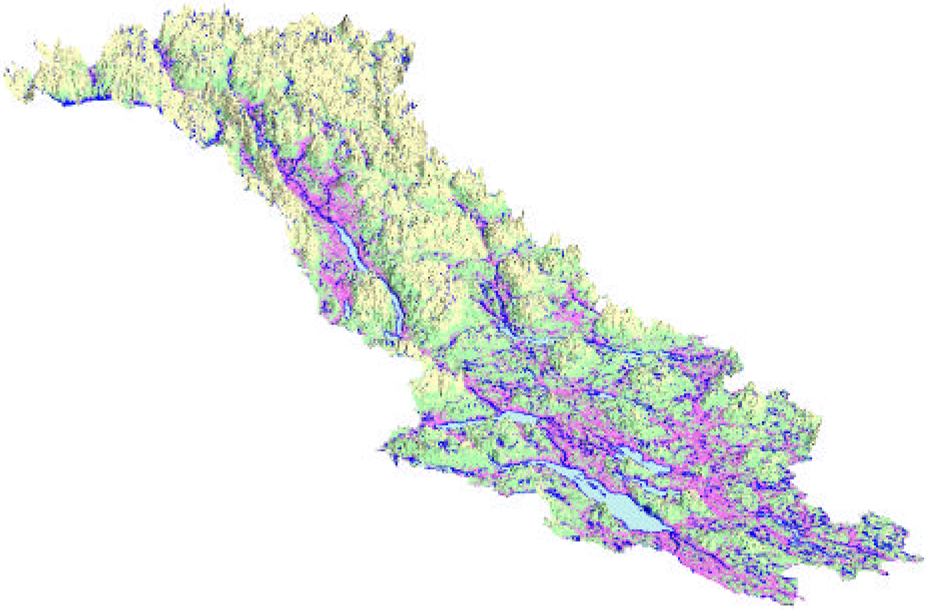
Fort St. James Forest District Archaeological Predictive Model Revision Project:



March 2004

ECOFOR
natural and cultural resource consultants

Fort St. James Forest District
Archaeological Predictive Model Revision Project:
Final Report

March 31, 2004

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ACKNOWLEDGEMENTS

The *Fort St. James Forest District Archaeological Predictive Model Revision Project*, was made possible through Forest Investment Account (FIA) funding, awarded through Canadian Forest Products (Canfor) and the Fort St. James Timber Supply Area (TSA).

We would like to thank everyone at Canfor's Fort St. James office who contributed to the successful completion of the project: Pat Bredin - RPF, and Tanya Kruisselbrink, RPF (FIA Coordinator), for believing in the value of this project and helping to make it happen; Jordan Kirk - GIS Manager, for generously providing us with important GIS data (TRIM). Also, at Canfor's Prince George office, our thanks to David Wlasitz (FIA coordinator) and Joe Kavanagh (Regional FIA coordinator) for their interest in this project and for funding approval.

In addition, we would like to acknowledge the assistance and direction of Kelly Douglas (Aboriginal Liaison Officer) and Barry Dobbin (RPF - Tenure Zone Officer), of the Fort St. James Ministry of Forests (FSJ MoF). Also, our thanks to Canfor, FSJ-MoF, Apollo Forest Products, BC Timber Sales, and Stuart Lake Lumber for providing important information necessary for the model assessment and revision.

We greatly appreciate the participation and contribution of the First Nations representatives that met with us to discuss the project, and the assistance of those who worked with us to develop the Cultural Heritage Resource Inventory: Chief Thomas Alexis, Danny Alexis, Victor Tom, Dwayne Martin, Beverly Bird and Jonathon Tom* of the Tl'azt'en First Nation; Chief Leonard Thomas, Fred Sam, Anne Sam, Clara Jack, Alec McKinnon, Rosemary Prince, Sharon Bird, and Adele McQueen* of the Nak'azdli First Nation; Alan Joseph Sr., Arthur Erickson and Jennifer Joseph* of the Yekooche First Nation; Cameron Beck, Jane Calvert, Rose Paul* and Belinda Frederick* of the

* Those individuals whose names have been asterisked worked as assistants during Phases I and II of the project.

Lheidli-Tenneh First Nation; Adele Chingee, Anita Tylee, Ryan Bichon, Lionel Chingee* and Vincent Chingee* of the McLeod Lake First Nation; Carrie Daley* of the Takla Lake First Nation; Gitxsan House representatives Larry Skulsh, Rena Benson, Gary Benson, Gloria Wilson, Billy Star, Yvonne Lattie, Wilmer Johnson, as well as Beverly Clifton-Percival, Catherine Blackstock, Myrtle Muldoe of the Gitxsan Treaty Office, and Vince Jackson and Darlene Vegh of the Gitxsan GIS and Watershed Departments.

Many thanks to Morley Eldridge and Kristi Benson of Millennia Research for being part of the team, for sharing their insight and expertise. Special thanks to Darryl Bereziuk and Kathy Beames from Alberta Western Heritage for assisting us with the statistical analysis.

We express particular gratitude to our Ecofor Project Team, model completion would not have been possible without the efforts of each and everyone of us: Nathan Bauman, Tara Bond, Eva Brooke, Colin Cooke, Adam Croxall, Ryan Dodds, Louise Foreman, Barbara Horrell, Jeremiah Joseph, Kira Kristenson, Angel Leblanc, Jordice Malasiuk, Laura McKersie, Amanda Marshall, Rob Paterson, Gareth Spicer, and Kevin Wilson.

Thank you to Randy Diston and Grant Luck, local pilots from the area for their time and for providing valueable historical information on old mining sites and cabin locations throughout the District.

In closing, we would like to acknowledge Normand Canuel, principle of Norcan Consulting, and his work to develop the original archaeological predictive model for the Fort St. James Forest District in 1999.

THE PROJECT TEAM

Ecofor Consulting, Fort St James, British Columbia

Ecofor specializes in providing natural and cultural resource consulting, management and training services to private industry, government agencies, Aboriginal organizations and communities. Our commitment to providing innovative and quality work that delivers results has enabled us to build strong working relationships with clients and project partners. The Ecofor team consists of experienced professionals from a variety of different fields: GIS, forestry, archaeology, wildlife and fisheries biology.

Millennia Research, Victoria, B.C.

Millennia Research has a strong background in creating, testing and using archaeological predictive models. With powerful GIS tools, statistical software, and the necessary statistical tests already developed, Millennia is able to use the compiled data for model assessment purposes in a quick and effective manner.

Alberta Western Heritage, St. Albert, AB

Alberta Western Heritage (AWH) specializes in a variety of different cultural resource management services, including GIS and predictive modelling. Similar to Millenia, AWH has the experience and necessary statistical software to analyze and assess the success rate of our revised model.

First Nations Assistants

Assistants from Nak'azdli, Yekooche, Tl'azt'en, McLeod Lake, Takla Lake and Lheidli-Tenneh First Nations worked with us on various phases of the project. Opportunities for training and information exchange have been provided and many have expressed their interest to be involved in future projects as we continue to develop these working relationships.

ABSTRACT

This report provides a detailed summary of the Fort St James Forest District Archaeological Predictive Model Revision Project. This work was generously sponsored through Forest Investment Account (FIA) Funding, awarded through Canadian Forest Products and the Fort St. James Timber Supply Area. The project took place between January 2003 and May 31, 2004. The project was a collaboration between Ecofor Consulting, Millennia Research, and Alberta Western Heritage, as well as First Nations partners with traditional territory within the Fort St James Forest District.

The underlying objective of the project was to assess and upgrade the existing archaeological predictive model used in the Fort St James Forest District. This model was developed by Norcan Consulting in 1999 and has been relied upon for development planning since its implementation. However, the model was not fully tested or evaluated before it was put to general use. The Norcan model had an estimated accuracy of approximately 45 %, i.e. 100 of 218 total sites occurred in areas of estimated high potential.

To develop the model to its full potential, we proposed a multi-phase project that would span approximately two years, which would include First Nations consultation, an analysis of the Norcan model, the creation of a Cultural Heritage Resource Inventory, and finally, the development of a new archaeological predictive model for the Fort St. James Forest District. Preliminary testing of the new model's accuracy indicates that it is approximately 75 %, i.e. 157 of 210 known archaeological resources occur in high potential areas. This report summarizes the initial phases of the project, provides a brief environmental and cultural background of the study area, and presents the development and assessment of the new archaeological predictive model for the Fort St. James Forest District.

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INTRODUCTION

In November of 2002, Ecofor Consulting submitted a proposal entitled the *Fort St. James Forest District Archaeological Predictive Model Revision Project* to Canadian Forest Products (Canfor), Fort St. James Operations' head office. This project proposal sought funding support from the Forest Investment Account (FIA), a provincial government mechanism for promoting sustainable forest management in British Columbia. Under this program, forestry licensees and tenure holders are allocated funds to support eligible programs within their timber supply area (TSA). With the generous support of Canfor and the Fort St. James TSA, Ecofor consulting was awarded funding to undertake the model revision project from mid-January 2003 until March 31, 2004.

The underlying objective of the proposed project was to assess and upgrade the existing archaeological predictive model for the Fort St. James Forest District (Fig. 1). Licensees and development planners within the district have utilized this model since its implementation in 1999. The accuracy and reliability of the Norcan model as a predictive tool has remained suspect because areas other than high potential were not routinely tested. Instead, Norcan effectively tested numerous areas dictated as high potential in the model in order to increase site inventory in the region (Canuel 1999b). Consequently, over the past four years, several concerns and problems associated with the model have surfaced. As a result, the model revision project sought to design a new and improved model for the study area.

To this end, Ecofor proposed a multi-phase project that would span approximately two years. Project partners were invited to come on board, including various First Nations with asserted territorial claims within the Fort St. James Forest District; Millennia Research and Alberta Western Heritage Consulting, archaeological consulting firms with valuable experience in designing and developing archaeological predictive models; as well as the many licensees within the TSA.

Phase I of the project involved consulting with First Nations to gain their interest and support and collecting the data necessary for the creation of the Cultural Heritage

Resource Inventory Database (CHRID). Additionally during this phase, background research was carried out to familiarize the project team with the work done to date.

During Phase II, the CHRID was created in order to manage and organize the immense quantity of archaeological data that has been collected over the years. Also during Phase II, the Norcan model was statistically analysed by testing the available site location data against the existing model parameters. The results of this analysis provoked several recommendations, which were addressed in the later phases of the project.

Initially, Phase III of the model revision project proposed that funding be allocated for field-testing. Unfortunately, due to funding cuts and time constraints, field-testing was not possible and therefore, the project proceeded onto Phase IV. We are exploring additional funding avenues to complete Phase III in the future.

During Phase IV, orthorectification of site location data was completed to improve the CHRID and a new predictive model for the Fort St. James Forest District was designed, created, and assessed. This report provides background information on the environmental, cultural, and archaeological aspects of the study area as well as some general information on predictive models. Following this, is a brief project summary of Phases I and II, and finally, we present the methods, results, and recommendations from Phase IV.

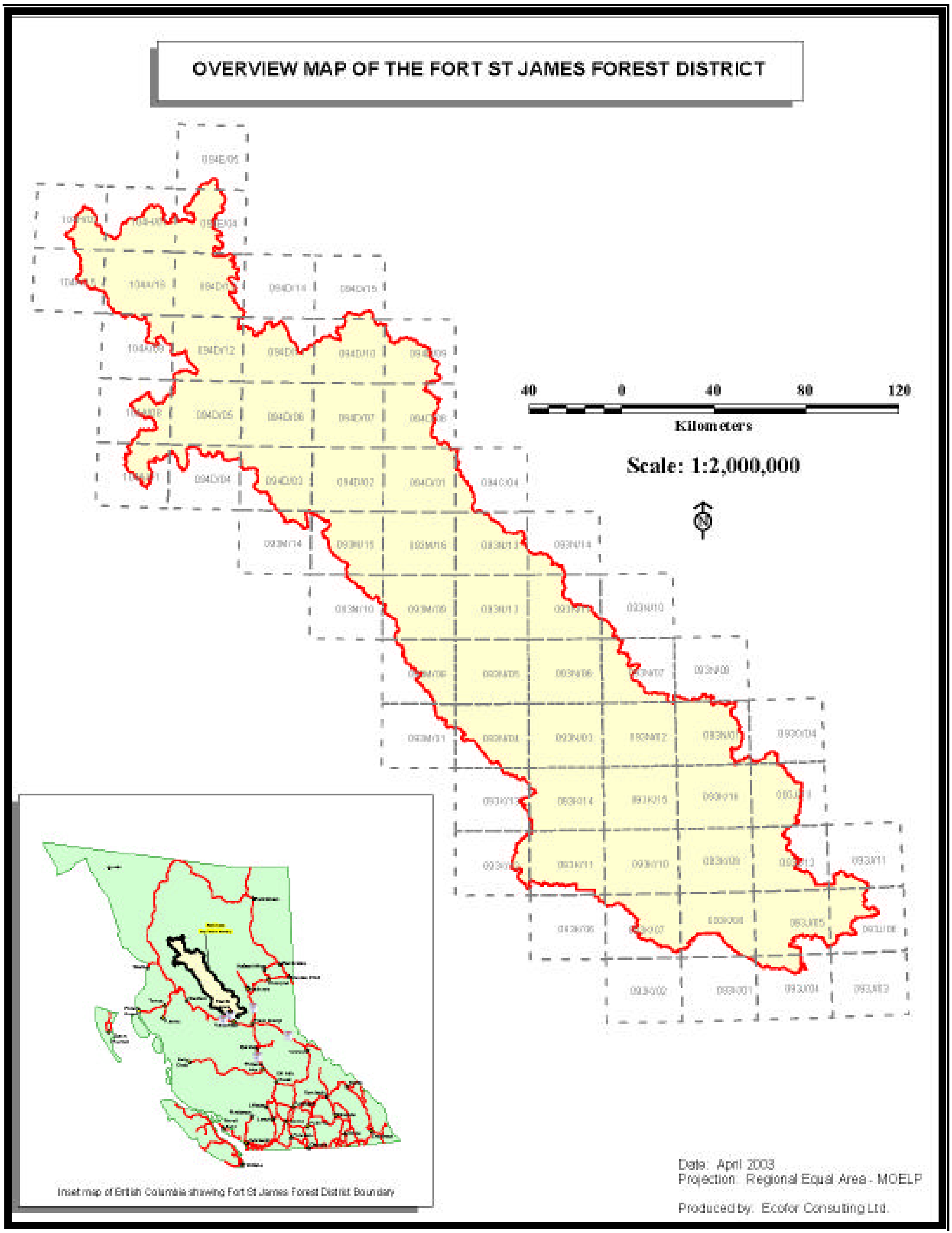


Figure 1. Overview Map of the Fort St. James Forest District

Backround

The Fort St. James Forest District is located in the north central portion of the province of British Columbia (see Figure 1).

Environment

Melt water channels and glacial lakes formed the topography and drainage courses of the region during the Pleistocene and early Holocene Epochs (Fladmark 1982), making for distinct upper and lower portions of the forest district. The upper portion of the study area (Figure 2) is characterized by steep, mountainous terrain flanking wide river valleys. Largely because of the geography, this area possesses fewer lakes compared to the terrain further south, and instead contains numerous large rivers including the Bear, Sustut and Skeena rivers, as well as numerous creeks. The Driftwood Valley is quite wide and features swampy undulating terrain with sporadic eskers. The most northerly part of the study area is located within the Northern Mountains Ecoprovince, which is part of the Sub-Arctic Highlands Ecodivision of the Polar Ecodomain.

In contrast, the lower portion of the Forest District includes an extensive system of lakes and streams within the various watersheds. Drainage primarily occurs from north to south, commencing with the enormous Takla Lake. Middle River drains this lake at its south end, which in turn feeds Trembleur Lake. The Tachie River drains Trembleur Lake, then flows into Stuart Lake, and then into the Stuart River. The Stuart joins the Nechako River, which empties into the Fraser River near the city of Prince George. A myriad of tributary creeks and rivers connect with any one of these rivers. Figure 3 provides a summary of the watersheds within the district. The lower portion of the study area is a part of the Manson Plateau, Babine Upland and Nechako Lowland ecosections and, in general, is characterized by gently undulating terrain with innumerable large lakes, rivers and wetlands, with an underlying geological base composed mainly of sedimentary rock (BC Ministry of Sustainable Resources 2001; Perrin & Blyth 1998).

Deposits of glacial till cover the majority of the study area, varying in thickness from 1 to over 10 metres, however, glacio-lacustrine sediments, alluvial sediments and bedrock outcroppings can also be found within the area (Plouffe and Williams 2001).

The study area lies within the Sub-Boreal Spruce (SBS) biogeoclimatic zone, as defined by the Ministry of Forests Research Branch (Medinger & Pojar 1991). Hybrid Engelmann-white spruce and sub-alpine fir forests typically dominate this zone, however, there are extensive stands of lodgepole pine in drier areas. The SBS biogeoclimatic zone also supports many wetland ecosystems, typically fens composed of sedges, scrub birch, willow and spruce.

Fish and Game Resources of Aboriginal Importance

The study area supports a considerably wide and abundant variety of fauna. Large mammals include black bear, grizzly bear, deer, moose, elk and sheep. Some of the fur-bearer species available are fisher, otter, marten, wolverine, mink, muskrat and beaver. Many different species of fish inhabit the lakes and streams within the study area, including rainbow trout, lake trout, dolly varden, steelhead, char, sockeye salmon, white sturgeon, whitefish, squawfish, suckers, and ling cod. Birds are plentiful, with 173 bird species known to inhabit the Fort St James Forest District, (Ministry of Forests 2001b), while several species, including migratory waterfowl, also stage and nest within the study area. Ducks, grebes, geese and swans were all taken as food (Sam 2001:30; Bond & Russell 1992). However, the availability of many of the important food species is not always predictable or dependable, and there are historical accounts and oral traditions attesting to this fact (Sam 2001:79-80; Fraser Lake and District Historical Society 1986:4; Bond & Russell 1992:17; Harris & Ingram 1972).

Cultural Setting

The study area is situated within the traditional territories of the following Carrier, Gitxsan, and Sekani First Nations:

- Dzitl'ainli First Nation
- Lheidli T'enneh First Nation
- Nak'azdli First Nation
- Takla Lake First Nation
- Tahltan First Nation
- Gitxsan First Nation
  - -Nii Kyap House
  - -Wii Gaak House
  - -Haiwas House
  - -Tsa Bux House
- Tsay Keh Dene First Nation
- McLeod Lake Indian Band
- Yekooche First Nation
- Tl'azt'en First Nation
- Kaska Dena First Nation
- Natoot'en First Nation

The Carrier people are composed of several smaller nations and belong to the Athapaskan family of language groups. The Carrier traditional territory encompasses the central interior region of British Columbia. Information on Athapaskan ethnography and traditional lifeways may be found in the following sources: Albright (1984), Bishop (1983), Bond and Russell (1992), Carrier Sekani Tribal Council (1998), Carlson and Mitchell (1997), Cranny (1986), Donahue (1978), Eldridge (1982), Fladmark (1976, 1986, 1999), Furniss (1993), Glynn-Ward (1932), Hall (1992), Helmer (1977), Hudson (1972, 1983), Jenness (1943), Marshall (2002), Sam (2001), Smashnuk (1999) and Tobey (1981). Ethnohistoric sources include observations on native lifeways by early explorers such as Alexander Mackenzie, Simon Fraser, John Stuart, Daniel Harmon and Father Adrian Gabriel Morice. Several of such ethnohistoric journals are published, such as Fraser (1960), Mackenzie (1967) and Morice (1893, 1978). Several sources are available on the historic era of the Fort St James Forest District, including: Harris and Ingram (1972), Klippenstein (1992), Morton (1988) and Owen (1990). Tobey (1981) cites a precontact population estimate for the northern and southern Carrier of approximately 8,500 people living in the area.

The Gitxsan ("people of the Skeena") people followed a relatively sedentary existence. They spent their summers catching salmon, and gathering plants, their falls hunting within house territory boundaries, and their winters gathered in longhouse villages (Carlson & Mitchell 1997:10-11). During the spring, families would travel to the Nass to gather oolichan (Adams 1973:5; Carlson & Mitchell 1997:11). Their villages were centred primarily at the confluences of major rivers along the Skeena, and also at strategic canyons within their territory. Houses were typically constructed of cedar planks (Halpin & Seguin 1990), and often the planks of winter houses were transported to spring and summer villages (Halpin & Seguin 1990:271; Carlson & Mitchell 1997:11).

The Sekani First Nation is composed of several different bands including the Tsay Keh Dena and the Kaska Dena whose territories are located in the Fort St. James Forest district. Traditionally, the Sekani were quite mobile in their pursuit of subsistence (Jenness 1937) and left very little physical trace upon the landscape. A nomadic people, they traditionally lived in tents constructed of poles covered with spruce bark or animal hide. The Sekani peoples focused upon hunting and trapping as their primary sources of food (Antilla n.d.). They pursued moose, deer, caribou, bear, rabbit, grouse, and groundhogs. Influenced by the Hudson Bay Company, they became semi-nomadic trappers after contact. Social organization among the Sekani is undocumented in the written records prior to the 19th century, during which some aspects of the phratric system adopted from the Carrier and the potlatch system adopted from the Gitxsan were observed (Jenness 1937:46-49). The Sekani territory in the Bear Lake and Takla Lake areas was the only known portion of their traditional territories that provided them access to salmon. The majority of their territory was restricted to the more northerly plateaus, which drain into the Arctic Ocean, more generally west of the Rocky Mountains and east of the Pacific divide (Jenness 1937:2-3).

Previous Archaeological Investigations in the Study Area

Very little archaeological research has been conducted in the study area. Archaeological interest in the area started in the late 1960s, when Elliot (1968) surveyed Takla Lake by canoe and John Corner (1969) studied pictographs in the interior of BC. Later, archaeological excavations were undertaken at the Historic Fort St James in 1971 and 1972 by Norris and Harris, and in 1971 John McMurdo identified several pictograph sites on Stuart Lake. Several surveys took place in the 1970s to assess possible impacts from forestry and railway extensions. Reports produced from these studies include, but are not limited too, Helmer and Mitchell (1972), Drew (1974), Hanson and Canuel (1978) and Irvine (1979). Very little archaeological information was recorded in the Fort St James Forest District through the 1980s and early 1990s. A survey of a proposed electrical transmission line between Takla Lake and Babine Lake (Simonsen 1984) and a survey of proposed logging blocks along the Driftwood River (Wilson 1994) were negative for any archaeological sites.

In 1995, Arcas Consulting Archaeologists Ltd. conducted an Archaeological Overview Assessment of the Fort St. James region (Brolly & Dewhurst 1995). The purpose was to catalogue all known sites in the area, and to produce a heritage potential model for the area with the intention of applying this towards cultural resource management planning. An archaeological resource overview was also completed by Traces Archaeological Research and Consulting Ltd. (Carlson and Mitchell 1997), which provided comprehensive summaries of previous archaeological investigations in the study area. Norcan Consulting created an Archaeological Predictive Model for the Fort St James Forest District in 1999, which is currently used to determine which development areas within the district need to be assessed archaeologically.

To date, the majority of archaeological investigations that have been carried out in the Fort St. James Forest District have been motivated by development activities, including forestry, railway extensions, road extensions and Hydro extensions. Archaeological consulting companies such as Antiques, Arcas, Ecofor, IR Wilson, Norcan and Traces have completed several surveys since 1995. The vast majority of the sites identified have been culturally modified trees (CMTs), however, many other interesting sites consisting of pictographs, historic cabins, traps, lithics, human remains, cache pits, house pits and hearths have also been found. Extensive trail systems are known to exist within the Fort St James Forest District and ground-truthing of the trails' locations are currently an on-going process. The results of these surveys has been to greatly increase the archaeological inventory of the Fort St James Forest District and record the past 4000-5000 years of human history in this area.

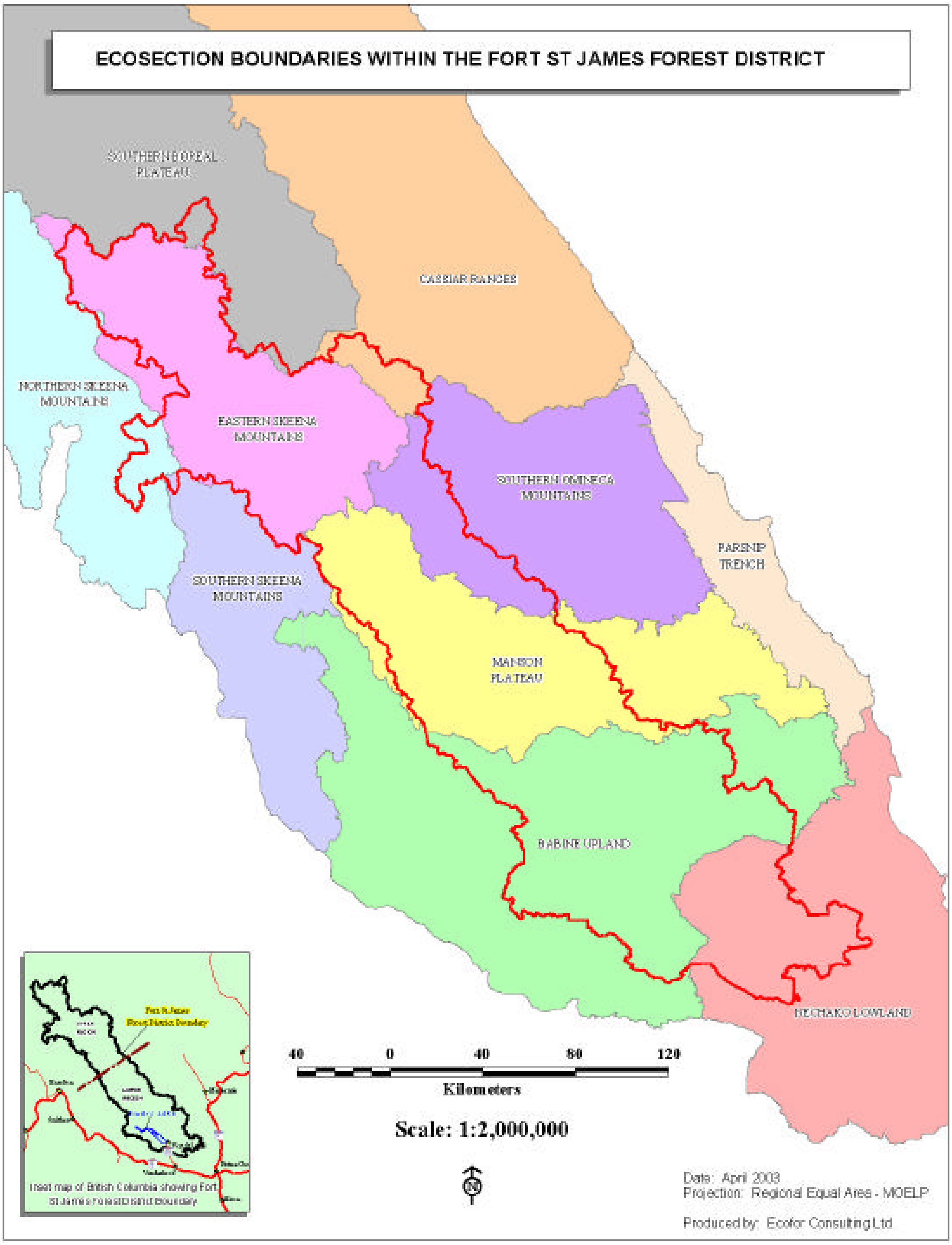


Figure 2. **Ecoregions of the Fort St. James Forest District**

Figure 3. Watershed Boundaries of the Fort St. James Forest District

PREDICTIVE MODELS

The use of predictive modelling in archaeology has stimulated both excitement and criticisms over the past thirty years, especially with new and rapid advances in GIS (Dalla Bona 1994a,b; Kohler and Parker 1986; Kvamme 1999). Deductive and inductive represent the two types of spatial analyses used in predictive modelling. The potential model currently used in the Fort St. James Forest District is **deductive**; that is, it "attempts to predict human behaviour and its associations with past landscapes and environments" (Canuel 1999a:20). Several assumptions are required to produce a landscape-based model in this way. Archaeologists must assume that native peoples were relatively constricted by their environment and that human choices about movement and occupation were based on landscape variables that are accessible and measurable to those who are using the model. Deductive models, as they begin with the human experience, are powerful because they attempt to model for where people chose to be. If archaeologists can model for where people chose to be, sites can be found.

However, deductive modelling relies very heavily on a modern - and often white male - archaeological interpretation of landscape variables. Peoples' choices about how they use the landscape are largely influenced by how they *perceive* that landscape. Archaeologists are, in turn, influenced by their own perceptions of the environment and how they *expect* these past peoples would have lived in relation to it. In an attempt to reduce this cultural bias, archaeologists often turn to the ethnographic record. This record, however, is often incomplete or biased itself and potentially only representative of one time period - generally the early post-contact. Unless the person recording the ethnographic details to be used was him- or herself a member of that culture, it is unlikely that the data recorded will provide any idea of how the people thought or made their decisions; information, which is vital for the production of a reliable deductive model. This is one important argument for using oral tradition and other sources of cultural data authored by local First Nations in the development of a deductive model. While this information may potentially remain biased towards the more recent generations of occupation of the land, it will at least bring us closer to an understanding of how these individuals and the peoples from whom they descended lived and perceived their environment.

The second type of models are **inductive** models. This approach involves observation of the environmental settings in which archaeological sites have been previously found, and then models for this type of landscape. It predicts that additional sites were located in similar settings, but is not concerned with the specific reasons of why they would be there. In this respect, inductive models are not as intrinsically explanatory as deductive models, but they remain predictive. While inductive models are theoretically less influenced by cultural bias, this type of modelling relies heavily on previous archaeological survey. Previous survey tends to be statistically biased (e.g. focussed near major water courses) and so this dependence can lead to a similarly biased model. One additional complaint about this type of model is that, often, only a simplistic formula (such as slope and proximity to water) or a computer-generated formula that is almost unintelligible (e.g. logistic regression) are used in inductive prediction of site potential.

Problems exist with both modelling approaches. In an attempt to overcome some of the issues of bias in deductive models and over-simplification in inductive models, a model based on data managed in a Geographic Information System (GIS) supplemented by human interpretation of site location can be used. In this technique, all accessible variables are statistically examined to see if patterns exist in site location. An archaeologist with knowledge of the cultural traditions of the area and with GIS can determine if the correlation is spurious, as well as combine variables in a way that makes sense on a human level (for example, sites might pattern in aspen stands, but only if no pine stands are nearby). These variables and combinations of variables can be tested against known site locations. This brings both a human and an ethnographic element (which variables to test and include in the model), and an objective or scientific element to the model (testing statistically where sites tend to occur). Also, it can overcome some of the problems of bias in deductive modelling by measuring where sites actually occur and how they pattern, irrespective of modern topography and perceptions. This is important when the ethnographic record and traditional use of an area is not well understood, and for sites dating to times long ago when the landscape and/or peoples' ways of living were often very different. Our revised model will use the inductive GIS-based approach.

PROJECT OBJECTIVES

For the purpose of developing a predictive model for the Fort St. James Forest District one must consider the general ideas that influence the selection of the independent variables. In order to create a model, we must assume that Native peoples were dependent on their environment for subsistence and that the environment ultimately affected their settlement patterns and thus, the archaeological evidence. The degree of success therefore depends on how well people knew or used their environment, and since people were able to survive in this region for thousands of years, native people had an acute knowledge of the landscape. First Nations in the area were highly mobile, hunter-gatherers whom depended on a seasonal round to provide an economy from a mixture of plants and animal resources (Dawson 1983; Tobey 1982; Bond and Russell 1982). People would follow the seasonal movements of animals, and would travel to areas where a specialized habitat supported a particular species in abundance (Brody 1998). Some scholars have tried to model first nations use of the landscape based on empirical observations of phenomena that are linked to cognitive decisions based on benefits versus costs (Whitley 2001). Whereas our model assumes that 100% of the landscape was utilized at some point in the past by First Nations peoples (Canuel 1999a). However, some areas have a higher probability of archaeological resources being located there due to frequent use of that area over time. Whereas, other areas may have been used less frequently, leaving behind a lower probability of finding physical remains of that activity.

When deciding which environmental variables on the landscape indicate higher probability of use, a number of factors needed to be considered. These decisions were made both on statistical analysis of known site locations, as well as through the use of ethnographic and oral historic evidence. We could not assume from the outset that certain areas on the landscape were never utilized, or are of no archaeological potential. We could however estimate areas where it is more likely that we could find archaeological sites

A variety of skills, including an acute knowledge of the landbase, enabled First Nations to locate food resources under different or difficult environmental conditions. When one food item became scarce they relied on a variety of other resources to compensate. Therefore, we made the assumption that the primary environmental variables, which affected settlement locations, were water and food resources e.g. plants, and accessibility to these two. Generally, all other variables are related to these in some way.

Water, including wetlands, was considered by our model to be, by far the most important element for choosing an activity location. Both humans and wildlife are highly dependent on water for survival. However, we identified an inherent problem in focusing on primary waterways, as this represents areas where people lived during the summer. In the winter, people were more mobile and were not as dependant on primary water sources because a secondary source, snow, was everywhere (Bond 2004). However, some water sources are more preferable than others and it is these that the model attempts to identify as higher probability areas. A water source would have been more preferable if it a) contained or attracted food resources and b) if it was easily accessible. There are numerous variables that enabled us to identify these preferences and therefore, the archaeological probability of an area.

First, archaeological sites are more likely to occur in close proximity to the water's edge. Proximity to water and wetlands are therefore variables within the archaeological predictive model. As distance from water increases, archaeological potential, and in turn, probability, decreases. Also, the size of the stream or wetland complex was a factor as the size of the source increased so did the number of food resources (eg., fish, wildlife). Fish was a critical food source and of high ceremonial importance to First Nations culture; therefore it was assumed that a high proportion of cultural heritage sites would be located in proximity to water that contained fisheries resources. Of lesser importance than fish, are the numerous animal resources used by First Nations for their fur, bone, and antler. The Carrier, for example, hunted caribou, moose, mule deer, beaver, hare, mountain goat and grizzly (Donahue 1978). The

Gitxsan, who inhabited territories around the Skeena River, hunted porcupines, groundhogs and lynx (The People of 'Ksan 1980). Many of these animals were likely killed via canoe if encountered during channel crossing or with traps. Many animals frequented wetlands, which provided open areas for food or for sun exposure.

The fact that different cultures have different practices added an element of unpredictability to our model, and it should be considered when determining which areas of the landscape were utilised more frequently than others. For example, the Carrier divided their traditional territories into management units called ‘keyohs’, whereby each family had a keyoh where subsistence activities such as hunting and gathering took place (Bond and Russell 1992; Hall 1992; Sam 2001; Tl’azt’en Nation 2004). Keyoh-holders were responsible for managing the resources on their keyoh in order to provide a continuous supply of food and material for the survival of the community, as a form of land stewardship. A similar form of stewardship is apparent within the Gitxsan communities, but in the form of “house territories” which lie the exclusive title of each house to its territories and resources. This title is entrenched in a complex legal system that validates the acquisition and inheritance of house territories and regulates rights of access and resource use, and is responsible for ensuring both the well-being of the house and the health of the territory (Sterritt 1998; Duff 1989). In the past, if an outside group needed to collect resources on someone elses 'house' or 'keyoh', would have been problematic; therefore, areas on the landscape that were away from the main travel corridors would have likely of been used under certain circumstances. So, it is important to keep in mind that because of this unpredictable aspect of human culture, no model can be 100% accurate.

PROJECT SUMMARY

Phase I

The principle objectives of Phases I & II of the Fort St. James Archaeological Predictive Model Revision Project included: 1) increased involvement of First Nations in the management and protection of their own cultural heritage through participation and meaningful consultation in the model revision project; 2) development of a Cultural Heritage Resources Inventory Database as a means of compiling, organizing and long term management of all existing (and future) archaeological information for the Fort St. James Forest District; 3) the use of this compiled data on site distributions within the district for assessing and suggesting necessary revisions to the predictive model.

First Nations Consultation and Participation

During Phase I, Ecofor invited all First Nations groups with traditional territories within the Fort St. James Forest District to participate in the model revision project. Through meetings and discussions, some of the First Nations groups expressed the need for more direct consultation with them in order to manage important cultural heritage features especially with regards to trail locations. As a result Ecofor updated the Fort St. James Cultural Heritage Trail map. The updated trail map provides a more reliable source of information about these important cultural heritage features. Another topic that stemmed from the discussions was the need for improved information sharing. For example, we discussed ways in which it would be possible to raise awareness about the location of important cultural features and traditional use areas without unsolicited disturbances. Unfortunately, the project timeline was too limited and it was decided to consider this possibility at a later date. Finally, those First Nations individuals who had the necessary skills and interest to work on the database project were selected in consultation with Ecofor. This participation provided an ideal forum for the exchange of information about aboriginal land use and archaeology between the First Nations participants and the archaeologists. This forum provided the opportunity for First Nations groups to express their ideas and concerns regarding how the model is developed and employed, and gave the archaeologists an opportunity to answer any questions, which may arise on this front. As such, First Nations were invited to participate in the initial planning and execution of the model revision project.

Cultural Heritage Resources Data Compilation

Over the years, a considerable amount of information has been collected through Archaeological Inventory Surveys (AISs), Archaeological Overview Assessments (AOAs), Archaeological Impact Assessments (AIAs) and other related cultural heritage studies. This information provides valuable data for modelling purposes but to date, has not been compiled into a manageable format conducive for this purpose. Before assessing the existing model, it was necessary to compile, organize and manage data about known cultural heritage sites. Information concerning already recorded cultural features was gathered from various sources including forest licensees, archaeological consultants' reports, academic studies, historical records, Government ministries and First Nations. Once this information was collected, we could then begin developing the Cultural Heritage Resource Inventory Database (CHRID)

Phase II

Cultural Heritage Resources Inventory Database

To compile and manage the data, which was collected during Phase I, Ecofor created a comprehensive and searchable Cultural Heritage Resource Inventory database. A total of 44 Heritage Inspection, Inventory and Survey Reports, which represents all the known archaeological assessments carried out between 1969 and 2003, were incorporated into the Cultural Heritage Resources Inventory Database. This searchable database was used as a device for long-term data management and was available to multiple users including First Nations, licensees, the Ministry of Forests and archaeological consultants. The CHRID was created using Microsoft Access, which allows one to store, sort and retrieve immense quantities data. The database is also a useful tool when querying multiple fields of information. Access can also be linked to GIS applications in order to spatially plot sites. First Nations project assistants were responsible for inputting the majority of data into the Cultural Heritage Resource Inventory. A copy of the database is provided with the updated model.

In the course of entering survey block and site information into the database, a number of issues were identified which impeded this work and brought the integrity of some of the available data into question. The majority of the challenges encountered involved inconsistencies in recording procedures, as well as missing and sometimes inaccurate locational data. Recommendations concerning recording standards, which should be enforced, are listed below. Adherence to the following would not only be of great use in the further testing and modification of the model; it would also enhance our ability to more effectively and efficiently manage archaeological data in the future:

1- Location data should be included for all areas surveyed as development block identifiers and boundaries often change following assessment. The location and boundaries of the surveyed block should be indicated on a 1:50,000 or better NTS topographic map so that they can be identified independent of forest development plans

2- When temporary Block IDs are used to designate proposed development areas at the time of the initial AIA, all efforts should be made to include in the final reports a cross-reference to the permanent Block ID later assigned

3- Spatial co-ordinates for all sites recorded in archaeological inspection reports - both AIAs and reconnaissance-level surveys – should be included in the reports, unless this has been established to be sensitive information. In the case of sensitive information, the specific location of the site should still be on record with a responsible body (the First Nations and/or the Ministry of Forests) and both available and accessible in the event that this information becomes necessary to the management or protection of these sites

4- These spatial co-ordinates should be checked for their accuracy and must be qualified: i.e. the NAD must be specified for all UTMs and longitude/latitude designations; the UTM grid zone must be included with UTM co-ordinates

5- The results of all AIAs, reconnaissance-level reports and AOAs should be filed with the governing body, for purposes of long-term data management

6- Maps included with archaeological reports must be referenced, and the locations of all shovel tests and survey coverage should be illustrated on these maps

Some of these recommendations are dealt with in Phase IV with the orthorectification of the site locational data.

Preliminary Model Assessment

An initial assessment of the Norcan model was undertaken during Phase II. This was achieved by collecting the necessary digital data, reviewing the rationale behind the set of the variables used, and finally, through statistical analyses. Using TRIM data, the Chi-square test was used to assess the observed site distributions against the distribution of the variables assumed to be predictive of site locations in the model.

Results of this variable-by-variable assessment suggest that the model needed revising. The following variables were checked for their correlation with observed site distributions: proximity to rivers; proximity to creeks/streams; proximity to seasonal streams; proximity to large lakes; proximity to medium lakes; proximity to small lakes; proximity to wetland complexes; proximity to large wetlands; proximity to small wetlands; aspect; and slope. Without exception, the results of the statistical analyses indicate that those variables used in the model do not predict site distributions in the manner suggested by the model.

The remainder of the variables employed in the Norcan model: cultural variables, fish, natural disturbance, sediments, drainage, surface and surface expression, were not statistically compared to site distributions because the data required for these analyses was either incomplete (cultural data), absent or too subject to user-interpretation for consistent results (fish, drainage, surface expression) or too coarse in its available form to be a meaningful prediction of location-specific entities such as sites (natural disturbance, sediments, surface). Clearly, these variables needed to be re-evaluated before being accepted as useful predictors of site potential. For example, 'cultural variables' require the collection of a non-biased random sample of archaeological sites before they can be used as a meaningful predictive variable.

Additionally, First Nations consultation is of value in helping to identify what environmental settings various site types are expected to occur. The experience and input of knowledgeable persons would considerably aid the development of predictive models.

With respect to the variables aspect, slope, natural disturbance, sediments, drainage, surface and surface expression, the Norcan model directs the user to identify 'the most dominant', 'the average' or, in the case of slope, 'the least sloping' feature in the survey block and then use this variable expression to determine the predicted site potential for the entire block. We recommended that this 'block averaging' approach is inappropriate for the prediction of archaeological site locations. Firstly, this approach is subject to considerable user-interpretation, making the model difficult to employ and the results inconsistent. Furthermore, by defaulting to a dominant feature, the model does not take into account those smaller areas of higher and lower archaeological potential that often exist within a survey block.

For these reasons, we strongly recommended and proposed to develop a location-specific predictive model using GIS. Development of a more accurate and reliable predictive model benefits not only the cultural resources and resource managers, but also the land developers enabling more informed decisions about proposed developments. By knowing where archaeologically sensitive areas exist, developers can either avoid them or plan to manage the cultural resources within them.

Phase III

Originally, Phase III proposed field-testing in order to ground-truth the Norcan model. However, due to funding cuts and time constraints, field-testing was not possible and therefore, the project proceeded directly into Phase IV. We are exploring other funding avenues and anticipate completing Phase III in the future.

Phase IV

In General, Phase IV consisted of two elements. The first was the orthorectification of the site location data in the CHRID and the second was the design, analysis, presentation and distribution of an updated model for the Fort St. James Forest District. The model development process contained the following stages:

1- Map sheet selection
2- Determination of Potential Variables and Their Weighting
3- Grid Construction and Model Completion
4- Analysis and Results
5- Model Adjustments
6- Model Testing Against Historic AIA Data

The following sections outline Phase IV of the project.

PHASE IV METHODS

Phase IV consisted of numerous steps in order to create an improved model for the Fort St. James Forest District. In order to create a more effective model Ecofor selected the appropriate map sheets for modelling, determined the variables that were most feasible to use in the model, then proceeded onto grid construction, model analysis, presentation and distribution. Additionally, as part of improving the Cultural Heritage Resource Inventory (CHRID) database, orthorectification using the site forms was done during this Phase. However, before this process began, several meetings took place to hear the concerns from interested parties to determine which variables were most important and how they should be weighted.

A FIA Task Force meeting took place on October 21, 2004[1]. The FIA task force was created to ensure that representatives of each of the First Nations with asserted traditional territories within the Fort St. James District were invited and involved in discussions surrounding how the model is built and implemented. The following First

[1] In attendence: Clara Jack (Nakazdli), Anita Tylee (McLeod Lake), Rosemary Prince (Nakazdli), Lionel Chingee (McLeod Lake), Fred Sam (Nakazdli), Alex Mackinnon (Nakazdli), Dwayne Martin (Tl'aszt'en), Sharon Bird (Nakazdli), Gareth Spicer (Ecofor), Kevin Wilson (Ecofor),and Amanda Marshall (Ecofor).

Nations were invited via an October 8th letter to attend the meeting: Dzitl'ianli; Gwinin Nitxw; Haiwas; Nii Kyap; Lheidli Tenneh; Nak'azdli; Takla Lake/Bear Lake; Treaty 8; Tsekeh Dene; Gitxsan Treaty Office; Kaska Dene; Lake Babine; McLeod Lake; Tahltan; Tl'azt'en; Tsa Bux; Wii Gaak; Wii Minosik; and Yekooche. Phone calls were made on October 20th to confirm who would be in attendance, and the meeting was held at Kwah Hall/Nakazdli Band Office in Fort St. James. Wii Minosik, Yekooche and Dzitl'ianli called to let us know that they had interest in the meeting, but were unable to send a representative. The FIA Task Force is responsible for ensuring that the quality use and implementation of the Predictive Model as well as ensuring the model will work to its utmost ability for the preservation and proper management of the District's Cultural Heritage Resources. At this meeting we discussed our model revision ideas, the old model, problems with it, a history of the project to date, and the change in funding plans. After the meeting, Gareth Spicer sent information packages to each of the First Nations, including a copy of the graphics used to illustrate our proposed revision to the model, and a brief description of each slide, in the hopes that we could communicate the basic themes of our proposed revision clearly. We also welcomed each group to consider contacting us to give a presentation in their individual communities.

Two other meetings also took place with the TSA at the Ministry of Forests on January 9, 2004[2] and March 1, 2004. These meetings served a similar purpose, to present and share ideas on preliminary model construction. Several suggestions came out of the meeting. For example, some individuals felt that too much emphasis seems to be placed on wetlands and wetland complexes as a variable. Also, individuals would have liked to see some element of probability factored into the model. We also discussed the importance of visually identifying the location of all known sites. As well, it was made clear that sites needed orthorectification to determine their proper locations. Everyone's ideas and concerns were noted so that they could be taken into account as the model was

[2] In attendance Joe Kavanagh (Canfor PG), Shawn Hales (Canfor FSJ), Christie Willmot (Stuart Lake Lumber), Leone MacDonald (BCTimber Sales-Vanderhoof), Susan Salokannel (BCTimber Sales-FSJ), Shane Perry (Apollo Forest Products), Tanja Kruisselbrink (Canfor FSJ), and Kevin Wilson and A. Marshall (Ecofor)

developed. Following these meetings, the orthorectification and actual model development began.

Orthorectification

The importance of accurate site location data cannot be overemphasized. Errors in plotted site locations are common but can easily be corrected by checking the recorded sites against geo-referenced TRIM II Orthophotos and adjusting their locations to the point most closely matching its description in the site forms and site sketch maps. In those cases where the site descriptions were too vague for this type of fine-tuning; these sites were highlighted and excluded from the database used for testing and refinement of the model.

This orthorectification process was completed during Phase IV in order to relocate sites as accurately as possible using known site location data.

Ortho rectification was accomplished using the Geographic Information Systems (MapInfo Professional software). This tool uses satellite images or aerial photography to orient the image into its correct geographic space. Then new geographic coordinates are assigned after relocating sites as accurately as possible using identifiable features in the image.

Available data on archaeological sites located in the district of Fort St. James was corrected in Phase I of the project and entered into the CHRID. Site location data was collected using the following sources: ortho/aerial photos (provided by Canfor and MoF), the HRIA database and B.C. Archaeological and Traditional Use Site Inventory Forms (provided by the Archaeology and Registry Services Branch), Interim and Final AIA Reports (provided by Antiques Archaeological Consultants Ltd., ARCAS Consulting, Aresco Ltd, Bastion Group, Big Pine Heritage, Ecofor Consulting Ltd., I.R. Wilson, Millennia Research, Norcan Consulting, Point West Heritage, Traces Research other sources included Canuel & Hanson (1978), Drew (1974), Helmer & Mitchell (1972) Irvine (1980), McMurdo (1971), Mohs & Hoy (1973), Sewell 1951).

This database was exported into a MapInfo table and the program created points using eastings and northings in a projection of NAD 83. Each site appeared as a point on the aerial photo and was checked using available maps and location descriptions. If the site was not in its correct position the point was relocated as accurately as possible and the new coordinates were entered into the database. When relocating sites, measurements were taken using features easily identifiable on available maps and compared to the ortho/aerial photos.

Incorrect site location information was corrected in the database through the examination of orthophotos. Some of the difficulties encountered during this process are as follows:

Human error. Several individuals were responsible for adding information to the database and as a result, some degree of inter-observer error was introduced. Additionally, typing errors were common and greatly altered the site location.

Incorrect projection (i.e. NAD 27 or NAD 83) information provided or entered. In some cases, site forms indicated that the site locations were in NAD 83 but were actually recorded in NAD 27 or vice versa. Similarly, individuals may have entered NAD 27 data into the NAD 83 columns.

Site location information unavailable or inaccurate. For some sites the information was simply not available or the information was visibly inaccurate.

Incorrect UTM zone inputted or provided (i.e. zone 9 or 10). Because the Fort St. James forest district straddles two UTM zones, errors were commonly made on site forms and/or when imputing the data in the database.

Note: NTS map sheet N/12 was entered as Zone 9 when in reality it is in Zone 10 for the purposes of a software translation error.

When identifiable features (water, landscape, vegetation) were not visible on the ortho/aerial photos, site locations were estimated using known block boundaries, built roads, railway lines or adjacent sites. Due to the lack of detailed site information and missing or inaccurate maps, many site locations were estimated.

Model Development

The first step in creating a new archaeological potential model was to select the appropriate map sheets. Presently there are 299 BCGS Map sheets that make up the Fort St James Forest District (see Figure 1). However, not all of these map sheets required archaeological predictive modelling, as a majority of areas are large bodies of water, designated parks, alpine areas, etc. Once these map sheets were determined, the preliminary model was built on the remaining map sheets.

Previously surveyed areas were also incorporated into the database in order to demonstrate portions of the landscape, which represent negative data, as well as to demonstrate portions of the landscape, which have been over and underrepresented in AIA field surveys. These previously surveyed areas were to be entered into the database, then checked and cross-referenced.

Determination of Potential Variables

Our Ecofor staff researched a wide spectrum of geological, ecological, historic, and ethnographic variables, with sensitivity to the practical availability of the information required. As a result, a revised list of variables and their related point have been encoded in a GIS spatial analysis programme.

The following section describes the variables that were chosen and the reasons they were selected specifically for the Fort St. James Forest District. Table 2 describes the justification for each weighting.

These variables are divided into two categories: Dependant and Independent variables. The Dependant variables are archaeological events which display physical evidence of that event occurring or not occurring, i.e. either the presence of archaeological resources (known site data) or the absence of archaeological resources (no site data). The Dependant variables used in our new model will not be given values or weights, but will instead be used to test the accuracy of the Independent variables. The Independent Variables are the non-archaeological characteristics or the biophysical, environmental factors such as slope, soil type, elevation, etc.

At the preliminary stages of the model, we began by including as many environmental variables as we could think of that may have an influence on predicting archaeological site locations. The variables chosen during Stage 1 of the model were weighted according to intuitive sense and group consensus, similar to the old Norcan model. This method had some obvious problems and inherent biases that we hoped to modify once our statistical analysis was completed. During Stage 2, the preliminary model was created, analyzed and several of the original variables were removed from the list, mostly due to inconsistent or irrelevant data sets. A Draft version of the preliminary model was presented to the Canfor's, Regional FIA Coordinator, and several problems were discussed regarding model weighting and problems with some of the variables chosen. Once our statistical analysis was available, the present variables list was again revised and some variables were re-weighted accordingly during Stage 3. See Table 1 below for a review of the three stages the model underwent. In the final model, the following variables were utilized: 1) Water Resources; 2) Soil Stability/Surficial Geology; 3) Proximity to Wetlands; 4) Landforms; 5) Forest Cover; 6) Aspect; 7) and Slope.

Table 1. Category Variables Chosen Over Three Stages

Category Variables	Stage 1	Stage 2	Stage 3
Water Resources Layer			X
Fisheries Resources	X	X	
Proximity to Lakes and Streams	X	X	
Travel by water		X	
Soil Stability/Surficial Geology	X	X	X
Drainage	X		
Wetland Matrix	X	X	X
Landform Variables	X	X	X
Wildlife	X		
Forest Cover Type	X	X	X
Aspect	X	X	X
Slope	X	X	X
Landscape Visibility/Lookouts	X	X	
Natural Disturbance Types	X		

The following section describes the variables that were chosen and the reasons they were selected or not selected for use in the final version of the model. Table 2 below, describes the justification for each weighting.

Table 2. Weighted Variable Components

Weight	Variable	Representative Components
5	Water Resources (Fish, Streams, Lakes, Travel Corridors)	Represents a critical need Focal point of the First Nation's lifeways Strong correlation to cultural heritage site locations
4	Slope, Aspect	Physical attributes of the landscape that directly influenced First Nation's lifeways Strong correlation to cultural heritage site locations
3	Wetlands, Landforms, Surficial Geology	Physical attributes of the landscape that determined resource use and availability Moderate-strong correlation to cultural heritage site locations
2	Forest Cover	Attributes that played minor role in selection of settlement, or the development of an area Moderate correlation to location of cultural heritage sites
1	No Variables fit this Category	Attributes that are not determining factors for critical needs Less significant for First Nations Minor correlation to location of cultural heritage sites
0	Historic mining, Known cultural features, Natural/Anthropogenic Disturbance	Background data not incorporated into model construction Relevant to archaeological field sampling May serve to test model reliability Indefinable, or not suitable for specific modelling purpose

Water Features

Weight: 5 out of 5

Primary Sources: FISS Data, TRIM data, BC Watershed Atlas Data, FPC Lake Classifications.

Assumptions: 1) Fish were a critical source of food and of great ceremonial importance to First Nations culture. 2) First Nations lived in close proximity to lakes and streams in order to access associated resources. 3) Waterways were historically used as travel corridors and navigational aids.

Discussion: First Nations settlements were typically located in close proximity to water bodies, as they relied heavily upon water features for sustenance and travel. Considering the following key aspects of First Nations use developed the water features category of the model:

- Water bodies provided potential for First Nations to gather resources such as fish, plants, wildlife, waterfowl, and water itself.
- Water bodies provided potential as transportation corridors (i.e. canoe route), or as navigational aids that could be followed from one point to another.
- Topography in proximity to streams and lakes provided potential for First Nations' use.

Each water body class (defined in Table 3) has a maximum buffer width, which indicates the width of the buffer zones adjacent to the Class A, A_{obs}, B, B_{obs}, and C water bodies. The maximum buffer width was determined by assigning 250 m for each value point assigned. Therefore, a Class A stream (Value 4) has a maximum buffer width of 1000 m. This will ensure that small streams and lakes, which were used less often by First Nations, receive a small buffer area, whereas large streams and lakes, which were used more frequently by First Nations, receive a larger buffer. There are two exceptions to this maximum buffer width; those being features with a value of 1 (Class C water bodies), and 5 (Class A_{obs} water bodies). Under the proposed system, these water bodies would receive a buffer width of 250 m and 1250 m, respectively. However, the maximum buffer width for Class C water bodies was reduced to 100 m as not to overstate the archaeological importance of these relatively insignificant water bodies. Additionally, the maximum buffer width for Class A_{obs} water bodies was capped at 1000 m to remain consistent with all other parts of the model.

A weight of 5, assigned to water features, is a numerical value that reflects the relative importance of the water features layer of the model. Since sustenance and travel provided by water features were considered critical needs and focal points of first nations culture (see Table 2), the highest weight of the predictive model has been assigned to these values.

The buffer widths and percentage scale factors presented in Table 3 are used to calculate the value of each raster cell adjacent to a given water feature. The values in the 0-50 column represent the score assigned to raster cells within 0-50 m from the edge of the selected water feature; the values in the next column represent the score assigned to raster cells from 51-100 m from the edge of the selected water feature, and so on. The values of each successive buffer are calculated by multiplying the water body class value by the weight, and then by the percentage scale factor. Buffer increments were selected to reflect the respective probability of encountering a cultural heritage feature within a given distance of a water feature.

Highest emphasis was given to large water bodies that potentially contained anadromous salmonids or game fish species and could be used as canoe routes (Class A and B). Lowest emphasis was given to small streams and lakes that do not contain anadromous salmonids or game fish species, and are too small to provide means to travel or navigate by (Class C). Class A_{obs} and B_{obs} water features were selected as individual points, where archaeological potential is higher due to barriers or confluences. These areas have increased probability of serving as fishing sites, camp sites, or portage routes, and therefore have increased probability of containing cultural heritage sites.

The first tool used to score watercourses where First Nation people may have fished, resided by, or traveled along is the provincial Ministry of Water, Lands, and Air Protection (MWLAP) Fish Information Summary System (FISS) data. The FISS database is available online and was queried to identify all documented water-bodies that support anadromous fish.

The second tool used to score watercourses was water discharge. Water discharge refers to the amount of water that flows down a watercourse at any given time. There are several different methods used to measure water discharge, but for the purposes of this model, stream magnitude was used. The B.C. Watershed Atlas database, available through the B.C. provincial government, lists the magnitude for all watersheds in B.C. The availability of data made stream magnitude the best option for this modelling process.

Magnitude is illustrated in the Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures (April 2001), and is re-produced below in Figure 4.

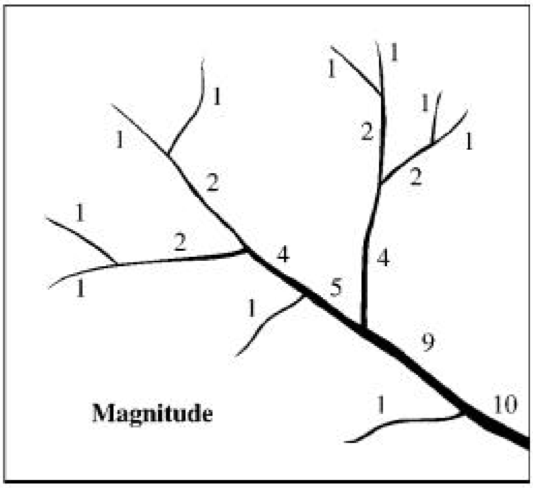


Figure 4. Stream magnitude (Adapted from Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures (April 2001))

As illustrated in Figure 4, stream magnitude indicates the number of tributaries that flow into a stream. With each new tributary entering a stream, discharge increases, and in turn, magnitude increases.

The following local examples illustrate the relationship between stream magnitude, the ability of the watercourse to sustain adult anadromous salmonids, and the navigability of the watercourse: 1) unnamed creeks of magnitude 10 (Class C) typically contain only juvenile fish and would not be used as a primary food source. These streams are very small, would not be navigable by canoe, and would not serve much use as landmarks; 2) Nahounli Creek (WSC: 182-594100) has a magnitude of 99 (Class A), and contains low numbers of rainbow trout and sockeye salmon. This is also a relatively small stream that would not be navigable, but does contain anadromous salmonids, and could serve as a landmark that could be followed to get from point A to point B; 3) the Kuzkwa River (WSC 182-819600-32400) has a magnitude of 985 (Class A), and contains rainbow trout, a significant number of sockeye salmon, and potentially other food fish species. This is a large creek that would be navigable by canoe, and could be followed as a landmark; and 4) the Tachie River (WSC: 182-819600), which has a magnitude of 4088 (Class A), and contains abundant trout and char, sockeye, chinook, and potentially sturgeon. A watercourse of this magnitude would be navigable by canoe or boat, could be utilized as a primary food source, and could be followed as a landmark (Source: Fishwizard Online Database, 2003).

The third tool used to score watercourses was the Terrain Resource Information Mapping (TRIM) 1:20,000 scale data. All streams that are mapped as double-line features in TRIM were given a higher score. Double-line streams are streams that are sufficiently wider so that the channel is effectively mapped using a line at each stream bank, instead of just a single line marking the stream location.

<u>Fisheries</u>

Fish utilization within the Forest District (FD) is complex not only because of the number of cultures present, but also because the FD encompasses three separate watersheds. The northwestern portion of the FD falls within the Skeena River watershed, which drains into the Pacific Ocean. A small part of the northeastern section of the FD is drained by the Omineca and Nation Rivers into Williston Lake. This system flows into the Arctic Ocean by way of the Peace River and Mackenzie River drainages. The remaining portion of the FD falls within the Fraser River watershed, which drains into the Pacific Ocean in BC's southwest corner. Due to the significant geographic variation among watersheds within the FD, a broad range of anadromous and non-anadromous fish species were likely available to First Nations.

Within the Skeena River watershed, there exists four anadromous fish species, all of which were harvested: sockeye salmon, chinook salmon, coho salmon, and steelhead (People of the 'Ksan 1980). Non-anadromous fish species that were harvested in both the Skeena and Fraser watersheds include: kokanee, lake trout, rainbow trout, dolly varden, bull trout, sturgeon, suckers, squawfish, peamouth, mountain whitefish, burbot, and lake whitefish (Cranny 1986; Morice 1893; and Morton 1988). Within the Fraser River watershed two anadromous fish species were harvested: the sockeye salmon and the chinook salmon (Cranny 1986). In the Omineca River watershed, there are no anadromous fish species present. Non-anadromous fish species harvested in the Omineca River watershed include all of those listed for the Skeena River and Fraser River watersheds, plus the arctic grayling. It is likely that additional fish species not present on this list were also used by Carrier cultures for various purposes, but these uses were not well documented.

Utilization of fish species was dependent upon the watershed in which the different First Nations resided. In the Skeena River watershed, the Gitxsan cultures focused primarily on gathering the anadromous species (People of the 'Ksan 1980). Cranny (1986) and Morice (1894) indicated that the Carrier living within the Fraser River watershed primarily sought anadromous species, especially sockeye salmon. Cranny (1986) also noted that sockeye populations in the Fraser River watershed were typically based on a four-year cycle of highs and lows. Consequently, when sockeye populations were at a low, the First Nations tended to switch to catching lake species for sustenance (i.e., lake trout, burbot, rainbow trout, kokanee). Sturgeon populations were present in the Fraser River watershed, but were not frequently caught in historic times because the technology was not available to contain the strength of a fish that could potentially weigh well over 400 pounds.

Water bodies were scored to reflect their respective sustenance value to First Nations. Highest emphasis was assigned to streams known to contain anadromous fish stocks, large streams (TRIM double-line streams or magnitude >101), and lakes situated along these watercourses (Class A). Moderate emphasis was assigned to magnitude 26-100 streams not selected as Class A, lakes situated along these watercourses, and large lakes that were not selected as Class A (Class B). Lowest emphasis was assigned to medium and small lakes not selected as Class A or B, and magnitude 1-25 streams not selected as Class A (Class C). Additional point-radius emphasis was assigned to obstructions and confluences, where fisheries values may be increased due to staging areas, resting pools, spawning beds, etc. (Class A_{obs} and B_{obs}).

The scoring scheme for fisheries values does not take into account detailed fish inventory data collected by forest companies and other organizations that has not yet been entered into the FISS database. These inventories provide four types of information that could have been incorporated into the model: (1) fish presence information; (2) fish absence information; (3) barrier locations; and (4) NCD/NVC reach locations. Fish presence information could potentially identify streams in class B with anadromous fish present, thus upgrading the stream to class A. Fish absence information could eliminate non-fish bearing reaches from the scoring matrix altogether. Additional barrier locations could upgrade streams in the A or B class to the A_{obs} or B_{obs} class. Known NCD/NVC reach locations could be eliminated from the scoring matrix. However, the data is inconclusive and/or inconsistent and will not be included in the model at this time.

Proximity to Lakes and Streams

Water resources are plentiful in the Fort St. James Forest District, and in the past, people settled in proximity to lakes and streams by necessity. For this component of water features, larger lakes and streams are weighted more heavily than smaller ones. The assumption is that larger water bodies contained more water, supported a larger number and greater variety of food and materials, and were thus a more valuable resource.

The proximity to lakes and streams component focused on the value of water for primary use (drinking, bathing, etc), and for collecting water-specific resources that may grow or congregate near water bodies. Water-specific resources include plants, furbearers (beavers, muskrat, etc.), waterfowl, fish present in small tributaries not evaluated in the fisheries component, and other wildlife.

A stream was classified as large, and was allocated the highest score if its magnitude is 101 or greater, or if it is mapped in TRIM as a double-line stream. Streams with magnitudes 100 or lower were classified as small, and were allocated the lowest score. Lakes were classified similar to the procedures outlined in the FPC Riparian Management Area guidebook. Lakes greater than 5 hectares (FPC class L1) were considered large, and received greatest emphasis (Class A and B), lakes less than 5 hectares (FPC class L3) were considered small receiving a low emphasis (Class C).

Travel By Water

Historically, waterways were an important means of travel within the Fort St. James Forest District. There are many large rivers and lakes that can be easily traveled by boat or canoe. In addition to water travel, waterways can also serve as landmarks to help an individual navigate, on the ground, from point A to B.

Areas adjacent to waterways were scored to reflect the likelihood of use by First Nations as a travel route. Highest emphasis was assigned to large rivers and lakes, because these features would have formed the primary transportation routes (Class A).

Additional emphasis was given to areas surrounding waterfalls and rapids on large streams, as with fisheries resources, because these areas would force people out of their canoes to portage the obstacle (Class A_{obs} and B_{obs}). Moderate emphasis was assigned to medium sized rivers, because these features may not have been used for canoe travel, but may have been followed as navigation landmarks (Class B). Little emphasis was assigned to small streams and lakes because these features were not as useful for transportation, or as landmarks (Class C). As the distance from the selected water body increases, the respective score decreases.

The relative sizes of water bodies were determined using stream magnitude and TRIM 1:20,000 double-line stream data. TRIM 1:20,000 double lined streams were streams mapped in TRIM that are wide enough to be represented by lines at each bank. These streams were considered large enough to navigate with a canoe (Class A). See Figure 4 for an illustration of magnitude.

Locations of waterfalls and rapids were identified using FISS data available on the MWLAP BC Fisheries Watershed Atlas. The database is available online and can be queried easily to identify exact locations of falls and rapids within the Fort St. James Forest District.

A concern was raised during preliminary model development regarding the potential for First Nation's use of topography adjacent to large water bodies where slope was confined. Original model weighting using the buffering system along large water bodies would have identified high potential areas along these large streams. In many areas of the Fort St James District, such as the Sustut Valley, there are very confined drainage systems. Within these confined drainages, the topography adjacent to the streams is too steep to provide archaeological potential (i.e. terrace locations for cache pits). However, the model addresses this factor in the slope category. A slope analysis was run to ensure that any confined areas adjacent to large water bodies were given a minimal scoring to ensure these areas were identified as low potential.

Table 3. Water Features Scoring Matrix.

Class	Class Triggers	Value	Max. Buffer Width	Weight	Buffer width and percentage scale factor 0-50 100%	51-100 90%	101-250 80%	251-500 70%	501-750 60%	751-1000 50%
A	Streams known to contain anadromous fish (FISS)	4	1000	5	20	18	16	14	12	10
	Magnitude 101 or greater streams									
	TRIM 1:20,000 double-line streams									
	Lakes located between or directly above Class A stream sections									
A_{obs}	Obstructions on Class A streams (rapids, waterfalls, etc.)	5	1000	5	25	23	20	18	15	13
	Confluence of Class A stream and Class A or B stream									
	Confluence of Class A stream and Class A, B, C, or D lake									
B	Lakes >5ha not selected as Class A waterbodies Magnitude 26-100 streams not selected as Class A streams	3	750	5	15	14	12	11	9	
	Lakes located between or directly above Class B stream sections									
B_{obs}	Obstructions on Class B streams (rapids, waterfalls, etc.)	4	1000	5	20	18	16	14	12	10
	Confluence of Class B streams									
	Confluence of Class B stream and Class B, C, or D lake									
C	Lakes 5ha or less, not selected as Class A or B waterbodies	1	100	5	5	5				
	Magnitude 1-25 streams not selected as Class A streams									

Surficial Geology

Weight: 3 out of 5

Primary Source: Plouffe 1991, Preliminary Study of the Quaternary Geology of the northern interior of British Columbia; and access via permission from Zhongyou Lu (LuStar Consulting) to Canfor's FTP site for the Takla and Sustut Regions of the District (Terrain Stability)

Alternative Source: Terrain Classification System For British Columbia, The Soil Landscapes of BC, and Terrain Information- A User's Guide to Terrain Maps in BC.

Assumption: Certain soils (i.e. surficial geology) are conducive to the preservation of archaeological materials and soil type was an important consideration when selecting activity areas.

Discussion: Hunter-gatherers typically preferred certain landforms for ease of passage, abundance of forage and game resources and when selecting activity areas. Moreover, landform features and overall terrain stability are largely dependent upon the underlying geological makeup of an area. Therefore, knowing the underlying geological makeup would assist when attempting to predict areas of high potential. To assess this we utilized two available data types, surficial geological maps for the southern portion of the district, and soil stability for the northern portion of the district[1]. The location of known sites was then overlain on these map sources to identify patterns of known site location and the underlying geology. Based on this data, values were then assigned to the total range of surficial geological categories and terrain stability classifications. However, this is only applicable for the summer months, as during the winter considerations of soil type become less important as the ground freezes, and is covered by snow and ice. The resultant data yielded some interesting trends. Areas near ancient lakes (i.e. glacial lake sediments) were more than twice as likely to yield lithic sites than areas underlain by glacial deposits, such as diamicton, or modern alluvial deposits. Therefore, these areas were given a relatively high value of 4. But by far the majority of sites (66% of identified archaeological resources) occurred on glacial till deposits. This category was given a value of 2 not because of the large number of sites that are found on till, but because 13 of 18 known cache pits are found on glacial till. This type of sediment appears to have been favoured for the storage of goods and was scored accordingly. By far the highest site density occurred on modern alluvial sediments. In total, 20 archaeological sites were found to be on alluvial sediments while only 3 no-sites were located on alluvial sediments. This low number of no-sites is due to the paucity of underlying alluvial sediments in the District. In summary, despite this lack of underlying alluvial sediments, they are unquestionably correlated with archaeological resources. The statistical data yield that the odds of site-presence are 7.004 times higher for alluvial sediments than for non-alluvial categories. For all these reasons, alluvial sediments were given the highest value of 5.

Areas that were composed of Bedrock were not awarded a value of 0 in recognition that exposures of bedrock are an essential requirement in the location of pictographs and petroglyphs. Slope alone cannot be relied upon to pick up these unique localities, as areas which contain bedrock outcrops, are steeply slopping, near water, etc. make prime localities for the finding of these ancient arts.

The probability that a given area will contain archaeological resources is also dependent upon terrain stability. Those areas that are classified as stable are thought to be more likely to yield archaeological resources. A conclusion supported by previous research as 88% of all known sites (both archaeological and CMTs) were found on "stable" terrain. Also, the age and stability of a landsurface will have an impact on the preservation of archaeological materials over a long period of time. Therefore, areas that are classified as "stable" received the highest rating (of 4 out of 5), while "potentially unstable" areas received a relatively low value of 1. These potentially unstable areas

[1] Unfortunately, surficial geology data is not currently available for the entire district, hence our need to utilize terrain stability in conjunction with it. Surficial data for the entire district will be available in 2005, at which

were not assigned a value of 0 as they may have been stable areas in the past. Unstable areas were not considered to be of potential when attempting to locate archaeological resources. Tables 4 and 5 below present these variables and their associated weightings.

Table 4. Surficial Geology Variables

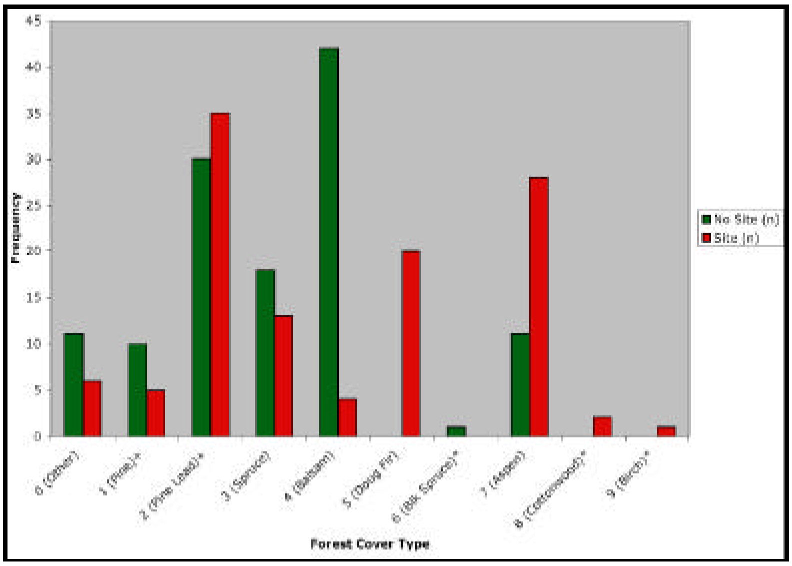
Variable			Value	Weight	Weighted Value
Ad	Deltaic Sediments	Sand and gravel	5	3	15
Af	Fan Sediments	Sand and gravel, with diamicton	5	3	15
Ap	Floodplain Sediments	Sand and silt	5	3	15
At	Terrace Sediments	Sand and gravel	5	3	15
Au	Alluvial Sediments, Undivided	Sand and gravel	5	3	15
c-Tb	Pinchi Creek Lens	Diamicton	2	3	6
Ca	Colluvial Apron and Talus	Rubble and blocks	0	3	0
Ch	Landslide Material	Dependant on source material	0	3	0
Cs	Slope Colluvium	Rock fragments	0	3	0
Gb	Glaciofluvial Blanket	Sand and gravel	4	3	12
Gd	Proglacial Deltaic Sediments	Sand and gravel	3	3	9
Gh	Ice Contact Deposits	Sand and gravel	3	3	9
Gt	Glaciofluvial Terrace Sediments	Sand and gravel	3	3	9
Lb	Glaciolacustrine Blanket	Sand, silt and clay	4	3	12
Lp	Glaciolacustrine Plain	Sand, silt and clay	4	3	12
Lv	Glaciolacustrine Veneer	Sand, silt and clay	4	3	12
O	Organic Deposits	n/a	1	3	3
R	Bedrock	n/a	1	3	3
Rs	Steep Bedrock Slopes	Bedrock outcrops and blocks	1	3	3
Tb	Till Blanket	Diamicton	2	3	6
Tm	Thick Till	Diamicton	2	3	6
Tv	Till Veneer	Diamicton	2	3	6
Tv-c	Till Veneer	Diamicton	2	3	6
U	Unknown-following terrain class as listed below in Table 5	n/a	0-4	3	0-12

time this variable should be revised.

Table 8. Forest cover type/weighting

Variable	Value	Weight	Weighted Value
Douglas fir leading	3	2	6
Aspen leading	4	2	8
Pine leading	5	2	10
Pine	4	2	8
Whitebark Pine	5	2	10
Cottonwood	1	2	2
Birch leading	1	2	2
Western Hemlock	1	2	2
Mountain Hemlock	1	2	2
Hemlock	1	2	2
Paper Birch	1	2	2
Spruce leading	2	2	4
Balsam leading	2	2	4
Black spruce	1	2	2
Non Commercial Brush	0	2	0
Balsam	1	2	2
White Spruce	2	2	4
Englemans Spruce	2	2	4
Sitka Spruce	2	2	4

Figure 5. Straight frequency histogram showing the difference between Site-Present and Site-Absent classes for Forest Cover types (archaeological site sample trial 1)



important to traditional first nations cultures (Turner 1997, 2001). Wetland resources were trapped, hunted, and gathered by First Nation peoples for numerous purposes, such as food, clothing, shelter and later to use as trade items during the fur trade (Cranny 1986; Morice 1893). Consequently, proximity to wetlands was considered a category in the predictive model. Table 6 outlines the total range of wetland variables considered in the model.

Wetlands are classified under the BC Forest Practice Code Act (FPC) based on size and biogeoclimatic zone. In the Fort St. James Forest District, wetlands fit into the categories of W1, W3, and W5. W1 wetlands are wetlands greater than 5 hectares in size, W3 wetlands are smaller than 5 hectares in size, and the W5 classification is assigned to a group of wetlands located in close proximity to each other. FPC wetland classifications have been pre-determined for all of the wetlands in the Fort St. James Forest District. This information was easily incorporated into the predictive model.

For the purpose of this model we have broken wetlands in to 5 categories ranked on the probability of traditional use. The FPC wetland classification system (W1-W5) has been used as the basis for the model, and slightly modified as follows. Wetland complexes (W5) were given the highest value because they were deemed to have the most significant potential for traditional use. Wetland complexes are often large and as such are expected to have the greatest diversity and density of traditional resources associated with them. The next highest valued wetland type was the W1 wetland associated with a defined stream (W1 stream). These wetlands have a much higher potential for sustaining fish because the associated streams can provide fish migration in and out of the wetland. The wetlands were also likely easier to locate and revisit by First Nations peoples, because it is assumed that the associated stream networks provided a travel route and definable landmark for locating the wetlands. The next highest value wetland class was the W3 wetlands associated with defined streams (W3 stream). These were given extra weight for the same rationale as the W1 wetlands associated with streams. There is a higher probability that First Nations people may have used these more frequently than the isolated W3 wetlands. The final two classes were the W1 and W3 wetlands without streams. These were given a minimal score due to the small size and isolated nature (no defined stream corridor or travel route), which was reasoned to have a lower probability of use by both people and animals.

For each of the wetland classes, a maximum buffer width is indicated in Table 7. Maximum buffer widths were determined by considering the value applied to each wetland class, and the probability of finding a cultural heritage feature within a given range from the wetland. The values chosen ensure that wetlands of high value (ie W5's) receive a large buffer width, and wetlands of low value (ie W3 isolated) receive a small buffer width. This system differs slightly from that used in the water features category. W5 wetlands receive a maximum buffer width of 500m. Beyond 500m the probability of a cultural heritage feature existing based on proximity to that W5 wetland is considered less likely. The same holds true for the maximum buffer widths assigned to each of the remaining wetland classes.

The weighting in Table 6 is a numerical value that serves to increase the overall score assigned to the wetlands category of the model in relation to the other categories in the model. Wetlands have been assigned a weight of 3, because they are physical attributes of the landscape that determine resource use and availability. This corresponds to the proposed justifications for weights provided in the Weighted Variable Components Table (Table 2).

The buffer zone widths and percentage scale factors presented in Table 6 are used to calculate the final point values that will be assigned to each raster cell adjacent to selected water features. The values in the 0 - 50 m column represent the number of points that will be assigned to raster cells within the 0 - 50 m range from the edge of the selected water feature; the values in the 51 - 100 m column represent the number of points that will be assigned to raster cells from 51 - 100 m from the edge of the selected water feature, and so on. These values are calculated by multiplying the value by the weighting, and then by the percentage scale factor. For example, a W5 wetland which has a value of 5, a weight of 3 and a percentage scale factor of 80 % would have a resultant weighted value of 12. This value is recorded in the cell for the W5 wetland column, under the 80 % percentage scale factor.

Table 6 Wetland Scoring Matrix

Wetland Class	Value	Max Buffer Width	Weight	Weighted Values			
				0-50	51-100	101-250	250-500
				100%	90%	80%	70%
W5	5	500	3	15	13	12	10
W1 with stream	3	250	3	9	8	7	
W3 with stream	2	100	3	6	5		
W1 isolated	2	100	3	6	5		
W3 isolated	1	100	3	3	3		

Landforms

Weight: 3 out of 5

Primary Source: Digital Elevation Model

Alternate Sources: NTS Map sheets

Assumption: Landscape features may have influenced the travel routes and habitation sites of aboriginal people in the past.

Discussion: The Fort St. James Forest District exhibits diverse terrain and topographical features. It is thought that early First Nations peoples likely preferentially selected areas of the landscape that were easily accessible and abundant in food resources. For example, a flat raised feature near water, such as a river terrace, is more easily traversed and provides a better area for human habitation than an elevated mountain feature. In order to represent this selective behavior in the model, these preferential types of features were identified and given the highest weighting. Weight diminished as the elevation increased towards isolated peaks. Consideration was also given to the areas immediately surrounding postglacial lakes and ancient fluvial landforms (e.g. old river terraces). These features are observable using the DEM but are made easier to identify when the DEM is combined with knowledge of surficial geology (Plouffe 1991) and NTS map sheets for the district.

Using the DEM as a tool, and with knowledge of the geological history of the area, the district was grouped into three distinct elevations. Those areas that were 181 - 830 meters in elevation were given a value of 5. This elevation range may seem extremely broad, however, this was necessary when considering the district as a whole, as the entire district increases in elevation towards the north and the east. For example, at the southern end of Stuart Lake the elevation of an ancient terrace is 680 meters; the elevation at the northern arm of Takla Lake is 690 meters and further north, the elevation of ancient terraces from the Sustut River are approximately 750 - 880 meters. All of these areas require a value of 5 out of a possible 5. Areas classified as less than ideal but still maintaining the possibility to contain archaeological resources were awarded a value of 3 and fall in the 831 - 1300 meter range. Finally, those elevations above 1301 meters were considered to have minimal potential and were awarded a value of 1.

Initially, this determination of which areas should be considered as having high versus low potential was done judgmentally, without utilizing prior knowledge of site location, so as not to skew results. Known sites were then overlain over top of the landscape map to visually test this whether the majority of known sites were in fact occurring in areas regarded as having high potential. A rough visual inspection confirmed that indeed, most sites were occurring in the elevation range of 750 - 880 m. During the initial stage of the model, the DEM had been divided into 8 different tiles to try and account for changes in elevation in the northern portion of the district, however, this proved to be problematic and the entire district was then treated as one tile.

Table 7. Landform Variables

DEM elevation	Value	Weigh	Weighted
181 - 830 m	5	3	15
831 - 1300 m	3	3	9
1301 - 2472 m	1	3	3

Forest Cover

Weight: 2 out of 5

Primary Source: Forest cover maps

Alternate Sources: Traditional use studies in correlation with forest type

Assumption: Forest cover types are assumed to be similar to what existed historically, preference being given to Lodgepole Pine leading stands for the collection of cambium.

Discussion: There is a great deal of variation in forest cover within the Fort St. James Forest District. The District includes, but is not limited too, Black spruce wetlands, Lodgepole Pine flats, as well as sub-alpine Balsam Fir forests. Each stand type is associated with a distinct plant community depending on the water and nutrients that are available. Virtually every species of tree has been recorded as serving some purpose within First Nations communities (Turner 2001, Turner 1998). Most notable and visible in the archaeological record are the cambium stripped Pine trees, which were used as a food source. Forest cover is linked to critical components of First Nations activities, but less significant than other variables, therefore, it receives a relatively low weighting of 2. Pine leading had by far the greatest quantity of sites (Figure 5) and as a result received the highest rating, of 5. Other types of pine received ratings of 4. After pine, aspen was considered to be of high importance. This is a result of both previous archaeological research (Canuel 1999b) and our statistical analysis. Areas of Aspen have a high site density; this means that statistically in the study area, roughly 25 % of aspen stands contained some type of archaeological resource (Table 9). An aspen stand was also found to be 3.315 times more likely to contain an archaeological resource than non-aspen stands. It is important to note at this point that CMT's were *not* included in the sample of known archaeological site data. Aspen received a proposed rating of 6 (out of 10) after a log odds ratio was performed on the available data (Table 10). For these reason aspen was awarded a relatively high rating of 4.

At this time it seems prudent to consider douglas fir. Though douglas fir received the highest site density (Table 9) and also the highest proposed weighted value (10 out of 10) as a result of the log odds ratio analysis, we only awarded it a value of 3. This is because the majority of the little douglas fir that does occur in the study area is on the eastern margin of Stuart Lake. This area is associated with a large number of pictographs, which appears to have skewed the data.

First Nations also frequently used spruce and birch trees (Turner 1998). Statistical analysis (Figure 5) revealed 13 of 114 (11.4 %) known archaeological resources occurred near spruce stands while only 1 site occurred near birch stands. Spruce therefore received a value of 2 while birch received a value of 1. Birch did not receive a value of 0, despite the paucity of known archaeological resources associated with it, as Turner (1998) documents its use in the past; even though no sites have been found as of yet in this district. Non commercial brush was given a value of 0 as this unproductive forest cover type is typically associated with wet ground and poor drainage. The other assigned values are summarized in Table 8.

Table 8. Forest cover type/weighting

Variable	Value	Weight	Weighted Value
Douglas fir leading	3	2	6
Aspen leading	4	2	8
Pine leading	5	2	10
Pine	4	2	8
Whitebark Pine	5	2	10
Cottonwood leading	1	2	2
Birch leading	2	2	2
Western Hemlock	1	2	2
Mountain Hemlock	1	2	2
Hemlock	1	2	2
Paper Birch	1	2	2
Spruce leading	2	2	4
Balsam leading	2	2	2
Black spruce leading	1	2	2
Non Commercial Brush	0	2	0
Balsam	1	2	2
White Spruce	2	2	4
Englemans Spruce	2	2	4
Sitka Spruce	2	2	4

Figure 5. Straight frequency histogram showing the difference between Site-Present and Site-Absent classes for Forest Cover types (archaeological site sample trial 1)

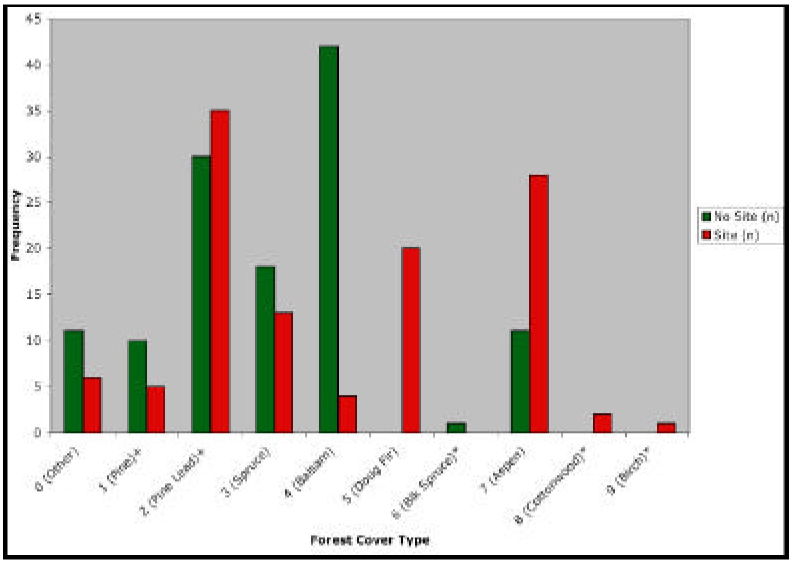


Table 9. Measure of site density based upon statistical analyses.

Forest Cover Type	Land Area		Site-Absent			Site Present		
	Square km	ha	n	%	Site absent/100ha	n	%	Site present / 100ha
Other	9.096	909.6	12	9.76	1.319	9	7.89	0.989
PineTot	26.3683	2636.83	40	32.52	1.517	40	35.09	1.517
Spruce	11.8658	1186.58	18	14.63	1.517	13	11.40	1.096
Balsam	28.9248	2892.48	42	34.15	1.452	4	3.51	0.138
Doug Fir	1.106	110.6	0	0.00	0.000	20	17.54	18.083
Aspen	4.6452	464.52	11	8.94	2.368	28	24.56	6.028

Table 10. Proposed ranking based on simple cross classification analysis for forest cover types.

Forest Cover Type	Log Odds Ratio	Absolute value above 0	Proposed Weighted value (0-10)
Balsam	-1.154	0	0
Spruce	-0.124	1.03	4
Other	-0.101	1.053	4.1
PineTotal	0.05	1.204	4.68
Aspen	0.52	1.675	6.51
DougFir	1.418	2.572	10

Aspect

Weight: 4 out of 5

Primary Source: Digital Elevation Model

Alternate Source: Air Photos

Assumption: Aspect refers to the compass direction the ground surface faces in association to the activity location.

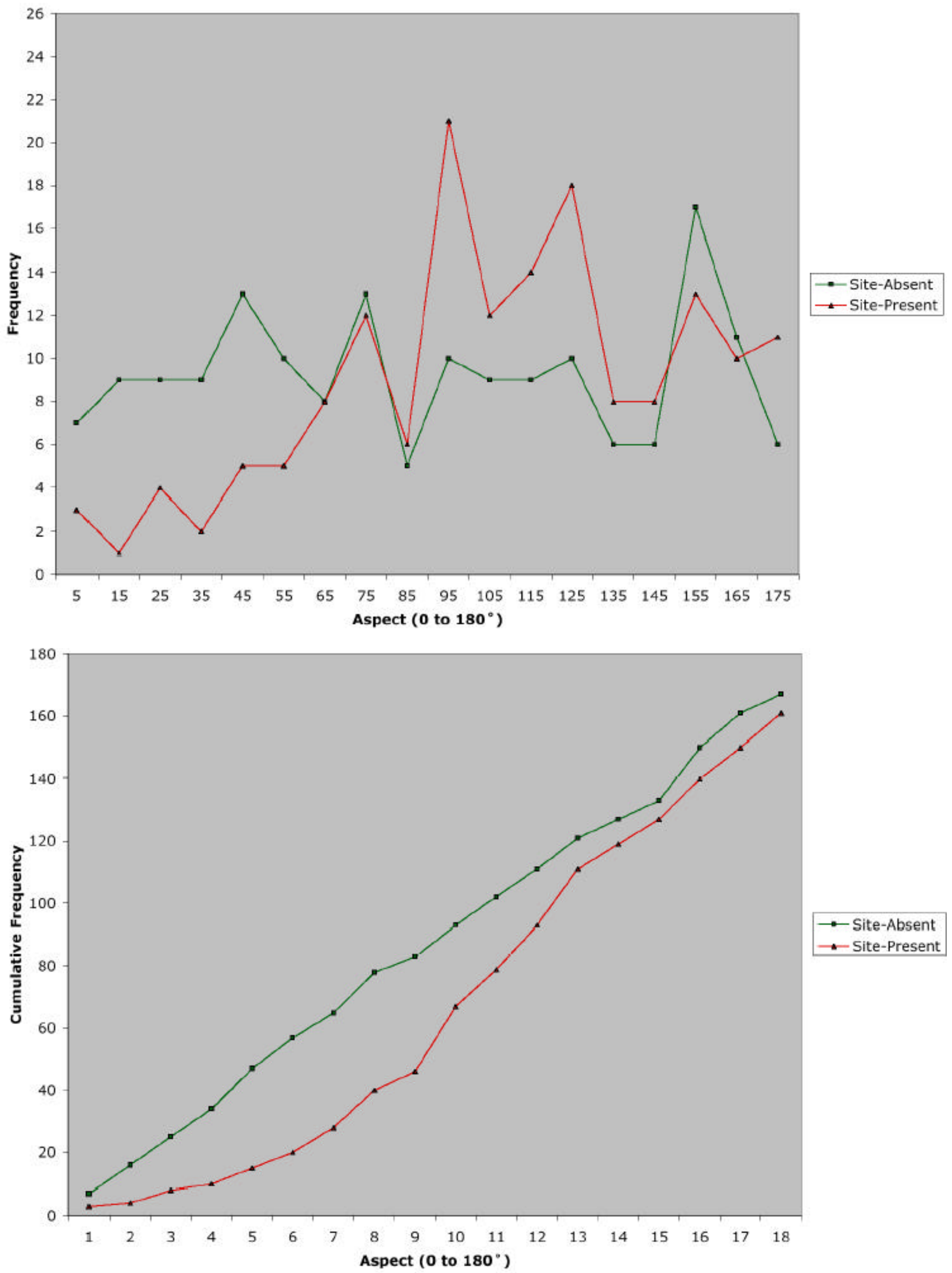
Discussion: In relation to aspect, the areas receiving the maximum exposure to the sun (horizontal, south facing) would be a preferred settlement location. The majority of winter activities will require a south-facing slope to provide the maximum protection from the chilling winds. In the summer, south-facing areas would be exposed to the sun and winds aiding in relief from flying insects and providing a more desirable location for settlement. Aspect is closely tied to slope, therefore, these two variables are weighted the same value, a 4 out of five. There are eight cardinal directions for aspect: N, S, E, W, NE, SE, NE, and NW. The aspect variables are outlined in Table 11.

The results of the univariate analysis yielded some interesting trends (figure 6), which aided when assigning values. SE/SW exposures yielded more sites than NW/NE exposures and therefore SE/SW was given twice the value of NW/NE. Some sites were found on N facing exposures and so this was rated at a value of 1, recognizing that sites do occur on N slopes but in very few numbers.

Table 11. Total Range of Aspect Variables

Variable	Value	Weight	Weighted Value
Flat/South Facing 0 160 to 203	5	4	20
SE/SW Facing 114 to 159 204 to 248	4	4	16
E/W Facing 69 to 113 249 to 293	3	4	12
NW/NE Facing 294 to 338 24 to 68	2	4	8
North Facing 339 to 23	1	4	4

Figure 6. Normal and cumulative frequency distributions showing the difference between Site-present and Site-Absent classes for Aspect (archaeological site sample).



Slope Variables

Weight: 4 out of 5

Primary Source: Digital Elevation Model

Alternate Sources: Air Photos

Assumption: Flat surfaces are a favourable for settlement.

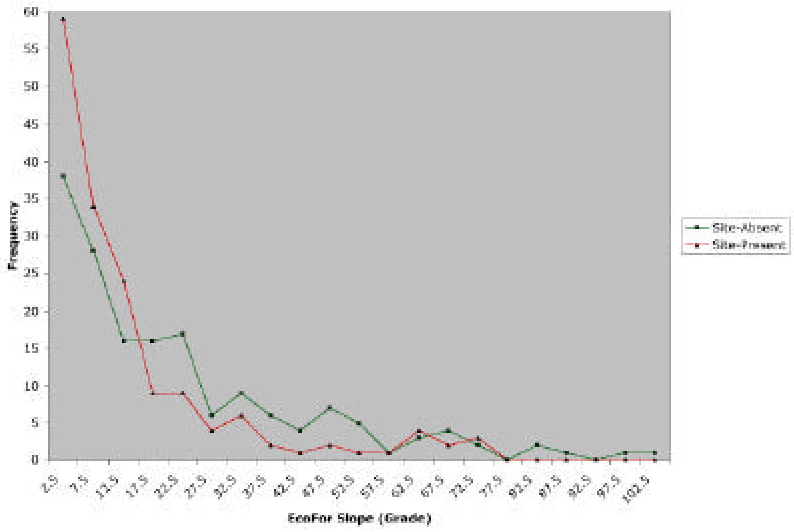
Discussion: Slope is a significant factor when choosing a settlement location and therefore, can be used to determine archaeological potential. Even today people are more likely to set up camp on flat to gently sloping surfaces. Slope inclination was measured as a percentage; that is, the vertical rise divided by the horizontal distance, then multiplied by 100. For example, a 100% slope has one unit of vertical rise for each unit of horizontal distance. A 40% slope has 4 units of vertical rise for each 10 units of horizontal distance. Slopes are sometimes measured in degrees, but there is difficulty in converting between the degrees and percent. A 100% slope is equivalent to 45 degrees, but a 40% slope is roughly equivalent to 22 degrees.

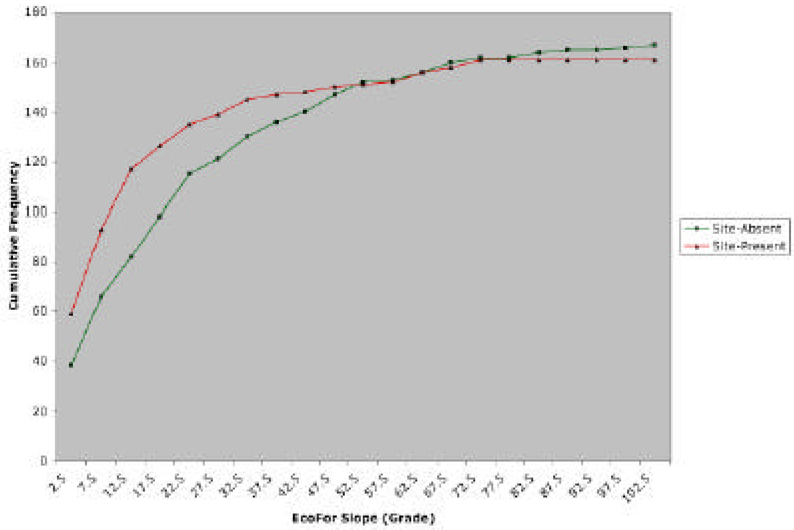
A univariate statistical analysis was preformed in order to determine ideal weightings for slope percentages. An equal sized site and non-site database was analysed, and the resultant site and non-site data was then plotted as both raw frequency (number of sites per unit of slope) and cumulative frequency (the rate of change in sites or non-sites per unit slope). These data were then used to identify natural breaks in slope percent grade. For example, there is a gradual decrease in the number of sites between 4.99% and 14.99%, yet there is a sharp decrease in site frequency at the 15 % grade as seen in Figure 7. Therefore, this was determined to be the best place to division between a value of 3 and a value of 1. The slope categories used to create the predictive model grid are outlined in Table 12.

Table 12. Slope

Slope (% Grade)	Value	Weight	Weighted Value
0 – 4.99 %	5	4	20
5 – 9.99 %	4	4	16
10 – 14.99 %	3	4	12
15 – 79.99 %	1	4	4
80 +	0	4	0

Figure 7. Normal and cumulative frequency distributions showing the differences between Site-present and Site -absent classes for Slope (archaeological site sample).





Visibility

Weight: None

Primary Source: Digital Elevation Model

Alternate Source: Relief shading and visual inspection

Assumption: Landscape features that provided good visibility (i.e. having a direct line of sight from one position on the earth's surface to another) were preferred areas to conduct certain activities.

Discussion: The aim of creating a revised predictive model was to include all areas that may have potential to contain archaeological resources. While many of these areas are associated with past settlement locations or areas used to collect resources, the model included additional factors such as visibility. Lookouts, or alternatively, areas with broad sweeping views of the landscape, may have been important for specific spiritual, ceremonial, or navigational activities. Therefore, lookouts have archaeological potential. Using the DEM (digital elevation model) in three dimensions, various view were simulated at different elevations. Bluffs situated between 1200 and 1300m appeared to offer the best broad-ranging views accessible to past peoples. During stage 3 of the model draft, it was determined that visibility would be better placed within the 'Known Recorded Sites Category' and referred to as lookouts. These potential 'lookout sites' would then be given a 0 - 50m buffer of high archaeological potential, but were removed from the model itself.

Natural Disturbance

Weight: None

Primary Source: Forest Practices code Biodiversity Guide book

Alternate Sources: Fire Reconnaissance Maps

Assumption: Stands within similar area exhibit the same natural disturbance pattern.

Discussion: Natural disturbance patterns have a significant impact on the ecological stability on the landscape and thus, shape the migration of human and wildlife populations. The natural disturbance variable accommodates typical forest stand age and its resulting biodiversity within an area. The more common a disturbance event occurs (forest fires, disease, insects and blowdown for example), the more an area within that section of the forest were typified by young forest stands or early invasive species such as berries and tender herbs. Young forests commonly have greater plant diversity and consequently, a greater attraction to animals and, in turn to people. As important as these factors are they are continually changing over time and difficult to measure and delineate. Natural Disturbance Type (NDT) was identified as broad regions based on the Biogeoclimatic sub-zones of the province. This data is extremely coarse and as a result, is not applicable for predicting the potential of location-specific entities such as archaeological sites.

Large-scale fire disturbances have been mapped in the district. It can be inferred that the occurrence of CMTs in these burned areas were very low unless cambium has recently been cut. These areas were highlighted throughout the district.

Table 13. Natural Disturbance types in the Fort St. James Forest District

Natural Disturbance Type	Description
NDT 1	Ecosystems with rare stand-initiating events
NDT 2	Ecosystems with infrequent stand-initiating events
NDT 3	Ecosystems with frequent stand-initiating events
NDT 5	Alpine tundra and Subalpine Parkland ecosystems

Historic/Mining

Category: Historic/mining

Weight: None

Primary Source: Old Department of Mines and resources reports; NTS mapsheets

Alternate Sources: Interviews with local pilots, Ministry of Mines Reports

Assumption: None

Discussion: The town of Fort St James and many other areas within the forest district have a rich history of mining and exploration that date back to 1869 when placer gold was first discovered in Vital creek 35 miles east of Takla Post. This section of our project aimed to identify many of these areas and outline some of the history associated with their discovery and subsequent mineral speculation/production. Much of the information was compiled from old reports written by the Department of Mines and Resources Canada (Armstrong 1949) and from interviews with local pilots whose knowledge of these areas has was recorded and mapped[2]. Many of the initial roads and trails developed in the district were constructed to facilitate the transport of supplies for mining activities. Although the locations of these activities will not be assigned weight in our predictive model they deserve merit and will be a useful planning tool (See Appendix II). Each area was indicated at its respective location and additional information was available in the report for reference. Known trail or road locations associated with the mines, known cabin sites, and Indian Reserves will also be highlighted on this map layer. This map layer is in its infancy, and over time as more data becomes available, it is suggested that it be updated, perhaps annually.

[2] **Randy Diston**, pilot with Pacific Western Helicopters (FSJ) was interviewed February 17th, 2004 and **Grant Luck**, Owner/Pilot Interior Helicopters (FSJ) was interviewed February 18th, 2004 by Nathan

Traditional use

Weight: None

Primary Source: Food plants of Interior First Peoples

Alternate Sources: Myriad of Traditional use studies

Assumption: Ecological diversity is directly associated with the pattern of traditional use

Discussion: For centuries, First Nations in British Columbia have harvested a variety of wild plants for food, medicines and implements required for a variety of tasks. Berries, nuts, roots, greens, mushrooms, lichen and cambium are a few examples of items that made up traditional diets. By careful observation and experimentation, they learned which plants were useful, the best seasons for gathering them, the most efficient methods of harvesting and the best ways of preparing them. There is a broad spectrum of literature that describes the traditional use and species associated with this use, but there is a lack of site-specific info pertaining to gathering or harvesting areas. First Nation communities were in many cases nomadic and as such they were opportunistic in many of their activities. Descriptions of First Nations hunting and trapping a multitude species of mammals, birds and fish are prevalent throughout much of the available literature. Hunting and gathering sites could and did change consistently with season and as well with the succession of natural disturbance. Many Bands in the Fort St. James District have for reasons of privacy declined to provide information on exact gathering locations, understandably so. Due to the wide variation in location and nature of traditional use and the lack of specific digital data in this regard and therefore, will not be assigned a weight at this time. Perhaps if further information becomes available one may be able to incorporate traditional use into in future revisions to the Predictive Model.

Known Archaeological Features

Weight: None

Primary Source: HRIA Database, B.C. Archaeological Site Inventory Forms and Final and Interim Reports for the Fort St. James District

Alternate Source: Air/Ortho Photos, CHRID Database

Assumption: Known archaeological features are accurately represented within the sources used.

Discussion: In order to determine the accuracy of the model grid, known archaeological features were assigned values based on their site type and then given buffers and can be overlaid on the predictive model grid. While archaeological features were not weighted within the actual model grid, they served to illustrate the validity (or invalidity) of the variables chosen.

The known archaeological features are presented as a separate layer which can be overlaid on the predictive model grid. The known archaeological features that are present within the Fort St. James Forest District that were used in this model are outlined and assigned values in Table 14. Rationale for the values assigned to each site type are provided below.

Each archaeological feature was assigned a value based on a scale of 0-5, where 5 is the highest value and 0 is the lowest. For example, data from known sites reveals that certain features have a high probability of being associated with other feature types (i.e. a trail site will likely be associated with traps, CMTs, and camping sites; and will eventually lead to a resource area or settlement site). This site type would be given a higher value and therefore a larger buffer than a site that is less likely to have associated features. Values were also assigned according to site dimensions with regards to cache pit and CMT sites, as the significance of these types of sites increases as the size of the site increases. Subsequently, each value was broken up into Low, Moderate and High potential buffer zones described in Table 15. A distance buffer was placed around each known archaeological feature according to the assigned value of each feature. Also, the start of the buffer zones was based on the outer boundary of a site if it is quite large.

Table 14. Values for Known Archaeological Features in the FSJ Forest District

Variable	Site Value
Isolated Lithic Site	1
Lithic Scatter	2
Trail (not GPS'd)	5
Trail (GPS'd)	1
CMTs	according to site dimensions (min 1)
Cultural Depression/Cache Pit	according to site dimensions (min 2)
Burials	5
Ceremonial/Sacred Sites	5
Rock Art	5
House Pit	5
Indian Reserves	5
Wooden Structures	1
Bridges	2
Dugout Canoe	2
Campsite	2
Trap	1
Cultural Materials (historic)	1
Faunal Materials	2
Hearth	2
Village/Multi Use Site	5
Historic Structure	1
Ferry Landing	1
Fish Weir/Station	3
Unknown Structure	2
Quarry	3
Lookouts	1
No Site*	0

Table 15. Buffers for Archaeological Site Value

Site Value	Buffer Size
1	0-100 m
2	0-250 m
3	0-500 m
4	0-750 m
5	0-1000 m

Rationale For Assigning Values to Each of the Site Types

The model was designed to predict areas of high potential within the Fort St. James Forest District. Consequently, any and all cultural features will have a relatively high potential for other features to be located within close proximity. Certain features will naturally have a higher value for the potential of additional or other cultural features within close proximity (i.e. village site vs. an isolated CMT site), are in many cases related to site significance, and are outlined in the following list of features with their respective values.

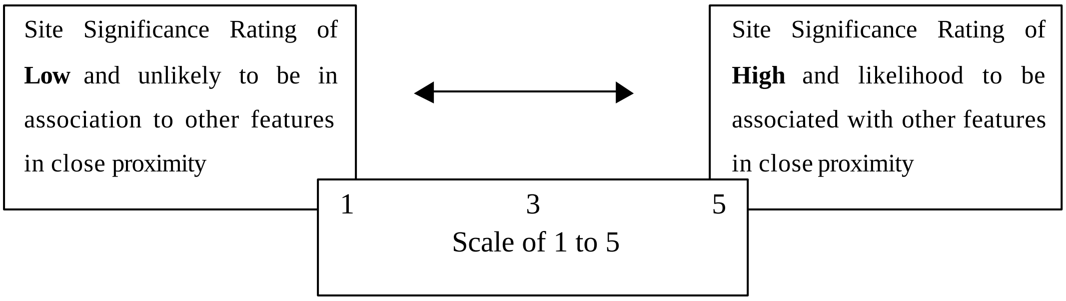


Figure 8. Site Significance Rating Scale

Site significance ratings are designed to assist in the development of appropriate recommendations for the management of specific site areas, and have been useful here to help define the value of a known site type on a scale of 1 to 5 (see Figure 8). The four categories of cultural heritage site significance defined by the Archaeology Branch in Appendix D of the *British Columbia Archaeological Impact Assessment Guidelines* (1998) to address pre-contact sites are: 1) Scientific Significance 2) Public Significance

3) Ethnic Significance and 4) Economic Significance. In most cases, archaeologists do not feel they are in the position to make decisions regarding the ethnic significance a site may hold for First Nations groups with regards to Pre and Post-1846 sites. Criteria for each category are outlined in the *Guidelines* and are listed below. Post-contact site significance is outlined within Appendix E of the *Guidelines* and lists three additional categories for post-contact sites: 1) Historic Significance 2) Integrity and Condition and 3) Other. For a full checklist of criteria for pre and post-contact site significance please refer to Appendices D and E, respectively, in the aforementioned guidelines.

Scientific Significance:

a) Does the site contain evidence, which may substantively enhance understanding of cultural history, culture process, and other aspects of local and regional prehistory?

b) Does the site contain evidence that may be used for experimentation aimed at improving archaeological methods and techniques?

c) Does the site contain evidence, which can contribute to paleoenvironmental studies?

d) Does the site contain evidence, which can contribute to other scientific disciplines?

Public Significance:

a) Does the site have potential for public use in an interpretative, educational or recreational capacity?

b) Does the site receive visitation or use by tourists, local residence or school groups?

Ethnic Significance:

a) Does the site presently have traditional, social or religious importance to a particular group or community?

Economic Significance

a) What value of user-benefits may be placed on the site?

Value ratings for our model are based on a scale of 0-5, where 5 is the highest value and 0 is the lowest. These values were assigned intuitively by the project archaeologist, and will correspond to the Low, Moderate and High Potential buffer zones, used to predict cultural features. This scaling method should prevent low significance sites from improperly outweighing other more highly significant sites. It was also felt important to include both a high and a moderate potential buffer zone to these sites, based on the assumption that the closer you are to a known recorded cultural heritage feature, the higher the probability of locating another feature. It was also taken into account that even though archaeologists place arbitrary protective boundaries around archaeological sites; however, traditional aboriginal use of the landscape associated with these sites may extend beyond the archaeological site boundaries (Howe 2003).

A setback to this method, however, is that buffering an area from the centre of a known point does not allow for delineation of landforms, for example, the edge of a terrace in association with a lithic site would be considered of high archaeological potential; whereas the lake adjacent to the terrace and/or the slope towards the lake would not necessarily be of high potential.

The following features are as listed in the Ecofor database for known archaeological features and were used as the headings for this portion of the model. Rationale for the assigned value for each site type are also provided:

Lithic: Lithic features were divided into two categories: 1) isolated lithic, and 2) lithic scatter. An isolated lithic site will receive a value of 1; whereas a lithic scatter, which is generally considered to be of higher significance, will receive a value of 2. The presence of a lithic site in an area will usually be considered by most archaeologists to be of moderate to high significance, due to the probability of additional features being located nearby.

Trails: Ultimately, the largest management expense for licensees and developers comes from the recording, mapping and dating of Trails and CMTs. Also, not surprisingly, in the neighboring Vanderhoof District 59.8% of all known recorded archaeological sites are found within 1 km of known trails in association with primary streams. Because primary streams are being treated as a separate variable in our model, and due to the fact that our District has a fairly accurate trail database; GPS'd trails will be given a smaller buffer zone (value of 1); whereas, non-GPS'd trails will require a larger buffer zone in an attempt to determine their exact location (value of 5). Therefore, identifying and ground truthing trails is a favourable endeavour for both archaeologists and licensees, as the trail would then be reduced to a value of 1, i.e. a 50 m buffer. All trails are going to be categorized or grouped together regardless of whether or not they are Pre-1846 or Post-1846 in age. The reason for this is that the determined age of most trails is based on the presence or absence of pre-1846 CMTs or other archaeological features in association, and in most instances a trails' age defaults to Post-1846 unless future evidence is presented or found to prove otherwise. Many trails that today are considered Post-1846, could in fact be proven to be Pre-1846 in the future.

An attempt was made to distinguish trail type (ie. Aboriginal or historic origin) and the appropriate weight assigned accordingly. There were problems associated with this method, including inconsistencies in the information available on each trail and inconsistencies in the names and origins of the trails, etc. Justification for our methodology: a non-GPS'd trail location is not accurately known, whereas, a GPS'd trail location is known to be exact (ground-truthed). All trails and assigned trail buffers (except for mining trails) will be plotted on the potential map with different symbols for GPS'd and non-GPS'd. Some trails have portions that have been GPS'd during individual AIAs, and therefore, will have smaller buffer zones for the known portions and larger buffer zones for the unknown portions. In addition, the buffer zone around sections of some trails has been reduced from 1000 m to 500 m. This is the result of discussions with Canfor, in which issues were raised regarding the 1000 m buffer on a few individual trails. Trails whose route appears to be located on the terraces of very close rivers and streams were identified and then examined on the DEM for the district to determine if these terraces or ledges would fall within a 500 m buffer. Buffers were subsequently reduced if the 500 m buffer would provide adequate coverage of these nearby stream terraces and ledges. In total approximately 17 trails (or sections of trails) received this reduced buffer. The trail reference numbers will be included on the map, and the licensee can contact the Ministry of Forests, for more detailed information on the trail itself.

CMTs: The size of the CMT buffer zones are based upon either the site dimensions or the number of CMTs within a known site. This is due to the varying degrees of spatial location as well as overall significance. Generally speaking, a site that contains 1 CMT is of lower significance than a site of 1,000 CMTs. Whether or not the CMT site is Pre or Post-1846 has no weight in assigning value. A site with 1-5 CMTs were given a value of 1, a site with 6-15 CMTs were given a value of 2. Sites with 16-50 CMTs were given a value of 3, sites with 51-200 CMTs were given a value of 4, and a site with 201+ CMTs were given a value of 5. When done this way the problem of a small Pre CMT site outweighing a larger Post site can be avoided. However, if site dimension data, based on the number of CMTs in the site, proves to be inaccurate then the values were adjusted accordingly.

Cultural Depressions/Cache Pits: Cultural depressions and cache pits are assigned values according to site size and dimension, the same as CMTs sites. 1-10 cache pits were given a value of 2, 11-50 Cache pits were given a value of 4 and 51+ were given a value of 5. Cache pits are usually considered to be archaeological sites of unknown age, due to the fact that they are difficult to age unless there is the presence of some sort of dateable material in association with the pit (i.e. if there is a tree growing out of the feature, a minimum age can be extracted from it; or another example might be the presence of charred bone or charcoal which can be used to retrieve radiocarbon dating samples). Usually all cache pits are considered to be of an overall high archaeological significance, and those that are of unknown origin or age are automatically protected under the *Heritage Conservation Act* section 13(2)(g) because they *may* be protected under subsection 13(2)(d).

Burials: Burials are very significant and require large buffers due to the sensitive nature of the general surroundings, or close proximity to a burial site. First Nations usually consider this type of information to be confidential, and are unlikely to provide an exact location for a sacred site. In this case all historic, prehistoric and unknown burial sites will receive a rating of 5, because of the potential of other features being in the surrounding area. Whenever possible, development should be planned and/or proposed away from areas which are in close proximity to known or estimated burial site locations.

Ceremonial/Sacred Sites: Most of the time we will not know exactly what types of features (if any) within its boundaries of an area that is considered to be sacred. First Nations usually consider this type of information to be confidential, and are unlikely to provide an exact location for a sacred site. These sites get an automatic rating of 5 because of the unknown nature of the features within the site and the unknown possibility of other features (trails leading to and from the area). Whenever possible, development should be planned and/or proposed away from areas which are considered to be of ceremonial/sacred significance.

Rock Art/Pictograph: An automatic 5 with largest buffer zone as these sites are particularly rare, and may be associated with hunting/fishing sites, trails, and/or spiritual ceremonial sites. Most of the rock art sites in the district were recorded in the 1970's and many of the site maps are hand drawn with poor accuracy, therefore exact locations may not be entirely accurate. Rock art sites also tend to cluster in areas therefore, we have decided to give this variable the highest value. Not all rock art sites have been found/recorded in the district to date, for example a new pictograph site was recorded in 2000 by Norcan (Permit 2000-120) that had not previously been documented.

House Pit: An automatic value of 5 is given, with the largest buffer zone, because they are relatively rare and could be associated with other features; hearths, satellite campsites, lithics etc.

Indian Reserves: An automatic value of 5 is given, with the largest buffer zone, because a majority of Indian Reserves are in the same location as historic and prehistoric village sites once were.

Bridge: Aboriginal bridges should be considered to be of particularly high significance as they are usually associated with trails. It is assumed that places where trails crossed over streams would have been a likely spot for a travelling party to stop for a break on either side of a stream. Only two known historic aboriginal bridges have been recorded in the district to date; therefore, these should be considered rare features. In our model, bridges are given a value of 2 because it is assumed the presence of additional features would be localized within 100m of a known bridge crossing location.

Rock Cairn: Rock Cairns mark trails, burials, sacred or ceremonial sites and are assigned a value of 5 because of their importance and rarity in the district.

Dugout Canoe: These features are considered rare, only one has been officially recorded in the District to date, and one other is said to exist near the Portage Indian Reserve. Canoe sites may contain other features in close proximity, for example a hearth for a fire that may have been set up to cook food. It is unlikely that people would have created a trail system to and from dugout canoe features, and these types of sites are unlikely to be revisited, and are therefore given a rating of 2.

Campsite: This site type is present in the Ecofor database, and is assumed to include all hunting campsites found in the district. This site type is vague in description on various site forms, and therefore is given a low value of 2.

Traps: Historic traps are often associated with traplines and trap line trails, and are not really significant on their own, but the possibility of other cultural features nearby is possible. A value of 1 is assigned.

Cultural Materials (Pre-1846): This site type is present in the Ecofor database, and is assumed to include cultural materials of unknown age and unidentified pre-contact cultural material sites. A value of 2 is assigned.

Cultural Materials (Post-1846): This site type is present in the Ecofor database, and is assumed to include all post contact cultural material sites found in the district.

This site types includes historic middens, surface garbage scatters such as tin cans, nails, bottles, etc. could be historic midden, surface garbage etc. A value of 1 is assigned.

Faunal Materials: Most likely associated with a hearth, campsite, village etc. and could provide evidence of subsistence. A value of 2 is assigned.

Hearth: This site type is present in the Ecofor database, however many sites do not specify whether or not the hearths are recent or old; therefore a value of 2 is assigned.

Village/Multi-use Site: Village and multi use sites are often one of the same. Village/multi use sites can easily be determined using the database and those sites, which contain features already considered to be of high significance, will automatically be defaulted to the highest buffer zone (value of 5). Village/multi use sites are considered to be very significant because of the multiple occupations or activities on or at the site and they usually contain high values of educational and scientific importance, not to mention aboriginal importance.

Historic Structure: Structures such as trappers cabins, wooden fences, etc. which are usually Post-1846 in age but may have trails or other features associated with them. A value of 1 is assigned.

Ferry Landing: It appears as though only one known site is presently recorded in the district, and is most likely associated with post-1846 historic activities. A value of 1 is assigned.

Fish Weir/Fishing Station: Considering that fish was the major food staple of the First Nations in the area, these sites are relatively significant. A value of 3 is assigned.

Unknown Structure: All other unknown structures go here (unknown origin, age etc.), and will receive a value of 2.

Quarry: A natural site where raw lithic materials were collected for the purposes of making stone tools. To date no quarry sites have been recorded in the district; therefore, they are given value of 3.

Lookouts: No definative lookout sites have been recorded in the district to date, however, there is potential for these areas to be prehistoric and historic lookout sites. Originally, this category was included in the actual predictive model and was termed a 'visibility' variable, however it was decided that it was better suited as a potential site type. Our assumption is that landscape features that provide good visibility (i.e. have a direct line of sight from one position on the earth's surface to another) would have been a preferred area to conduct certain activities: such as specific spiritual, ceremonial, or navigational activities (Hobbs and Nawrocki 2003). Using the DEM (digital elevation model) in three dimensions, various views were simulated at different elevations. Bluffs situated between 1200 and 1300m appeared to offer the best broad-ranging views accessible to past peoples. Several additional high bluffs were chosen under the 1200m elevation, if they were higher in relation to the surrounding landscape.

No Site: A rating of 0 is given to an area in which no sites were found, obviously due to the fact that there are no features present to be buffered. These 'No Site' locations are used to test the accuracy of the model (*see our statistics and analysis section*).

Site dimensions will only be used for the commencement of buffers for cache pit sites and CMT sites. All other buffers will commence from the single point plotted on the map for known sites.

Model Development Summary

In summary, model construction experienced three primary stages in terms of the variable categories chosen and the values and weights assigned to each of them. During Stage 1 of the model draft, we started with 12 categories, however during Stage 2 it was decided to drop "Wildlife", "Drainage", and "NDT" categories from the model. During

Stage 3 of the model revisions, “Fisheries”, “Proximity to Water”, and “Travel Corridors” were combined into one category and renamed “Water Resources”; and the “Visibility” category was also dropped. The final version of the model, is based on 7 main variable categories: 1) Water Resources; 2) Soil Stability/Surficial Geology; 3) Proximity to Wetlands; 4) Landforms; 5) Forest Cover; 6) Aspect; and 7) Slope.

The final coverage generated using all the variables outlined in the model display the archaeological potential for the study area.

GRID CONSTRUCTION

The Fort St James predictive model was created by compiling several weighted variables into a final grid. The final grid scores were divided into three ranges to illustrate areas of high, moderate and low potential. The ranges were adjusted to represent the most accurate depiction of the area. The methods used to create the final grid are outlined below.

Methods

There are two main approaches used to develop predictive models: the numerical approach and the weighted value approach. The numerical approach uses statistics to evaluate and determine associations between the presence of archaeological sites and specific characteristics of the physical environment. Conversely, the weighted value method relies on the supposition that each variable contributes in a different way to the potential of site locations. Developing and applying a weighted scale, which effectively ranks variables numerically, achieves this. Site potential is therefore determined by the arithmetic addition of all variables, giving areas of high potential the largest numeric scores. Figure 9 illustrates the weighted value method.

The revised archaeological predictive model for the Fort St. James Forest District used the weighted value approach. Each variable was analyzed and combined to produce a final grid. To complete the grid analysis, we used MapInfo version 6.5 with the Vertical Mapper version 3.0 extension (a GIS mapping program). This program was selected because it had the functionality and sophistication to meet the needs of this project.

Weighted value variables were represented in one of two data formats: vector or raster. Vector data is comprised of polygons, lines or points. This type of data was applied to variables such as forest cover and surficial geology. Other variables such as slope and aspect used raster data, derived from the DEM. Raster data is composed of rows and columns of data cells (pixels). Each variable, independent of the data format, was represented as a grid.

Grids are spatially linked to the Earth and are registered with the desired coordinated system. All of the vector data and the raster grids were oriented within the Universal Traverse

Mercator coordinate system, NAD83, Zone 10. While the forest district is split over two UTM zones (9 and 10), all the data was projected as zone 10 in order to facilitate modelling and translating.

Each grid is composed of cells that are arranged in rows and columns. Each cell has a cell size equal in width and height. Cells in a grid are comparable to pixels in an image. When the grids were created from the vector data we determined that the most appropriate cell size was 30 by 30 meters as this cell size best represented the data. Decreasing the cell size can increase sharpness however, the file size increases quite substantially and becomes less manageable. The grid layer for each variable was itself weighted and then added together to determine the overall value of each cell over the entire area (see Figure 9). This total value represents the level of potential of that cell.

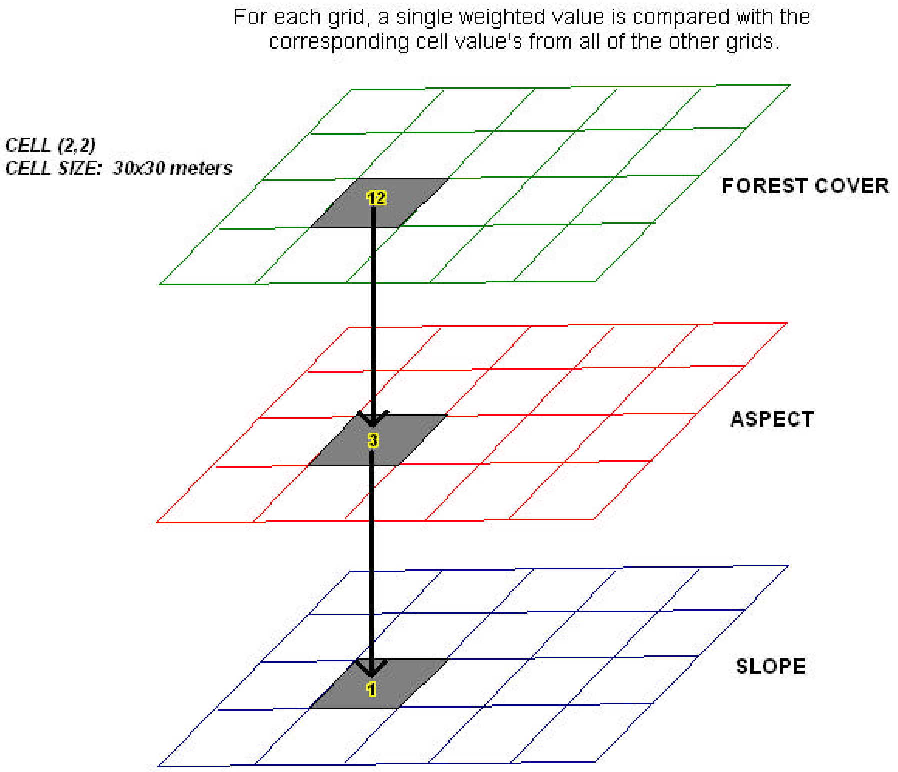


Figure 9. Weighted Grid Analysis.

Data Sources for Modelling

Archaeological Site Database

The Fort St James Cultural Heritage Resources Inventory Database was created during Phase II of this project in order to collect and gather information regarding areas surveyed and determine the correct locations of features. The information was plotted and overlain onto orthophotos to determine correct locations. Once all the site locations were verified the database was converted into excel spreadsheets and split into the two UTM zones to be used for verification of our results in addition to visual representation of the location of areas surveyed where sites and no sites were found.

Cultural Heritage Trails

The cultural heritage trail coverage consisted of a small percentage of GPS'd located trails and a majority of estimated trail locations. This trail layer was used for visual representation and verification of the model results.

Fort St James Forest District Boundary

The boundary for the Fort St James Forest District was assessed to determine which areas would be omitted from the model. Due to the topography of the upper northern section of the area consisting mostly of Alpine Tundra and the fact that it is considered "inoperable" (i.e. will never be harvested) it was removed from the analysis. There were 36 mapsheets in this upper northern section out of the 293 mapsheets that make up the entire district boundary. All the coverages and grids were clipped to this revised boundary. Figure 10 illustrates the area of the Fort St James boundary that was omitted from the analysis.

Figure 10 Potential Model Revised Boundary.

Forest Cover

Forest cover data was originally in vector format. The specific species criteria were queried out and a column was added to the attribute table that contained all the weighted values for each criteria. Since the weights were assigned in vector format, the grid was produced based on the weight column. Figure 11 illustrates the forest cover coverage in its original vector format. Figure 12 illustrates the raster grid produced from the weighted values assigned to each species types.

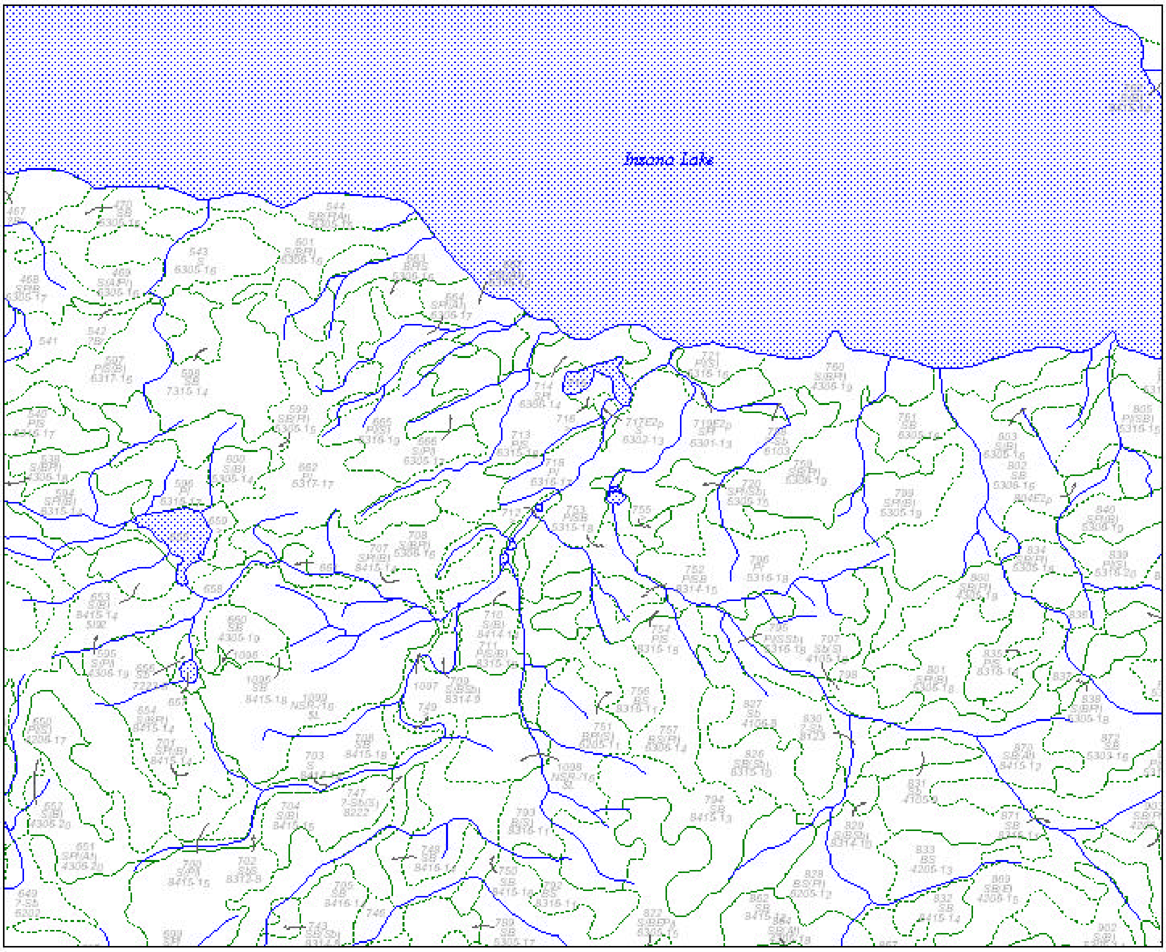


Figure 11. Forest Cover in Original Vector Format.

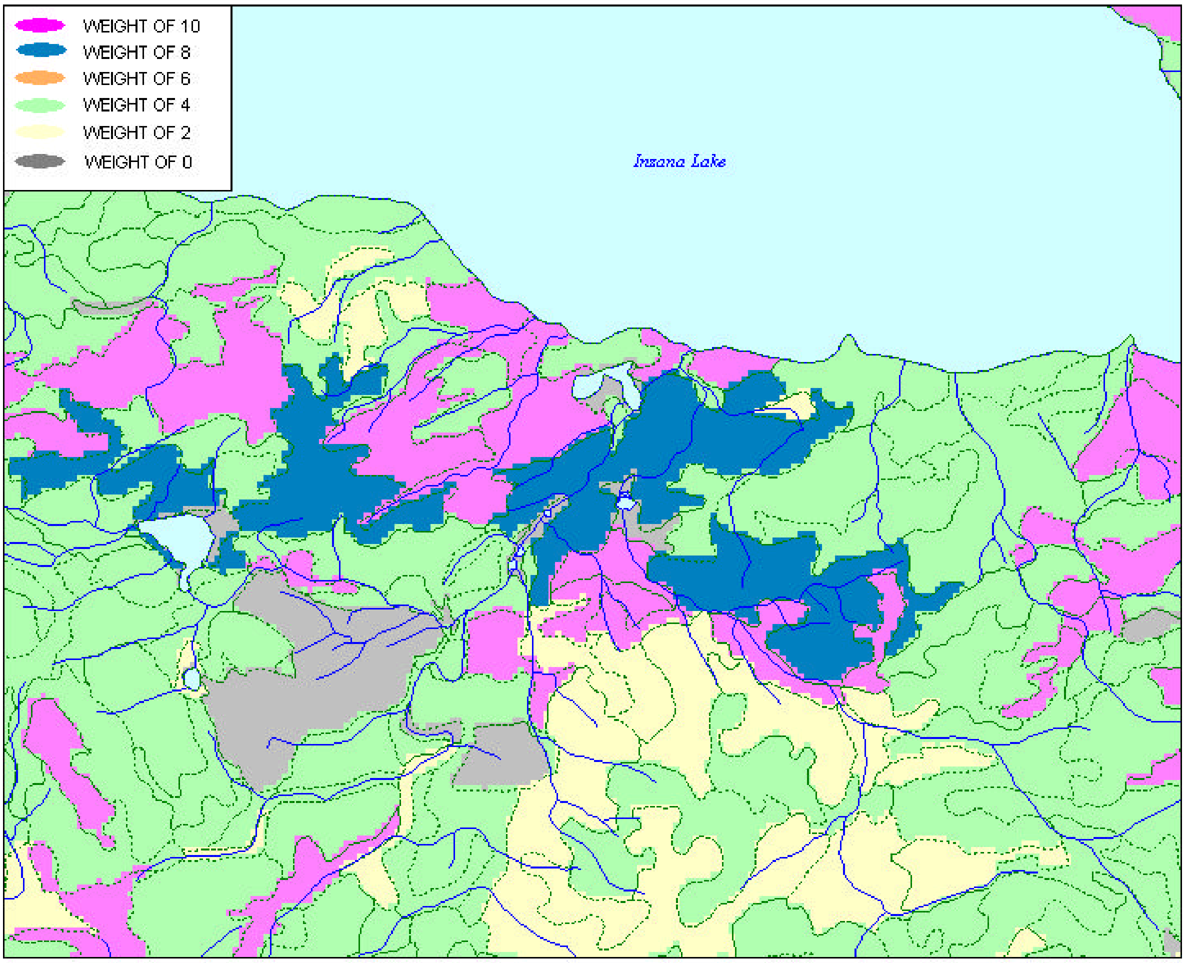


Figure 12. Forest Cover as a Weighted Grid.

Slope

Slope was derived from the DEM, and is a built in analysis tool that will automatically calculate the slope of the elevation data. It was created using percent grade values and the grid was reclassed according to the variable weights. Figure 13 illustrates the weighted slope grid.

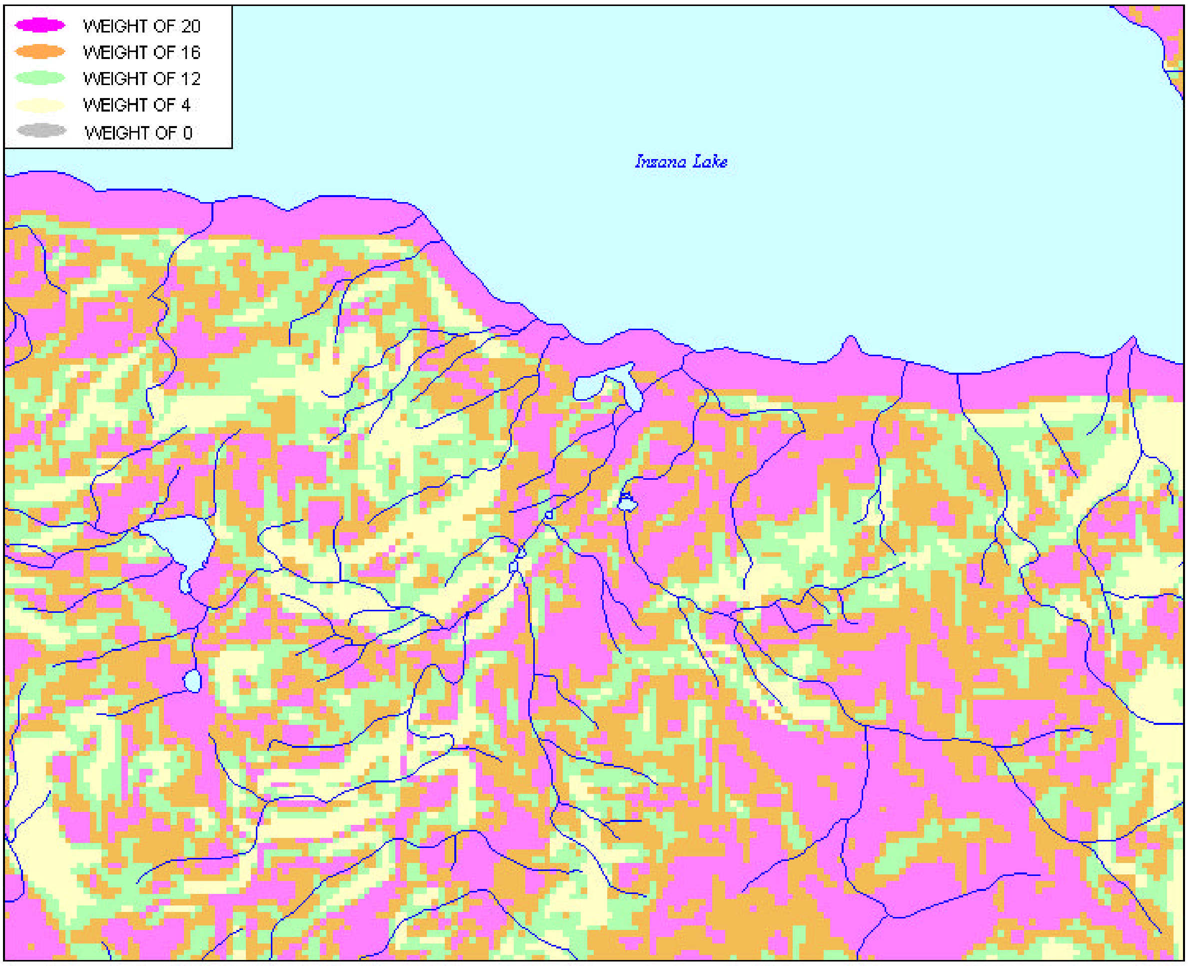


Figure 13. Slope Grid with Weighted Values.

Aspect

The aspect grid was derived directly from the DEM. Like slope, it is a built in analysis tool within Vertical Mapper that automatically creates the aspect grid using the elevation data. The aspect grid was reclassed using the variable weighted values. Figure 14 illustrates the weighted values associated with aspect.

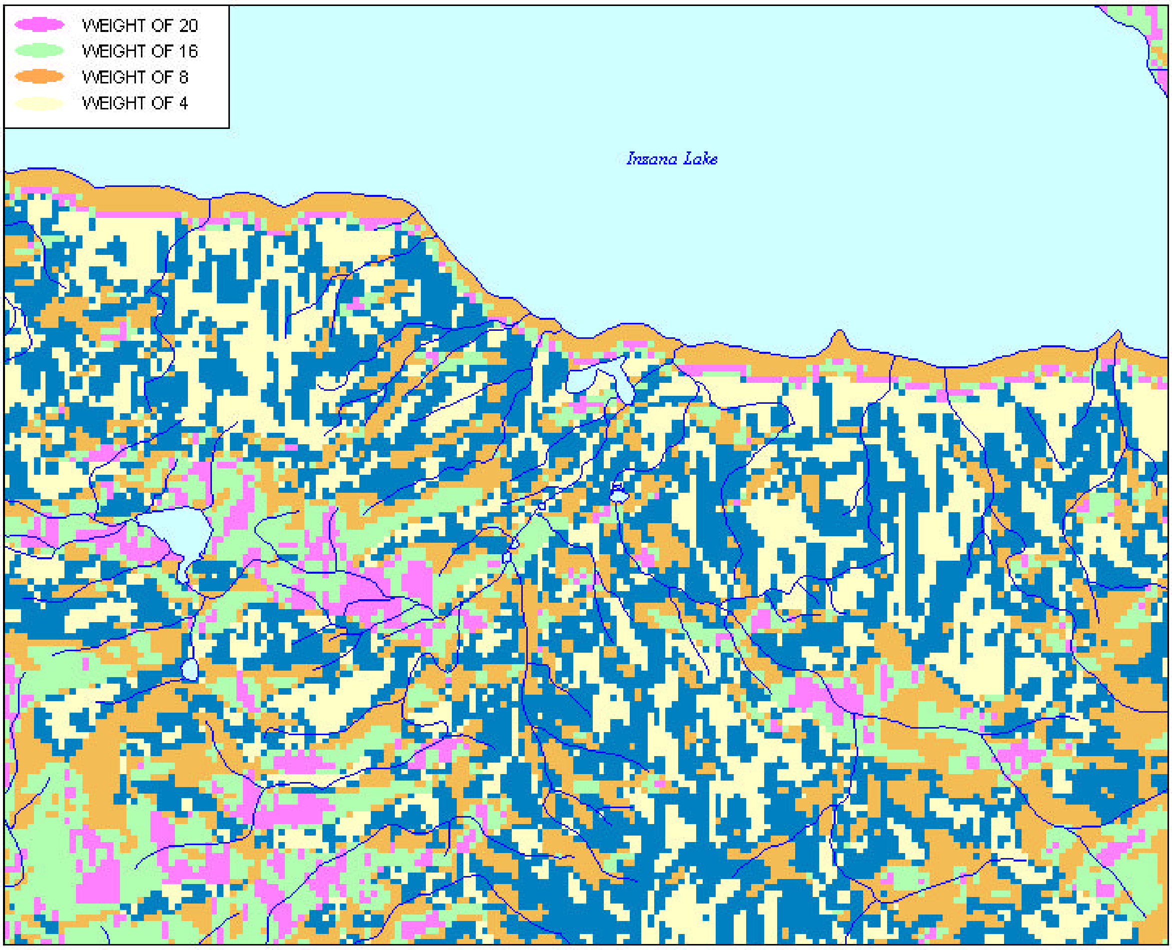


Figure 14. Aspect Grid Classified with Weighted Values.

Surficial Geology and Terrain Stability

Surficial geology data was only available for the southern section of the district and therefore, terrain stability data was obtained and used for the northern section. Both sets of data were used in vector formats. Each coverage was queried on the selected variable categories and a column was added to the attribute table that contained the corresponding weight values. Once the weighted values were added the grid was created based on the specific weight values assigned. Figure 15 illustrates the surficial geology vector coverage with the corresponding types. Figure 16 illustrates the surficial geology raster grid with the appropriate weighted values.

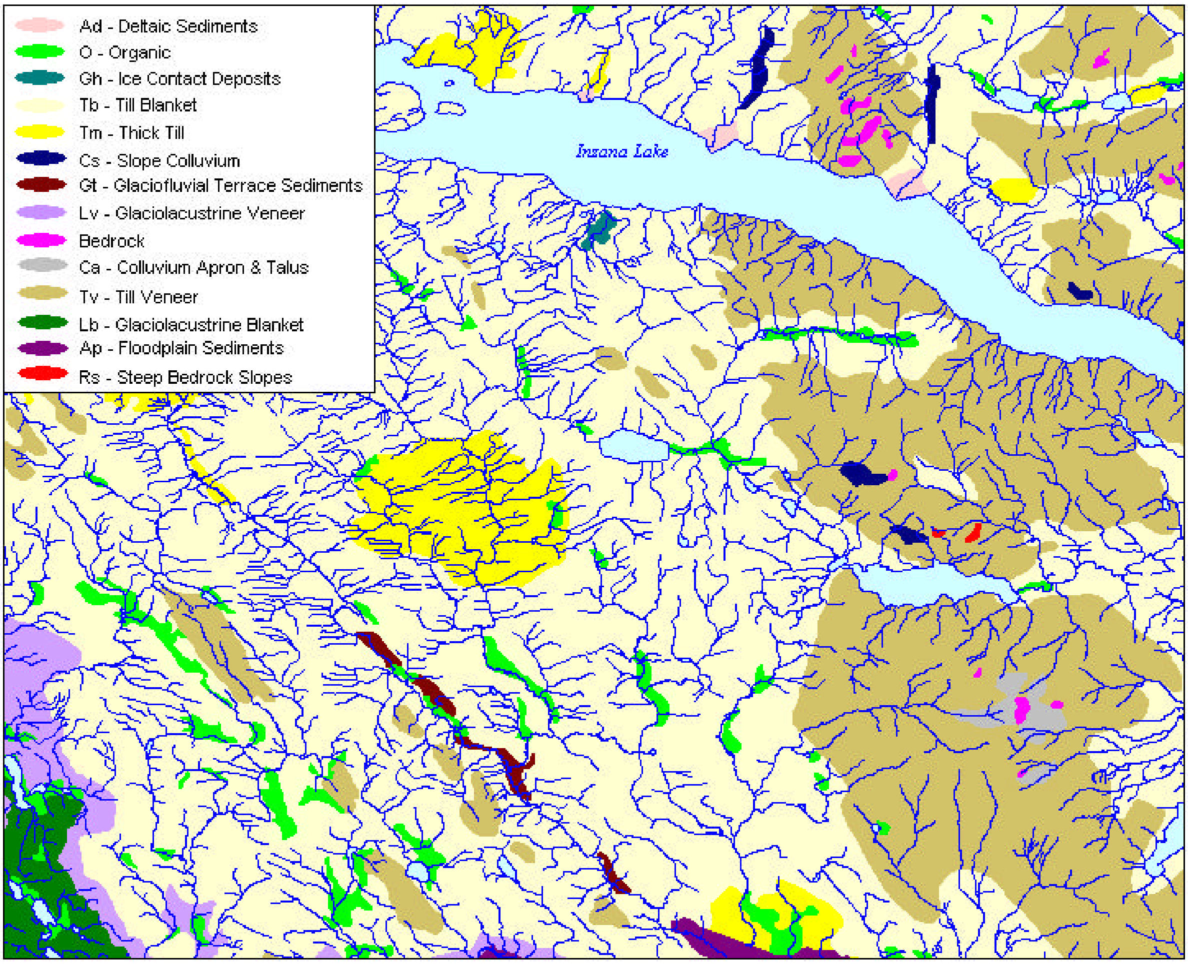


Figure 15. Surficial Geology polygon coverage.

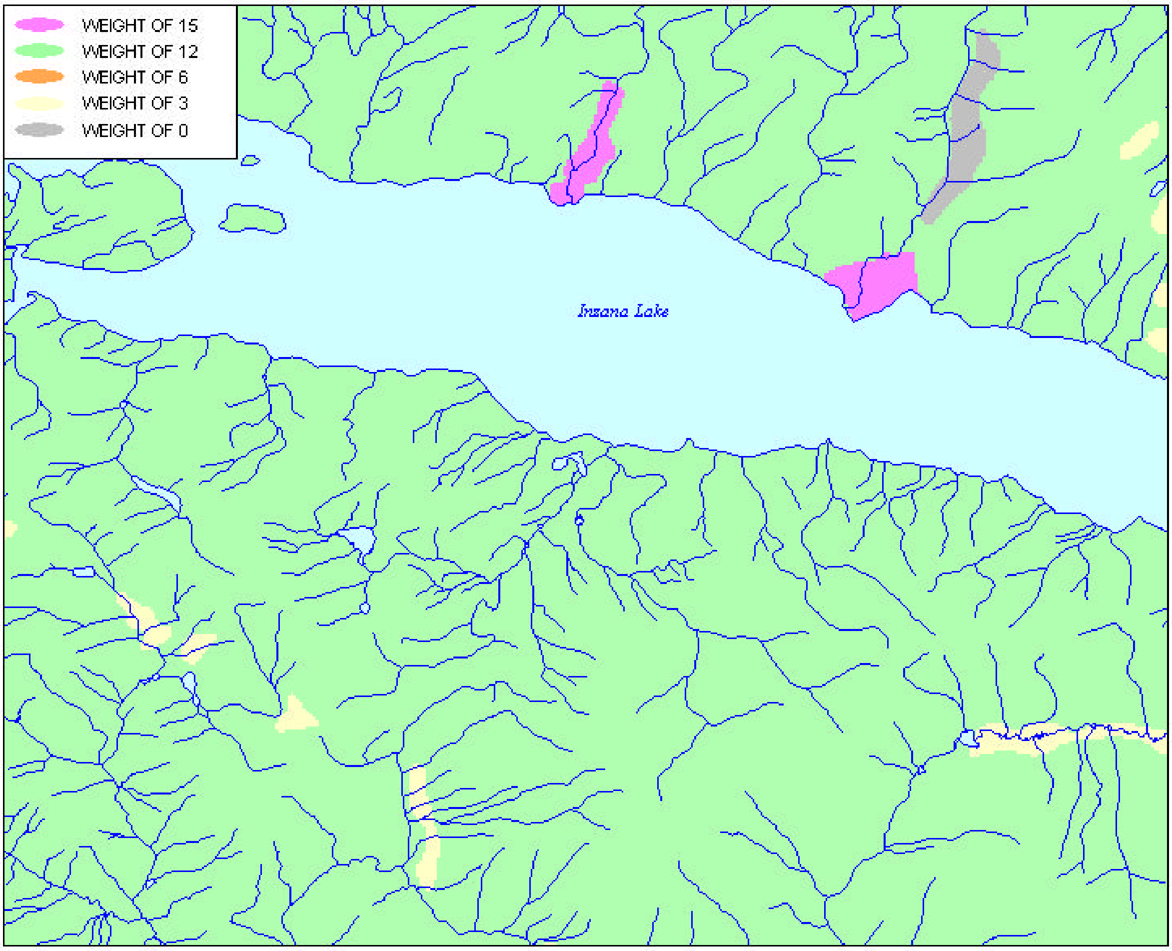


Figure 16. Surficial Geology weighted grid.

Landforms

Landforms were selected based on visual inspection of the DEM relief shading and 3D image. NTS maps were also used to help determine landforms. Three elevation categories were identified and weighted accordingly. Contour regions were created using the DEM and a weight column was added. Contour regions had to be created in order to reclass the elevation values. Elevation ranges could not simply be reclassed according to the assigned weight, therefore, the three elevation categories for landforms were selected and the contour regions were created based on that. Once the regions were created the grid was produced based on the weight values (see Figures 17 and 18).

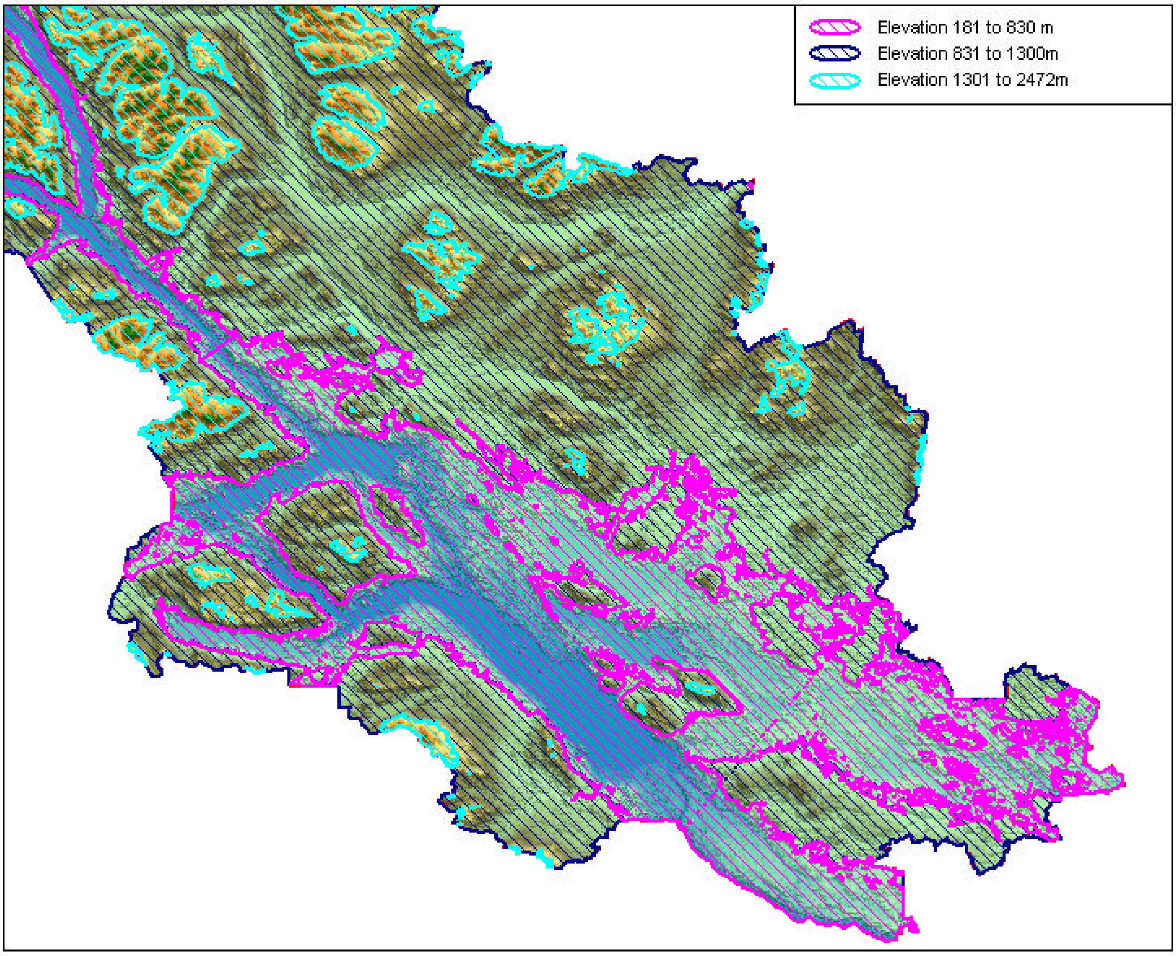


Figure 17. Contour regions selected based on elevation ranges to determine landforms.

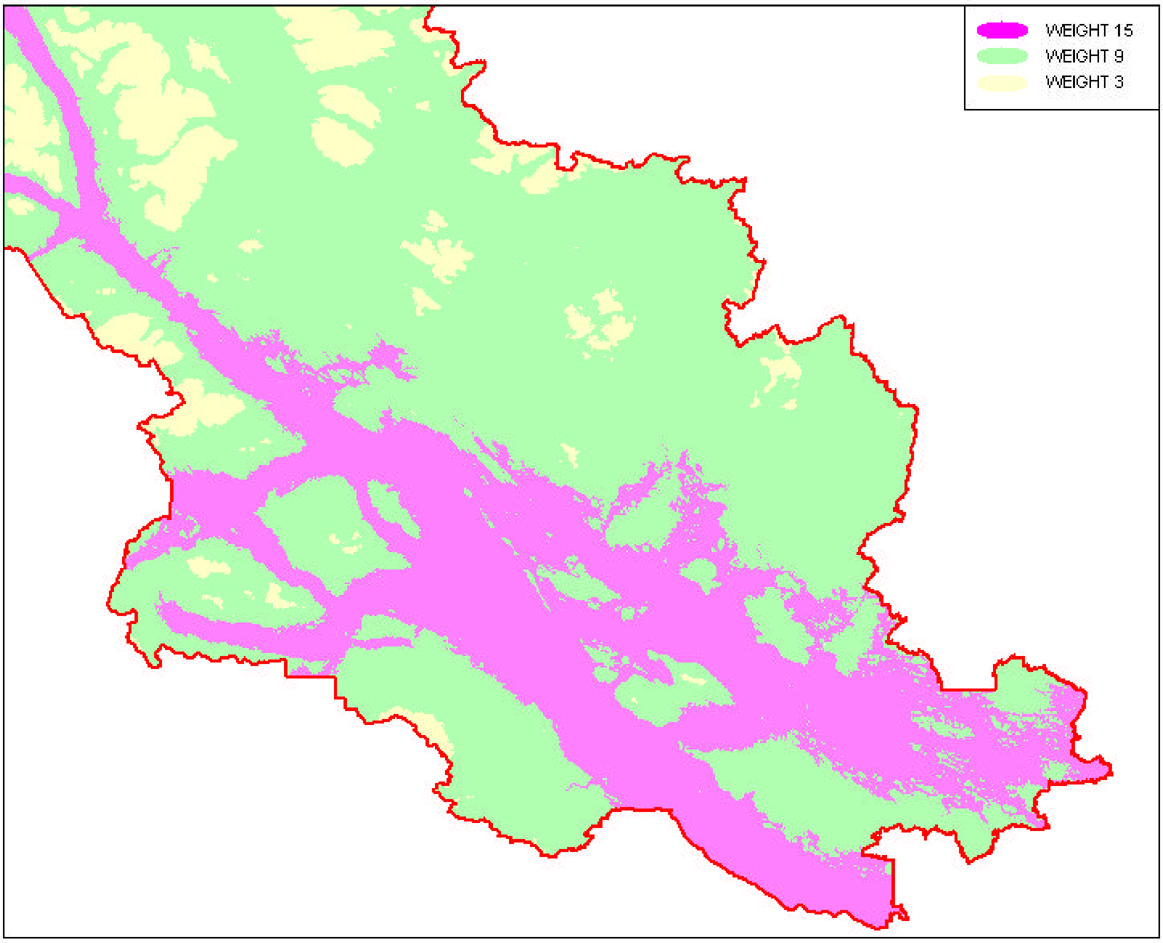


Figure 18. Landforms weighted grid produced from contour regions.

Wetlands

The wetland vector coverage consisted of classified polygons. Each classification (W1, W3 and W5) was queried and separated into coverages. Various coverages were intersected with streams to determine if a wetland was isolated or not. W1 and W3 wetlands were buffered according to stream intersected wetlands and isolated wetlands. Each coverage had a weight column added to the attribute table and buffers were run at selected intervals. Each buffer had a specific weight that populated the weight column. Each weight value was combined as one table and a grid was produced for each weight. Each weighted grid was then merged into one grid using the highest value to ensure that no values were account for more than once and the highest values were retained. Figure 19 illustrates the wetland coverage with buffers at selected intervals. Figure 20 illustrates the wetland grid after all the wetland classes were merged into one.

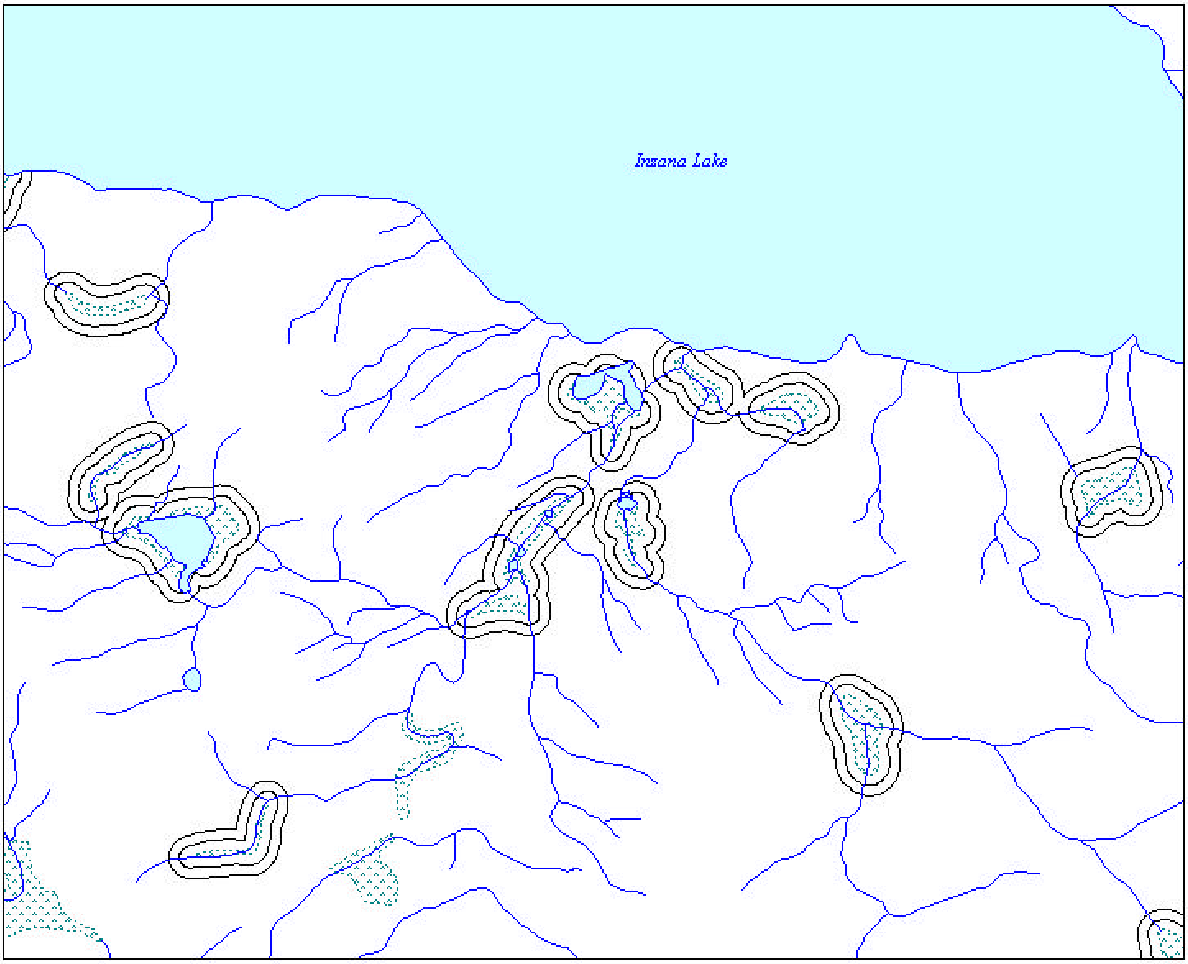


Figure 19. W3 classified wetlands with buffers at selected distances.

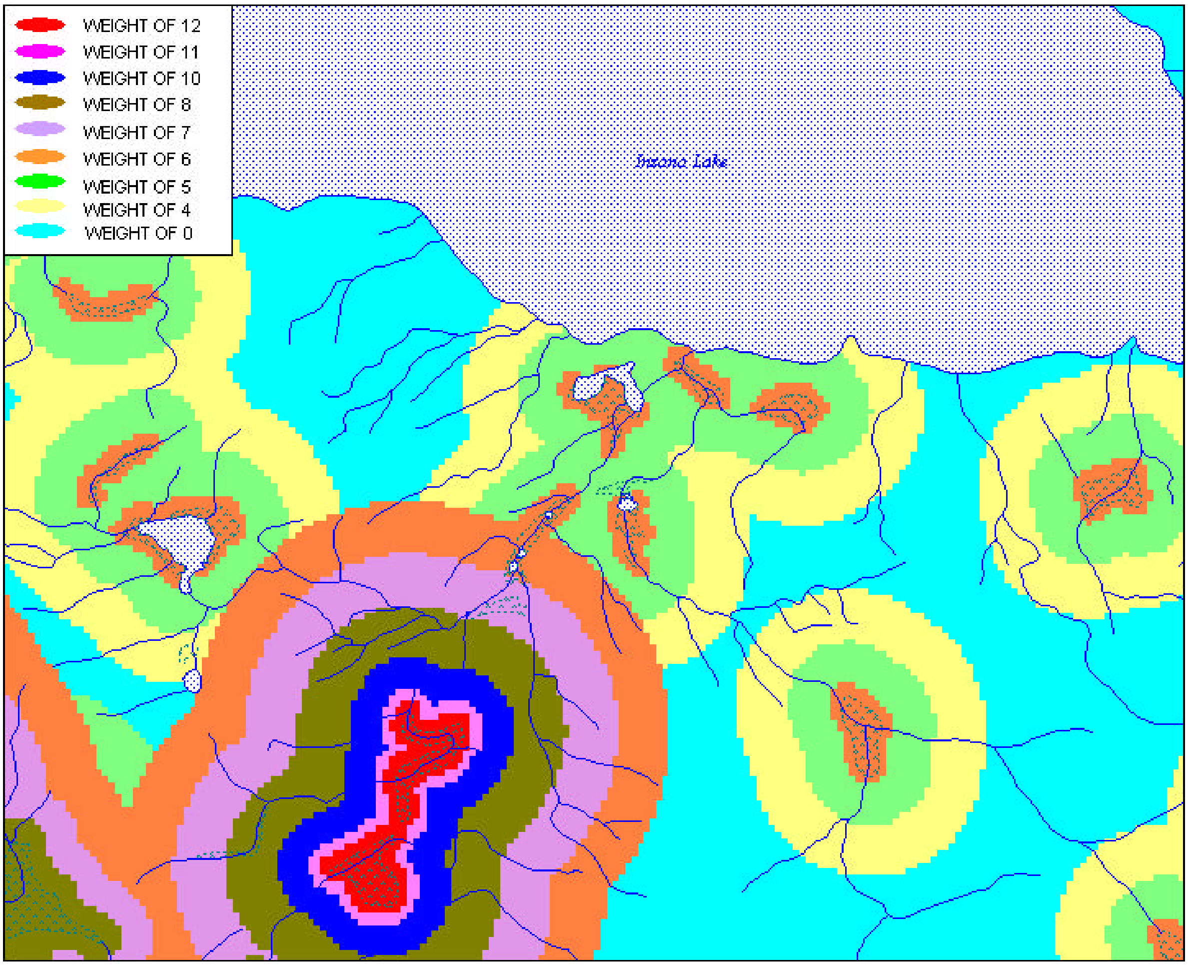


Figure 20. The final merged buffer grid for wetlands.

Water Resources

The variable for water resources took into account confluences, obstructions, lakes and rivers that supported salmon habitats; proximity to water; and use of water as travel corridors. The confluences and obstructions were assessed and identified by a point coverage and fish species present was a point coverage obtained from the FISS database. The double line streams and lakes were polygon coverages and selected based on size. The stream coverage consisted of arcs and were selected based on magnitude. Buffers were performed on each of the vector layers and were assigned appropriate weighted values. Individual grids were produced based on weighted values and then were merged together to produce a final grid that would be used for the model analysis. By creating the individual grids first then merging them reduced any redundancies and allowed for the areas that were weighted higher to be properly displayed. Figure 21 illustrates Class A lakes, double line streams, fish bearing streams and confluences. The buffers were done at corresponding intervals based on importance. Figure 22 illustrates the final grid produced for fisheries resources with all the individual grids merged together.

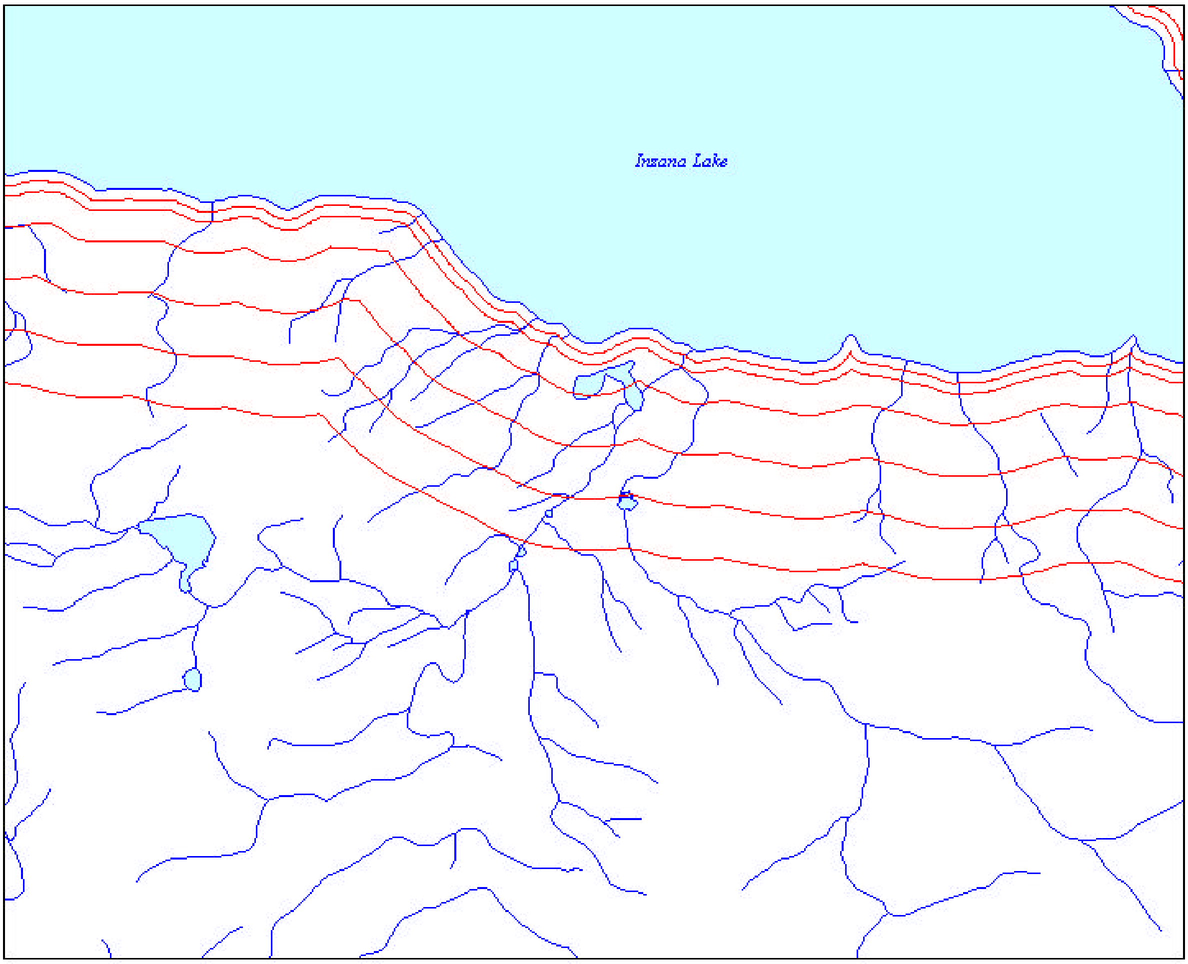


Figure 21. Buffers for Class A water features data.

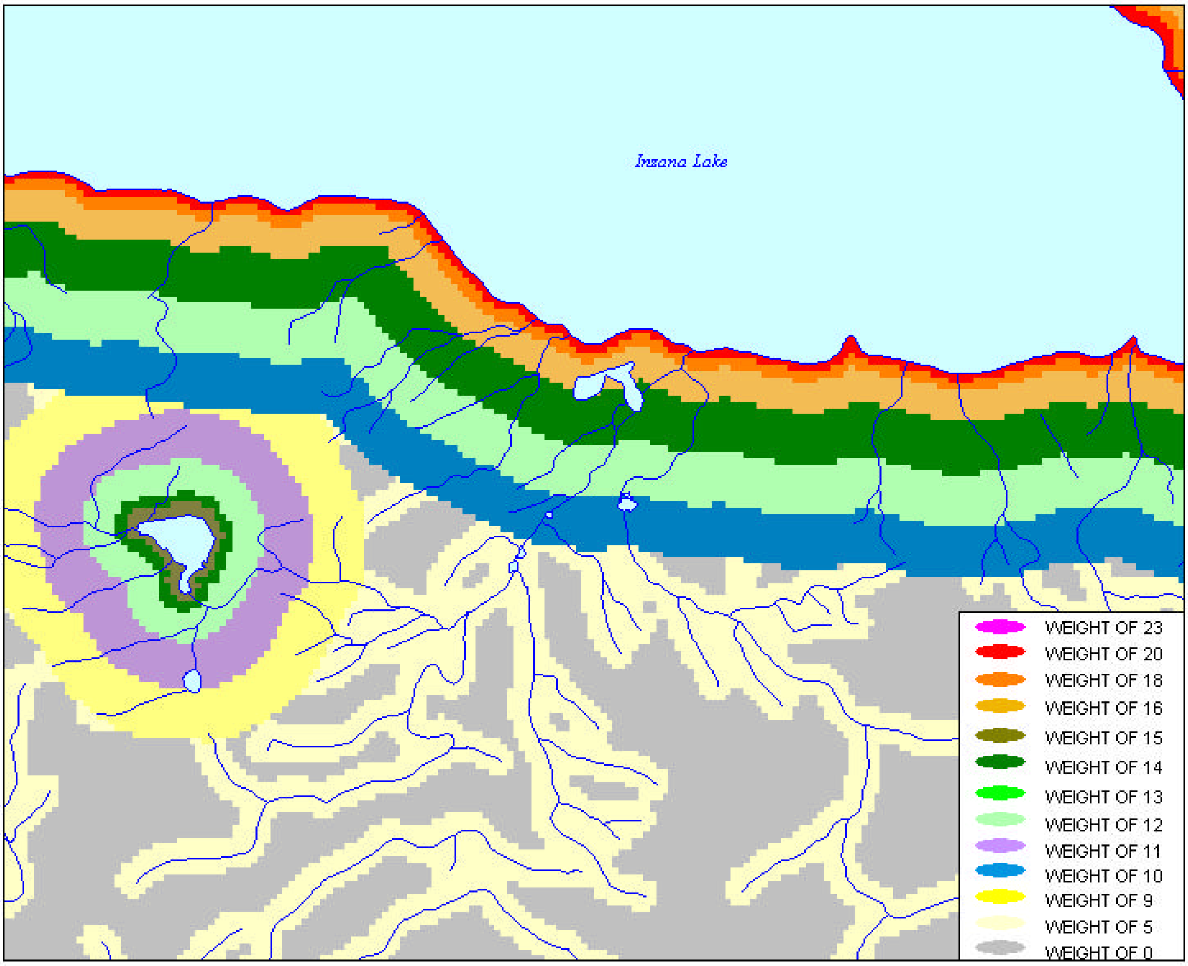


Figure 22. Overall water resource grids merged into one.

Archaeological Potential

The final grid produced to determine the Archaeological potential of the Fort St James Forest district added up all the weighted value grids for each variable and created a final 30 x 30 meter grid layer that was ranked from 0 to 115. These values were assessed and a final range was select to display low, moderate and high potential areas. Figure 23 illustrates the final grid potential.

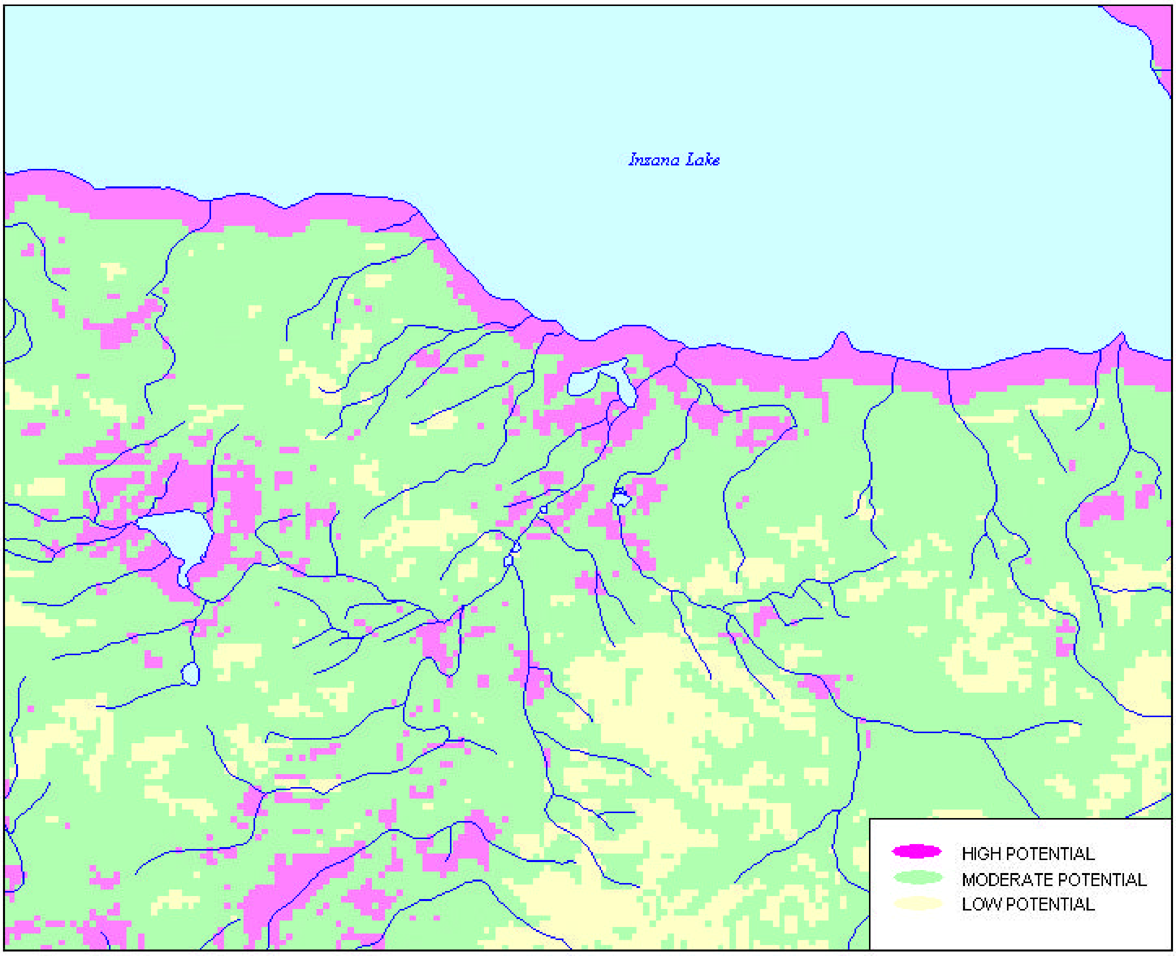


Figure 23. Final Model Potential.

RESULTS AND ANALYSIS

Alberta Western Heritage conducted statistical analyses in order to assess the reliability of the model result. Unfortunately, not all of the statistical data was available to be summarized here. However, much of the analysis was ready and was used to refine weightings and the values assigned to each variable component. In addition to statistical analyses, the model was subjected to a final set of tests. Model variables were tested against AIA data to assess the model's accuracy. These tests compare the predicted distribution of sites to the observed patterns of landscape features and archaeological site data to determine the relevance and reliability of the revised model. Testing and refinement of the model variables was repeated until an acceptable match between observed and predicted site potential in the sampled sections of the Forest District was reached. Preliminary testing against the AIA data is presented below.

AIA Testing

Prior to final model completion, a preliminary analysis was conducted to assess the validity of the predicted archaeological potential. Archaeological Impact Assessment (AIA) data for 3 selected cutblocks was overlaid on the model grid. These blocks are SKUZ 023, TAK 458 and SUS 122. These blocks were chosen because areas in each block were specifically identified in which the model failed to capture some aspect of the study area. AIA data shows areas that were traversed by field archaeologists, areas that were shovel tested and the locations of archaeological features and sites. In addition, each coverage that contributed to the overall model (e.g. surficial geology, forest cover, slope, etc.) was analyzed with the cutblock overlain to determine its contribution to the overall potential of the area. Utilizing the overlain AIA data in combination with in-field assessments (summarized in the appropriate interim reports) and the individual coverage's allowed for testing of the validity the predictive model, this highlighted areas that required further refinement.

In general it was found that forest cover significantly increased the potential of areas that otherwise may not have received as high a rating. In light of this fact, combined with the results of univariate and multivariate analysis, it was determined that the overall weighting for forest cover be reduced from a 3 to a 2. A similar result was found for the surficial geology category and as a result the overall weighting was decreased from a 4 to a 3. The modelled potential of slope and aspect matched very well with in-field descriptions. The statistical analyses results for aspect and slope brought to attention the close association between these two variables and site location; therefore, both of these variables were increased in weighting from a 3 to a 4.

Model Scoring

The entire range of points achieved for the total number of categories was anywhere between 3 to 115 points at the highest. Determining numerically where the division between low and moderate or moderate and high potential was initially going to be done without consideration of prior data. The range of points would simply be divided in thirds. However, when this method was applied to the revised model, problems became apparent. This may be due to the fact that at the time of running model, all the stats were not available. Therefore, not all of the variables (all but water) were altered based upon statistical analyses. Whatever the case, the model needed to be adjusted in order to better reflect actual, in-field potential. To best determine how to adjust the model, we choose six blocks of known low potential (in-field determined), six blocks of known high potential and six other randomly chosen blocks. We then adjusted where the division occurred between low, moderate and high potential to best reflect the in-field ratings of these blocks. Though not the most empirical method, it is the most practical and allows us to calibrate the model to best reflect the in-field assessments. Some of the results from this analysis are summarized below.

Blocks that were considered to be of low archaeological potential in-field included: CUN 537, 534, MAC 141, 136, CUN 528 and 529. The blocks which were considered to be of high archaeological potential based upon in-field assessment include: SUS 124, 141, SBAP 036, HAT 457, TAK 433, BE 10. The six randomly chosen blocks included: KOT 037, 038, A5, A64424 Blk 171, SKUZ 13/14 and SCUN 005. After reviewing all of these blocks with various numerical divisions between low/moderate and moderate high, the following point breakdown was agreed upon as best representing infield assessments:

- Low: 0 – 42 points
- Moderate: 43 – 65 points
- High: 66 – 115 points

Overall, it was found that low potential covered 37 % of the forest district, moderate 37 % and high 26 % of the forest district. These values do not net out areas such as lakes and wetlands. Several of the major lakes fall into areas of high potential and if netted out would significantly reduce the amount of land area classified as high potential.

All eighteen of the blocks examined above were classified as high potential using the Norcan previous archaeological predictive model for the district. Had this new GIS based model been available when assessing these blocks for an AIA, not all would have required in-field assessment. In fact, 879 hectares (of 1,718.42 total hectares) of land would not have required in-field assessment. The new model would have reduced the survey area to 51 % of what was previously required for survey and 4 of the blocks would not have required survey at all.

Finally, the last test was to determine how many of the 210 known archaeological resources fell into areas of each potential rating. It was found that 157 archaeological sites existed in areas classified as high potential, or 75 %, 45 sites fell in to areas classified as moderate potential (21 %) and 8 in areas classified as low potential (3.8 %).

In addition to this "no-site" data was analysed to determine how many occurred in high, moderate and low potential. No-sites are blocks that were surveyed but no heritage resources were found. 247 no-sites were found in the study area with 70 falling into areas of high potential, 110 in areas of moderate potential and 18 in low potential. This works out to 65 % of no-sites falling into areas other than high potential. It is important to remember when considering no-site data, that it is next to impossible to generate meaningful data from no-site locations. When a block is surveyed and no sites are found, the exact location of a “no-site” is arbitrarily placed in the centre of the block. However, because various areas in a block can have different potential ratings, the potential of a no-site is ***not*** representative of the overall potential of that block. In short the number of no-sites represent the number of survey blocks in which no sites were found and cannot change, the number of no-sites per potential rating can change depending on where the no-site location is placed within the block. The analyses summarized previously are much more meaningful when attempting to gauge the effectiveness of the model to predict the location of archaeological resources.

Additional testing is recommended for the 2004 field season, and should be completed pending additional funding, to further refine the match between observed and predicted site potential in the Fort St. James Forest District.

SUMMARY AND RECOMMENDATIONS

The *Fort St. James Forest District Archaeological Predictive Model Revision Project* was completed for Canadian Forest Products (Canfor), Fort St. James Operations' head office. This project received funding support from the Forest Investment Account (FIA), a provincial government mechanism for promoting sustainable forest management in British Columbia.

The underlying objective of the proposed project was to assess and upgrade the existing archaeological predictive model for the Fort St. James Forest District. To do this, Ecofor conducted a multi-phase project. In summary, Phase I of the project undertook First Nations consultation to gain their interest and support and collected the data necessary for the creation of the Cultural Heritage Resources Inventory Database (CHRID). During Phase II, the CHRID was created in order to manage and organize the immense quantity of archaeological data that has been collected over the years. Also during Phase II, the Norcan model was statistically analysed by testing the available site location data against the existing model parameters. The results of this analysis provoked several recommendations, which were addressed in the later phases of the project. Phase III of the model revision project proposed that funding be allocated for field-testing. Unfortunately, due to funding cuts and time constraints, field-testing was not possible and therefore, the project proceeded onto Phase IV. Finally, Phase IV improved the CHRID through orthorectification of sites and a new predictive model for the Fort St. James Forest District was designed, created, and assessed. The following section provides the final recommendations as a result of this project.

RECOMMENDATIONS

The revised predictive model reflects areas of archaeological potential across the landscape. While the model does not reflect the probability that sites will occur in a given area, it represents the likelihood of such an event. Sites are *more likely* to occur in areas of high potential than areas of low potential. This benefits all parties involved in heritage resource protection in several ways, the most notable being planning. Areas slated for new development can be assessed and areas of high potential can be either be avoided, or focused on during AIA surveys, thereby reducing costs incurred by the licensees. This model has been designed by archaeologists with expertise in the Fort St. James Forest District and thus, attributes that are important when conducting fieldwork were incorporated into the model. As such, we recommend that our predictive model be tentatively applied to the Fort St. James Forest District and that it replace the earlier Norcan predictive model.

That said, this model is not meant to be a final static representation of the archaeological potential of this region. The model should be subject to further evaluations, testing, and modifications. Changes to the model should occur as field assessments are completed and as improvements to the data sets are made. The importance of field-testing cannot be overemphasized. Field assessments in relation to the model will enable us to assess the accuracy of high potential areas and adjust areas that may be rated too high or too low. If future funding is not available to field-test the model this report recommends that a portion of each licensee's operating costs be allocated to some model testing during future AIAs to determine the accuracy of environmental variables and predicted values on the landscape. As well, improvements to the digital information used to create the model will aid in refining the overall model. Surficial geology data will be available for the entire district in 2005 through Predictive Ecosystem Mapping (PEM) data, and should be incorporated as soon as funding is available. General improvements in the quality of GIS data can improve landform and forest cover classifications. And finally, annual updating of GPS'd trails, site inventory, "no-site" data, and a record of AOAs will substantially benefit the model. All of these model refinements ultimately serve to benefit both the licensee and the archaeologist. As an example, the identification and ground truthing of trails reduces the surrounding high potential buffer from 1000 m to 50 m, a decrease in the amount of area classified as being high potential.

Another benefit to annually updating and testing the model would allow for future statistical analysis on particular areas, located far away from major travel corridors that may have received large quantities of AIAs that have consistently resulted in "no-site" data. These areas could be re-evaluated for their probability to contain archaeological sites, as more data becomes available.

Implementing these changes to the model on a yearly basis is required in order to maintain and improve the efficacy of the model. Costs for maintaining the model on a yearly basis could be incorporated into the cost of original block assessment should the licensees choose to do so. This could, perhaps be decided by the Timber Supply Area (TSA) group in conjunction with the District Manager.

In order to create accessibility and maintain the applicability of the model, it should be centrally housed at one location and site location data, "no-site" data, and AOA data, be updated and incorporated into the database on a yearly basis. Modifications to the model cannot be made ad hoc to meet predetermined management conditions without significantly decreasing the models utility and increasing the risks of impacting unknown archaeological resources. Finally, it is our intent to develop further working relationships with each of the First Nations in order to develop trust and encourage incorporation of traditional use data into the model.

APPLICATION OF THE MODEL

Application of the model is made for specific forestry development areas on, for example, a block by block basis. This would also apply to a proposed road permit area, small scale beetle salvage sites, or any other type of forestry development. If the proposed development area was 100 % previously disturbed and no known archaeological sites were found, then no further work is required. Of course licensees must notify the District Manager and/or the Archaeology and Registry Services Branch if cultural heritage resources are identified during development.

Once the archaeological potential of the development area is classified, the appropriate response is determined according to resultant potential of the model illustrated in the table below.

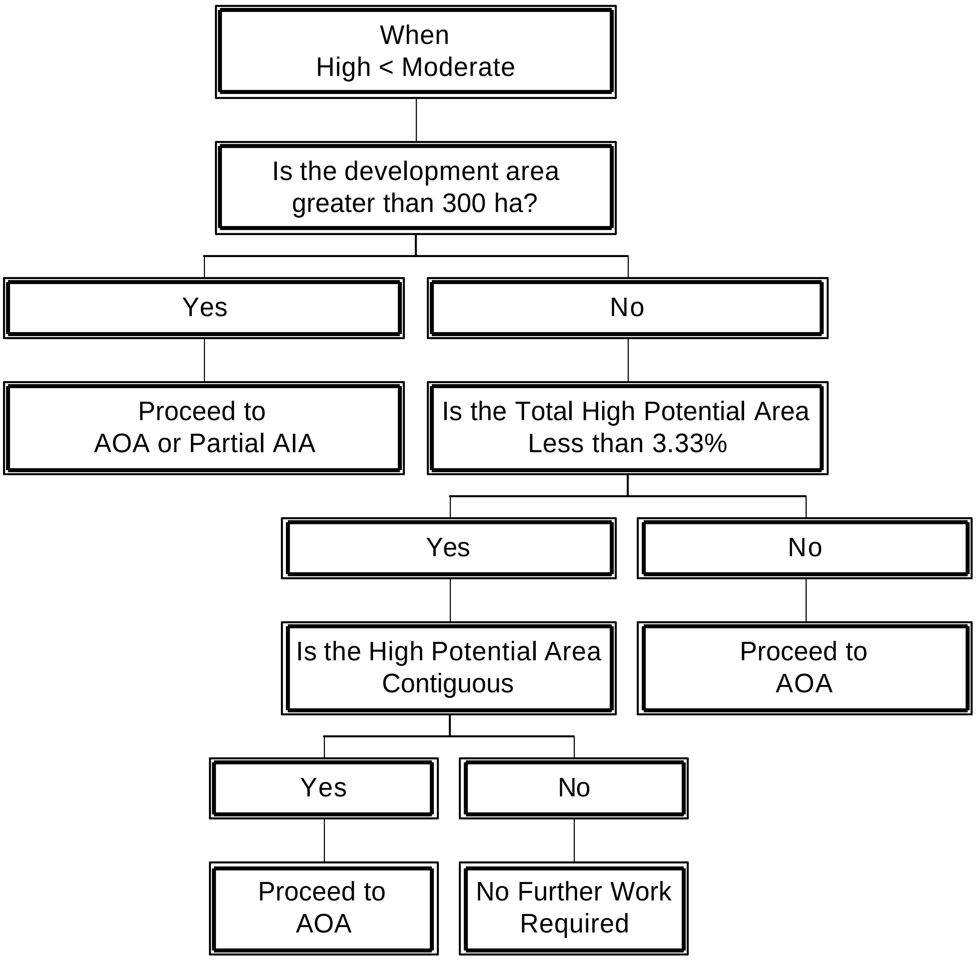
Table 16. Archaeological Potential Result and Recommended Action.

If the development contains:	The recommended action is:
High	AIA
High > Moderate	Partial AIA
High = Moderate	AOA or Partial AIA
High < Moderate	Follow the recommended action matrix
Moderate *or* Moderate - Low	No further work
Low	No further work

If the development area consists of solely high potential an AIA must be conducted for the entire development area. When a development area contains both high and moderate potential and when the high potential area is *greater than or equal to*, the moderate potential area, a partial AIA must be conducted in the areas of high potential. Often portions of high potential within a proposed development area could easily be avoided by designing block boundaries or road right-of-ways accordingly, or removed from the block through the incorporation of wildlife tree patches (WTPs). If uncertain, the licensee may want to consult with a qualified archaeologist to determine the best course of action.

In instances where the high potential area *is less than* the area of moderate potential, the licensee should follow the recommended action matrix outlined in figure 24.

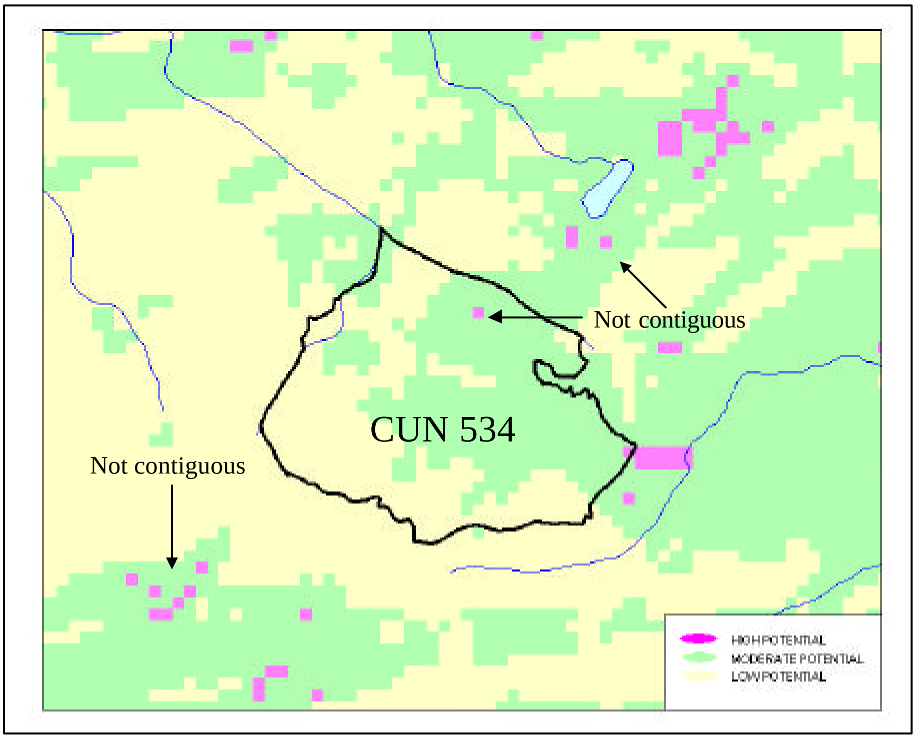
Figure 24. Action matrix for the model.



When the total area of high potential is less than that of moderate potential the licensee must first determine the size of the development area. If the development area is greater than 300 ha the area must undergo either an AOA or a partial AIA. The decision to undergo either an AOA or proceed directly to an AIA is left up to the licensee.

If the development area totals less than 300 ha then the licensee must estimate the area of high potential within the total development area. If the high potential area within the development area is greater than 3.33%, the licensee must proceed with an AOA. If the high potential area is less than 3.33% the licensee must determine if the high potential is contiguous. For instance, areas are not contiguous when there are sparse pixels of high potential that are not in contact with one another (Figure 25). If the areas of high potential are not contiguous no further work is required. However, if the areas of high potential are contiguous or if the licensee is uncertain of the best course of action, an AOA should be conducted.

Figure 25. Block CUN 534 and an example of non-contiguous high potential.



When the development area contains no areas of high potential and it is classified as moderate, moderate/low or low, then there is no cultural heritage concern and the licensee is clear to proceed with development without an AOA or AIA.

If an AIA is not conducted and subsequently surface features are identified, the area adjacent to them should be assessed. While areas that are designated moderate, moderate and low, or low potential do not require further work, licensees should consider training their staff in heritage feature identification and to watch for features while in the field. For areas of particular concern to First Nations, or in areas of known post-1846 CMTs or other features of unknown age or origin, at minimum, qualified personnel should conduct PFRs (preliminary field reconnaissance). Contrary to the old model, most development areas will only require partial AIAs in areas of high archaeological potential rather than a full survey of an entire block.

We propose that the above recommendations be accepted by the District Manager as guidelines to determine when and where AOAs or AIAs will be required using the new model. These guidelines should not be set in stone, as they may need to change over time as the model becomes more refined and of greater accuracy.

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APPENDIX I

1- CD of Fort St. James Forest District Archaeological Predictive Model

-includes historic mining layer

-includes known recorded sites and trails layer with suggested buffers

APPENDIX II

Overview Maps

1x 1:375 000- Overview Map of the FSJ Forest District Predictive Model

1x 1:385 000- Historic Mining Site Locations Overview Map

1x 1:385 000- Known Recorded Sites and Trails with Suggested Buffers Overview Map

3x 1:50 000- Predictive Map Example Sections 1, 2 and 3