Archaeological Potential Mapping in the Fort Nelson Creek Forest District

Final Report
Accompanying 1:50,000 Potential Maps

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INTRODUCTION TO ARCHAEOLOGICAL POTENTIAL MAPPING

Archaeological sites are the material remains of past human activity. Not all human activity leaves durable material remains, but, where it does, human life in the past can be known through archaeological investigation. Examples of archaeological sites include habitation sites (*e.g.* villages, camps), resource procurement sites (*e.g.* kill/butchery sites, caches, lookouts, quarries, culturally modified trees, fishtraps), ritual/spiritual sites (*e.g.* rock art), and human burial sites.

Any of these sites will be in a location appropriate to the needs of the activity carried out. For example, campsites will likely be on flat, well drained land with a source of fresh water and a favourable exposure. While many of the environmental criteria which past people used to select such locations may seem obvious, others may be culturally-specific and thus not as obvious. So, while it might appear that, for example, immediate proximity to water constitutes the foremost criteria of where to locate a campsite, it may be only one of many choices which people make within their culturally specific view as to what constitutes an appropriate camping spot. Other resources, topographic features, views over surrounding terrain, and spiritual or religious beliefs may also come into play.

Archaeological potential mapping is an attempt to categorize the landscape according to its suitability for human activity of the kind which leaves archaeological remains. A central challenge of potential mapping is how to use existing environmental data in order to predict archaeological resources which are the cumulative result of millennia of diverse, culturally-specific behaviours, occurring within a changing social and natural environment. This topic is well reviewed by Moon (1995) and Wansleeben and Verhart (1997).

MODELLING THE POTENTIAL FOR ARCHAEOLOGICAL SITES

Generally, archaeological potential mapping has occurred within the framework of cultural resource management. Government and other agencies often possess a legal obligation and moral duty to manage and protect cultural resources, including archaeological sites. First Nations have a strong and abiding interest in cultural resources, including archaeological sites. Potential mapping has been particularly widespread in North America where a strong regulatory environment, large land areas, high quality environmental data, and interested First Nations make it both desirable and possible to map large areas for their archaeological potential.

Any experienced archaeologist carries a mental model of possible archaeological site locations. These typically include a combination of landform, environmental history, seasonality, specific ethnographic information, and cross-cultural generalization. When performing archaeological inventory, these variables are judgmentally combined and applied, and field decisions of where to look for sites are made. Similar decisions may also be made by looking at a map and outlining areas considered to have greater or lesser archaeological potential. Such *intuitive potential maps* may seem very useful in practical applications, but the decision-making process by which potential polygons are defined is complex, subtle, and not amenable to automation. Furthermore, these intuitive maps may be subject to considerable, yet indefinable, bias stemming from the archaeologist's amount and kind of field experience, their school of thought, as well as the other sources of bias common to automated potential maps discussed below.

There are two main kinds of automated archaeological potential models (Dalla Bona 1994).

Inductive models work from known site locations outwards to the landscape of unknown sites. In other words, a set of known sites is examined for knowable environmental correlates. A model is created which can describe the location of these sites. The model is then applied to an area with unknown archaeological resources. This second area is then subdivided according to the presence, absence, or co-occurrence of the environmental variables which were found to describe site location, in the expectation that such a description will have some predictive value for site location.

Deductive models start from generalized principles of human behaviour, and the sorts of environmental variables favourable to human activity. These include basic parameters such as access or proximity to fresh water, relatively flat and well-drained terrain, proximity to food and other resources, and other factors, such as prevailing wind, and exposure. The landscape is then subdivided according to the presence, absence, and co-occurrence of these supposedly relevant factors.

Each approach has its strengths and weaknesses. Inductive models do not require the application of generalized, and perhaps culturally-inappropriate, models of human behaviour. Rather, the site locations are taken as an expression of culturally specific behaviour, and useful correlated environmental and other variables are then sought in order to extrapolate the known set of site locations into larger areas of potential for such sites. However, for such an approach to be valid, it requires a representative sample of the site universe, *i.e.* archaeological sites of all different types and ages, and from all different environmental zones, must be included. Such representative samples are not available in the Fort Nelson District, and, indeed, are not normally available anywhere unless systematic archaeological survey has been conducted.

Deductive models are easier to apply in areas with little previous archaeological research. Using generalized principles of human adaptation, large areas of terrain can be categorized according to their suitability for human activity. The drawback of this approach is that, in the absence of a representative sample of archaeological sites in the region, it is difficult to assess or test the validity of the model. Supposing a sample were to be available, it is then preferable to apply or incorporate elements of an inductive model into the deductive one, perhaps through a defensible weighting of the environmental variables.

In summary, an ideal program of archaeological potential mapping is an iterative model-building procedure, in which the model is adjusted until the best fit between the potential map and the known site locations is obtained.

ARCHAEOLOGICAL POTENTIAL MAPPING IN THE FORT NELSON FOREST DISTRICT

I. Outline

The Fort Nelson Forest district is a large, environmentally diverse area, which is incompletely known archaeologically. As there is not a usable sample of archaeological sites (*i.e.* a statistically representative sample of site locations based on random or systematic sampling of the region), a deductive modelling program was selected as the most appropriate to implement.

The modelling was done using TRIM (planimetry and DEMs) and Ministry of Forests FC1 (vegetation) data. The final maps were plotted in NAD83 using TRIM planimetric features. Where required, FC1 forest cover data that resided in NAD27 was projected to NAD83.

The model is built with the following procedure:

1. A set of eight environmental variables with relevance for the location of archaeological sites was chosen. These variables are discussed below. Apart from relevance, all variables were required to be known for the forest district as a whole, in order to ensure that all mapsheets were consistently categorized for potential. For example, use of data that might only be present for one sub-region would result in unrealistically higher potential scores in that sub-region.
2. Where present, each variable was assigned a score of 1. The model develops additively, as mapsheets with polygons defining each variable are overlaid with each other. Cumulative polygons representing the overlaps are created, and scored by simply adding up their scores. This produces a composite map of cumulative potential scores. All variables were assumed to have equal weight. This point is discussed further below.
3. All land was assumed to have some potential for archaeological sites, and therefore was assigned a baseline potential of 1.
4. Water bodies were considered to have no potential for archaeological sites and were coded as null, or zero potential.
5. Swamps are considered to be reasonably attractive of general human behaviour, especially in winter, but such activity is not likely to leave recoverable archaeological evidence. However, in and around swamps micro-topographical terrain features have a much higher potential for the recovery of archaeological material. Since such micro-topographical features (small hummocks, slight rises, *etc.*) are not visible at the resolution of the TRIM D.E.M, they were not able to enter the model. In recognition of this high potential for sites combined with the low ability to model this potential, swamps were designated as special management zones. Due to the large portion of the land base in the Fort Nelson Forest District which is classified as swamp, it is probably a matter of some urgency for the Archaeology Branch to develop guidelines for use of these areas. While these areas may not have commercial timber, they may be subject to collateral damage by logging activities.
6. The result is a set of maps categorized on an eight point scale of increasing potential based on the co-occurrence of environmental variables.

II. Variables used to model archaeological potential

The following variables were used to create the potential maps.

1. Vegetation

All terrain with vegetation coded as leading pine/leading aspen forest cover was given a score of 1, as was terrain coded as Open Range or as Meadow.

(a) Rationale: This vegetation cover indicates a well-drained ground cover, and was included on the strength of Walde's (n.d.) comments on its utility as a useful predictor of moderate archaeological potential in this area.

(b) Discussion: A similar procedure was used to define "moderate potential" in the Strategic Model for the NE LRMPs (Walde's 1:250,000 model). As per Walde's model, we have included areas harvested in the last 20 years, on the assumption that these areas were mainly pine and aspen. The relevant vegetation pattern is that which existed while the archaeological record was being created over the past millennia, not the currently existing vegetation. To some extent, then, use of vegetation may skew the model towards recent sites. Nevertheless, some predictive capability is expected as some landforms may have been poorly drained for millennia.

2. Aspect

Flat terrain and terrain with slope less than 11% (see below) was coded for its aspect. Aspects from east through south to west (90 - 270 degrees) were scored as 1. Remaining exposures were scored as 0.

(a) Rationale: In northern latitudes, a southerly exposure is often considered to be more favourable at many times of the year for human activity because it affords greater warmth and light.

(b) Discussion: Flat areas (Slope 0 - 5%), which have no single aspect, were scored as 1. The aspect field was conservatively defined to include not only southerly, but also westerly and easterly exposures. The use of solar aspect is only one sort of aspect which might have cultural relevance. For example, orientation to prevailing wind is another likely influence on site location, but data on this variable does not currently exist.

3. Slope

All terrain with less than 11% slope was given a score of 1.

(a) Rationale: human activity is more likely to be carried out on areas which are flat or gently sloping than on those which are steep.

(b) Discussion: As absolute flatness is not necessary for human activity, a conservative break-point of 10% slope and less was chosen. There are intrinsic problems in dividing a continuous variable, such as slope, into discrete categories. In the absence of external information to define what constitutes a culturally-relevant degree of flatness, a conservative definition was used. There are limits to the precision with which one can model slope from the Digital Elevation model, which itself is derived from survey and photogrammetric data.

In particular, what may be truly important are very small flat areas within more sloping ones: small terraces, linear ridges, and other breaks in slope. At the resolution of existing data, there is no way to model these landforms accurately, and so they are not specifically categorized within the model. However, those of sufficient size and elevation to be captured by the Digital Elevation Model are included.

4. Wide Rivers

Rivers wider than 20 metres were buffered by a zone 100 metres wide to either side. This zone was given a score of 1.

(a) Rationale: Transportation corridors are more likely to attract human activity by facilitating trade and access to resources.

(b) Discussion: The use of an existing categorization of "large" rivers was pragmatic. In practice, some smaller rivers may also have been navigable, and stretches of some larger ones may have been impassable. Nevertheless, this categorization encapsulates an important source of environmental variability. The choice of 100 metres was judgmental. Much of the direct activity may have centered on the immediate riverbank area, and on bars, small islands, and other unstable riverine features. However, there would also have been considerable activity on terraces and better-drained land set some distance back. The problematic need to make continuous variables discrete applies to most of the environmental variables in the model.

5. Large Lakes

All lakes with an area greater than one hectare were selected. A buffer zone 100 metres wide around these lakes was created, and assigned a value of 1.

(a) Rationale: Lakes are sources of fresh water as well as sources of special resources, and thus tend to attract human activity.

(b) Discussion: The choice of a 100 metre buffer was made for much the same reasons as it was for Wide Rivers, above. The choice of a 1 hectare break point was made judgmentally, based on experience and qualitative assessment of the existing site inventory. Human-made water features, such as reservoirs, were not buffered as their shoreline is arbitrary in relation to past human activity.

6. Stream Proximity

All streams were buffered by 100 metres along each bank, and this buffer zone was assigned a value of 1.

(a) Rationale: Access to fresh water is a crucial resource for humans, as well as for animal resources exploited by humans.

(b) Discussion: The buffer size of 100 metres was arrived at judgmentally, based on experience and judgmental assessment of known site locations. In practice, proximity to water might better be conceived of as a continuous variable: the importance of the water source diminishes as the distance from water increases. However, data and processing constraints prevent the use of a continuous variable. In any case, there are no known culturally relevant thresholds at which to make breakpoints. Thus, as with the other variables, conservative buffer zones were selected, in the expectation that the model will continue to develop over time as a formal or informal process of ground-truthing is implemented.

7. Swamp Proximity

All swamp perimeters were buffered by 100 metres, and this surrounding buffer polygon was assigned a score of 1.

(a) Rationale: Swamps hold important plant resources and are attractive to game. In winter time they may be attractive open travel corridors.

(b) Discussion: The 100 metre buffer is chosen judgmentally. In effect, swamps are treated somewhat like lakes and streams (see Discussion 6.a). As noted above, swamp micro-topography may be a crucial predictive variable (See Discussion 3.b). In future versions of this model the 100 metre buffer may be revised.

8. Waterbodies

Lake and river surfaces, were scored as null. Null scores took priority over any other scores these features may have received for slope, aspect, *etc.*, and so these features were set as zero potential in the model.

(a) Rationale: Waterbodies are not likely to support the sorts of human activity which leave material remains.

(b) Discussion: Considerable activity would have taken place on the surface of lakes and rivers, but such activity will not normally leave identifiable material remains. This does not diminish the non-archaeological importance of these features. Also, dam reservoir areas are coded as null, nevertheless, there is considerable potential for finding archaeological sites in bare soil areas exposed during draw-downs.

III. Notes on the Model Building Process

The model as presented constitutes a pragmatic model of general activity in the environment as it exists today. The implications of this are:

As a pragmatic model, the use of existing data is maximized, and use of inappropriate or incomplete data is avoided. Thus, such data sources as the derived wildlife model (biophysical mapping) for the area were not incorporated because of the inaccuracies introduced by re-projecting this 1:250,000 data at a 1:20,000 scale.

As a model of general activity, only everyday practical activity in the world is accounted for. The implications of this are that there are some classes of archaeological sites which are not modelled. In particular, rock art sites, quarry sites, alpine sites, fishtrap and fish weir sites, culturally modified trees, and historic sites are not specifically modelled, although there may well be correlation between these special-purpose sites and the environmental variables used. Thus, the mapped potential categories do not represent all possible kinds of archaeological data.

The use of modern environmental data to model the accumulation of many millennia of human activity means that the model may be biased to the recent past, or, at least, to periods in the past when the environment is similar to today. The implication is that the location of archaeological sites produced during periods when the environment was different may not be aptly modelled by the potential maps. This is a significant problem with no ready solution, made more serious by the fact that these older sites may be of more cultural and scientific interest.

IV. Assessment of the Model

1. Unlike adjoining Forest Districts in the Northeast, there were insufficient numbers (n = 98) of known archaeological sites in the Fort Nelson Forest District to attempt a quantitative assessment of the model. In any case, as noted in the parallel reports for Fort St. John and Dawson Creek Forest Districts, valid assessment of these potential models is not possible in the absence of a statistically representative set of archaeological sites. The process used in those forest districts to attempt a preliminary assessment of the model is detailed below. While such a preliminary analysis could be performed for Fort Nelson as well, it would likely be so misleading as to do more harm than good.

2. Archaeological potential mapping involves a complex assessment of environmental and archaeological data as to their relevance for understanding general and culturally-specific human behaviour over the long term. As such, it is not a procedure that leads to quick or absolute answers. Logical and practical steps which could be taken to improve or assess the current model are discussed below.

A). The most effective means of assessing the model would be to conduct validating archaeological fieldwork. A random, stratified random, or systematic survey design should be implemented which would provide an unbiased and representative sample of sites against which to test the model. If such a research program were implemented, it would then also be possible to inductively fit the environmental data to site location. For example, it would be possible through factor analysis, logistic regression, or some other statistical technique to weight the input variables. This would greatly strengthen the reliability and validity of the modelled potential polygons, and would, in effect, calibrate the model: the meaning of the resultant potential categories could be quantified. For example, one might be able to say, within Category 4 there will be, on average, 1 site per square kilometre, while within Category 1 there will be only be 1 site per 10 square kilometres.

Some probabilistic field inventory in the Northeast has been carried out. Of particular interest are the Peace River Site "C" pondage surveys (Alexander 1982), a small probabilistic survey associated with the Northeast Coal Project (Ball 1978), and the Liard River Survey (Mitchell & Loy 1981). None of these, singly or together, constitutes a representative sample for the region as a whole, as they are spatially constrained and unrepresentative of all major environmental divisions. It might be possible to incorporate some effectively random surveys, such as those associated with well-head impact assessments and transmission corridors, in order to quickly and cheaply increase useful survey coverage.

A key point is that *null data* for site location is needed. One must be able to model non-site locations, or low/no potential areas, rather than leave this as a remainder after site location is modelled. Areas where no sites were found are not normally systematically mapped, nor is this data kept by the Archaeology Branch (Eldridge and Mackie 1992). However, some such data may be derivable through analysis of project reports. A promising source would be well-head or drilling platform archaeological impact assessments, because they are of a standard size and may be distributed arbitrarily in relation to archaeologically relevant environmental variables. Such a study would require time and resources outside the scope of the current project.

B). As noted, the existing model is for sites which are the result of general-purpose activity in the landscape. Some special purpose models might also be considered, such as seasonal models; alpine models; rock-art models; and models for historic sites. Further, potential for sites of a certain age could be modelled. Of particular interest would be potential for sites from the earliest period of the peopling of the Americas, a process which is believed to have occurred along a transportation corridor partially within this Forest District.

A set of targeted models aimed at subsets of archaeological site types would likely be of greater accuracy than a single model for all site types and site ages.

C). For reasons discussed above, the potential model only includes currently available data at a consistent resolution. Should further data become available, such as finer-grained wildlife data or more consistent fisheries data, it could be incorporated with the aim of improving the precision of the model. Incorporation of these data would not necessarily be a complex process, but, as it would require the recalculation and production of a modified set of potential map sheets, the process could be expensive.

D). Finally, other data sources should be consulted. For example, there are considerable sources of highly relevant information available in Traditional Use Studies, Ethnographies, Ethnohistoric Sources, and in First Nations communities. Additionally, judgmental assessments of archaeological potential (intuitive mapping by experts) are also of considerable value. These data would be difficult to incorporate within the potential model itself as they have a very different character, derivation, scope; and scale; and are of variable consistency across the study area. Nevertheless, when available, these data are of considerable utility in the assessment of archaeological potential. Such sources of data should be consulted when cultural resource management decisions are being made. In particular, Walde's 1:250,000 scale intuitive model retains utility as an assessment (albeit at a coarse scale) of archaeological potential by a locally experienced and knowledgeable archaeologist. It is recommended that the maps created in the current project not be used in isolation from other, qualitatively different sources of information. See Wansleeben and Verhart (1997) for a general discussion of the relationship between holistic cultural models and ones driven by Cultural Resource Management needs.

CONCLUSIONS

Archaeological potential maps at 1:20,000 scale (plotted at 1:20,000 and 1:50,000) based on general principles of human behaviour have been created within the Fort Nelson Forest District. These maps have the following characteristics:

- they are based on a set of reliably derived, consistently available, fine-grained environmental variables.
- these variables each make an unweighted contribution to the model.
- these variables are considered to be relevant for the positioning of *general* human activity in the landscape.
- polygons defined by the intersection of these environmental variables are coded according to their potential for general human activity, and, therefore, for the presence of general activity archaeological sites.
- these polygons are categorized on an eight-point ordinal (1 through 8) scale of increasing potential, based on the cumulative overlay of the environmental variables.
- swamps are categorized as Special Management Areas, to be defined by the Archaeology Branch.
- the potential maps do not include culturally-specific information from local First Nations people, nor from ethnographic or ethnohistoric sources. Such information is often not amenable to computer modelling, yet may be of substantial utility in determining location of sites, especially relatively recent ones, and in assessing the cultural significance of such sites.
- the potential maps do not include detailed information from local archaeologists. Such expert information is often not amenable to consistent modelling at 1:20,000 scale with current data sets, yet it retains substantial utility for management purposes.
- interpretation of these maps should acknowledge their inherent conservatism and the current inability to validate them through fieldwork or statistical analysis. The set of maps should therefore be treated as an untested hypothesis.
- cultural and archaeological resource management decisions made on the basis of these maps needs to be in accordance with the normal cultural resource management process. In particular, the Archaeology Branch will need to develop a management protocol for their interpretation.
- potential mapping should be seen as an ongoing process and the utility of these maps should be periodically reviewed, and the model adjusted if necessary. Suggestions are made regarding ways to improve the potential mapping process. These maps should not, therefore, be treated as a final product.
- these maps are of hypothesized *archaeological* potential only, and do not bear any necessary relationship to areas of Aboriginal Rights or any other legal domain.

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