However, given the testing methodology that was imposed no conclusions about the model of environmental variables can be made. Such evaluation must wait for further testing.

TASK 1 RESULTS

DATA GATHERING

Archaeological Data

Several sources of archaeological information were reviewed for this project. The collections at the U.S.D.A. Forest Service (Superior National Forest) formed one primary source. The collections of the UMD Archaeometry Laboratory, although focused primarily on the Reservoir Lakes, have numerous examples of early sites. The Photograph Files of avocational collections yielded additional site locations. Finally, the collections at the Anthropology Department at the University of Minnesota and the SHPO site files were also included. The SHPO files, however, largely duplicate the other sources.

Data on known archaeological sites within the three county area were first reviewed for the presence of diagnostic artifacts. Paleoindian and Early/Middle Archaic projectile point types were usually recorded in site files. In addition, several other artifact classes were considered diagnostic as well. Trihedral adzes are identified as Paleoindian/Archaic in neighboring areas of Ontario. Large knives of Knife Lake siltstone are also considered diagnostic of this period. Finally, knives with parallel or collateral flaking are also considered early.

Information on diagnostic artifacts was verified by physically inspecting the site collections. The Superior National Forest and Archaeometry Laboratory collections are curated at the UMD Archaeometry Laboratory. Not only were the diagnostics verified, all sites in these two collections were reviewed for unrecorded diagnostic artifacts. The Photographic Files were compiled from physical inspection of collections in Duluth and forms an inventory of formal tools. The collections in Minneapolis (UM Anthropology and the Minnesota Historical Society) were reviewed by appointment.

In addition to diagnostics, data on lithic material types were also gathered. Patterns of lithic types differ between major traditions in northeastern Minnesota (S.L. Mulholland in prep.). If stringent specific criteria for artifact frequencies and material type were met, then assignment to a cultural period can be done. This method was applied primarily to the Superior National Forest and Archaeometry Laboratory collections.

A total of 108 sites were identified that appear to represent Paleoindian and Early/Middle Archaic traditions in northeastern Minnesota (Figure 2). Sites with diagnostic artifacts were assigned a confidence level of 1 while sites with only lithic debitage data were assigned a level of 2 (Appendix A). Note that large Knife Lake siltstone knives were not considered diagnostic if occurring on a site with Woodland diagnostics. Such a site was included only if other Paleoindian or Archaic diagnostics were present.

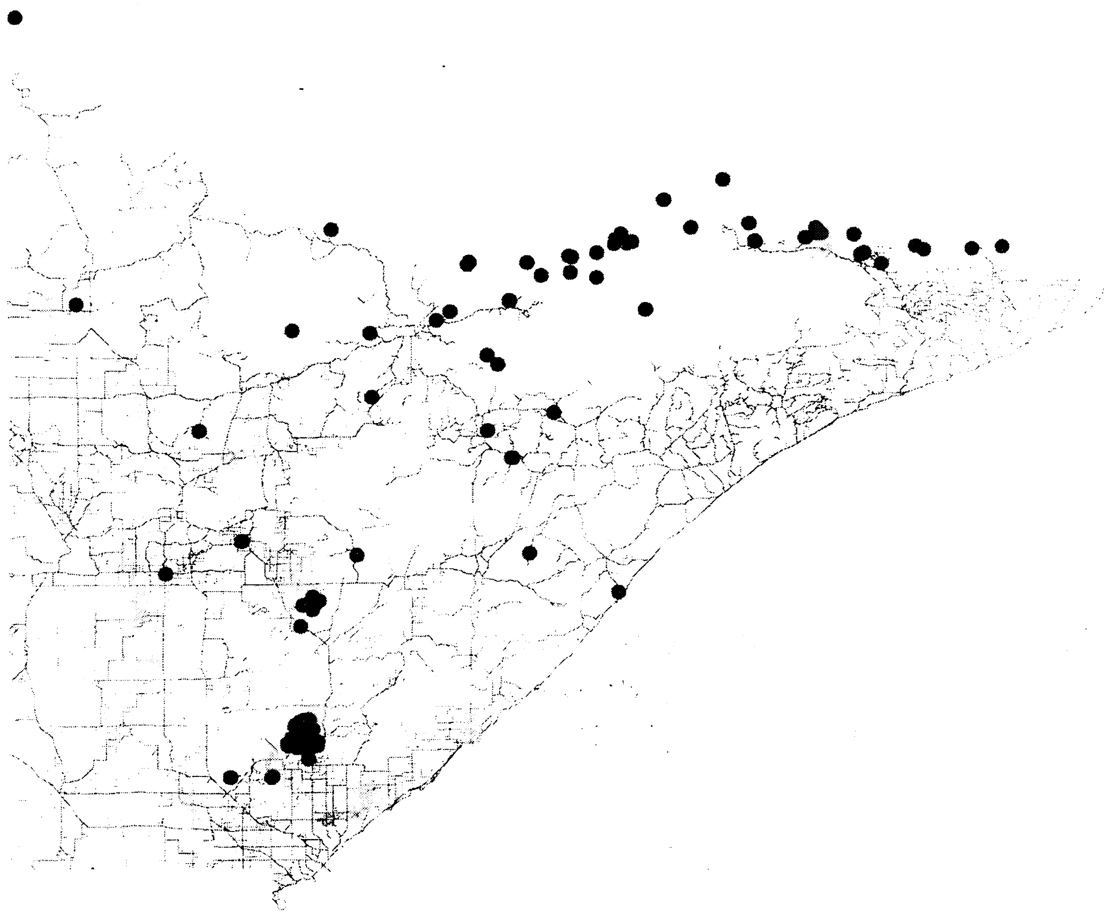

Figure 2. Known Archaeological Sites.

Once the sites were selected, location data were recorded. [Environmental data on elevation, slope, aspect, and distance to water were also recorded but not used as a result of the inconsistent amount of information recorded between sites.] Universal Transverse Mercator (UTM) coordinates were recorded in NAD27 to be consistent with SHPO database standards. Coordinates from site records were verified by checking against the original site maps. Locations as shown on the maps were entered into Terrain Navigator/MapTech and the UTM coordinates recorded. The data for the 108 sites were then delivered to the computer technician for data entry.

Environmental Data

Project personnel considered approximately 70 environmental variables (Appendix B) as having some potential for being significant factors in the location of archaeological resources. This list was generated from Mn/Model information supplied by Mn/DOT personnel. It was reduced in discussions with the senior project personnel; variable definition and derivation procedures were refined in discussions with Mn/DOT personnel.

This project was not funded to undertake any research to determine specific environmental parameters necessary for accurate description of the environmental context of the sites selected. All the environmental data came from current state GIS databases (many supplied by Mn/DOT from Mn/Model) except the pollen variables. Data from Archaeometry Laboratory palynological projects was reviewed and the coniferous/deciduous ratio used as a surrogate for the forest cover. Two early time periods were included as well as the average of the two (see below for details). In general, cores in the northwest part of the region were coniferous and those in the southeast, nearer Lake Superior, were mixed forest.

The environmental variables selected for testing are a mixture of data from state databases or coverages and derived variables. Given below is a brief description, source, and, for derived variables, the method. Metadata are available from the Minnesota Department of Natural Resources (DNR) >Data Deli= for variables downloaded from that source.

- *Drainage* is from a coverage called Soil_Cat that was supplied by Mn/DOT personnel.

- 16 variables are from a coverage called >Landform= that was supplied by Mn/DOT personnel. The data are from the UMD Geology Department and DNR as amended for Mn/Model. Much data were missing for northeastern Minnesota in this coverage so all variables were deleted that contained only >NO_DIST= (not distinguished) or >NODATA.= Five were used: *geoassoc, geodesc*, *seddesc*, *geomreg1*, and *landscape5*.

-*Distance to Lake* comes from a United States Geological Survey (USGS) coverage called >dlglkpy2' which is a lake and wetland polygon shapefile. This was changed into a polyline coverage, the lakeshores on the reservoir lakes were redrawn to conform to pre-reservoir levels, and a >nearest feature= function done to obtain the distance, in meters, from the nearest lake for each site (see *in water* below). Note that this coverage is at 1:100,000 scale. This provides lake data that are consistently complete at a minimum feature size of approximately 5 acres; mapping to the 2 acres level is present in some areas.

- *Distance to Stream* is from USGS coverage >dlgstln2,= DLG Streams. A simple >nearest feature= function gave us that distance. The variable *Flow* is from the same coverage and is the coded flow of the nearest stream. This coverage is also at the 1:100,000 scale.

- *Distance to Water* is derived by simply telling Excel to choose the lesser of *Distance to Lake* and *Distance to Stream*.

- *Slope*, *Aspect*, *Weighted*, *VIS 5000* all were derived from USGS 30 m Digital Elevation Models (DEMs). It is important to remember that the elevation figures represent the average elevation of a 30 m square and in those cases where the point is within a square, may not represent the actual elevation of a particular point. Thus, in reference to elevation, >point= means the 30 m square containing that point.

Slope was derived directly by using the >surface function of ArcView. The program uses the eight 30 m squares adjacent to that one in which a point lies and computes the angle in degrees of the vertical rise between the highest and lowest.

Aspect measures the azimuth of the slope, i.e., the direction that water would run across the square in which the point is located as measured from true north. Since aspect is unidirectional, there will be large differences in value for aspects near north but in opposite directions.

Weighted is a derived variable that corrects for the unidirectional nature of aspect. The working assumption was that people would prefer a south-facing slope, an assumption more or less borne out by the aspects derived for known sites. The actual direction in degrees from 0 to 180 was used, then counted down from 180 to 0 clockwise from 180. Thus 90 and 270 each has a value of 90, 30 and 330 each has a value of 30, and so on.

VIS 5000 was designed as a measure of >vista,= i.e., the view an observer has from the square in which he is standing. A 5000 m circle (buffer) was placed around each of the points, assumed a viewpoint of 1.5 m above terrain, and calculated the number of 30 m squares which could be seen from the square in which the point was located. The calculation was performed using the >viewshed= subprogram from the >surface= menu of Arcview. The program accounts for elevation barriers but does not consider barriers resulting from vegetation. It was believed that vista was important to the people under study but the numbers didn=t bear that out. The average vista for the random points is 7483.60 and for the known sites 7128.96. In an effort to explain where our working hypothesis went wrong, the spatial distribution of the known sites was re-examined; none were overlooking Lake Superior while at least 32 random points did. In an effort to control for this only those random points within 10 k of a known site were considered. The results were very different. The average vista for the random points shrunk from 7483.60 to 5542.69. Although the data cannot be constrained that way, vista is considered an important variable if the >Lake Superior= factor can be controlled.

- *In Water*: We changed the >lakes and wetlands= theme to a poly line shapefile to allow us to measure the distance to water. The ArcView program, which cannot measure the distance to a polygon from outside that polygon, simply measures the distance to the nearest polyline. In essence it measures the distance to the nearest shoreline without stating whether that point is on the wet or dry side of the shoreline. The >lakes and wetlands= theme was rerun as a polygon shapefile and asked the computer database which points were inside the boundaries of the polygons. The result is the *In water* variable. When the coverage was built it was programmed to look at each minimum mapping unit (approximately two acres) that had shoreline. If 60% or more was in water, the entire square was deemed to be water; if less than 60% was in water, the entire square was deemed to be land. Thus it was possible for some lakeshore points to be deemed by ArcView to be in water. This variable was mostly for our own use and subsequently was not chosen for use in the final database.

- *Major Watershed* and *Province* come from a coverage called >Watershed Basins= (bas95ne3.pat), available from the Mn/DNR.

- *Core #*, *Core Name*, *8000BP*, *9500BP*, *Average* all come from a coverage built at the Archaeometry Laboratory from pollen data. Six cores were chosen where the data met reliability standards: Big Rice Lake, RLB-B2, August Lake, Gegoka Lake, Cloquet Lake, and East Bearskin Lake (Figure 3). *Core #* is 1 through 6 in the order above; *Core Name* is the names listed. The >nearest feature= subprogram in ArcView was used to attach the pollen core attributes to the individual points. *8000BP* and *9500BP* refer to the two strata within the core from which the data were extracted; the numbers in those columns are the conifer/deciduous ratios at those strata. Deciduous was defined as <0.5, mixed forest as 0.5 to 2.0, and coniferous as >2.0 (Table 1). Two lakes lacked material from 9500 BP. *Average* is derived from averaging the 8000BP and 9500BP ratios. It should be noted that this approach to reconstruction of late Pleistocene/early Holocene vegetation patterns is only preliminary and would benefit from additional data points. However, it is considered an improvement over the vegetation data from the late 1800s (Marschner 1974).

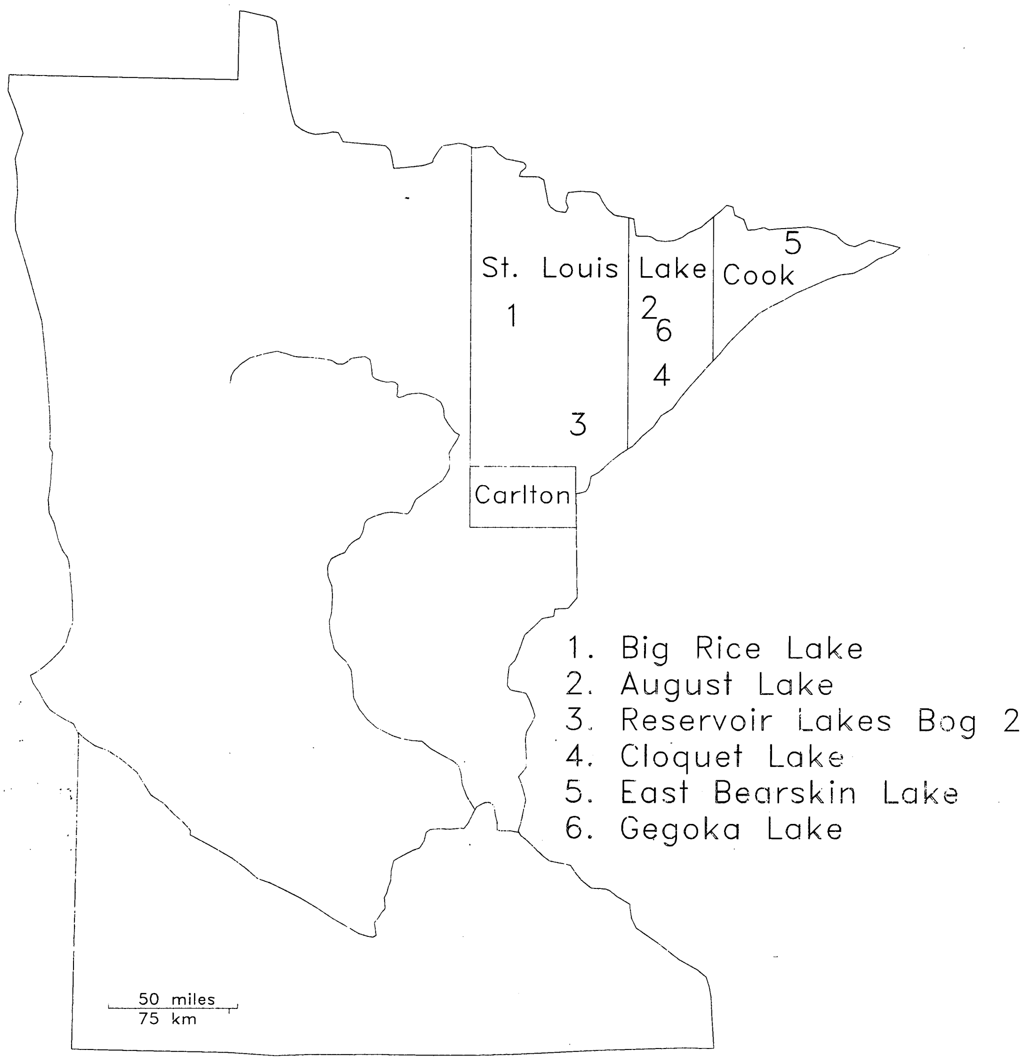

Figure 3. Location map of selected pollen sites in northeast Minnesota.

Table 1. Coniferous/Deciduous Ratios from Pollen Cores

Core	8000BP	9500 BP	Average
Big Rice	2.29	2.95	2.62
RLB-B2	0.87	0.67	0.77
August Lake	2.30	n/a	2.30
Gegoka Lake	1.56	3.55	2.55
Cloquet Lake	1.74	n/a	1/74
East Bearskin	1.68	1.48	1.58

In developing the following variables it was assumed that the people would prefer sites which were relatively flat and well drained, i.e., slightly above the surrounding land.

Elevation is taken from the 30 m DEM and represents the average elevation for the 30 m square in which the point is located.

- *Min90m* is the lowest elevation of all 30 m squares wholly or partly within a 90 m radios of a point.

- *Max90m* is the highest elevation derived as above.

- *Mean90m* is the average of all squares wholly or partly within a 90 m radius of a point.

- *ht abv min90m* is the height of a point above the square having the lowest elevation within 90 m of the point.

- *ht abv mean90m* is the height of a point above the average elevation of all squares wholly or partly within a 90 m radius of a point.

Databases

Two databases were built using ArcView GIS and Excel spreadsheets. On the first, site data from 108 known archaeological sites were entered. The fields included our assigned ID, site ID, county, map datum, X/Y coordinates (UTM), legal description, context, and setting. The second table consisted of a series of randomly generated points, each with its X/Y coordinates, computer generated ID, our assigned ID, and >randjack= group. Identical environmental variables were added to both tables.

The tables were imported into the ArcView project as event themes. Because the site database was in NAD27, the first step was to convert it to NAD83. This was done using a conversion tool available from the DNR >Data Deli.=

ANALYSIS OF DATA

Statistical Analyses

In consultation with Mn/DOT personnel and UMD statistics professor Ronald Regal, two multivariate statistical approaches were chosen for investigation: CART SPlus (a tree method) and logistic regression using SAS. Our data were submitted to N. Danz and T. Jones of UMD=s Natural

Resources Research Institute for processing. To determine the environmental variables common to the 108 known sites, a series of non-site points was needed for comparison. About 150 of the randomly generated points were selected randomly and used as non-site data. The procedures were run on 83 known sites and 125 random points; the remaining 50 locations were used in model validation.

CART SPlus was rejected following a preliminary analysis. It separated the points into four groups based on the environmental variables but there was only one point in the highest probability group. Logistic analysis proved to be a viable approach. Logistic regression is a multivariate statistics that can be used when predictor variables are either qualitative or quantitative. It is used to estimate the relationship among one or more independent (predictor) variables and a dependent variable. In logistic regression the relationship between the predictor and the predicted values is assumed to be nonlinear. The logistic regression analysis can be summarized as:

Site Selection: The original data files contained independent variables for 112 known sites and 656 random points. For the sake of data quality, four of the known sites and 103 of the random points were dropped from the analysis. Of the 661 locations used in the analysis, 108 known sites and 150 randomly selected random points were used for model building and model validation. The probability of a point having archaeological significance was assigned to each of the remaining 403 random points.

Independent Variable Selection: Summary statistics were computed for each independent variable to assess data quality. Variables that had a significant proportion of null values or that were not appropriate for logistic regression were eliminated from subsequent analysis. A variable named aspect2 was created, which consists of three categories (north-facing, south-facing, and no aspect) so that the continuous variable named aspect could be better used. The 19 variables that remained were: xcoord, ycoord, distance to water, slope, vis5000, pollenavg, elevation, min90m, max90m, mean90m, htabvmin90m, htabvmean90m, aspect2, flow, geoassoc, geodesc, seddesc, geomreg1, and landscape5.

Logistic Regression: A stepwise logistic regression was carried out using SAS. In the model building phase, 83 randomly selected known sites and 125 randomly selected random points were used (25 each of the known sites and random points were withheld for model validation). The stepwise procedure selected distance to water, flow, pollenavg, and height above mean 90m as significant variables. The model validation phase assessed whether the model correctly predicted whether each of 50 locations was a known site or a random point. At the 0.43 probability level, the model correctly classified 78% of the 50 locations (23 of

25 known sites; 16 of 25 random points). The 0.43 threshold was chosen as it was close to the 0.40 used in building the model (sites vs. non-sites were 40%:60%). The real probability is unknown but is probably much lower. A second method of assessing model performance is the area under the Receiver Operating Characteristic (ROC) curve. For this model, it is 0.894. Using this model classification success rate and other model diagnostics, the model was concluded to be adequate. The influence of spatial autocorrelation in the data was addressed by including the x and y coordinates in the set of explanatory variables. The prediction phase calculated the probability that each of the remaining 403 random points would have archaeological significance. Once additional random points were provided, the prediction phase was run to calculate probability values for those as well.

Similar results were produced by the two methods (Appendix C). The logistic regression analysis selected four variables as significant: distance to water, flow, pollenavg, and htabvmean90m (height above mean 90 m). The model validation stage classified 78% of the points correctly at the 0.43 probability level and was considered adequate. CART selected distance to water, flow, and distance to lake as significant variables. The overall misclassification rate was 17.9%. Two variables, distance to water and flow (category of stream flowage), were selected by both methods as significant.

Once the analysis of the known sites was completed (Appendix D), the data for the randomly generated points were processed excluding the points used as non-sites. Each point was assigned a probability of containing a site based on the associated environmental variables. Two probabilities were assigned, one each for logistic regression and CART. The logistic regression probabilities were continuous numbers but the CART probabilities were one of four discrete numbers: 0.9783, 0.6296, 0.1951, 0.0851. Since the probabilities were discrete and only one point was in the highest group, CART was considered not appropriate.

The 403 random points were divided into five categories based on logistic regression probability value. The categories were based on equal increments, 0.178, and contained different numbers of points. Note that the large number in category 5 is a result of many points having a probability of 0. In consultation with Mn/DOT personnel, a target amount of points for survey was set by category (Table 2).

TABLE 2. Probability Categories

Group	Range	# points	Target
1	0.89-0.70	13	15
2	0.70-0.53	35	15
3	0.53-0.35	115	10

4	0.35-0.17	71	5
5	0.17-0.00	220	5

Point Selection

The randomly generated points were sampled as the basis for field survey based on several factors. First, groupings of points were sought in order to maximize the survey time by minimizing the time to access points. Since there were many more points in the lower probability categories than the higher ones, more attention was paid to the points in the higher categories. Clusters were quite obvious in category 1 -3 with a more widespread distribution (as a result of greater numbers) in the lower categories. However, a mix of probabilities was required for the field testing so points in the lower categories near clusters defined on the higher categories were included. An effort was made to select clusters in all three counties.

Another major factor in selecting points for survey was land ownership. Points on public lands were preferred as it was considered easier to obtain permissions. Public agencies included the Superior National Forest, all three county Land Departments, the DNR (both Forestry and Parks divisions), and Mn/DOT. Corporate lands included Minnesota Power and Potlatch Corporation. Some private lands were included if the point was of a fairly high probability.

The initial year of the project focused on this process for one of the ten files of randomly generated points (a randjack). Field survey was carried out on approximately half of the 50 points targeted. The lack of results prompted a revision of the methodology. It was decided that more high probability points were needed if there was any chance of finding site material. The remaining nine randjacks were screened by Mn/DOT for location in wetlands and distance from roads. Points only 1 mile (1.5 km) or less from roads and outside wetlands were resubmitted for statistical analysis. These additional points were then used for selection of the remaining points for survey. A total of 50 points were tested, 23 in the first season and 27 in the second (Appendix E). The points include a mixture of probability for sites and are located in all three counties.

After points were selected, application for permissions and licenses was made (Appendix F). All points required a State Archaeology license since State funding was involved. A multiple project license was obtained for each year of the project. An Archaeological Resource Protection Act (ARPA) permit was required for Superior National Forest lands; one license was issued for the project duration. Permission from all land owners was obtained as well; denial of permission was cause for rejection of a point. Finally, the field supervisor made the final decision as to which points to survey. This decision was based on degree of access to any particular point. [Probability data were not supplied to the field crew.]

TASK 2 RESULTS

METHODS

Points were located in the field using a hand-held Global Positioning System (GPS) unit to find the UTM coordinates. Plotting the coordinates on USGS topographic maps gave an indication of location and access. However, specific location was done with the GPS. Each point in reality represents a 30x30 meter area. Once the point was reached in the field, the ground conditions were reviewed. Some points could not be reached as a result of extensive saturated ground not indicated on the map. Others were in developed areas with obviously disturbed ground around the center point. Several alternative placements of shovel tests were utilized in these situations (Figure 4).

Ideally, a grid of 16 shovel tests on a 10 m interval was placed around the center point (Ideal Grid). This grid of 4x4 tests covers an area of 30x30 m, a size comparable to some of the coverages. If the ground was suitable, this arrangement of shovel tests was the preferred option.

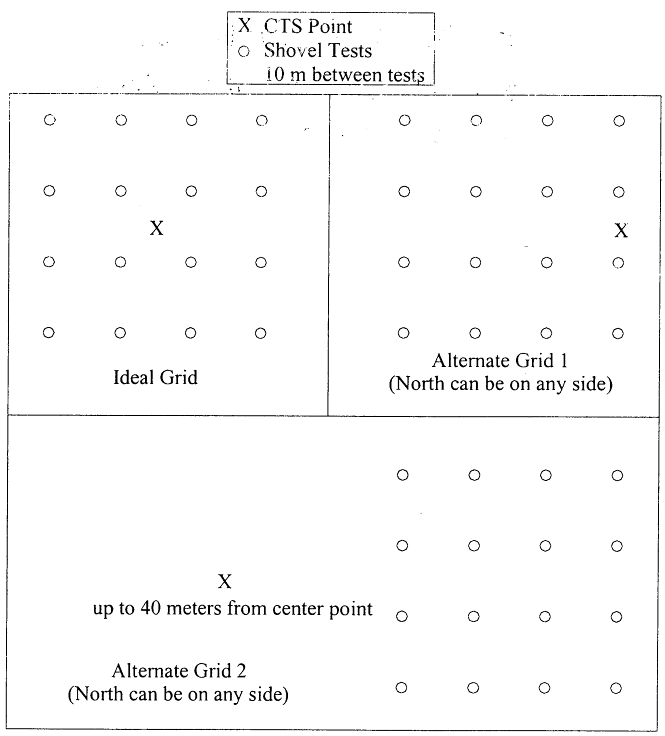

Figure 4. Potential arrangements of shovel test grid.

In many cases, saturated or disturbed ground precluded testing in the immediate vicinity of the point. The crew supervisor had the option of shifting the survey area up to 30 m in any direction to find better ground. Alternative Grid 1 shows the shovel test placement when the ground was unsuitable for testing to one side of the center point but suitable in another direction. The grid is shifted only 15 m in this direction (relative to the Ideal Grid). In some cases, unsuitable ground was more extensive. Alternative Grid 2 shows the center of the grid shifted up to 30 m from the center point. Placement of the grid was dependent on the ground conditions; in some cases, not all 16 shovel tests were placed. Effort was made to obtain the maximum number of shovel tests for each point.

Data on the number and placement of test holes, sediments, vegetation, and topography were recorded in field notebooks. All sediment was screened through 1/4 inch mesh and replaced in the test holes. All points were located on USGS topographic maps, both 1:100,000 (Appendix G, Figures 1-8) and 1:24,000 (Appendix G, Figures 9-44). Shovel test forms for all tests were completed in the office (Appendix H).

POINT DESCRIPTIONS

1) Point 16 St. Louis County (Appendix G, Figure 9). This point is located on gently sloping terrain with a wetland to the west and north, a clear cut on slightly higher ground to the east, and a gentle slope rising to higher ground to the south. The center point was located in a testable location and 16 test holes were placed around it. All shovel tests were negative. Vegetation was predominantly aspen with some birch, fir and white spruce. No pines were located in the test grid but were present on the higher ground to the south. The test area sediments were primarily silty sand to sands with pea sized gravel. Larger rocks were present but not common. Occasional clayey sediments were encountered but were not as ubiquitous as the sands. Sediment colors varied from shades of brown to dark brown in the >A= horizon to yellow and gray browns below. No water resources were visible from any point on the test grid. The aspect of the test area=s slope is to the southwest.

2) Point 382 St. Louis County (Appendix G, Figure 10). This point is located on very gently sloping terrain with wetlands to the east and north, and higher ground to the west and south. The center point was located in a testable location and 16 holes were placed in a grid around it. All shovel tests were negative. Vegetation was dominated by mature aspen with small firs as the primary understory component. Occasional red or white pines were observed in or near the examination area. The test area sediments were dominated by sands with very little silt or clay content. Silts were primarily restricted to the >A= horizon while some clays were observed in the deeper deposits. Very little gravel or rock was encountered until the deeper deposits were reached. Sediment colors in the >A=

horizon varied from shades of brown to dark brown. The dominant colorations of the lower sediments were yellow and gray brown variations. No open water was observed from any point in the test area. However, wetlands were clearly visible from the northern and eastern edges of the parcel. The eastern wetland may in part be the result of flowage interruption by the railroad grade located slightly to the east. The aspect of the test area slope is to the northeast.

3) Point 381 St. Louis County (Appendix G, Figure 10). This point is located in a wetland environment. The area is an alder and sphagnum moss wetland with interspersed small openings containing sedges and reeds. Occasional small stands and single trees of black spruce and black ash were observed in the area of the center point. Attempts were made to identify testable terrain within the parameters of the research design. No testable area was identified within these parameters In any direction the closest testable area was over 100 m away. No testing was conducted at this location. Sediments observed in root throws were black to very dark gray brown when dried and were mostly organic silts. These were shallow and over-lay a bouldery deposit.

4) Point 344 St. Louis County (Appendix G, Figure 11). This point is located on gently sloping terrain with a large wetland to the west. Similar sloping terrain is located to the east, south and north. The aspect of the slope is to the west northwest. This test area is located in the Toimi Drumlin Field and is characterized by the southwest to northeast drumlins with large wetlands interspersed between the rises. The center point for this examination area was located on the edge of the wetland and was shifted 15 m to the east in order to be able to place the full 16 hole test grid. The center point was originally in a low sphagnum moss boulder field that became increasing wetter as one progressed west. By moving the grid 15 m to the east and using that point as the northwest corner of the test area all 16 holes could be dug on testable ground. All test holes were negative. Vegetation was split between an open aspen woodland with grassy areas in the north to a denser aspen and fir tree cover in the south. In addition the southern portion of the test area had numerous blow-downs, primarily of old, dead firs. No pines were observed in the test area. The test area sediments varied from sandy to occasional clayey silts in the >A= horizon. Rock and gravel content was generally very high in all sediment horizons. Below the >A= horizon the sediments became more sandy with decreasing silt and clay content. Sediment color in the >A= horizon varied from brown to dark brown shades. Below the >A= horizon the variation of sediment coloration increased from brown and gray browns to red brown shades. No water resources other that the wetland to the west were visible from any point in the test area.

5) Point 360 St. Louis County (Appendix G, Figure 12). This point is located on very gently sloping terrain, even though the US Geological Survey map shows it as appearing to have more relief than

what was observed. The center point of this test area was not attained due to increasingly wetter lowland conditions. This again contrasts with what was shown on the US Geological Survey map which indicates an area that should be dry. The attempt to reach the center point stopped approximately 35 m south and 25 m east of its location. This area was already extremely wet and untestable and had been for over 75 m. The terrain and surface conditions present at the stopping location was a boulder field in an alder, tamarack and black spruce stand. Much of the area was covered with sphagnum moss. Soils that could be observed from root throws indicated that they were shallow, 10 to 15 cm thick, over a boulder base. Sediment appeared to be a grayish white silt when dry to black when saturated. The aspect of the probable test area would be to the northwest. No testing was conducted because no suitable test area was identified within 50 m of the stopping point. Higher ground with white and red pines were visible to the east and south but these areas were well outside the parameters of this examination. Many of these white pine areas were crossed attempting to reach the examination area. They frequently formed points of land extending out into the wetland to the west, excellent locations for possible archaeological sites. Standing water was observed in low spots near the test area. These wetlands are associated with Berry Creek.

6) Point 378 St. Louis County (Appendix G, Figure 13). This point is located on very gently sloping terrain with wetlands to the north and east. It has a slope aspect to the east northeast. The center point is located near an abandoned farmstead at the railroad stop of Shaw, Minnesota. The westernmost tests in the grid were in an old hay field of the farmstead. The test location was primarily in a white spruce and fir stand, except those on the western edge as noted above. No pines were observed in the test area. A total of 16 test holes were placed in the examination area. All tests were negative for pre-Contact archaeological materials. However, at least two of the test holes encountered buried modern debris from the farmstead. Sediments in the test area were primarily sands with varying amounts of silt and gravel. The >A= horizon deposits can generally be characterized as silty sands ranging in color between brown and dark brown. The lower sediments were primarily sands with small amounts of clay and silt noted at some test locations. Lower sediment color variations ranged from brown and gray brown shades to yellow and red browns. No open water was visible from the examination area, but a large wetland attached to Bug Creek formed the western boundary of the parcel.

7) Point 640 Lake County (Appendix G, Figure 13). This point is located in a wetland. The only high ground within 100 m of the center point is in a cedar stand. It is only marginally higher and consists of a hummock covered surface with sphagnum moss covered rocks. If any slope aspect can be ascertained it is probably to the east northeast. The center point for this test area is a boulder and rock area in an alder wetland. All attempts to relocate the test area within the project parameters

encountered only marginally better terrain, none of which was testable. No test holes were placed at this location. Most of the area west of the center point, including large tracts of the lower hummock areas, had been clear cut. Most of this area had subsequently been root-raked, exhibiting extensive surface disturbance. Vegetation at the center point was mostly alder with cedar stands to the south and north. Sediment observed in root throws was a shallow organic silt, usually black in color when saturated. No water related resource, other than the wetland, was observed from this test location.

8) Point 637 Lake County (Appendix G, Figure 13). This point is located on a slightly sloping terrain that forms a small point of land that overlooks a wetlands to the east and south. Most of the slope for the test area occurs in the northern and western portions. The southern part of this point is on two different elevations, with the lower portion not tested as part of this examination. This lower area was outside of the parameters of the investigation and may actually be a better location for testing than the upper portion. An old railroad related logging road bordered the test area on the west side. This road now functions as a snowmobile trail. The aspect of the slope for this examination parcel is to the south southeast. The rise on which the testing was conducted is about 1.5 to 3 m above the adjacent wetlands to the east. The actual center point was located near this edge of the rise. It was shifted approximately 20 m west in order to able to place the full 16 hole grid in the examination area. A total of 16 test holes were placed in the examination area. One possible cultural artifact was identified, a piece of quartzite-like debitage, was recovered from test hole 4. Upon closer examination in the lab this item was determined to be natural in origin. Therefore, all test results from this location were negative. Vegetation in the test area was dominated by mature aspen and large firs. The understory was open with occasional small firs and hazel clumps. Sediments for both the upper and lower deposits in the test area were primarily silty sands with varying amounts of gravel. Gravel and rock content was highest on the western edge of the examination area. This may in part be due to overburden from the excavation of the railroad grade. Numerous pieces of blast rock also littered this area. Sediment coloration of the >A= horizon varied from brown to dark brown. Below the >A= horizon the sediment coloration ranged from brown to tan-brown and shades of red and yellow brown. The only water related resources in the immediate vicinity of the test parcel is the wetland associated with the head-waters of West Split Rock River.

9) Point 377 St. Louis County (Appendix G, Figure 14). This point is located on the edge of a clear-cut. The clear-cut exhibited extensive evidence of surface disturbance as a result of land preparation processes for aspen regeneration. The test grid was moved 20 m east into a wooded area that had not been cut. The area was gently sloping with an aspect toward the southeast. An extensive

wetland was located to the northeast and east of the test area. A total of 15 shovel tests were placed in this examination area. One hole location on the northeastern corner of the test grid was in a wetland area that was not testable. All test holes were negative. Vegetation in the examination parcel was primarily aspen with an occasional white pine. The wetland area was dominated by tamarack to the east and alder and black ash to the northeast. Much of the surface area of the test parcel had scattered large boulders and numerous depressions from past root throws. Sediments in the area were mostly sands to silty sands with varying amounts of gravel and rock. Frequent large rocks were encountered in the test holes, often terminating the test. Sediment coloration in the >A= horizon was mostly shades of dark brown with occasional lighter brown encountered. Below the >A= horizon sediment coloration varied from shades of yellow and red brown to light browns, some with gray hues. Other than the wetlands to the east and northeast of the examination parcel no additional water resources were observed near the test area.

10) Point 375 St. Louis County (Appendix G, Figure 15). The center point for this test location was in a deflated, rocky alder wetland that appeared to be part of drainage route for an area to the north or south. The test grid was moved approximately 30 m to the east to a higher location on more testable ground. The terrain of this higher ground was slightly sloping with an aspect toward the south southwest. This rise was fairly small and only 12 of the 16 test holes could be placed on it. The remaining four holes, along the northern transect, fell into a wetland area. All test holes conducted at this location were negative. Vegetation at the test location was dominated by birch and fir with a fairly open understory of hazel. The adjacent wetland areas were predominantly alder with open areas containing sedges. No pines were observed in or near the test area. Sediments within the examination area were primarily sands with occasional silty sands observed in the >A= horizon. Gravel and rock content varied in size and volume with at least one test hole recording gravel amounts comprising approximately 25% of the sediment matrix. Most gravels were pea sized and rocks generally small in size. Sediment coloration of the >A= horizon was brown to dark brown. Below the >A= horizon the sediment color varied from tan brown to shades of red, orange and yellow browns. Other than the wetland adjacent to the test locality no other water resources were observed from the examination parcel.

11) Point 650 Lake County (Appendix G, Figure 16). The center point for this examination parcel is located in a tamarack and black spruce wetland. The investigating personnel were able to reach with 50 m of the center point before surface condition became too wet and dangerous to continue. The ground surface, at the point of termination, had switched from a wooded wetland covered with a dense mat of sphagnum moss to open areas with pools of standing water. The US Geological Survey map shows this area as high ground and is obviously in error. No high ground was observed

within at least 150 m of the center point. Therefore, the center point could not be relocated to a more testable higher location. However, this high ground is a well pronounced rise that warrants future consideration for testing. Vegetation at the center point and in the general area was primarily tamarack, black spruce, and alder, with some black ash. Most of the area has an open understory with a deep sphagnum moss ground cover. No soils data are available but based on the entry route the sediments are most likely shallow and organic over a boulder to cobble base. The test area is in a wetland with no discernable flowing water.

12) Point 34 Lake County (Appendix G, Figure 16). The center point for this testing area was located in standing water. The closest high ground was approximately 70 to 80 m west of the center point, beyond the parameters of the project that allow movement of the test grid. The vegetation at the center point was wetland grasses and reeds with cedar, alder, black spruce and tamarack present on the periphery of the area. No soils data were available from the immediate center point area. However, sediments on a high ridge that formed a finger-like projection into the wetland show a very rocky and bouldery sandy silt with the possibility of heavily fractured bedrock. This ridge was not tested and may be worth examination in the future. The only water resource present was the pond, formed by a beaver dam, in which the center point was located. No other flowing water was within sight of the examination area.

13) Point 636 Lake County (Appendix G, Figure 17). This center point is located on the east bank of Big Thirtynine Creek. The ground conditions at that locality are lowlands dominated by alder. In order to conduct a testing program at this locality, the examination grid was moved approximately 40 m to the west to a low terrace on the west side of the creek. The terrain of the terrace is nearly flat and it is approximately 0.5 m above the wetlands to the east. The aspect of the slope, which is very minimal, is to the east. Access to this locality was via Forest Highway 11 which is not shown on the location map. A total of 15 shovel tests were placed at the relocated examination area. A possible piece of lithic debitage was recovered from test hole 3 but was determined to be of natural origins upon later examination. All test holes were negative. Test hole 16 could not be placed because it fell into an alder wetland on the western periphery of the examination grid. Vegetation in the examination area was aspen, white pine, spruce and fir with a dense understory of hazel on the dry ground and alder in the wetlands. Sediments in the test area consisted of primarily sands with some silts primarily in the >A= horizon. Rock and gravel content was extensive, at times approaching 30% or more of the sediment matrix. Most of the gravel was pea sized but pockets of larger sized pieces were encountered in some test holes. Rock content varied between holes with larger rocks numerous. Sediment color was primarily a dark brown in

the >A= horizon with brown and red browns shades below. Big Thirtynine Creek flows past this test location approximately 25 to 30 m to the east.

14) <u>Point 353</u> St. Louis County (Appendix G, Figure 18). The center point of this locality was located on the edge of a slight knoll that rises up on a broad gently sloping plain. The center point was moved approximately 15 south southeast thus allowing a 16 test hole grid to be placed on the knoll. The terrain of the knoll is gently sloping with its long axis running north northeast by south southwest. To the east and west of the knoll is lower ground with numerous hummocks indicative of an upland wetland. The aspect of the plain on which the knoll is situated is to the south southwest. A total of 16 test holes were placed at this location. All shovel tests were negative; no cultural materials were identified. Vegetation on the knoll included white and red pine, spruce, aspen, fir and some birch with an understory dominated by hazel and small fir saplings. The vegetation on the lower terrain adjacent to the knoll was primarily aspen in the drier areas and alder in the lower, wetter locations. Sediments at the test locality were silty sands to sandy silts in the >A= horizon. Below the >A= horizon considerable variation between test holes was observed, ranging from sandy silts to sands and sandy clays. The coloration of the >A= horizon was generally brown to dark brown. The lower sediments were generally gray and yellow brown shades. These sediments often exhibited red brown staining indicative of a reducing environment from periodic episodes of saturation. No visible water resources were observed from this test locality.

15) <u>Point 634</u> Lake County (Appendix G, Figure 19). The center point of this locality was located in a cedar and black spruce wetland. Though the US Geological Survey shows this area as being very hilly the test locality is situated in a perched upland bog. In order to conduct testing the examination grid was moved approximately 40 m north onto slightly higher ground. The terrain at the new test locality is gently sloping with an aspect to the south southwest. If the area was devoid of trees and brush it would provide an excellent view of the Palisade Creek Valley. A total of 16 shovel test holes were placed at this examination locality. All test holes were negative. Vegetation at the test locality includes birch, black ash, maple, cedar and fir. Very little understory was observed and consisted primarily of scattered hazel clumps, small fir and maple saplings. The sediments in the test area were very rocky and gravelly with a sand to sandy silt matrix in both the >A= and lower soil horizons. Numerous large rocks were observed on the surface of the test area. Gravel and rock content was extensive with the volume at times approaching 33% of the sediment matrix. Sediment coloration was usually brown to dark brown in the >A= horizon, varying to shades of yellow and red brown deeper in the soil column. No water resources, other than the perched bog, were present in the immediate area of the test locality. However, this location does overlook the valley of Palisade Creek, which flows into Lake Superior.

16) Point 616 Lake County (Appendix G, Figure 20). The center point of this locality is located in an extensive wetland. It was not possible to actually get to the general area of the center point. However, observations of the area from a nearby road allowed for a determination that it was not testable. The terrain of the test locality was flat with discernable high ground within 100 m of the locality. The US Geological map for this location shows a small island of supposed high ground just north to northeast of the center point. However, the vegetation on the higher ground was the same as that at the center point locality. The vegetation at the center point locality is tamarack, black spruce and what appeared to be alder as the understory. This vegetation regime is indicative of wetland conditions. The only possible high ground in the vicinity of the center point occurs approximately one-tenth mile to the north northeast. No shovel testing occurred at this locality. No sediment information was available but heavy organic soils should be expected. No flowing water resources were observed near the testing locality but it is located within a very extensive wetland.

17) Point 434 St. Louis County (Appendix G, Figure 21). The center point at this locality is on a moderate slope with a southwest aspect. The terrain of the area is forested with steep to moderately rolling hills. Much of the area to the north of the test locality has been clear-cut with some moderate surface disturbances resulting from the use of heavy equipment. This test locality overlooks a wetland approximately 50 m to the south. Testing was possible around the original center point, no relocation was required. A total of 16 shovel tests were placed at this locality. All test were negative. Vegetation in the test area was dominated by oak and aspen with an understory of hazel and small fir saplings. No pines were observed in the immediate test area. Sediments were mostly a silt to silty sand in the >A= horizon. Below the >A= horizon the dominant sediment was sand but sandy clays and silty clays were also encountered. Gravel content varied from minimal to extensive and included small numbers of rocks, none very large. The color of the >A= horizon was primarily dark brown and frequently had a thin whitish gray deposit associated immediately below it. Lower sediment coloration varied considerably from tan and gray brown to shades of yellow, red and orange brown. Other than the wetland to the south no other water resources were observed in the vicinity of the test locality.

18) Point 15 Cook County (Appendix G, Figure 22). The center point of the examination locality was located approximately 50 m into Moore Lake. In order to conduct some examination of the shoreline at this locality the grid was moved to the lake shore on the north side of the road. The terrain at this locality varied considerably and can be best described as uneven with relatively flat areas to rolling hills with occasional steeper slopes. The surface of the area was strewn with boulders making it difficult to find places to shovel test. The northern half of the locality was

untestable because of slope and rock exposures. A total of 6 shovel tests were placed at this examination locality. All tests were negative. The vegetation was predominantly spruce with some red pine and small birch. Sediments were extremely rocky with very shallow soils. Test holes frequently ended after 20 to 30 cm. Soils were mostly a rocky sandy silt to sand. The >A= horizon sediments were brown to dark brown in color and the lower materials ranged between red and yellow brown shades. This location was on the north shore of Moore Lake.

19) Point 503 Cook County (Appendix G, Figure 23). The center point for this testing locality was located approximately on the southern shore of McDonald Lake. McDonald Lake is actually a wide spot on the Cascade River. This area is a wetland environment and may actually be a floating bog on the shore of the lake. The test locality was observed from nearby high ground because it was inaccessible and untestable. Higher and drier ground is located 150 to 200 m south but this is well beyond the parameters allowed for moving the test locality. The vegetation is dominated by alder and floating bog. The higher ground to the south has white pine and birch. It is also very rocky and may not be very testable. No soils information for this test locality was available. This locality is either in McDonald Lake or on wetland shoreline of the lake.

20) Point 502 Cook County (Appendix G, Figure 23). This testing locality is located north northeast of Dick Lake on the north side of Forest Road 170. The terrain is very gently sloping with an aspect to the south. A small intermittent stream or drainage occurs between the road and the testing locality. Most of the northern part of the test locality was untestable due to very rocky terrain. A total of 10 shovel tests were placed at this locality. All tests were negative. The vegetation at this locality was primarily birch, aspen and fir with an understory of hazel and small fir saplings. Vegetation on the lower ground to the south was primarily alder. No pines were observed at this testing locality. Sediments were silt to silty sands with varying amounts of gravel and rock. Generally the soils were very rocky. Sediments below the >A= horizon were mostly sands with some clayey components observed. Soil coloration was mostly brown to dark brown in the >A= horizon and brown to red brown shades below. The only water resource available in or near the testing locality was the intermittent stream, which may be more the result of the road construction than a natural water course.

21) Point 516 Cook County (Appendix G, Figure 22). The center point for this test locality is located in a flat wetland. The terrain has very minimal relief and no perceptible slope aspect. The center point is located on wet ground that is not testable. The field crew was able to get to within approximately 80 m of the center point before surface conditions became too tenuous to continue. No shovel testing was conducted at this locality. The vegetation is dominated by cedar and black

spruce with some alder as the main understory species. The high ground south of the center point is over 80 m away and was not testable because of blown down trees. Most of the ground surface on the high ground was covered by fallen trees, sometimes meters thick. No sediment data were available for this test locality but heavy organic soils should be expected.. No visible water resources other than the wetland in which the center point is located were visible in the test locality.

22) Point 401 St Louis County (Appendix G, Figure 24). This test locality is located near the northern shoreline of Fish Lake Reservoir. The center point is located on a small rise approximately 65 m north northeast of the reservoir. The terrain in this area consists of rolling flat topped hills and ridges with intermittent stream drainage between some of the hills. The aspect of the slope on which the center point is located is to the southwest. Below the test area is a gentle slope toward the reservoir. A total of 11 test holes were placed in the examination area. The northeastern and northern peripheries of the test area were not testable because of steep slope or disturbance resulting from road construction. All tests were negative. Vegetation at the test locality was primarily birch and fir with an understory of hazel and ferns. Scattered white and red pine occur in the vicinity of the test locality. The >A= horizon sediments were mostly gravelly and rocky silts to silty sands. Their color varied from brown and dark brown to a dark grayish brown. Below the =A= horizon the sediments were mostly rocky and gravelly sands and sandy silts that were shades of brown to yellow brown. Fish Lake Reservoir is adjacent to the test locality. No other water related resources were observed in the test locality area.

23) Point 137 St. Louis County (Appendix G, Figure 25). The center point for this test locality is located in a black spruce and tamarack wetland. The terrain is relatively flat with no visible relief within the vicinity of the test locality. No slope aspect was readily determinable for this locality. The survey crew was able to reach within approximately 70 m of the center point before being halted by unpassable surface conditions. Because the area was a wetland no shovel testing of this locality was conducted. The vegetation in the vicinity of the center point was predominantly tamarack and black spruce with some cedar. The understory had minimal vegetation with alder as the primary species. No sediment data were available but heavily organic soils should be expected. No water resources outside of the wetland were observed in the area of the test location.

24) Point 1807 Cook County (Appendix G, Figure 26). The center point for this test locality is located on the eastern end of the north shore of Devil Track Lake. It is located alongside one of the now abandoned runways of the old Grand Maoris-Devil Track Airport. This runway is now used as an access road for private dwellings in the area. The terrain is gently sloping with an aspect to the south southwest. Most of the area exhibits evidence of extensive surface modification, probably

the result of runway construction. Recent housing developments along the old airport shoreline have further impacted the integrity of the area=s sediments. No testing was conducted at this locality due to the extent of the ground disturbance observed. Vegetation is mostly young aspen and birch. Sediments observed in push pile and root throws are sandy with numerous rocks and high gravel content. Devil Track Lake is the primary water resource at this locality.

25) <u>Point 1838</u> Cook County (Appendix G, Figure 27). The center point for this test locality is located just north of Bally Creek and south of the Bally Creek road. The test locality has gently sloping terrain with a south facing aspect. The center point was located in low terrain in an alder stand. Movement of the test grid approximately 40 m north placed its northern edge on slightly higher, testable ground. This placed the test hole line approximately 1 to 2 m north of the small terrace-like edge that separated the higher and lower terrain. A total of 4 test holes were placed along this edge. All tests were negative. Vegetation in the lower terrain was predominantly alder. On the higher ground it was aspen, spruce and fir with a very dense understory of hazel and small fir trees. Sediments along the edge of the terrace were primarily silt to sandy silt in the >A= horizon. Below the >A= horizon silty sands were observed with some clayey sands. All soil horizons had large numbers of rock and up to 30% of the sediment matrix composed of gravel. Soil coloration varied from dark brown in the >A= horizon to grayish white and dark red browns in the lower deposits. Bally Creek formed the primary water resource for this test locality.

26)<u>Point 1821</u> Cook County (Appendix G, Figure 28). The center point for this locality is at the southeastern corner of the junction of Cook County routes 60 and 58. The locality is gently sloping with a large marshy area on its northern edge. This test locality has a south southeast aspect. Wetlands approximately 20 m south of the center point prevented moving the test locality to a better spot. The wetlands to the south are associated with an unnamed tributary to Woods Creek, while those to the north were most likely derived from drainage alterations resulting from road construction. A total of 8 shovel test holes were placed in the area between the wetlands. All tests were negative. Vegetation at the test locality was primarily aspen and birch with some fir for the over story and primarily hazel as the understory. In the wetlands the dominant vegetation was willow and alder. Sediments at the test locality were a sandy silt in the >A= horizon generally becoming rockier and sandier with depth. In at least two test holes clay was identified as part of the lower sediment matrix. The >A= horizon sediments were brown to dark brown in color with brown and red brown shades present in the lower soil levels. An unnamed tributary and associated wetlands were the closest water resources to the test locality.

27) Point 1848 Cook County (Appendix G, Figure 27). The center point of this test locality is located in a wetland with areas of pooled water. The terrain is nearly flat with no perceptible slope. If an aspect of the slope could be determined it would most likely be to the south. Comments on the field notes include that if this point scored above a 10% probability then the statistical analysis was worthless. It was later learned that this point rated a 56% probability. The survey crew was able to get within 75 m of the center point before conditions became too wet to continue. No testable ground was identified for more than 100 m from this stopping point. No tests were placed in this swamp locality. Vegetation was black spruce and alder. Sediments are most likely very organic silts and clays. The closest water resource other than the wetland in which the center point is located is Bally Creek approximately 0.5 miles to the south.

28) Point 1543 Lake County (Appendix G, Figure 29). This test locality is located along the sloping hillside of the Saw Tooth Mountain Range as it runs along the Lake Superior shoreline in Minnesota. The center point is on a steep, approximately 35 to 40 degree slope with a southeasterly aspect. The access road shown for this point does not exist. Access was provided by Mr. Fernstadt of Fernstadt=s Resort using his 4 wheel All Terrain Vehicle. The test locality is very rocky, with numerous large boulders strewn across its surface and was too steep to test. No test holes were placed at this location. Vegetation at the test locality consisted of aspen, fir, white and yellow birch, and occasional white pines. The sediments observed in a root throw were mostly reddish brown silty sands with some clay and numerous rocks. They appear to be very shallow, possibly only 15 to 20 cm, resting on top of bedrock or boulders. The primary water related resource for this location would be Lake Superior.

29) Point 1527 Lake County (Appendix G, Figure 30). This test locality is on gently sloping terrain with a westerly aspect. The center point is located in an old clear cut. The test area is located on the side of a large shallow knoll that overlooks wetlands to the west and south. A total of 13 shovel test holes were placed around the center point. Three of the four southernmost test holes were not dug because their placement would have required trying to dig in the saturated soils of a wetland. All test holes were negative. Vegetation in the test locality was primarily young aspen, approximately 10 to 15 years old. An occasional large white pine or spruce was left standing in the clear cut. Sediment of the >A= horizon was a dark brown silty sand that was very rocky and gravelly. Below the >A= horizon was a red brown sand with very little silt. The gravel content of the sediments below the >A= horizon varied from a significant portion of the matrix volume to being present in very minimal amounts. Very large rocks littered the surface of the test area and were encountered in the test holes. Other than the extensive wetland area to the west of the test locality no other water resources were observed in the immediate area.

30) Point 1512 Lake County (Appendix G, Figure 31). The center point for this test area is in a clear-cut on a gentle slope situated above a wetland to the south. The aspect of the slope is to the south southeast. Disturbance within the clear cut was minimal with no large areas of surface disruption. The examination area was testable and a total of 16 holes was placed in it. All test holes were negative. Vegetation was a mosaic of young aspen and fir trees, hazel, grasses, and a variety of other herbaceous plants. An occasional larger spruce was also present in the clear-cut. No pines were visible within the immediate area of the test locality. Sediments in the test area were primarily sandy silts to sands in the >A= horizon and gravelly sands below. The gravel and rock content varied from approximately 33% of the sediment matrix to a minimal presence. Sediment color in the >A= horizon was primarily shades of brown to dark brown. Below the >A= horizon the sediment coloration varied from shades of brown to red browns. Other than the wetland to the south, no other water resources were visible or present within the test locality.

31) Point 797 St. Louis County (Appendix G, Figure 32). The center point for this test locality is in a rolling, hilly terrain with a slope aspect to the southeast. The southernmost point of the test locality grid was located approximately 11 m north of a wetland. This wetland connects to Anchor Lake and may represent an eutrophied portion of the lake. A total of 16 shovel tests were placed within the area. All shovel tests were negative. Vegetation within the test area was aspen, spruce, fir and small numbers of birch. No pines were observed in or near the test locality. Sediments in the test locality were silts and sandy silts in the >A= horizon. Below that the sediments become increasingly more sandy except in the southern part of the test area where occasional clayey sands were encountered. Generally the sediments were gravelly with numerous rocks. Sediment coloration in the >A= horizon ranged from shades of brown to dark brown. Below the >A= horizon color variations of light brown with yellow and red browns were observed. The primary water resource near the project area is Anchor Lake and the wetland associated with it. From the shovel test location numerous higher points were observed jutting out into the lake and wetland. These appear to be high probability localities for pre-Contact occupation sites.

32) Point 755 St. Louis County (Appendix G, Figure 33). This center point is located in a wetland environment with very gentle to flat terrain. If any slope aspect is present it is to the south. The center point is near Shiver Creek and in wetlands associated with the stream. No shovel tests were placed at this examination locality. The area was too wet to shovel test with the closest testable terrain approximately 70 m to the north. This testable area is on a higher, terrace-like land formation with soils that look to be mostly gravelly sands. This testable area may have a reasonable probability of containing evidence for pre-Contact sites. Vegetation in the test locality was

tamarack, black spruce and alder. On the higher ground to the north, aspen dominated the tree cover. No sediment data for the test area were available but soils with a heavy organic component should be expected. The primary water resource in the area is Shiver Creek and the wetlands associated with the stream.

33) Point 852 St. Louis County (Appendix G, Figure 34). The center point for this test locality is located on very gently sloping terrain with an aspect to the north northeast. The US Geological Survey map indicates that the terrain is on dry ground with wetlands to the north and northeast. However, wetland conditions were encountered approximately 350 m south of the center point with no evidence to suggest any rise in the terrain beyond that point. The field notes indicate that the closest testable ground may be approximately one-quarter mile away from the center point, and it was only marginally testable. No testing was conducted at this examination locality. Vegetation at the test locality and immediate vicinity consisted of alder, willow, black spruce, and tamarack. Stunted aspen trees were present along the edge of the wetland. No sediment data for the examination locality were available but heavy organic soils should be expected. No water resources other than the wetland were observed in the test area.

34) Point 916 St. Louis County (Appendix G, Figure 35). The center point for this locality is located in an abandoned farm field. The terrain is relatively flat with a slope aspect to the north northeast. This field is currently too wet to farm. This suggests that the farm field was most likely a wetland that had been drained for agricultural purposes. The ground conditions in the field are best described as hummocky with lower wet areas between the small rises. One test hole was placed in the field and encountered the water table at less than 5 cm below the surface. The test locality was determined to be untestable and no other tests were dug. The one test hole that was dug was negative. Higher and drier ground was observed in the vicinity of the examination area but these turned out to be old fence lines and tree wind breaks. These areas probably accumulated wind blown sediments and were more resistant to wind and water erosion, thus allowing for them to remain higher than the surrounding fields. Vegetation at the examination locality was alder in small clumps, willow, sedges and reeds. In the adjacent field areas tamarack, black spruce and alder dominate. In the wind rows and fence lines the vegetation is mostly aspen with some birch. The sediment in the one test hole was very organic with at least a 6 cm duff, below which was a saturated, very dark brown organic rich clayey silt. No water resources other than the wetland was observed from the test locality.

35) Point 930 St Louis County (Appendix G, Figure 36). The center point for this test locality is located in a flat very gently sloping wood lot. The aspect to the slope, as best as can be determined,

would be to the northeast. The test locality surface condition was hummocky with numerous low areas that accumulated small pools of standing water. The water table was found to be within 15 cm of the surface. No point within 100 m of the center point was found to be testable, thus the grid could not be shifted. It was determined that this area was not testable and no shovel tests were placed in this examination area. Vegetation at this location consisted primarily of alder and black ash which are wetland species with some aspen which is wet ground tolerant. No pines were observed within the examination area. Sediments observed from root throws and an adjacent gravel pit indicate that the soils are very sandy with small, pea sized gravels. The soil coloration was shades of yellow brown. The gravel pit to the east of the examination locality was most likely a small rise that has since been removed leaving the eastern area heavily disturbed. No water resources other than the wetland was observed in the immediate area of the examination locality.

36) Point 965 St. Louis County (Appendix G, Figure 37). The center point for this examination locality is on a west bank terrace of the Whiteface River. This test locality was located in a low wetland area approximately 40 to 50 m north of the higher banks directly adjacent to the river. This terrain is flat to very gently sloping with a northern facing aspect. The grid was shifted approximately 50 m (slightly beyond the acceptable distance parameter to shift the grid) to the south in order to be able to place one line of four test holes. These four test holes were negative. They were at least 20 or more m from the river bank. The river bank is an area that would be an excellent location for future testing. Vegetation at the examination locality was black ash and alder. The surface was very irregular with numerous tussocks. Near the rivers edge in the area that was shovel tested the vegetation consisted of basswoods, white pine, and aspen. Sediments in the area shovel tested consisted primarily of a sandy silt in the >A= horizon, becoming sandier with depth. Sand particles increased from fine to medium size with depth. Soil coloration was brown in the >A= horizon, becoming lighter tan and yellow brown shades with depth. The Whiteface River is the primary water resource at this test locality.

37) Point 1023 St. Louis County (Appendix G, Figure 38). The center point for this test locality is on flat to very gently sloping terrain. If any slope aspect to the terrain can be determined it is most likely to the west. The surface of the test area and its immediate vicinity is very irregular and is low and wet with numerous depressions that are filled with water. No testable areas were identified within 100 m of the center point. Therefore, no shovel testing was conducted at this location. This is another example of where a US Geological Survey map indicates dry ground conditions where in actuality a wetland exists. It is possible that the railroad grade to the east of the test area has altered the ground water drainage patterns enough to create this wetland. Vegetation in and near the examination area consists primarily of black ash, alder, cedar and tamarack with a few aspen. No

pine were observed in or near the examination area. No soils data were available from either shovel tests or root throws. Based on sediment observation from the general area an organic rich soil of sandy silts and sands should be expected for this test locality. The closest water resource, other than the wetland, is the Little Whiteface River approximately one-half mile to the northeast.

38) Point 982 St. Louis County (Appendix G, Figure 37). The center point for this test locality is located on very gently sloping terrain. The examination area has a slope aspect to the northeast. The surface terrain is somewhat irregular with numerous root throws and disturbances resulting from past logging related activities. A wetland occurs on the northern periphery of the grid. A total of 15 shovel tests were placed at this location. The location of hole 16 was in a wetland area with pools of standing water in depressions and was not dug. All shovel tests were negative. The dry ground vegetation in the test area consisted of young aspen, approximately 10 to 15 years old, and small firs. Hazel and aspen saplings formed a dense understory. The wet area vegetation was primarily alder with some black ash. No pines were observed in the examination area but were present closer to the stream, east of the test location. Sediments in the test area were mostly silts with some sands in the >A= horizon. The silty soil continued below the >A= horizon but in general became sandier with depth on the south end of the examination grid. Sands were much less prevalent in the soils of the northern part of the grid. In this area the deeper sediments frequently contained clays forming a clayey silt. Sediment coloration in the >A= horizon was gray to gray brown. Below the >A= horizon was a grayish white zone followed by shades of yellow brown. The deeper yellow brown soils frequently exhibited lenses of reddish brown coloration indicative of reduction staining from periodic episodes of saturation. The only water resource visible from the test location was the wetland to the north. However, an intermittent stream channel that is a tributary to the Whiteface River is near the test locality. This area is slightly higher than the test locality and would be excellent area to examine for evidence of pre-Contact occupation.

39) Point 1126 St. Louis County (Appendix G, Figure 24). The center point at this examination locality is located on flat to very gently sloping terrain. Though the US Geological Survey maps shows the area as dry ground it is a wetland. The higher elevation to the north of the point could not be located during the field examination, or observed during access attempts from the reservoir side of the project. If any slope aspect can be determined for the examination area it would most likely be to the northeast. This test area is near the current shoreline of Fish Lake Reservoir. Water access to the test locality is not possible due to an extensive shoreline marsh and floating bog. Access was achieved overland and encountered wetland surface conditions at the examination locality. No testable high ground was identified within grid shift parameters of the project. The distance parameter for shifting the grid was nearly doubled to search for testable terrain but failed to find any.

The reason for this attempt was that the reservoir lakes system, of which Fish Lake Reservoir is a part, is a high probability area for pre-Contact occupations (Mulholland and Shafer 2000). The presence of the Fish Lake Dam site (21SL15) and other sites on the reservoir suggested that if dry ground could be found, this locality would most likely have a very high probability of testing positive. No drier, testable terrain was identified and no testing was conducted. Vegetation was predominantly alder and willow with sedges and reeds observed along the reservoir shoreline. No soils information is available but saturated organic sediments should be expected. Fish Lake Reservoir forms the current primary water resource for the test locality. However, the pre-dam water resource would have been the Beaver River and associated wetlands.

Upset of a little soft

40) Point 1167 St. Louis County (Appendix G, Figure 39). Of all the center points examined this locality was the most unique and untestable of the entire study group. This locality overlooks a wetland that is associated with Wild Rice Lake Reservoir. The terrain is gently sloping with an aspect to the south southeast. The wood lot in which the center point is located was recently cleared and a house constructed at that location. In fact as best as could be determined, the center point for this locality appears to be in the living room of a very expensive private dwelling. The immediate area around the dwelling has been extensively disturbed by construction, tree removal and landscaping for at least 70 ms. No testing was conducted at this location. It was unlikely that any pre-Contact cultural properties would be discovered beneath the hardwood floor the dwelling=s livingroom, though it clearly could be classified as an occupation floor from one of the post-Contact periods. Vegetation in the vicinity of the center point was predominantly aspen with some red and white pine. No soils data are available from an undisturbed context but from the disturbed areas around the dwelling, a gravelly sand and silt matrix should be expected. Wild Rice Lake Reservoir and the associated wetland are the primary water resource for this locality.

41) Point 723 St. Louis County (Appendix G, Figure 33). The center point for this locality is located on very gently sloping to flat terrain. The aspect of the slope is to the west northwest. This examination locality is in an extensive wetland. Attempts to access the point off of Forest Highway 11 were able to get within 150 m of the point before conditions in the wetland demonstrated that no testing would be possible. No shovel tests were placed at this examination locality. Vegetation was black spruce and alder with an occasional small tamarack. No soils data were observed in the examination area but saturated organic sediments should be expected. This is a lowland area between two drumlins and is part of the Toimi Drumlin Field. The only water related resource between the two drumlins that border the examination area is the wetland in which the center point is located.

42) <u>Point 802</u> St. Louis County (Appendix G, Figure 25). The center point for this examination area is located on sloping terrain with a northwestern aspect. The test area is on a hill slope of approximately 20 to 30 degrees. The center point and area around it for at least 100 m has been clear cut and has had site preparation for aspen regeneration conducted on it. This site preparation methodology involved root raking with a plow-like implement akin to a chisel plow. This creates large disturbed areas with numerous large rocks being brought to the surface. An attempt to find a testable area within the parameters of the study were unsuccessful. The area is boulder strewn with numerous depressions and cavities between rocks. Often the boulders and rocks were less than 5 cm below the surface and were covered with only a thin duff or grassy root mass. No shovel testing was conducted at this examination locality. Vegetation in the test area was small aspen and fir saplings with ferns and other herbaceous plants. The vegetation around the clear cut was predominantly fir and spruce with some aspen. No soils data were available for this test locality but based on information from the surrounding area it is most likely a silty sand. The only water resource near the examination area is a wetland to the northwest.

43) <u>Point 968</u> St. Louis County (Appendix G, Figure 40). The center point for this examination area is located on flat to very gently sloping terrain. The aspect of the slope for this locality is to the southwest. The surface terrain in the area of the center point is irregular with numerous small depressions. These depressions were filled with water indicating a high water table. Most of the examination area is in a wetland with some portions having been black spruce, that was logged off, and sphagnum moss. Approximately 50 m north of the examination locality is the trench rim of a valley cut by a tributary steam to the Whiteface River. This area was slightly outside of the grid shift parameters for this testing program but two test holes were placed along this trench. The other two test hole localities along the wall of the trench were either disturbed or too wet to test. North of this test line the terrain slopes steeply down into the stream valley. Both shovel tests were negative. Vegetation was mostly small willow and alder in the test area except along the trench wall where white spruce was present. Sediments in the test holes was a silty sand in the >A= horizon with sandier deposits below. Gravel and rock content was minimal. Soil coloration was dark brown in the >A= horizon and shifted to shades of yellow brown in the lower sediments. The water resources for this locality include the wetland in which most of the area was situated and the tributary stream to the Whiteface River to the north.

44) <u>Point 949</u> St. Louis County (Appendix G, Figure 41). The center point for this examination locality is located on flat to very gently sloping terrain. The aspect of the slope is to the north or northwest. The center point at this locality is located on a driveway or access road to a private dwelling. This location was once a farmstead that has since been abandoned and then later occupied,

but not actively farmed. Attempts were made to shift the grid to either the east or west of the center point. The area to the east of the center point is a grassy field. It was discovered upon examination of this field area that it was littered with metallic debris, broken pieces of equipment, along with plastic and metal containers that are similar to those that in the past have held fertilizers, pesticides and herbicides. In the interest of crew safety this area was not tested because of concerns over possible hazardous materials in the sediments. The grid was then shifted to the west side of the driveway. This was also a field with tall grasses. This field is in part presently used as a log landing and exhibited evidence of extensive disturbance activity. This disturbance evidence was in the form of push piles of sediment for the construction of ramps and to level the ground surface. These piles were removed from the immediate area as evidenced by deeply incised cuts and scars within the examination area. No testing was conducted on this side of the access road. Vegetation was predominantly grass with small aspen saplings. No soils data were available except from the push piles on the west side of the access road. These indicate a generally sandy soil with some pea sized gravel. An unnamed tributary to the Whiteface River is the primary water resource near this test locality.

45) Point 1503 Lake County (Appendix G, Figure 42). The center point for this examination locality is in very gently sloping to flat terrain. The aspect of the slope is to the southwest. This area is shown as dry ground on the US Geological Survey map but is in reality an extension of the upland wetland shown on the map to the north and northeast. The test locality and the immediate area around it, for over 100 ms, is a bouldery wetland with numerous root throw depressions that were filled with water. Attempts to relocate the test grid to better terrain were unsuccessful. No shovel testing was conducted at this locality. Vegetation at and near the center point was mostly alder with some cedar, black spruce and willow. Soils observed in the root throws were sandy and very rocky. They were generally shallow and over-laid a rocky base. Other than the wetland, no additional water resources were observed in or near the testing locality.

46) Point 1541 Lake County (Appendix G, Figure 43). The center point for this examination locality is located on flat to very gently sloping terrain. If any aspect to the slope can ascertained it is most likely to the west or northwest. The center point is in a wetland with no discernable drier ground for at least 400 m in any direction around it. The US Geological Survey map shows an area of dry ground to the east southeast of the center point but this area is a black spruce wetland. The examination crew was able to get within 80 m of the test locality before being forced to turn around. No testing was conducted at this location. Vegetation was dominated by tamarack, black spruce, reeds, sedges and alder. No sediment data were available for this locality but heavily organic soils

should be expected. The only water resource visible for this examination locality is the wetland in which it is situated.

47) Point 1542 Lake County (Appendix G, Figure 43). The center point for this testing locality is near that of test point 1541. It is located on flat to very gently sloping terrain. The slope aspect, if it can be measured, is probably to the west northwest. The US Geological Survey maps shows this point as being located on dry ground. However, this point is actually located in a black spruce wetland. Since this is the area of the highest land elevation in the immediate area (within 400 m or more) no relocation of the examination grid was feasible. No shovel testing was conducted at this test location. Vegetation at the center point was black spruce with some tamarack. No sediment data were available but heavy organics should be expected. The only water resource in the area of the test locality was the wetland in which it is situated.

48) Point 1491 Lake County (Appendix G, Figure 44). The center point for this test locality is located on very gently sloping to flat terrain. If a slope aspect can be determined it would most likely be to the south southwest. This test area is located just north of the confluence of Martin and Caribou Creeks. This is an ideal location for pre-Contact sites if dry ground conditions exist. The US Geological Survey map shows this area as being dry. However, the field survey team found the surface conditions far from dry. The area is an alder and willow wetland with no discernable dry uplands within 100 plus m of the center point. No shovel testing was conducted at this locality. Vegetation in and near the center point was predominantly alder and willow with some black spruce. No sediment data were available but saturated organic soils should be expected. The primary water resources in the area are Martin and Caribou Creeks and the associated wetlands.

49) Point 1152 St. Louis County (Appendix G, Figure 39). This point is located on terrain that slopes to the north. The center point was located 30 m west of a DNR wildlife road. The grid was shifted to place the center point on the south edge to allow for 15 holes. [One hole was still within the existing road ditch.] All shovel tests were negative. Vegetation was dominated by spruce with heavy underbrush and many dead trees and branches. The test area sediments were dominated by sandy silts with moderate to heavy gravel and rock content. Gravel increased with depth. Sediment colors in the >A= horizon varied from shades of brown to dark brown. The lower sediments were generally dark yellow brown in color. No open water was observed from any point on the test area.

50) Point 1103 St. Louis County (Appendix G, Figure 24). This point is located on a low terrace between two swamps (east and west). The center point was located on the very eastern edge of the terrace. The grid was shifted to the west to attempt shovel testing. Eight test holes were placed at

this location with the other eight holes (four corners and central holes on west half) being too wet for testing. All shovel tests were negative. Vegetation was dominated by young aspen and raspberry plants. The test sediments were dominated by a silty sand over a fine sand with some silt. Very little gravel or rock was encountered until the deeper deposits were reached. Sediment colors varied from dark brown in the >A= horizon to dark yellow brown below. No open water was observed from any point on the test area. However, wetlands were clearly visible.

CONCLUSIONS

EVALUATION OF ENVIRONMENTAL VARIABLES

Probability values were assigned to a total of 4237 randomly generated points (Table 3). The initial analysis was only on Randjack 5; the rest of the randjacks were processed later. [A randjack is a computer file of 656 randomly generated points; 10 randjacks were supplied by Mn/DOT.] A total of 101 points were selected to obtain permission from landowners and appropriate licenses. Several factors were considered when selecting points for potential survey. Clusters of points within each of the three counties were sought to maximize survey time by minimizing travel. Points in public ownership were preferred for ease of obtaining permission, although points on private land were also included. Points with higher probability values were also preferred; such points often guided the selection of a cluster of points. However, points in all probability categories were selected as per consultation with Mn/DOT personnel.

Table 3. Distribution of Random Points by Probability Category

Class	Probability	Randjack 5	Rest of randjacks
1	1.00-0.89	0	23
2	0.89-0.7.	13	163
3	0.70-0.53	35	359
4	0.53-0.35	115	693
5	0.35-0.17	71	744
6	0.17-0.00	220	1801
[points with 0.00		88	621]

Of the 50 points that received field survey, 23 were from randjack 5 and surveyed in fall 2000; the additional 27 points were chosen from the rest of the randjacks (once points more than a mile or 1.5 km from roads and in wetlands were eliminated) for survey in summer 2001. The first batch represents a spread across the probability categories while the second batch did not include points from the lower two categories (Table 4). No points with a probability greater than 0.89 were present in Randjack 5.

Table 4. Distribution of Selected Random Points by Probability Category

Class	Probability	Randjack 5	Rest of Randjacks
1	1.00-0.89	N/A	2 selected, 1 surveyed
2	0.89-0.70	8 selected, 4 surveyed	18 selected, 7 surveyed
3	0.70-0.53	17 selected, 11 surveyed	27 selected, 12 surveyed

4	0.53-0.35	7 selected, 3 surveyed	12 selected, 7 surveyed
5	0.35-0.17	6 selected, 3 surveyed	none
6	0.17-0.00	4 selected, 2 surveyed	none

A comparison of the points selected and those actually surveyed shows that approximately half of the points selected from each category were surveyed (Table 5). Note that the surveyed points are those that received a field visit, whether or not any shovel tests were placed.

Table 5. Comparison of Selected and Surveyed Random Points

Class	Probability	# Selected	# Surveyed	% Surveyed	% Total Survey
1	1.00-0.89	2	1	50%	2%
2	0.89-0.70	26	11	42%	26%
3	0.70-0.53	44	23	52%	44%
4	0.53-0.35	19	10	53%	19%
5	0.35-0.17	6	3	50%	6%
6	0.17-0.00	4	2	50%	4%
Total		101	50	50%	100%

Many of the points surveyed were untestable, mostly from saturated ground conditions (Table 6). A few points were in disturbed context (1), rocky areas (1), or both (1). However the vast majority were in wetlands and for most the grid could not be shifted to higher ground. Interestingly, a greater proportion of the second batch was untestable. Only about 40% of those in Randjack 5 (9 of 23) were untestable while 2/3 (18 of 27) points in the rest were untestable.

Table 6. Distribution of Untestable Surveyed Random Points by Probability Category

Class	Probability	Randjack 5	Rest of Randjacks
1	1.00-0.89	N/A	1
2	0.89-0.70	0	5
3	0.70-0.53	4	7
4	0.53-0.35	1	5
5	0.35-0.17	3	N/A
6	0.17-0.00	1	N/A

No new archaeological sites were discovered. During the 2000 field season, one possible flake was found on point 636. A possible shatter piece was also recovered on point 637. When examined after cleaning, both were considered to be natural pieces. A total of 299 shovel tests were placed on 23 points; all three counties and all probability categories were included.

The lack of positive results precludes any evaluation of the predictive value of the environmental variables tested. Although the logistic regression model was tested on a portion of the known sites, the field survey design had neither enough random points for a rigorous test nor enough high probability locations for even an initial test. Without any positive results, it is impossible to say whether the variables are useful in predicting new site locations. Without a spatial application of the model, it is also impossible to compare the results to that of Mn/Model.

Several possible interpretations can be explored. One is that these variables have no predictive value; the negative results of survey derive from use of invalid environmental variables. In other words, the concept of using known site location to predict other sites is not valid, either for early sites or for northeastern Minnesota or perhaps both. Since the concept has been widely used, this is unlikely. Another interpretation is that the test was invalidated from any of several problems in the methodology; perhaps combinations of several factors could interact to exacerbate the results. These problems are detailed in the next section and suggestions for future directions made.

A third interpretation is that the low density of random points (constraints by Mn/DOT) or the low number of points surveyed (constraints by budget) reduced the chance of locating sites beyond a reasonable likelihood. If the original testing program as initially conceived had been conducted, there would have been a greater chance that at least some sites would have been found. New sites, although not proving the model, would have at least indicated whether the model as constructed was worth further testing. A more extensive testing program incorporating random sampling with a much larger sample and distribution over the entire range of probability values could then have been planned.

FUTURE DIRECTIONS

Several problems were encountered during the project that should be addressed in any future expansion of this approach. Although none were insurmountable, more extensive research to provide better data or methods would undoubtedly increase the confidence in the model. To some degree, most of these problems are shared by the Mn/Model approach.

The known archaeological sites are the result of survey and research over several decades, very little of which was based on a statistical approach. Therefore the distribution of sites is clustered (Figure 5). Many sites are in the Boundary Waters Canoe Wilderness Area (BWCAW) of the Superior National Forest with a second cluster around the Reservoir Lakes north of Duluth. This reflects the relatively intense survey for prehistoric sites in the BWCAW and the relicensing survey for Minnesota Power. Gaps occur elsewhere; for example, there are almost no known sites on the North Shore of Lake Superior. This strong bias in the archaeological survey that has produced the known sites is recognized as a problem for Mn/Model (Elizabeth Hobbs, personal communication, 2001). It may be unrealistic to expect the known sites to predict new locations in the areas where gaps occur. Note that the surveyed random points are scattered in the lower 2/3 of the project area, avoiding the BWCAW (one of the areas where sites are well represented).

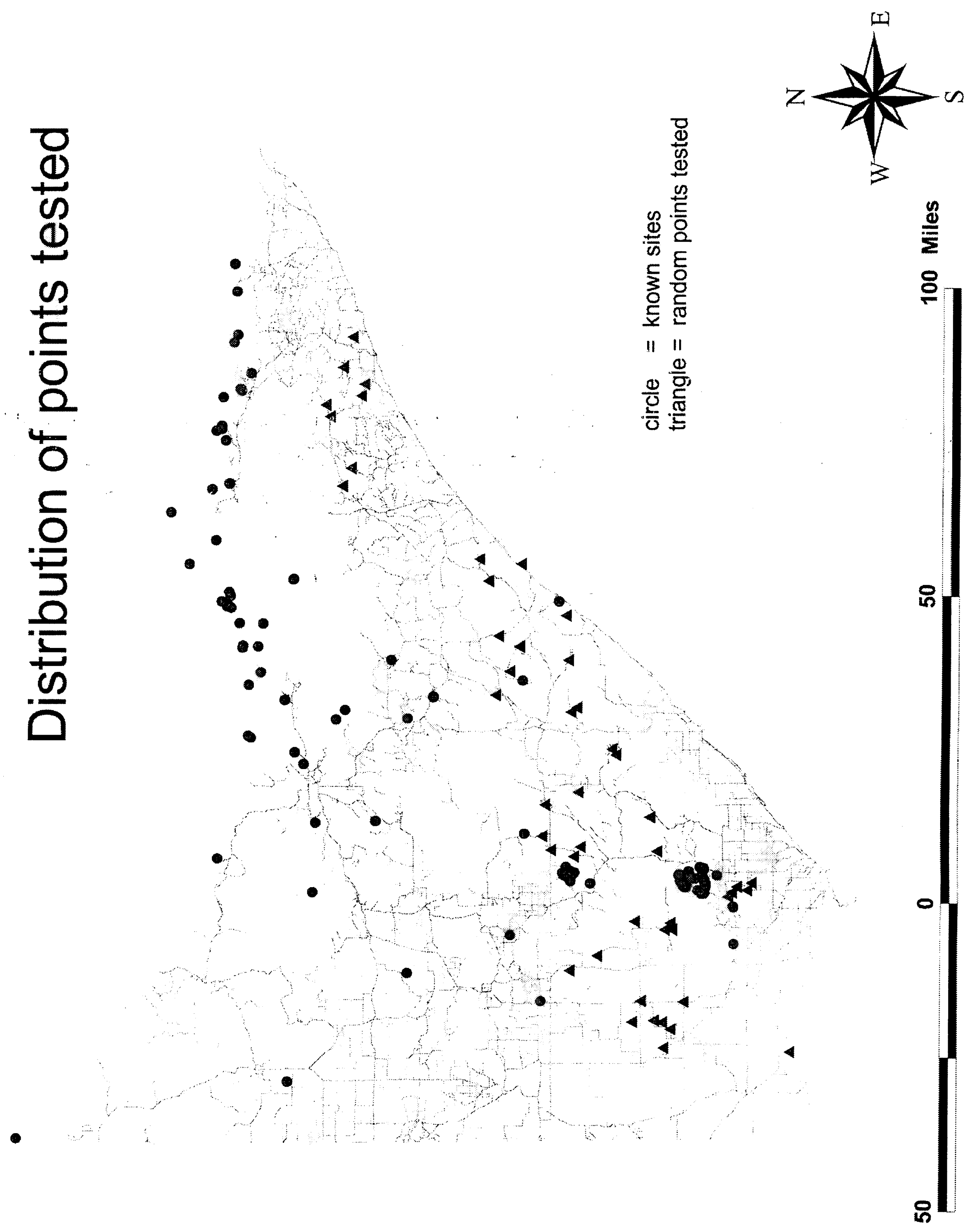

Figure 5. Known archaeological sites and surveyed random points.

Little can be done to add new sites to the database except by continued surveying for various projects and recording avocational/amateur finds. These methods are likely to continue to be not based on statistical theory or methodology. Until coverage nears 100%, the sample cannot be considered as random. However, if a stratified approach is used then the existing data may be useful. If a large-scale division such as geomorphic region is used in a stratified approach, then the areas of clustering and gaps can be defined. For example, the BWCAW is mostly within the thinly covered Canadian Shield; this is identified as the Tower-Ely Glacial Drift and Bedrock Complex (University of Minnesota 1981). Other physiographic provinces are defined across northeastern Minnesota. If necessary, fewer but larger regions may be defined. It may be that the existing data are sufficient to predict site locations within the BWCAW or around Reservoir Lakes.

Obtaining environmental data illustrated other problems with the methodology. Many coverages were missing for northeastern Minnesota. One of special interest was soils but others such as previously disturbed ground were equally elusive. If specific data are not readily available through GIS coverages, the amount of time to obtain it precludes any easy or widespread use of those variables. Soil sheets are available for St. Louis County from the modern State Survey but the information would have to be gathered from County soil offices as the atlas is not published. County-wide soil surveys have not been undertaken for Lake and Cook Counties. Not much can be done until such data have been compiled. Site-specific information can be obtained from site visits but county or region wide information is prohibitive in terms of time.

A related problem is the coarseness of coverages for which data are present. The unit size of recorded data is crucial; the smaller the unit, the better the resolution. If data are coarse, important variables may be masked. For example, a polygon that contains both water and land may be coded as either depending on the amount of each. Sites located on peninsulas or islands often appear to be in water when they really are short distances from water. Use of coverages such as the National Wetlands Inventory (NWI) mapped at 1:24,000 scale may have provided better resolution. However, note that these coverages would have required more extensive computer capability. In addition, the NWI does not map wetlands smaller than 3 acres in evergreen forested areas and so would not have provided substantially better resolution than the lake and wetlands coverage used in this project.

Fine-grained environmental data must be gathered from site visits. Most if not all computer coverages are too coarse to provide more than just a general sense of the type of environment. Even at a 20x20 m or 30x30 m grid, many micro-environmental variables are masked. Many of the points visited were shown on USGS topographic maps (and indicated by coverages) as dry when field conditions indicated saturated ground (in many cases, extensive wetlands). [Note that both the 2000 and 2001 field seasons were not considered especially rainy so the wetlands were not more extensive from immediate conditions.] Factors such as general quality of mapping and base air photos as well as the year in which mapping was done may also affect extent of saturated ground indicated on coverages (Elizabeth Hobbs, personal communication 2001).

Environmental variables also need to be considered not just in the present sense but in the past. Especially for early Holocene/late glacial times, many variables differ from what is presently seen. The pollen data can substitute for vegetational regimes, with a reduced scale. The potential for this set of data is indicated by the selection of the preliminary pollen model (which is based on only six cores) as one of the four variables in the logistic regression equation. Additional efforts to improve the resolution and quality of pollen data are needed. Similarly, past waterways such as old river channels or filled lakes need to be reconstructed for the distance to water variable. In particular, the reservoir lakes provide additional challenges. In order to model the environment, it was necessary to Adrain@ the reservoirs, redraw the lakeshores at original (early 1900s) levels, and situate the sites. However, random points within the reservoir basins were essentially untestable even if they had high potentials.

Greater efforts need to be made to research landscapes of the past. Immediate post glacial landscapes may have been especially dynamic but knowledge of the processes can help inform the search for early sites. The statistical analysis selected four variables as significant; two have to do with water, one with vegetation, and one with elevation. Landscape reconstruction can predict where water courses occurred while topographic and sedimentologic processes affect elevation. Vegetation can be reconstructed from pollen cores and corollary data. However, all these analyses require intensive effort.

The statistical analyses highlighted the need for information on non-sites as well as known sites. Although defining the random points as non-sites appears to work well (given the uniformly negative results of the survey), a better approach would be to identify non-sites and use the environmental variables from that universe. This could be done at two scales. First, sites are often discovered during survey on transects. The Superior National Forest has ample records of transects where few or no sites were found; the transect study of 1982 across Environmental Land Types would provide much data on where sites are not located. Highway surveys and other corridor studies would provide the same information outside of the SNF.

On a finer scale, sites that appear to be good locations to experienced archaeologists but tested negative would form a database that might provide much finer distinctions between sites and non-sites. This distinction may be too fine for the present state of computer coverages but could start toward the necessary detail for fine-tuned predictions. For example, although distance to water has long been known as a factor in site location, not every stretch of waterway has sites on it.

In regard to compatibility with Mn/Model, additional information on location of past surveys would provide data for a survey probability model. Such a model was constructed for northeastern Minnesota as part of Mn/Model. Incorporation of additional data, both existing (such as the 1982

Environmental Land Type surveys on the Superior National Forest) and from new surveys (such as in this project) would be useful. This would aid in comparison of results to those predicted by Mn/Model.

Finally, the problems associated with field testing need to be carefully considered. Shovel testing typically samples a relatively small area and volume. Increase in test hole diameter to 50 cm (or more) and decrease of grid interval to 10 m (or less) is strongly recommended. In addition, the survey area needs to be chosen to fit the objectives. If a statistical approach is needed, the low probability of locating sites in dense vegetation and rough terrain dictate a large number of points be surveyed. Alternatively, a relatively large area (greater than the grid cell of coverages) could be surveyed around a randomly chosen point. Both methods require greater time and funds than were available to this project.

If a preliminary test of variables is the objective (as was the original proposal for this project), then other methods of choosing survey areas can be used. Stratification of areas is a common approach, using a variety of factors. Specifically, a focus on high probability areas can be used to see if there is any validity to the approach. It is understood that by surveying only the high potential areas, sites will only be found in high potential areas. This type of survey bias is well-known in archaeology where Aintuitive@ methods are often prevalent. As long as the bias is known, it can be taken into account in the evaluation. It should be noted that the intuitive or biased approach to survey finds the most sites in the most efficient manner.

The major suggestion for field testing is adopt a staged approach. Testing high potential areas is the necessary first step to determine if there is any chance to find sites following a particular model. Whether it is statistical or intuitive in nature, if no sites are found then the logical assumption is that there is something wrong with the approach. Finding sites doesn=t necessarily imply that the approach is valid since the danger of a Aself-fulfilling prophecy@ is obvious. However, if sites are found then a statistical field test can be done as the second stage. As mentioned above, this type of field survey will require greater effort and funds so it may be cost effective to try a focus on high potential areas first.

FINAL WORD

The uniformly negative results of the field survey in this project do not negate the model formed from analysis of known site. We remain convinced that the approach is valid; the use of known archaeological sites to predict locations of new sites makes much sense. A sample of over 100 sites of Paleoindian/Early to Middle Archaic affiliation seems to approach a sufficient number. The clustering of known sites in two areas is acknowledged as a serious problem that needs to be addressed in future work. Additional information on site distribution in relation to geomorphic/physiographic regions is needed. Coarseness or lack of environmental data is more difficult to address but at least some scale of resolution is possible with present coverages. Site specific gathering of information may be necessary to reach a finer scale. In any event, a test of the four environmental variables chosen still needs to be made.

Perhaps of most immediate solution is the question of non-site definition. Information on areas where survey was conducted but no cultural materials recovered can be compiled relatively easily. The Environmental Land Type survey in the SNF covered all districts and attempted to include representative proportions of the different land types present. Other corridor surveys are likely more scattered and lack a statistical basis. As additional survey is conducted perhaps the gaps in the region will be slowly covered. At the very least, data for a survey probability model can be compiled.

The question of field methodology is central to the success of any project. Given the limited objectives and preliminary nature of the original proposal, the insistence on randomly generated points for field testing was inappropriate for even a preliminary test. This project, with the limited budget, was not initially intended to be a Amini-Mn/Model@ and do a full-scale statistical approach to site prediction. The intention was to explore variables common to known sites in northeastern Minnesota and provide data that could be used for future research. The non-site data that was generated will be useful for Mn/Model but the selected variables still are not tested.

The problem of finding sites was well known to Mn/DOT personnel. The last comment on review of the original proposal reads:

> AThe very low site densities in Minnesota will also pose problems for field testing, particularly when labor intensive methods (shovel testing) are employed. You may find yourself with few new sites, particularly when moderate and low site potential areas are tested in equal proportions to high areas.@ (Elizabeth Hobbs and Craig Johnson, 11-3-99).

In the same vein, survey for Mn/Model had similar results (Craig Johnson, 2-9-01). Survey conducted by Leech Lake Reservation Heritage Resources occurred over two seasons and found few sites. The first season focused on lakeshores, long known to have high potential. The second season switched to random locations; no sites were found in that season. The combination of a random sampling strategy (that produces non-site data) with a focus on high probability areas (which locates sites) is recommended for future testing of the environmental variables generated by this project.

The results of statistical analysis on 108 known early archaeological sites indicate four environmental variables may have significance for predicting site locations. Distance to water was suspected as a prime factor from many prior works. The type of stream flow is a new variable but related to waterways. Height above the mean elevation in a 90m grid around a site or point has some interesting possibilities. Surprisingly, aspect and slope were not selected as significant but some parts of these variables may be incorporated in htabvmean90m. Finally, vegetation as represented by the average of coniferous/deciduous ratios between 8000 and 9500 BP strata in pollen cores is also significant. Whether any or all of these are artifacts of the methodology employed or are true predictors requires additional field testing. It is sincerely hoped that additional research will be conducted in the near future to resolve some of the questions raised by this project.

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