The Mackenzie Timber Supply Area
Archaeological Overview Assessment Final Report

Heritage Potential Modeling

B.C. Permit 1996-191

December, 1997
The Mackenzie Timber Supply Area
Archaeological Overview Assessment Final Report

Heritage Potential Modeling

B.C. Permit 1996-191

by

T.H. Gibson, J. Finnigan, C. Ramsay, and B. Low
Western Heritage Services Inc.
Saskatoon and Prince George

submitted to

Mackenzie AOA Steering Committee
and
B.C. Archaeology Branch

December, 1997
Contents

1.0 Introduction ......................................................................................................................... 1

2.0 Project Location .................................................................................................................. 1

3.0 Archaeological Resource Inspection Approach ................................................................. 1

4.0. Background Environmental and Historical Research Review ........................................... 5
  4.1 Environmental Overview ....................................................................................................... 5
  4.2 Precontact Historical Overview .......................................................................................... 6
  4.3 Discussion of Precontact Archaeological Site Data ............................................................ 8
  4.4 Postcontact Archaeological Overview .............................................................................. 12
  4.5 Ethnography Overview ..................................................................................................... 13

5.0 Development of the Mackenzie TSA Heritage Potential Model ........................................ 15
  5.1 Introduction ....................................................................................................................... 15
  5.2 The Modeling Procedure .................................................................................................... 16
    5.2.1 Data Processing Procedures ......................................................................................... 16
    5.2.2 Modeling Criteria .......................................................................................................... 18
      5.2.2.1 Aspect .................................................................................................................... 18
      5.2.2.2 Slope .................................................................................................................... 18
      5.2.2.3 Hydrology ............................................................................................................. 18
      5.2.2.4 Slope Change ......................................................................................................... 19
      5.2.2.5 Terrain Character ................................................................................................. 19
    5.2.3 Variable Processing ...................................................................................................... 19
  5.3 Initial Model Performance Analysis ................................................................................... 20
    5.3.1 Analysis Using Existing Data ..................................................................................... 20
    5.3.2 First Stage Model Field Investigation .......................................................................... 23
  5.4 Comparison With other Studies ........................................................................................ 24
    5.4.1 Dawson Creek Model ................................................................................................. 24
    5.4.2 The Vanderhoof Model ............................................................................................... 25
    5.4.3 Summary ..................................................................................................................... 26
  5.5 Model Resolution ............................................................................................................... 26
  5.6 Revised Mackenzie TSA Model ....................................................................................... 26
    5.6.1 Revised Model Performance ....................................................................................... 30
    5.6.2 Using the Model ........................................................................................................... 30

6.0 Conclusions and Recommendations .................................................................................... 31

7.0 References ........................................................................................................................ 34

Appendix A. Example of AOA Field Survey in the Finlay River Region.
Appendix B. Text Summary of GIS-based Field Information Collected during the AOA
Appendix C. Statistical Summary of GIS-based Field Information Collected during the AOA
Appendix D. General figures showing survey and site locations and a sample of the predictive model

Western Heritage Services Inc.
Tables

Table 1. Summary of major previously recorded archaeological sites in the Mackenzie TSA. 9
Table 2. Analysis of distribution by model variables. ......................................................... 18
Table 3. Site frequency by site potential zone ................................................................. 22
Table 4. Variables used in the draft of the Dawson Creek Model .................................... 25
Table 5. Model performance in the top 50% of land area .............................................. 29

Figures

Figure 1. Mackenzie Timber Supply Area location and Forestry Operating Areas .......... 2
Figure 2. Pedestrian survey of the exposed beach at Corless Bay, Chunamon Forestry SA. 3
Figure 3. Provisional cultural-historical sequence. ...................................................... 7
Figure 4. Old bridge across the outlet of Germansen River from Germansen Lake .......... 12
Figure 5. Density of sites by heritage potential zone. ................................................... 21
Figure 6. Cumulative percentage of land area and archaeological sites ....................... 21
Figure 7. Relationship between pixel size and real world accuracy ............................. 27
Figure 8. Effect of pixel size on the area classified as high medium and low ............... 27
Figure 9. Comparison of initial and revised model performance ................................... 29
Executive Summary

TimberWest Forest Ltd., in conjunction with Finlay Forest Industries and the BC Ministry of Forests requested an archaeological overview assessment of the Mackenzie Timber Supply Area, located in northeastern British Columbia. The primary goal of the overview was to develop a GIS-based predictive model of archaeological heritage potential for the region. Only a few archaeological sites had been previously recorded within the timber supply area, which encompasses more than 6 million hectares of mountainous terrain. This work was undertaken by Western Heritage Services Inc.

Background literature surveys demonstrated that there had been very little previous archaeological study in the vast region. Since the heritage potential model required some archaeological data to calibrate and ascertain its effectiveness, and archaeological field assessment program involving drive-through surveys of roads and forestry cut blocks was implemented. The field techniques included pedestrian surface surveys, spot checks and subsurface testing on a wide variety of landforms. Determination of archaeological potential for landforms was based on discussions with band members, terrain associations with currently known sites from a background literature review, and general boreal forest site location knowledge.

During the relatively short field assessment program, approximately 5,000 square km of land were observed through drive-through and pedestrian inspection of over 1800 km of road and trail. Nevertheless, the inspected areas comprise less than 0.1 percent of the entire Mackenzie TSA. Twenty-nine new precontact archaeological sites were found during the survey, many of them in interior locations away from major rivers. Most of the sites were surface lithic finds, often associated with contemporary trails or evidence of contemporary habitation.

The heritage potential model developed for the TSA is a raster based model with a cell resolution of 100 m. The principal variables used in defining the model were derived from TRIM data, and included distance from water, slope, aspect, elevation, and distance from a landform edge. Some use was made of LandSat satellite imagery to derive vegetation and wetlands, although this data source was not available for the entire TSA.

The heritage potential modeling appears to be moderately successful in predicting the location of heritage-sensitive localities, based on an analysis of the limited site data that were collected, and by direct testing through interim modeling field verification. It also compares favourably with heritage potential models developed elsewhere in B.C., Saskatchewan and Ontario.

Overall, the model provides the first comprehensive heritage management tool for the Mackenzie TSA. While the model is an important tool, particularly because of its regional scale, it is still requires significant improvement because of the limited data that were available to develop it. The iterative design of the model ensures that it can be relatively easily improved with the addition of new data.
<table>
<thead>
<tr>
<th>Project Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Manager:</strong></td>
</tr>
<tr>
<td><strong>Permit Holder:</strong></td>
</tr>
<tr>
<td><strong>Report Authors:</strong></td>
</tr>
<tr>
<td><strong>Report Illustration/Typesetting:</strong></td>
</tr>
<tr>
<td><strong>Field Studies Participants:</strong></td>
</tr>
<tr>
<td><strong>Interim Model Field Assessors:</strong></td>
</tr>
<tr>
<td><strong>Data Entry/Analysis:</strong></td>
</tr>
<tr>
<td><strong>GIS:</strong></td>
</tr>
<tr>
<td><strong>Remote Sensing:</strong></td>
</tr>
<tr>
<td><strong>Modeling:</strong></td>
</tr>
</tbody>
</table>
Acknowledgements

There are many people who supported the undertaking of this project. The project was initiated two years ago by Alan Simcoe from TimberWest Forest Ltd, who began assembling the funding to undertake this work. Forest Renewal B.C. ultimately provided this support, enabling the project to proceed. A committee was formulated including Al Balisky from TimberWest Forest Ltd., Joan Thomas of Finlay Forest Industries, and Lyle Bonthoux and Eric Forget from the Mackenzie District Ministry of Forests. Much gratitude is extended to the First Nations involved in the project, including the Fort Ware Indian Band, Tsay Keh Dene Band, McLeod Lake Indian Band, Takla Lake Indian Band, and Noostel Keho.

Chief Emil McCook from the Fort Ware Indian Band discussed some of his heritage concerns in the area near Fort Ware. In previous projects in the Buffalo Head area Melvin and Doreen McCook discussed heritage resources and Doreen undertook a drive-over of this area with Terry Gibson.

Chief Johnny Pierre from the Tsay Keh Dene Band discussed archaeological issues with the archaeological survey teams. Michael Metcalf arranged for band members to provide consultation for different areas of the Tsay Keh Dene homeland. Discussions with several band members were very informative. Pat and Maureen Pierre and Vera Poole discussed archaeological concerns that they were familiar with in the Davis-Ospika areas. They undertook field surveys in previous studies undertaken by the Tsay Keh Dene Band. Elder Jean Isaac discussed general land use information as well as expressing concerns about the Ingenika area.

Chief Harry Chingee from the McLeod Lake Indian Band provided information on heritage and archaeological concerns and arranged accommodations for part of the survey crew at McLeod Lake. Vern Solonas and Harley Chingee discussed concerns that they knew of and provided references to people who possessed specific knowledge of various areas. Elders Theresa Alexander and A. Solonas Sr. provided information about their specific knowledge areas.

The authors are also grateful for the discussions and help from many people at the McLeod Lake Indian Band office. They would also like to thank Jim and Janet Bresheres for their hospitality and discussions. They outlined land use, heritage, and archaeological concerns for the Noostel Keho in the homeland claim area around Germansen Landing. Scott Müller from Germansen landing also discussed the industrial mining history of the area, and provided information on this historic period.

Al Balisky of TimberWest acted as project administrator, and provided invaluable assistance in field expedition and committee meeting arrangements. Doug Glaum from the BC Archaeology Branch provided comments throughout the project, and served as government liaison to the project. Daryl Roberts of TimberWest provided considerable support by supplying critical GIS information for the modeling program, and advice on data management requirements.
1.0 Introduction

The Mackenzie Archaeological Overview Assessment Project was initiated in July, 1996. Preliminary work included literature searches for documents relevant to the study area, which included historical, ethnographic, government and consultant reports and academic publications. The AOA steering committee meeting identified a number of forestry operating areas in which to focus the field-based overview assessment. Satellite imagery of the Mackenzie TSA supplemented the most recent forestry maps in the preparation for the field assessment.

Fieldwork for the archaeological overview assessment began on August 22, 1996. Preliminary field work included discussions with the McLeod Lake Indian Band, Takla Lake Indian Band, Tsay Keh Dene Band, and Fort Ware Indian Band. Archaeological field surveys of the Mackenzie TSA began on August 28 and proceeded to September 29, 1996. This work involved two crews of three field personnel each. In addition, a number of interviews, discussions, and some field excursions were carried out with band members. Unfortunately, the later-than-anticipated fall scheduling of the field work meant that several aboriginal assistants who were to accompany the crews had other commitments by that time and were unable to take part in the assessment work.

The archaeological field work involved drive-through surveys of Forestry Service Roads (FSR’s), forestry haul road Main Lines (M/Ls) and forestry cut blocks. The detailed archaeological assessment work included pedestrian surface surveys, spot checks, subsurface tests, and excavation tests. Drive-through surveys involved frequent pedestrian linear or spot survey checks at locations determined to have high archaeological potential and/or good ground exposure. Determination of archaeological potential for landforms was based on discussions with band members, terrain associations with currently known sites from the background review, and general boreal forest site location knowledge.

A detailed description of the archaeological survey and survey results is found in an accompanying volume (Gibson et. al. 1997). The following sections (2.0 to 4.5) originally appear in that volume, but are duplicated here for convenience of the reader.

2.0 Project Location

The Mackenzie Timber Supply Area (TSA) is located in northcentral British Columbia (Figure 1). Six forestry Operating Areas (OA’s) were selected as target areas for detailed archaeological survey at the first steering committee meeting in July. These target areas included Buffalo Head, Davis-Ospika, Finlay River West, Mesilinka River/Chunamon, Blackwater, and the Philip Operating Areas (Figure 1). The preliminary review of satellite imagery and initial field survey work provided some basis for re-evaluation of these target areas. It was decided that it would be worthwhile to undertake further general overviews of additional forestry OA’s, particularly if they were adjacent to the original target areas. This approach provided a larger sample and included more extensive survey data from a greater range of topographical areas within the Mackenzie TSA.

3.0 Archaeological Resource Inspection Approach

The modeling approach taken for the Mackenzie AOA project incorporated a field-based overview survey in order to provide ground truth data for development of an archaeological predictive model.
Figure 1: Mackenzie Timber Supply Area Location and Forestry Operating Areas.
for the Mackenzie TSA. The survey strategy was focused on conducting archaeological inspections of terrain with good exposure characteristics so that archaeological remains could be readily detected if they were present in an area. The general survey approach involved “drive-through’s” of target areas to assess their general exposure and overall archaeological resource potential for the target areas. Suitable localities were then given more detailed inspection, as described below. Ground truth survey data and discussions with First Nations provided additional information which modified and supplemented the preliminary target approach.

After a drive-through inspection, pedestrian spot checks and detailed linear surface surveys were undertaken in localities with good exposure and/or with high archaeological potential. Detailed survey approaches varied depending upon the extent and type of exposure, soil type, and the overall topographic locale. Exposed areas were surveyed using pedestrian transects spaced between 10 m and 20 m apart. If an archaeological resource was identified, survey transects were refined to between 1 m to 5 m apart. It was observed that archaeological lithic materials in the region were dominated by black and grey basalts, siltstones, and obsidian. The basalt and siltstone materials blended in with the ground surface making their observation difficult.

Portions of forestry cut blocks and secondary roads were pedestrian-surveyed because these impacted areas often contained good exposures of the local terrain. Stockpile and wood loading areas afforded some of the best exposures within the cut blocks and provided good areal exposures with minimum overburden disturbance. The narrower linear exposures provided by ditches of graded roads provided less good exposure because of the heavy subsurface impact they usually sustained. Sometimes drag trails and cleanup activities in cutblocks exposed topographic features with higher archaeological potential. These features accordingly received more intensive pedestrian survey. On the shoreline of Williston Lake, forestry installations such as log clumps and barge loading points provided substantial areal exposures for pedestrian surveys (Figure 2). In addition, permanent and temporary camp grounds, bridge crossings, exposed beaches associated with creeks or rivers, and natural/construction cut profiles were investigated with walkover inspections.

Infield determination of high archaeological potential was based on the experience of the field personnel in associating topographic relief using archaeological site location concepts derived from similar locations. High heritage potential locations were identified for terraces and ridges adjacent to lakes, rivers and creeks, and at confluences of creeks and rivers. The inlets and outlets of tributaries associated with lakes were considered to have high archaeological potential as well. Localities which provided visual overviews of open swamps, valleys or lakes were also considered to have high heritage potential because these locations may have been used as hunting stands or

Figure 2. Pedestrian survey of the exposed beach at Corless Bay, Chunamon Forestry SA.

**Western Heritage Services Inc.**
routes for trails. Evidence of previous habitation or human passage in an area also represented high heritage potential. In many localities, traditional use sites were encountered, and these were inspected, photographed and their locations recorded using a Global Positioning System receiver (GPS), with an estimated accuracy of between 50 and 100 m. Also, existing trails were often followed from the edges of roads into forest, sometimes for several km. While surface exposure in traditional use camps was usually good, along the trails exposure was often poor, and only spot locations provided natural subsurface soil visibility. Some trowel testing was made along a few trails, but this kind of slow testing was rarely undertaken. Trail location recording was somewhat problematic, especially in forested conditions where GPS accuracy was seriously degraded under tree canopy. Trail locations were usually sketched on maps, but their locational accuracy remains somewhat general.

Several discussions with First Nation peoples provided specific information on old camp areas, historic cabins, trails, burials and cemeteries. These contemporary-use and traditional-use heritage sites were also visited, surface inspected, photographed and their locations recorded, where they could be relocated. However, no subsurface testing was undertaken out of respect for First Nation people's contemporary-use areas. In several cases it was ascertained that these contemporary or historical trails and camp areas did have some antiquity. For example, it was often noted that remnant cabin outlines or depressions were in the vicinity of more recent cabins, and in other situations precontact archaeological surface finds or features were associated with old historic trails. Unfortunately, the short field time involved in this archaeological overview assessment did not provide ample time for detailed mapping of many contemporary-use heritage resources, such as cabins and trails.

In some localities subsurface tests (40 x 40 cm in size) were employed to assess areas with good heritage potential but limited exposure. These tests were conducted along terraces, ridges, a few sandy pine covered localities, at moss covered hearth outlines, and at some surface artifact find spots. These tests were made based on a judgmental or a systematic approach using a shovel or trowel. Also, an uncontrolled subsurface sampling approach involved routine checks of tree falls, rodent burrows, and cut banks by trowelling through the loose soil or exposed mineral soil horizons. When variable exposure existed at a high potential locality, judgemental subsurface testing was employed in areas of poor exposure. If a locality had high archaeological resource potential and poor overall exposure a systematic subsurface testing approach was employed. Systematic testing usually involved tests being placed approximately 50 m apart, and oriented parallel with a terrace or road. Some systematic testing would consist of two or three linear rows test pits of varying lengths, depending upon the size and potential of the local ground topography. The details of judgmental and systematic assessment approaches were documented in field notes for each locality. When possible, a 6 mm mesh screen was used for sifting the excavated soil. If wet or organic soil conditions would not allow screening of the soil, careful observations were made while trowelling through the loose soil matrix.

As previously mentioned, any identified sites were located using a GPS. Information for each heritage or archaeological site was systematically recorded in field notes and then placed on B.C. Archaeological Site Inventory Forms. The general catalogue and analyses of collected archaeological materials employed standard methods that are used by Western Heritage Services Inc., and...
which conforms to standards set by B.C. Archaeology Branch.

During the relatively short field assessment program, it is estimated that approximately 5,000 square km of land were observed by drive-throughs of 16 forestry supply areas in the Mackenzie TSA (Figure 1). This included an estimated 1733 km of road and trail transect surveys, and 1269 ha of ground inspected (Appendix C/1 and C/2; Appendix D, Figure D-10). Nevertheless, the visited supply areas comprise less than 0.1 percent of the entire Mackenzie TSA. During the drive-throughs, spot checks and detailed surveys were made of areas of varying habitation potential, where accessibility was available from the access routes. As such, these archaeologically assessed areas are effectively a fraction of a percentage of the visited supply areas. Therefore, the assessment program did not come anywhere near demonstrating the archaeological potential of the region, and could not be expected to even if the same level of archaeological survey were maintained for many years. Nevertheless, the field program did provide valuable ground truth data which served as the basis for defining and calibrating the variables used for designing the heritage potential model for the TSA.

4.0. Background Environmental and Historical Research Review

4.1 Environmental Overview

The study locality is situated within a geographic feature known as the Rocky Mountain Trench, located in north central British Columbia. The trench was formed by the near-convergence of the Rocky Mountains on the east, and the Omineca and Cassiar Mountain ranges on the west. Several principal rivers flow through this narrow, elongated lowland. The Parsnip River enters from the south. The Finlay River flows from the north, intersecting the Parsnip at Finlay Forks. The intersecting rivers create the Peace River, which exits to the east through the Rocky Mountain range onto the northern plains of northwestern Alberta. North of the Finlay are the Fox River, and north again the Kechika River, whose source is less than 50 km from the Yukon border. The construction of W.A.C. Benett Dam on the Peace River northwest of Hudson’s Hope in the mid 1970’s, caused the Parsnip, Finlay, and Peace Rivers to crest their banks and create an enormous reservoir called Williston Lake. This artificial lake extends from a few km north of McLeod Lake in the south to the Tsay Keh Dene Band’s village on the Finlay River, occupying over one third of the trench area.

The Parsnip and Finlay River valleys in the Williston Lake area are between 8 and 25 km wide. Before inundation, the valley floors were flat or slightly rolling, broken by the meandering river systems. Back from the valleys, the mountains rise steeply, especially along the tributary rivers, which are characterized by swift flowing, relatively narrow channels, forming occasional canyons. A few have well-defined terraces which may have provided good areas for camp sites or trails. The soils of the region are predominantly silty clay (derived from mountain shales), which tend to retain moisture, and in general offer less than ideal drainage. Only a few terrace locations exhibit sandy soil characteristics and these are considered to be areas of higher archaeological potential.

White spruce, poplar and birch dominate the lower portions of most of the valleys. The forest vegetation in the lower valleys maintains a fairly dense understory, with numerous tree-throws. Foot travel in these areas is difficult. The easiest travel routes appear to be along the terrace edges of major rivers and streams, and nearly all such waterways with developed terraces are bordered by
existing trapping and game trails. The higher slopes are more open, with less undergrowth. They are dominated by black pine and subalpine fir (see MacKinnon et al. 1992).

Moose, black and grizzly bears, wolves, wolverines, beaver, otter, muskrat, fishers, ermine, lynx, mink, rabbit and squirrels inhabit the valleys. Higher altitudes harbour caribou, goats, sheep, marten, and deer. Blue grouse are also found in higher elevations. Rivers contain whitefish, trout, arctic grayling and ling. In 1793, Alexander Mackenzie reported herds of bison and elk in the region as well, however, these were soon extinct from the area (see McGhee 1963:9; Morice 1978:39).

4.2 Precontact Historical Overview

The geologic-climatic episodes of the late Quaternary for the Rocky Mountain Trench region begin with the Olympia Nonglacial Interval which occurred from 60,000 to 26,000 years ago. The Fraser Glaciation in this region is divided into the Early Portage Mountain Advance, Late Portage Mountain Advance, and Deserters Canyon Advance. These episodes range between 26,000 and 9,000 years ago. A postglacial period follows soon after 9,000 years ago. This postglacial time is the presumed period of earliest aboriginal occupation in the region. However, interpretation of the Quaternary geological history for the region is far from complete, and recent refinement of dating techniques may revise and update theories on glaciations, interglacials, and nonglacial intervals (Clague 1981). The original inhabitants of the Rocky Mountain Trench at the time of Euro-Canadian contact were the Sekani, who arrived in the area in the middle of the 18th century (Lanou 1992: 1). Despite being relatively recent newcomers to the region, there is ample evidence of their occupation in the form of existing settlements, old trails, camping areas, and a fairly rich oral history which has been passed down from grandparent to grandchild. This oral tradition includes descriptions of historic meeting places, personal trapping localities, and family settlement localities which suggest the area was well-used, despite evidence which suggests that the Sekani population was never very large (Denniston 1981).

There is some evidence of pre-Sekani habitation of the trench, but there has been very little actual archaeological survey of this area. Surveys of the Williston Basin Reservoir impoundment area (principally at or below the 2200 foot contour interval) found few sites, even though historic trails followed at this elevation along the Finlay and Parsnip River valleys. McGhee’s (1963: 12) survey of the Finlay and Parsnip Rivers prior to inundation revealed only 17 sites, 16 which are considered to be precontact. He attributed the remains to be early Sekani, even though no historic trade materials were found on the sites (McGhee 1963:20). He suggested that there would be a greater chance of finding sites away from the rivers, in the uplands, especially around lakes. Near the rivers, habitation would be most likely found on well-defined terraces situated above the planned reservoir full-supply zone, where foot travel was easier.

The precontact cultural history of the region is virtually unknown. A very generalized cultural historic outline of the region has been derived from ethnohistorical accounts, cultural chronologies of neighbouring regions, and educated speculations (Figure 3; also, see Fladmark 1986). The earliest people in the area were part of the PaleoIndian Period, entering the area during postglacial times. These peoples maintained a fairly distinctive material culture. For example, Fladmark (1981) identified stemmed and lanceolate shaped spear heads from the Peace River headwaters of the Ft. St. John area. Some of these early materials are part of the Cody-Alberta complex that are
Figure 3. Provisional Cultural-Historical Sequence for North Central British Columbia. (adapted from Ramsay (1996)).
associated with the northern Great Plains between 6,000 and 9,000 years ago. Other early material cultures from the neighbouring Cassiar district include unifacial and blade tool assemblages which are associated with excavated contexts that may predate 9,000 years ago (Smith and Harrison 1978: 116-120).

The Archaic Period for the region has been identified after 6,000 years ago. It was typified by a greater variation in material culture. This included a broad range of projectile point styles, part of a generally diverse tool kit. Spear head styles included large side-notched projectiles points, as well as lanceolate shaped, stemmed, and corner-notched styles. The dominant boreal forest cultural complex during this period is called the Shield Archaic (Wright 1981). Other archaeological cultures identified further north and west reflect arctic adapted stone tool technologies, such as the manufacture of blades, microblades, and specialized blade cores, indicating that neighbouring cultures influenced the boreal cultures of the north central BC interior, where such artifacts are found in lesser abundance. The Parsnip-Finlay-Peace drainage system is part of the Arctic Ocean watershed. Consequently, there never was a seasonally abundant salmon supply which provided such a major influence on interior BC First Peoples who lived on Pacific drainages.

Late precontact cultures in the Finlay-Parsnip-Peace region, like earlier ones, continued to be influenced by precontact cultures from the southern interior of BC, the northwest coast, the Arctic, and from the northern Plains. During the Proto-European contact period, territorial movements of the Beaver-Sarcee-Sekani groups of Athapaskan peoples within the region were common (Denniston 1981). Ethnohistoric and historic records provide some documentation of the Sekani bands and their territories during historic times (see Black 1955; Harmon 1957; Ingram and Harris 1972; Innis 1970; Mackenzie 1970; McDonald 1872; McLean 1849; McLeod 1971; Morice 1906).

4.3 Discussion of Precontact Archaeological Site Data

A review of the BC Archaeological Site Inventory identifies a number of archaeological sites that have been recorded in the region (Table 1; Appendix D). However, the majority consist of late historic cabins, recorded as part of a general inventory of local land use several decades ago. As well, local people have reported obvious precontact artifacts from the Williston Lake (including the north Finlay River) region, some from areas that have not been officially recorded in the provincial inventory.

As previously discussed, very little archaeological work has been undertaken in the Mackenzie TSA region and archaeologists have yet to adequately document the culture history of the area. However, from the data that are known, general comparisons can be made with studies from adjacent regions and possible artifact assemblage relationships can be made between Mackenzie TSA region and elsewhere in British Columbia.

A recent article by Ian Wilson (1996: 29-34) briefly addressed the recoveries from several PaleoIndian sites in the vicinity of Pink Mountain, located 150 km east and northeast of the study area. In general, materials from these sites are similar to materials recently recovered by Ramsay from the Davis River, Ospika Point and Tsay Keh Dene village localities in the Williston Lake region of the TSA. Pink Mountain locality materials included a microblade core, side-notched projectile points, lanceolate leaf-shaped points, large stemmed points, and laterally retouched macroblades.
<table>
<thead>
<tr>
<th>Borden</th>
<th>UTM</th>
<th>Easting</th>
<th>Northing</th>
<th>M a r ,</th>
<th>Culture</th>
<th>Site p e</th>
</tr>
</thead>
<tbody>
<tr>
<td>GfR-1</td>
<td>10UDR</td>
<td>497512</td>
<td>6093865</td>
<td>93/14/1</td>
<td>Precontact</td>
<td>Surface;</td>
</tr>
<tr>
<td>GfR-2</td>
<td>10UDR</td>
<td>497512</td>
<td>6093865</td>
<td>93/3/14</td>
<td>Postcontact;</td>
<td>Trading Post;</td>
</tr>
<tr>
<td>GgR-1</td>
<td>506997</td>
<td>5992181</td>
<td></td>
<td>93/0/2</td>
<td>Postcontact;</td>
<td>Trail;</td>
</tr>
<tr>
<td>GgR-2</td>
<td>492578</td>
<td>6180553</td>
<td></td>
<td>93/0/3</td>
<td>Precontact</td>
<td>Surface; Isolated; Lithics;</td>
</tr>
<tr>
<td>GhR-1</td>
<td>491862</td>
<td>6114242</td>
<td></td>
<td>93/0/3</td>
<td>Precontact</td>
<td>Surface; Isolated; Lithics;</td>
</tr>
<tr>
<td>GhR-2</td>
<td>488782</td>
<td>6120771</td>
<td></td>
<td>93/0/3</td>
<td>Precontact</td>
<td>Surface; Isolated; Lithics;</td>
</tr>
<tr>
<td>GiR-1</td>
<td></td>
<td></td>
<td></td>
<td>93/0/6</td>
<td>Precontact</td>
<td>Surface; Isolated; Lithics;</td>
</tr>
<tr>
<td>GgSb-1</td>
<td></td>
<td>417188</td>
<td>6114109</td>
<td>93/1/1N</td>
<td>Precontact</td>
<td>Cache;</td>
</tr>
<tr>
<td>HaRp-1</td>
<td>10VET</td>
<td>526921</td>
<td>622292 1</td>
<td>94/1/2</td>
<td>Precontact</td>
<td>Surface; Lithics; Detritus;</td>
</tr>
<tr>
<td>HaRp-2</td>
<td>10VET</td>
<td>52783 1</td>
<td>6223638</td>
<td>94B/2</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HaRs-1</td>
<td>10VET</td>
<td>557700</td>
<td>6212155</td>
<td>94B/3</td>
<td>Natural</td>
<td>Palaeontological</td>
</tr>
<tr>
<td>HeSc-1</td>
<td></td>
<td>412602</td>
<td>6253355</td>
<td>94C/8</td>
<td>Postcontact;</td>
<td>Trading Post; Cabin;</td>
</tr>
<tr>
<td>HdSd-1</td>
<td></td>
<td>3998 10</td>
<td>6277764</td>
<td>94C/10</td>
<td>Precontact; Postcontact;</td>
<td>Surface; Lithics; Historic</td>
</tr>
<tr>
<td>HeSe-1</td>
<td></td>
<td>397856</td>
<td>6281523</td>
<td>94C/15</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HeSe-2</td>
<td></td>
<td>381903</td>
<td>6295708</td>
<td>94C/15</td>
<td>Precontact</td>
<td>Surface; Isolated; Lithics;</td>
</tr>
<tr>
<td>HeSe-3</td>
<td></td>
<td>382421</td>
<td>6296003</td>
<td>94C/15</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HeSg-1</td>
<td></td>
<td>382366</td>
<td>6297087</td>
<td>94C/15</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HeSg-2</td>
<td></td>
<td>369376</td>
<td>6280625</td>
<td>94C/11</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HeSg-3</td>
<td></td>
<td>372577</td>
<td>6290568</td>
<td>94C/11</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HeSh-1</td>
<td></td>
<td>366255</td>
<td>6284267</td>
<td>94C/11</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HeSh-2</td>
<td></td>
<td>366255</td>
<td>6284267</td>
<td>94C/11</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HeSh-3</td>
<td></td>
<td>366255</td>
<td>6284267</td>
<td>94C/11</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HeSi-1</td>
<td></td>
<td>349170</td>
<td>6292274</td>
<td>94C/14</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HfSf-1</td>
<td></td>
<td>381128</td>
<td>6304238</td>
<td>94C/15</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HfSf-2</td>
<td></td>
<td>257146</td>
<td>6393317</td>
<td>94E/11</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HfSf-3</td>
<td></td>
<td>421602</td>
<td>6253346</td>
<td>94C/15</td>
<td>Precontact</td>
<td>Surface; Lithics;</td>
</tr>
<tr>
<td>HgSg-1</td>
<td>10VCT</td>
<td>371183</td>
<td>6322740</td>
<td>94F/3</td>
<td>Postcontact;</td>
<td>Log Cabin; Cache;</td>
</tr>
<tr>
<td>HgSg-2</td>
<td>10VCT</td>
<td>371621</td>
<td>6325561</td>
<td>94F/3</td>
<td>Postcontact;</td>
<td>Cabin; Cache;</td>
</tr>
<tr>
<td>HgSg-3</td>
<td>10VCT</td>
<td>372023</td>
<td>6324929</td>
<td>94F/3</td>
<td>Postcontact;</td>
<td>Surface; Refuse;</td>
</tr>
<tr>
<td>HgSg-4</td>
<td>10VCT</td>
<td>373277</td>
<td>6321827</td>
<td>94F/3</td>
<td>Postcontact;</td>
<td>First Nations; Grave House</td>
</tr>
<tr>
<td>HhS1-1</td>
<td>10VCT</td>
<td>358770</td>
<td>6341762</td>
<td>94F/3</td>
<td>Postcontact;</td>
<td>Cabin; Depression</td>
</tr>
<tr>
<td>HhS1-2</td>
<td>10VCT</td>
<td>357376</td>
<td>6342739</td>
<td>94F/3</td>
<td>Postcontact;</td>
<td>Cabin;</td>
</tr>
<tr>
<td>HhS2-1</td>
<td>10VCT</td>
<td>352688</td>
<td>6347856</td>
<td>94F/3</td>
<td>Postcontact;</td>
<td>Cabin; Surface; Refuse;</td>
</tr>
<tr>
<td>HhS3-1</td>
<td>10VCT</td>
<td>354765</td>
<td>6349639</td>
<td>94F/6</td>
<td>Postcontact;</td>
<td>Cabin;</td>
</tr>
<tr>
<td>HhS5-1</td>
<td>10VCT</td>
<td>352871</td>
<td>6352956</td>
<td>94F/6</td>
<td>Postcontact;</td>
<td>Surface; Refuse;</td>
</tr>
<tr>
<td>HhS6-1</td>
<td>10VCT</td>
<td>351834</td>
<td>6351136</td>
<td>94F/6</td>
<td>Postcontact;</td>
<td>Cabin;</td>
</tr>
<tr>
<td>HhS7-1</td>
<td>10VCT</td>
<td>351773</td>
<td>6355007</td>
<td>94F/6</td>
<td>Postcontact;</td>
<td>Log Cabin;</td>
</tr>
<tr>
<td>HhS8-1</td>
<td>10VCT</td>
<td>353002</td>
<td>6330929</td>
<td>94F/6</td>
<td>Postcontact;</td>
<td>Log Cabin;</td>
</tr>
<tr>
<td>HhS9-1</td>
<td>10VCT</td>
<td>347411</td>
<td>6348049</td>
<td>94F/5</td>
<td>Postcontact;</td>
<td>Log Cabin; Surface; Arborlyph; FORT;</td>
</tr>
<tr>
<td>HhS1-1</td>
<td>10VCT</td>
<td>341463</td>
<td>6350694 1</td>
<td>94F/5</td>
<td>Postcontact;</td>
<td>Log Cabin; Surface; Arborglyph; FORT;</td>
</tr>
<tr>
<td>HhSj-1</td>
<td>10VCT</td>
<td>341882</td>
<td>6367759</td>
<td>94F/5</td>
<td>Postcontact;</td>
<td>Surface; Lithics; Historic; Trail;</td>
</tr>
<tr>
<td>HiSt-4</td>
<td>10</td>
<td>240359</td>
<td>6370139</td>
<td>94E/6</td>
<td>Postcontact;</td>
<td>Historic; Trail;</td>
</tr>
<tr>
<td>HiSu-1</td>
<td>10</td>
<td>231752</td>
<td>6376217</td>
<td>94E/6</td>
<td>Postcontact;</td>
<td>Subsurface; Surface; Refuse;</td>
</tr>
</tbody>
</table>

Table 1. Summary of major previously recorded archaeological sites in the Mackenzie TSA.

Western Heritage Services Inc.
A review of known site data distributions sheds little light on the human habitation characteristics of the Rocky Mountain trench in this region, or in areas beyond (Appendix D, Figure D-2 to D-10). Site clusters are evidently related to the intensity of archaeological survey; in the absence of regional study, there are simply no data. For example, intensive survey on the far west reaches of the Finlay River resulted in the identification of several dozen sites (at least half with precontact remains, Appendix D, Figure D-3). Elsewhere, intensive survey along the Finlay River identified at least a dozen sites, but all were postcontact in age, a function of the apparent ethnographic survey that was conducted there. The first precontact sites were discovered during this AOA project. McGhee discovered a cluster of sites at Ingenika Point during his pre-flood survey, and a few along the reservoir boundary, but it is apparent from the present project that many more were missed because they were located on terraces well back and above the river, which now represent the fluctuating shoreline of Williston Lake.

As a consequence there is such a paucity of precontact archaeological information from the Mackenzie TSA region that it is in fact difficult to compare the local archaeological recoveries to regions that have received more intensive study. Any detailed interpretation awaits discovery of many more sites, especially sites used for longer term habitation or which contain sufficiently diverse artifact assemblages to enable comparisons with more complex sites found elsewhere in the British Columbia interior.

### 4.4 Postcontact Archaeological Overview

Postcontact historical records provide fairly good documentation of Euro-Canadian entry into and settle of the region. Alexander MacKenzie passed through the Peace River valley on his way toward the Pacific in 1793 and met the bands that were living along the Parsnip River and at McLeod Lake (Mackenzie 1970: 286). Simon Fraser undertook a journey through the region in 1805-1806. He established a post at the Rocky Mountain Portage in 1905. He also aided La Malice and James McDougall in founding the McLeod Lake Post in 1805 and the Stuart’s Lake Post in 1806 (Morice 1906 [1978]:53-60). Daniel Harmon managed the Stuart’s Lake Post and chronicled...
his experiences between 1800 to 18 16. Samuel Black explored the upper reaches of the Finlay River in 1823-24. Archibald McDonald and George Simpson travelled through the area in 1828 on their trip to the west coast. The McLeod Lake Post was maintained through the remainder of the 1800s to present day. Grahame Post was occupied between 1891 to 1922, and the Liard Post between 1904- 1911 (see the Hudson Bay Company Archives, Winnipeg). Diamond Jenness (1937) carried out ethnographic studies of the Sekani people over 4 weeks in 1924.

Gold discoveries reported in the Omenica area in 1860 initiated a gold-rush which peaked in the early 1870s. Placer mining continued with sporadic and poorly reported discoveries, until larger companies moved in and began controlling the mining developments. In 1898 the new Klondike and Yukon goldrush drew some prospectors and miners away from the region. However, placer and hardrock mining continued in the Omenica area during the early 1900s in spite of difficulties transporting materials and equipment into the region. Mining activities resurfaced with the introduction of new technologies and economic changes in the early to late 1930s. Some of this work resulted in large projects such as flume construction in the Germansen and Manson Creek localities (see Hall 1978, 1994). Some of these latter constructions are still extant (Figure 4).

4.5 Ethnography Overview

In the west the Subarctic culture area extends from the northern MacKenzie lowlands south to the Rocky Mountain chain, which in turn gives way to the Yukon Plateau and the British Columbia Plateau (Waldman 1985: 41). Within this region subarctic people are divided into two primary linguistic groups: in the west are the Athapascans, with the Algonquians in the east (ibid: 42). Culturally, Athapascan tribal groups are categorized by their range of traditional land use. The Athapascan groups within the MacKenzie TSA are the Sekani and Carrier since their traditional territory encompasses the majority of this region. However, the Beaver, located to the east, would have had a substantial influence within this area.

The aboriginal people of the Subarctic had to cope with long, harsh snow laden winters, as well as short summers that were plagued with clouds of mosquitoes and black flies (Waldman 1985: 42). Sparse Subarctic resources dictated that only a low level of political or individual control could be maintained over food harvesting and stored supplies (Clark 1991: 69). Since all First Nations exploited a succession of animal and supplementary plant foods, nowhere could they live year round in one place (McClellan and Denniston 1981: 375).

Athapascans were nomadic, hunting, fishing, and foraging in small bands united by dialect and kinship (Waldman 1985: 42). Survival in the Subarctic required a well established seasonal round and firm understanding of the cycle of subsistence activities and related travel. People had to be at the right place at the right time to find migrating game or intercept a run of fish (Clark 1991: 69). Life literally revolved around the seasonal migration of game that included caribou, moose, musk oxen, deer, beaver, mink, hare, otter and porcupine. Fish and wildfowl also helped provide the necessary nutrition to live in a relatively severe environment (Waldman 1985: 42). At every opportunity, groups of Sekani moved into salmon country and exploited this relatively rich resource. However, streams in Sekani lands within the Mackenzie TSA were part of the Arctic drainage and thus devoid of salmon. Fish available to the Sekani were largely whitefish, trout, and suckers (Denniston 1981: 436 ).
Within the Subarctic environment, it was the subsistence lifeway of the Athapascans that most influenced their settlement patterns, although the presence of hostile or friendly neighbours could also be important (Clark 1991: 69). Athapascan’s shared the same basic cultural forms and way of life (Helm 1965: 363), which partly reflected the rugged environments to which they had adapted over the centuries (McClellan and Denniston 1981: 372). Patterns and techniques of subsistence used in marginal areas tended to persist through time and to be shared between peoples (Clark 1991: 69). The concept of individual ownership of land was not developed and the group monopolized hunting territories and fishing sites only during their period of seasonal use (Tobey 1981: 418).

What justified the Subarctic social structure adopted by the Athapascans was the unity of the physiographic block in which the people lived, and their distinctive subsistence and deployment patterns, which combined big and small game hunting with fishing and some gathering into an annual round of high mobility. Because of the constant fission and fusion, the sizes of local groups at any particular time varied greatly (McClellan and Denniston 1981: 373, 374) depending on the resources of their areas (Denniston 1981: 434). Although a local group might consist of a single extended family (Goldman 1940: 334-335; McClellan and Denniston 1981: 374), more often two or three families camped and traveled together. All households usually met during some part of the year even though they did not always stay together. Others who joined the group for hunting, fishing, or trading had to validate their presence either through primary kin ties or by setting up a formal partnership with someone in the band (McClellan 1975: 13-16; McClellan and Denniston 1981: 374).

Helm and Damas (1963: 11) note that the factors in the increasing sedentation and stabilization of the base community in the Subarctic have been primarily technological and economic in nature. The prime force was the introduction of the fur trade and access to new technology. However, although the exact aboriginal subsistence patterns of the subarctic cannot be known before the effects of the Euro-American fur trade were being felt, it is known that well into the nineteenth century seasonal movements appear to have continued to be dictated more by the availability of food and traditional social interests of the First Nations than by the goal of trapping furs (McClellan and Denniston 1981: 375). As long as the area remained in relative isolation the annual round continued to be followed despite the increased trapping of fur animals. But the 1858 gold rush upset this pattern, with the most serious consequences occurring among the Southern Carrier whose easternmost lands contained the Caribou gold fields.

There is strong historical evidence to indicate that the Carrier and Sekani Athapascan groups occupied the Mackenzie TSA region for a considerable period of time prior to the contact period. For example, in May 1793 Alexander McKay ascended the Parsnip River, noting several herds of elk and bison, which have since disappeared from this area, and on the 9th of June met his first party of Sekani’s. The Sekani’s had heard of Europeans, but having never seen any, immediately took to flight. Morice (1978: 38) notes that when McKay sent men to “parlay” they were received with the brandishing of spears, the display of bows and arrows, and loud outcries. Once their fears were dispelled McKay inquired into their possession of iron work. He was told they got it from people (the Carriers) who lived up a large river (the Fraser), who in turn got it from the Coast Indians. This reference places the Sekanai in their traditional territory in a historical context and it is one of the first references to the Fraser and the Carrier Indians. In fact, there are numerous references to the Sekani and Carrier in this region historically. Of particular note is a reference by Simon Fraser, who in 1805 left the Rocky Mountain Portage Post and led an expedition as far the Pack River, a
tributary of the Parsnip River. He entered this stream and ascended until he came in view of a
narrow lake, seventeen miles long, which he named McLeod Lake. There on a peninsula formed
by a tributary, Long Lake River, and its outlet, by latitude 55° 0' 2" north, he founded the first
permanent post ever erected within British Columbia, that of Fort McLeod (Morice 1978: 54).
Morice (ibid.) notes that Fraser established this post to accommodate the trade with the Sekani Indians,
and for a short time it even served as a supply house for the forts later established among the Carriers.

In terms of archaeological correlation to the Sekani and Carrier within the Mackenzie TSA, the
absence of pre-contact research within this region is marked and any direct correlation between the
recovered archaeological materials and First Nations groups known to occupy and use the area
historically is tenuous. Undoubtedly, the material remains of the historic Sekani and Carrier are
scattered throughout their traditional territory. Whether or not cultural continuity can be declared
for these groups and earlier precontact sites remains to be proven. However, it is not surprising that
the archaeological sites located to date tend to correspond with the numerous drainage systems, in
particular the Parsnip River drainage, as these routes would have been used extensively as travel
corridors and during seasonal movements by both the Sekani and Carrier.

5.0 Development of the Mackenzie TSA Heritage Potential Model

5.1 Introduction

Heritage potential modeling has been used for forestry management in Canada for about 5 years.
Pioneering work in this area was undertaken simultaneously in Northwestern Ontario (Dalla Bona
1994, 1995) and Central Saskatchewan (Finnigan and Gibson 1993; Finnigan et. al. 1995). The
Northwestern Ontario Centre for Archaeological Resource Prediction studies were designed to
determine if sites could be reliably predicted in boreal forest situations. The Saskatchewan project,
referred to as CRIMP (Cultural Resources in Integrated Management Planning) focused on designing
strategies for applying heritage potential models to forestry management processes, so that
heritage resources could be protected from inadvertent damage through forestry practices. Both
studies succeeded in developing GIS-based predictive models of heritage potential for their respective regions. The Ontario modeling approach was incorporated into a government forestry management plan that is gradually being applied to the entire forested region of the province. The results of the CRIMP model are currently being used for screening heritage impacts from forestry development virtually all of the commercial forest zone of Saskatchewan.

Although both modeling projects were similar in concept and execution, the CRIMP project will be
discussed in detail here, since it is probably most relevant to the Mackenzie TSA. The CRIMP model was based on a series of mappable parameters which permitted a number of hypotheses to be tested, and was self-correcting because it could be refined each time new survey data were acquired. For the CRIMP project, six target areas 10 x 10 km in size were used to develop and test the model. Each of these target areas was archaeologically surveyed on multiple occasions and the new survey data were used to test previous model predictions. Although it was originally anticipated that multiple models might be required, a single model, called the West Central Saskatchewan Commercial Forest Model (WCSCFM), was developed and subsequently applied across the entire CRIMP study area, estimated to be at least 6 million hectares in extent.
The WCSCFM (Finnigan et al. 1995) defined heritage potential as the average number of sites per square km. The more sites that could be found per square km within a given area, the higher the heritage potential that would be assigned to that area. The WCSCFM did not predict the actual location of archaeological sites, only whether a particular landform had a potential to contain these sites. The WCSCFM proved to be quite powerful. It predicted that, in general, 7% of the total landscape within any given portion of the forested region of west central Saskatchewan had no heritage potential and 63% of the landscape could be considered low potential for archaeological site occurrence. Less than 23% of the landscape had moderate heritage potential, and only 7% of the landscape exhibited high heritage potential.

The goal of the Mackenzie AOA project was to transfer the field methodologies and modeling procedures used in the CRIMP study to the Mackenzie TSA, producing a heritage potential model which could also serve as a means of determining if proposed forestry developments would take place in areas of high heritage potential. A major limitation to the process was the lack of archaeological data which could be applied to the model in order to calibrate its accuracy for the specific region it was to be applied to. Limited archaeological survey was undertaken in a number of areas within the TSA in the fall of 1996 to acquire some baseline comparative data (see Part 1 of this report). The actual modeling program was begun in March, 1997, with the acquisition of suitable data sets to create the model for the TSA. The modeling program was largely completed in June, 1997, with final adjustments taking place in July and August, 1997.

5.2 The Modeling Procedure

Archaeological potential modeling is a process in which a given parcel of land is assigned some measure of probability of finding archaeological remains in that location. There are many types of potential models that can be developed, ranging from explicitly stated “intuitive” models which individual archaeologists use to evaluate the chance that an archaeological site will be found in a particular location, to multivariate statistical models which assign probabilities to the heritage potential statements. The advantage of statistical models, including the modeling approach used in this project, is that it is easier to analyse each of the decisions which are used to evaluate heritage potential. These models are more systematic and therefore easier to apply than models built on personal intuition.

Multivariate statistical modeling was not considered for this project because there was insufficient existing site data to obtain a statistically reliable model result. Nevertheless, the approach taken here fits in well with a class of statistical models known as “logistic models” and it is possible to convert the current model to a logistic model in the future. Although the modeling approach adopted for this project is raster-based, and iterative in operation, it is also designed for easy GIS application. As a consequence, it is easy to update as new site data are acquired. It is believed that this raster modeling method represents the best approach for managing heritage impacts within the Mackenzie TSA, especially if the model can be coupled with an integrated heritage management approach that addresses forestry practices as they are currently undertaken in the Mackenzie TSA.

5.2.1 Data Processing Procedures

For the Mackenzie AOA project, a significant portion of the archaeological potential model was
built using provincially available TRIM landscape digital data. These data sets were available for almost all of the timber supply area in compressed archive format, and were provided by TimberWest, the lead proponent of this project. Some use was also made of LandSat satellite image data to supplement the information obtained from the TRIM data sets. This information was provided jointly by TimberWest and Western Heritage Services Inc.

The data set as a whole was too large to model as a single unit since each map layer ranged between 100 to 200 megabyte in size. For organizational purposes, the data were divided into 1:250 000 NTS map sheet sets. Although this made the data sets smaller in size and therefore more manageable, many of the GIS operations still took many hours to process for each map layer.

The modeling was carried out in a raster analysis package called Map Factory (Kirby 1996). It is based on the data model developed for the original Map Analysis Package by Dana Tomlin. The raster modeling format was chosen because past experience demonstrated that rasters were computationally efficient and easy to analyse at a cell (pixel) level. In addition, critical comparative data sets such as LandSat imagery were already available in raster format. Finally, because of their spatially discrete nature, heritage sites are particularly efficient to display as rasters.

Map Factory uses a scripting language to manage map processing, so a set of standardized model processing scripts were created in the application to analyze the many data sets and generate the eventual model. These scripts were processed for each of the data sets for each of the mapsheets. The standardized scripting method ensured that each of the model variables were processed in exactly the same manner.

TRIM data were de-archived, loaded into MicroStation 95 for inspection, then transferred to TNTMips for reprocessing and rasterizing into 30 m cells. This initial cell resolution was chosen because it matched the resolution of the LandSat data and had been used elsewhere with success. Also, while it is possible to re-sample the 30 m data to a larger cell size, it is not possible to re-sample to a smaller cell size, so the smaller, more computationally intensive, cell size was used. As will be discussed, a much larger cell resolution of 100 m was eventually found to be of sufficient accuracy for this study.

Some problems were found with the TRIM data. For example, the vertical resolution (elevation contour interval) was generally too large to capture the subtle landforms that often contain sites. There were also a number of noticeable errors discovered in the contour data and there are likely other, more subtle errors that could not be traced down. In the hydrology layers, there were problems in importing lakes as polygons and they had to be hand-edited for rasterization. As a consequence, hydrology polygons could not differentiated by types for this particular study, although it is possible that they can be more specifically identified in future modeling studies.

Map layers of slope, aspect, and hydrology were used as the primary raw data variables for model processing. With only limited information on the distribution of sites, the initial model followed the criteria used during the CRIMP study. Each model variable was assigned a value of either 3 (very important for site locations), 2 (moderately important for site locations), or 1 (not important for site locations). Areas which were not considered suitable for habitation under any conditions or where no archaeological sites could ever be found (for example, in the middle of water), were assigned a value of -3.

Western Heritage Services Inc.
5.2.2 Modeling: Criteria

5.2.2.1 Aspect

Aspect has been used elsewhere as a means of predicting the location of archaeological sites. Experience elsewhere in the boreal forest has shown that it is in fact a somewhat weak predictor (Finnigan et. al. 1995), and without good information on how existing sites are oriented, the classification of aspect used in this study was by necessity arbitrarily defined, and quite simple. Cells facing north were given the lowest ranking (assigned modeling value) while cells facing east were given the highest. The criteria ranking used was:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cells facing east, south, southwest</td>
</tr>
<tr>
<td>2</td>
<td>Cells facing southeast and west</td>
</tr>
<tr>
<td>1</td>
<td>Cells that are level or are facing north, northeast, northwest</td>
</tr>
</tbody>
</table>

5.2.2.2 Slope

Slope was generated by measuring the average change of elevation between adjacent cells. Since the TRIM data provided a relatively coarse contour interval (30 m), it was felt that the slope values might be biased towards higher slope values. Therefore, slope values as high as 30 degrees were accepted as possibly containing sites. The range of slope values was coded as follows:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>Cells with greater than 31 degrees slope</td>
</tr>
<tr>
<td>3</td>
<td>Cells with 0 to 10 degrees slope</td>
</tr>
<tr>
<td>2</td>
<td>Cells with 11 to 20 degrees slope</td>
</tr>
<tr>
<td>1</td>
<td>Cells with 21 to 30 degrees slope</td>
</tr>
</tbody>
</table>

5.2.2.3 Hydrology

The undifferentiated hydrology layer was spread into 100 m distance buffers back from individual stream courses and water bodies. Given the density of water over the modeling area, this produced a distance to the stream value for nearly every cell on a processed map sheet. For the initial model formulation it was felt that most sites would be relatively close to water and so this hydrology distance map was recoded with the following weights:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cells located from 1 to 300 m from water</td>
</tr>
<tr>
<td>2</td>
<td>Cells located from 301 to 500 m from water</td>
</tr>
<tr>
<td>1</td>
<td>Cells located from 501 to 1000 m from water</td>
</tr>
</tbody>
</table>
5.2.2.4 Slope Change

The digital elevation model was filtered with a high bypass filter to isolate areas of major slope change such as valley and terrace edges. A series of 100 m wide distance buffers were created back from these edges to a distance of 1000 m.

As in hydrology modeling, it was assumed that being closer to a landform edge was more important than being farther back from it. The landform edge was recoded as follows:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cells located from 1 to 100 m from a landform edge</td>
</tr>
<tr>
<td>2</td>
<td>Cells located from 101 to 200 m from a landform edge</td>
</tr>
<tr>
<td>1</td>
<td>Cells located more than 201 m from a landform edge</td>
</tr>
</tbody>
</table>

5.2.2.5 Terrain Character

For some of the map layers LandSat satellite imagery (30 m resolution, obtained in summer 1994) was used to provide additional data on terrain character, especially general soil conditions derived through vegetation classification. Two separate images were available, covering the southern two-thirds of the TSA. The classification that was made of the TSA is considered very preliminary, and its accuracy could only be determined by reference to a few forest cover maps and general topographic maps that were available at the time of classification. As a consequence, only about one third of the TSA could be classified with any confidence, and classifications with less confidence were rejected.

Terrain character classification provided information about the location of water, coniferous forest, mixed wood forest, deciduous forest, upland shrubs, wetlands, bare rock and ice. Although the classification varied somewhat by image, the classified data were recoded as follows:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3:</td>
<td>cells containing bare rock and ice</td>
</tr>
<tr>
<td>3:</td>
<td>Cells containing mixed woods, deciduous trees and meadows.</td>
</tr>
<tr>
<td>2:</td>
<td>Cells containing softwoods</td>
</tr>
<tr>
<td>1:</td>
<td>Cells containing all other classes (ie. cloud, shadow, unclassified, etc.)</td>
</tr>
</tbody>
</table>

5.2.3 Variable Processing

The actual first draft of the model used a simple mathematical tabulation where the values of each cell in each variable map layer were added together to form an individual cell heritage potential value. The result proved to be less than satisfactory along the edge of Williston Lake because the lake was large, artificial and tended to disrupt the range of map values. To accommodate this distortion, a simple fix was implemented. The contribution of cells close to water was multiplied by three (i.e. the water ranking became 3, 6, 9 instead of 1, 2, 3). This emphasized the importance of the lake edge, which in almost all cases was also an important landform edge.
The final draft of the map produced a range of potential values ranging from 1 to 21. These were sliced into 3 categories and defined as high, medium, and low heritage potential. The data could have been sliced as either high or low, but for visual interpretation, it is believed that three values work better. Analysis of similar models shows that as heritage potential values increase, so does the actual probability of finding sites. Where the line is drawn is between high and low heritage potential is more of a management decision than a modeling decision.

5.3 Initial Model Performance Analysis

Once a preliminary model was constructed, it was evaluated against the 1996 and earlier survey data and against some random spot checks made in areas found in the 93N and 930 NTS map sheets. The areas for spot checking were chosen because they provided good road access for field evaluation. A survey crew was provided with a heritage potential map of the region and told to drive to any areas with good exposures and evaluate the. Field crew were asked to make observations on the overall heritage potential.

The existing site data were checked against the model mapsheet, and against individual model variables. This provided an infiel test of the first run model performance.

5.3.1 Analysis Using Existing Data

Three mapsheets, 930, 94C and 94E, were represented by more than 10 heritage sites each, so a complete analysis was run on each of the model variables for them (Table 2). It was apparent from this table that some modification of the modeling coding was required. The worst fit was with the aspect data, which appeared to be a much stronger variable in the Mackenzie TSA than in other areas of the boreal forest. The remaining variables showed some correlation with the model coding chosen.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Sites</th>
<th>Slope Sites</th>
<th>Edge Sites</th>
<th>Water Sites</th>
<th>Vegetation Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>4</td>
<td>5</td>
<td>100</td>
<td>100</td>
<td>unclass</td>
</tr>
<tr>
<td>NE</td>
<td>4</td>
<td>10</td>
<td>200</td>
<td>200</td>
<td>softwoods</td>
</tr>
<tr>
<td>E</td>
<td>a</td>
<td>15</td>
<td>300</td>
<td>300</td>
<td>hardwoods</td>
</tr>
<tr>
<td>SE</td>
<td>a</td>
<td>20</td>
<td>400</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>9</td>
<td>25</td>
<td>500</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>SW</td>
<td>15</td>
<td>30</td>
<td>600</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>5</td>
<td>&gt;30</td>
<td>700</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td>NW</td>
<td>a</td>
<td></td>
<td>800</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>level</td>
<td>a</td>
<td></td>
<td>900</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>60</td>
<td>20</td>
<td>29</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 2. Analysis of distribution by model variables
With regard to the data from the three mapsheets, the distribution of sites by potential value was quite positive. Not only did the percentage of sites increase sharply with increased heritage potential values (Figure 5) but the overall density of sites correlated with this trend as well (Figure 6).

Figure 5. Density of sites by heritage potential zone.

Figure 6. Cumulative percentage of land area and archaeological site.
The cumulative distribution of land by heritage potential values also mirrored the distribution of sites within the TSA (Table 3; Figure 6). Sixty percent of the sites fell within only 40% of the land with the highest potential values. Essentially the space between the two curves in Figure 6 is a measure of the model efficiency.

The initial testing showed that the model had some validity, but suffered from a lack of comparative data. Not surprisingly, many sites were indeed located fairly close to water features. The term “water feature” was used because sites were located on terraces or along the edge of the valley along Williston Lake. Before the reservoir was built, these sites may have been situated a long way from the actual river channels, but they were located along the valley which is considered a water feature.

Unfortunately the presence of the reservoir confuses the modeling somewhat and the cell weighting alteration used to deal with this problem may unfairly bias the model in other regions beyond the reservoir. The presence of Williston Lake also increases the difficulty of interpreting the model because some of the variables that would be affecting site location are under water. The model could be improved by incorporating the original contour information, but it may just be as easy to create a better adjustment to the model. The LandSat images show areas where there are eroded beaches and shallow water; these tend to be upper terrace features. It may be possible to use seasonal low-water satellite data to improve the model performance.

<table>
<thead>
<tr>
<th>Potential Zone</th>
<th>ha</th>
<th>Sites</th>
<th>(Sites/ha)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>722.07</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>2</td>
<td>2693.43</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>3</td>
<td>8202.15</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>4</td>
<td>12007.8</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>5</td>
<td>67736.07</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>6</td>
<td>70835.04</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>7</td>
<td>83017.35</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>8</td>
<td>105750.72</td>
<td>1</td>
<td>0.9456</td>
</tr>
<tr>
<td>9</td>
<td>170024.31</td>
<td>1</td>
<td>0.5882</td>
</tr>
<tr>
<td>10</td>
<td>108166.68</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>11</td>
<td>108280.08</td>
<td>2</td>
<td>1.8471</td>
</tr>
<tr>
<td>12</td>
<td>169998.39</td>
<td>1</td>
<td>0.5882</td>
</tr>
<tr>
<td>13</td>
<td>326339.1</td>
<td>3</td>
<td>0.9193</td>
</tr>
<tr>
<td>14</td>
<td>364648.68</td>
<td>5</td>
<td>1.3712</td>
</tr>
<tr>
<td>15</td>
<td>335417.76</td>
<td>8</td>
<td>2.3851</td>
</tr>
<tr>
<td>16</td>
<td>202105.26</td>
<td>1</td>
<td>0.4948</td>
</tr>
<tr>
<td>17</td>
<td>97838.64</td>
<td>1</td>
<td>1.0221</td>
</tr>
<tr>
<td>18</td>
<td>58561.11</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>19</td>
<td>47399.13</td>
<td>3</td>
<td>6.3292</td>
</tr>
<tr>
<td>20</td>
<td>2714.76</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>21</td>
<td>1721.16</td>
<td>0</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Table 3. Site frequency by site potential zone.
5.3.2 First Stage Model Field Investigation

The initial model was submitted to Western Heritage field personnel in Prince George, who undertook a field investigation to determine its performance. These archaeologists had not been involved in the model development and this essentially amounted to a blind test. Evaluation involved driving out to specific areas where access could be gained, and comparing the model predictions against "gut feelings" of site potential provided by the surrounding terrain. While this approach was subjective in nature, archaeologists generally possess good intuitive abilities to identify where sites are likely to be located on a landscape. Most models strive to be as accurate as experienced archaeologists. Unfortunately, no local Native residents were available to accompany the evaluation team, although a Native archaeologist did take part in the survey.

The study concentrated on the south part of the timber supply area, since this area was readily accessible at that time of year. The principal investigator was Bruce Low, accompanied by Brian Scribe. Bruce Low provided the following comments about the field evaluation:

"Due to time, the only area we were able to cover consisted of the SW 1/4 of the forest district. Actually, I suppose that is pretty good and most other areas should relate to this locale anyway.

Overall, the model stands up well, although (as you previously noted yourself) it does need to be tightened somewhat. It was easy, however, to take an isolated location and say "okay, now why is this area red or white?" and then relate it to the larger region. For example, much of the area along the northern channel of the Manson river is red. Some of these locations are rather steep, but in the overall context they fit into the model because of the location of the Manson River, the number of streams and drainage zones into the river, and the frequent occurrence of sheltered terraces throughout this locale. These situations (good water sources, travel routes, and sheltered locations suitable for occupation) actually occur along all the major rivers within the MacKenzie Forest District, including the Williston Reservoir. The problem here, as I am sure you are aware, is that it would take much more time and work than we have devoted to actually test some of these locales for archaeological resources.

We did note two areas that did not fit into your model. The first is a zone that extends northwest of Burden Lake. On the modelling maps this area is marked white. I believe this occurred because of its vicinity to Blackwater Swamp to the north. This whole area has a low altitude in comparison with the rest of the region and is fairly flat. Almost the whole of Blackwater swamp is very marshy and obviously wet. However, the area we examined is actually a small plateau that extends along a ridge that separates Burden Lake from Blackwater swamp. The area is flat, sandy, and dry and still below the larger surrounding peaks, therefore it would have also been sheltered. The ridge that this plateau is located on actually extends from here to the Manson River and would have provided a good travel corridor. All in all it looks like a perfect location for a camp."
The second zone is around Porcupine Mountain. A fair amount of this area is marked red, however, the locale is very steep and rough. There are some drainages but it seems to be a bit off the beaten path of what would make a good travel corridor.”

This brief survey indicated some of the problems with regional modeling. Small ridges which may have been locally quite important, may in fact have been too small to be accounted for in a regional model. Secondly, some areas were identified as possessing high heritage potential that were just not good site locations.

There is a place for expert knowledge in applying potential models. If an area is rated as having a high potential and no sites are ever found, there are likely unmodeled factors that are lowering the potential. Site potential models should be continuously evaluated and applied using knowledge.

5.4 Comparison With other Studies

After the initial model was presented, the Archaeology Branch provided information on two related modeling projects: one for the Dawson Creek Forest District and one for the Vanderhoof Forest District. Both are instructive and lend support to the Mackenzie Modeling Project.

5.4.1 Dawson Creek Model

The Dawson Creek model was incomplete and only a statement of variables was provided (Table 4). There was no supporting analysis regarding its performance. Basically, the model used aspect, hydrology, slope, vegetation, and special features (eskers, caves, hot springs) as modeling variables. The variables describing the density of moose, caribou and deer were also employed.

All of the hydrological features in the Dawson Creek Model were buffered at 100 m, which is less than the buffering used in the initial MacKenzie model (300 m). Only a single distance buffer was used, meaning that any area within the buffer was weighted high, anything out was weighted low. This is different from the Mackenzie model which uses a high/medium/low approach.

Aspect criteria were based from east to west looking south. This was congruent with the MacKenzie model, where north-facing landforms were expected to have a low site potential.

Special feature criteria used in the Dawson Creek model were likely quite important predictors. This kind of information was not available during the Mackenzie modeling process, but it could be incorporated whenever it becomes available.

Wildlife habitat criteria were also not used for the Mackenzie AOA model, again because they were not available. However, at the level where they are useful for modeling, wildlife habitat data will probably reflect slope, aspect, and vegetation.

The Dawson Creek study considered localities with less than a 11% slope to possess high heritage potential. This is similar to the weighting assigned to the present study, and also to the Vanderhoof model.

5.4.2 The Vanderhoof Model
- Aspect = East through South to west
- Slope < 11%
- Large Rivers (>20 Metres wide) buffered 100 metres
- Lake > 1 ha, buffered 100 metres
- Any river/creek/lake, buffered 100 metres (including above criteria)
- Fish bearing lakes and rivers
- Moderate Potential as defined in 1:250K strategic model: Leading Pine or Aspen forest cover species and recent harvesting (1976-1996)
- Meadow, Cultivated or Open Range Land
- Wildlife Potential for moose, caribou or deer
- Geologically significant features (Hotsprings (30 metre buffer) and caves (30 metre buffer))
- Eskers (15 metre buffer)
- Null ● swamps, water

Table 4. Variables used in the draft of the Dawson Creek Model.

The Vanderhoof model is in its second edition. The forest district was divided into 5 zones which were treated as mutually exclusive:

- Trail Corridors
- Glacial Lake Nechako
- High Elevation > 1,150 m
- Middle Elevation 790 - 1150 m
- Low Elevation - less than 790 m.

The key predictive variable used was water, enabling the landscape to be divided into big lakes, small lakes, ponds, streams, secondary streams, tertiary streams, and wetlands. Within each of
these zones, distance to water variables were measured from 1:50 000 maps. The distance to water varied from 50 m to 300 m depending on the type of water body and zone.

Slope was added as a separate variable and areas with a slope greater than 24 degrees were excluded. The exception was in the area of trails, which often traversed steep slopes. The Vanderhoof study also considered eskers as a special feature which had a high heritage potential.

Like the Dawson creek study, the Vanderhoof study considered a landform as high if it was located within a specified distance from a high potential variable. Landforms were considered low if they had a slope of greater than 24 degrees. Any land that fell outside of the buffer but had less than 24 degrees slope was rated as having medium potential.

5.4.3 Summary

In summary, a comparison of the Mackenzie TSA Model with the models developed for the Vanderhoof and Dawson Creek regions shows more similarities than differences. Many of the same variables were considered, and a similar approach was taken in how the variables were interpreted. A major difference was in the size of the buffers around water features. The two studies suggest that a 100 m buffer is sufficient to capture high potential areas. This change is incorporated in the final draft of the Mackenzie TSA model.

There are other general differences in how the variables are handled. The Mackenzie study is multivariate in nature and incorporates the contribution of individual variables to heritage potential as a continuum. The other studies treat variables as decision points - if the variable is present then high potential is demonstrated.

5.5 Model Resolution

The first draft of the Mackenzie model was completed as a raster image with a cell size (pixel resolution) of 30 x 30 m. The original data were compiled at this resolution because it was always possible to clump data at a later date, if necessary. Generally speaking, the choice of cell size should reflect the underlying accuracy of the data (Figure 7), and the planning level that the model data will be used for. After examination of the first draft model, it was decided that accuracy of the model would not be affected by combining cells to form a model with 100 m resolution. This has been done elsewhere with good results since, within limits, combining the 30 m cell size model data into 100 m cell sizes generally resulted in little change in interpretation and sometimes little or no loss of precision. For example, Figure 8 shows the modeling differences of a 30 m and 100 m cell size model overlaid on a harvest plan in the commercial forest area of Saskatchewan. The great advantage of reducing cell resolution to 100 m (1 ha) is the tremendous savings in data management and processing gained when applied to raster information, since data file sizes are reduced significantly.

Based on this information, the final Mackenzie model was generated with a 100 m cell size. This reduced the file size of each model sheet by nearly 90%.

5.6 Revised Mackenzie TSA Model

Using information from elsewhere, and reconsidering weighting values for various variables after
Choice of Resolution

Figure 7. Relationship between pixel size and real world accuracy.

Figure 8. Effect of pixel size on the area classified as high, medium and low.
reviewing the independent field evaluation, the Aspect, Hydrology and Landform edge variables were recoded. The revised attribute codings were as follows:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Revised Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cells facing south, southwest</td>
</tr>
<tr>
<td>2</td>
<td>Cells facing southeast and west</td>
</tr>
<tr>
<td>1</td>
<td>Cells that are level or are facing north, northeast, northwest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Hydrology</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cells located from 1 to 100 m from water</td>
</tr>
<tr>
<td>2</td>
<td>Cells located from 101 to 300 m from water</td>
</tr>
<tr>
<td>1</td>
<td>Cells located greater than 300 m from water</td>
</tr>
</tbody>
</table>

The Landform Edge was recoded as follows:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Landform Edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cells located from 1 to 100 m from a landform edge</td>
</tr>
<tr>
<td>2</td>
<td>Cells located from 101 to 300 m from a landform edge</td>
</tr>
<tr>
<td>1</td>
<td>Cells located greater than 300 m from a landform edge</td>
</tr>
</tbody>
</table>

In an initial attempt, the elevation classes from the Vanderhoof Forest District were used. While parts of the Mackenzie area are higher, areas over 1150 meters are high in both areas. However, some of the Mackenzie TSA has no low elevation areas (areas less than 740 m).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Elevation Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Cells located from 1 to 740 m in elevation</td>
</tr>
<tr>
<td>2</td>
<td>Cells located from 74 1 to 1150 m in elevation</td>
</tr>
<tr>
<td>1</td>
<td>Cells located higher than 115 1 m in elevation</td>
</tr>
</tbody>
</table>

The model used for the Mackenzie AOA follows a simple mathematical formula based in large part on the original CRIMP model (Finnigan et al. 1995). The summary equation used evaluate potential is:

\[
\text{Model} = \text{Aspect} + \text{Slope} + (\text{Distance to Water} \times 3) + \text{Distance to Edge} + \text{Elevation}
\]

This equation can be calculated for each cell in the model, corresponding to each 30 m cell (or 100 m cell, depending upon desired resolution) on the ground. The equation evaluates to heritage...
Figure 9. Comparison of initial and revised model performance.

<table>
<thead>
<tr>
<th>Heritage Potential</th>
<th>Remaining Area</th>
<th>% of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>50%</td>
<td>88%</td>
</tr>
<tr>
<td>12</td>
<td>41%</td>
<td>76%</td>
</tr>
<tr>
<td>13</td>
<td>32%</td>
<td>58%</td>
</tr>
<tr>
<td>14</td>
<td>25%</td>
<td>45%</td>
</tr>
<tr>
<td>15</td>
<td>18%</td>
<td>42%</td>
</tr>
<tr>
<td>16</td>
<td>9%</td>
<td>24%</td>
</tr>
<tr>
<td>17</td>
<td>4%</td>
<td>12%</td>
</tr>
<tr>
<td>18</td>
<td>2%</td>
<td>9%</td>
</tr>
<tr>
<td>19</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>20</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>21</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>22</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>23</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 5. Model performance in the top 50% of land area.
potential values between 3 and 21. The efficiency of the model and the meaning of these numbers is explained in the following subsections.

5.6.1 Revised Model Performance

The revised heritage potential values from the new model extend from 1 to 21. As indicated in Figure 9, although the distribution of sites by potential zones has not significantly increased, the gap between the cumulative percentage of area and the cumulative percentage of sites has. This gap is one measure of model performance and the larger the gap the better the performance. The model now suggests that 76% of the sites can be found in 41% of the land area. As indicated in Table 5, 58% of the sites are found in only 32% of the dry land base (areas covered by water are excluded). If areas covered by water were included, this statistic would rise to 58% of the sites being found within 25% of the total timber supply area.

5.6.2 Using the Model

As discussed above, the Heritage Potential Model returns a heritage potential value between 1 and 21. These data have a least rank order significance: 1 is very low potential and 21 is very high potential. For the data to be used in a management context, categories of heritage potential should be defined. For example, two areas exhibiting a heritage potential of 1 and 5 respectively would not generally be treated differently from one another in making a management decision. However, two areas with a heritage potential of 1 and 15 probably would receive different management treatments, since the latter has a much higher chance of containing sensitive heritage resources than the former.

Based on a subjective evaluation of the number of sites encompassed in each zone, areas with heritage potential values of 1 to 12 were considered as low potential, values of 13 to 15 were considered medium potential and areas with values with 16 to 21 were assigned high heritage potential. Low, medium and high categories were used, since this is a common scale for evaluating heritage concerns.

While the management concerns for “low” and “high” potential lands are clearcut, the term “medium potential” creates some ambiguity, particularly for individuals with no strong experience in cultural resource management. It is suggested that “medium potential” areas be treated as “high potential” areas unless there is local knowledge that would indicate otherwise. In this context, “medium potential” is regarded as the zone where there is room for local expertise in the decision making process.

It is important to reiterate that the model addresses heritage potential and does not address whether or not a site is present in a given location. It is entirely possible to find heritage sites in low potential zones. Where sites are known to occur, there are site specific heritage concerns that must be addressed. Therefore, it is suggested that specific localities that are located within 200 m of known sites should be considered having “high heritage potential”. This size of buffer is suggested to take into account the error that is probably inherent in the recorded location of the heritage site.
6.0 Conclusion and Recommendations

The primary goal of the Mackenzie TSA Archaeological Overview Assessment Project was to develop a means of predicting the location of heritage sensitive land so that forestry developments could avoid impacting archaeological sites during their operations. A review of past archaeological work in the northern half of the province indicated that the TSA, dominated by mountainous terrain split by the Rocky Mountain Trench, had in fact received virtually no archaeological study. Even during the development of the gigantic Williston Lake Reservoir, which ultimately flooded a significant portion of the Finlay, Peace and Parsnip rivers, only cursory archaeological field reconnaissance was undertaken. The result was that although there were many archaeological studies to draw on from areas surrounding the TSA region, there was no useful information to be gained from the actual area in question. Consequently, a field inventory program was initiated to collect some baseline information about the heritage potential of the region prior to producing a predictive heritage potential model.

Archaeological field work involved drive-through surveys of roads and forestry cut blocks. The field techniques included pedestrian surface surveys, spot checks, subsurface tests, and excavation tests. Determination of archaeological potential for landforms was evaluated in a number of regions within the TSA, and local residents were queried about general and specific land use patterns in the areas they were familiar with. During the relatively short field assessment program, approximately 5,000 square km of land were visited. Though this was less than 0.1 percent of the entire Mackenzie TSA, the information was considered sufficient to begin building a heritage potential model.

Despite the relatively insignificant coverage of the vast region, twenty-nine new precontact archaeological sites were found during the survey, often in areas where current and past human habitation was evident. Although no time-diagnostic items were recovered from the sites, the simple existence of the sites in conjunction with areas of current land use provides important clues about how the land was used in the past.

The resulting model provides an estimate of heritage potential for every hectare (100 m cell) of terrain within most of the TSA boundary. The principal variables used to produce this estimate were distance from water, slope, aspect, elevation, and distance from a landform edge. Variables describing habitable condition characteristics were also used, where available. In fact, availability of modeling variables was not uniform across the TSA. Consequently, the predictive performance of the model is not uniform as well, and this must be taken into account when it is applied to various parts of the TSA.

Fortunately, the modeling method utilized for this study is dynamic in nature, and this provides many opportunities to improve its overall performance as more uniform modeling information is made available. Also, entirely new modeling information can be added to it, further improving its predictive capability.

One aspect that this project did not address was how the model should be used for determining responses to potential impacts from forestry activities. Work on predictive modeling and forestry management elsewhere indicates that there are effective (and ineffective) ways of applying the
model, and that these have significant implications in the responses that the forest industry can take in preventing impacts to potential archaeological sites. The role of professional archaeological expertise in interpreting the model cannot be discounted.

Finally, it must be pointed out that this model has never been formally tested in any way. Although one area was field inspected to assess the conformity of the model to actual landscape conditions, no fieldwork has been undertaken to determine if the high potential zones actually contain more archaeological sites than zones classed as low heritage potential. Comprehensive field testing of the entire modeled area is highly desirable, since the purpose of the model is to focus archaeological field surveys on areas of high heritage potential, and de-emphasize work in areas of low potential. However, such testing will probably require many years of fieldwork, which presumably will result in many iterative model improvements. Consequently, if the current model is to be used as a tool for purposefully limiting fieldwork in certain areas, planners must be cognizant of its limitations and be prepared to consider other sources of information (particularly informant data) that could assist in determining heritage potential for a given locality.

In many ways, this project is simply the beginning of a long-term program to develop a heritage management process for the TSA. Therefore, it is useful to conclude with a set of recommendations that can set this process forward from its promising start.

Recommendations:

1) First Nations' Involvement

Despite attempts to involve local First Nations directly in the archaeological assessment program, circumstances prevented much active participation. Nevertheless, considerable evidence of traditional land use was observed, and a strong congruence of traditional land use and precontact land use was detected. Generally, lack of First Nations' involvement with the model evaluation means that there is a substantially body of information that was not utilized in model building. It is recommended that there be some First Nations evaluation of the model currently developed, and that their observations and recommendations be used in improving subsequent iterations of the model.

2) Trail Mapping

While trails could be considered as part of Traditional Land Use, they are distinct physical entities that can be mapped in their own right. They also appear to have a powerful predictive capability in determining where archaeological sites are located. It is recommended that a trail mapping project be initiated with local First Nations.

3) Improved Vegetation Coverage

Bringing a unified vegetation cover data set into the modeling process would be useful. There are several sources for these data and it is believed that this would not be a major undertaking. The vegetation data reinforce patterns derived from the topographical data and provide indications of subtle landscape units that are not within the mapping resolution of TRIM.
4) Incorporation of Special Features

Although not addressed as variables in this particular study, modeling work elsewhere has indicated that certain topographic or natural features on the landscape can influence the location of human settlement. Features such as eskers, caves, mineral springs and salt licks can provide important travel corridors or habitation locations for human populations, or promote animal congregation in specific localities, which in turn become favoured hunting areas. It is recommended that subsequent modeling iterations consider these kinds of features, and incorporate them into the modeling process.

5) Additional Heritage Survey

The number of recorded heritage sites in the area is considered both inadequate for modeling, and ineffective for impact management. This data set can be improved through more locality-specific surveys of forested areas, and through some additional baseline inventory studies. In fact, this is a critical shortcoming in the current heritage potential model, in that hundreds of additional site locations are needed to more accurately calibrate it, and demonstrate its relevance for heritage management in the timber supply area. It is strongly recommended that follow-up archaeological surveys be implemented to gather additional modeling information in the immediate future.

6) Periodic Revision of Heritage Potential Model

The Heritage Potential Model is meant to be dynamic and is designed to be modified as knowledge of the heritage of the Mackenzie TSA evolves. It is recommended that the model be re-evaluated on a regular basis as new data are acquired. Also, new kinds of data sets should be incorporated as they become available.
7.0 References

Ackerman, Robert E., T. D. Hamilton, and R. Stuckenrath

Carlson, Roy L. (SFU)

Black, S.

Clague, John J.

Clark, D. W.

Clague, John J.

Clark, D. W.

Dalla Bona, Luke

Dalla Bona, Luke

Davidson, G.C.

Denniston, G

Finnigan, J.T. and T.H. Gibson
Finnigan, J. T., T. H. Gibson and D. Russell

Fladmark, K.R.


Gibson, Terrance H.


Gibson, T.H. and J.T. Finnigan

Goldman, I

Hall, Ralph

Harmon, D.W

Hall, Ralph
Helm, J.  

Helm, J. and D. Damas  

Ingram, G.C., and D.A. Harris  

Innis, H.A.  

Jenness, D.  

Kirby, K. Chris  

Lanoue, G.  

MacKenzie, A.  

MacKinnon, Andy, Jim Pojar, and Ray Coup- (ed.)  

McClellan, C.  

McClellan, C. and G. Denniston  

McLeod, M. (editor)  
McDonald, A.
1872 Peace River: A Canoe Voyage from Hudson’s Bay to the Pacific, J. Durie and Sons, Ottawa.

McGhee, R.

McLean, J.
1849 Notes on Twenty-Five Years Service in the Hudson’s Bay Company. Richard Bentley, London.

McLeod, M. (editor)

Morice, A.G.

Ramsay, C.

Rousseau, Mike K., Ian C. Franck, and Jeff D. Bailey

Smith, J.W. and V. Harrison

Stryd, Arnoud R. and Michael K. Rousseau

Tobey, M. L.
Waldman, C.  

Wilson, Ian R.  

Wright, James V.  