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REGIONAL SAMPLING IN A FORESTED SITUATION:
ARCHAEOLOGY AND THE NORTHEAST COAL STUDY

by

Bruce Frederick Ball

B.A. (Hons.) Simon Fraser University 1975

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS
in the Department
of
Archaeology

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SIMON FRASER UNIVERSITY
April 1980

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Title of Thesis/Dissertation: 
Regional Sampling in a Forested Situation: Archaeology and the Northeast Coal Study

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Archaeological survey results from northeastern British Columbia are presented. Data collection was based on a regional sampling scheme undertaken for the Northeast Coal environmental study. Problems of heritage resource evaluation in such vast forested regions as the Northeast Coal study area are viewed as being best served through implementation of formal sampling techniques.

Ecological anthropology and sampling theory provide the theoretical and methodological bases for the study and are reviewed to emphasize some of the problems and considerations in the design of the research. As well, the concept of cultural resource management is briefly discussed to impart some insight into the difficulties normally associated with cultural resource management studies.

Results are presented from: 1) A pilot survey undertaken as a test of the sampling scheme as well as to provide information on the characteristics of the region; and, 2) survey sampling in a control corridor area of the study region. These latter results are used to make predictions about
heritage resource potential in 29 other portions of the study area. Similarity among 32 corridor areas is determined through comparison of 20 environmental attributes scored for each of the respective areas.

Results of the survey and comparison suggest that 19 of the 29 corridor regions have some potential for containing heritage resources. Heritage resource potential of these 19 regions is shown by the degree of similarity displayed between them and the three strata of the survey sampling control area.
Nothing here but history
Can you see what has been done

(Fagen and Becker 1976)
ACKNOWLEDGEMENTS

Funding of the research undertaken in the Northeast Coal study was provided through the Heritage Conservation Branch of the Government of British Columbia. In the next paragraphs I would like to acknowledge a few friends and teachers whom I feel were prominent throughout my experience at Simon Fraser University.

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objectivity and innovation. Richard Casteel provided stimulation, insight and, a humorous but prophetic appraisal of the world of cultural resource management and "archaeology land", in general. Knut Fladmark also provided guidance in my research and, as a charter member of the Thursday evening meetings of the Cognitive Archaeology Society, provided encouragement as well as perception and discernment in solving weekly problems in prehistory and world affairs. However, most of my revelations and comments were bounced off of my senior supervisor and for this I am most obliged. Jack generously provided encouragement, support and direction and for this, along with putting up with my tenaciousness and a bent for taking the easy way out, he is to be commended.

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My sincerest appreciation goes to my family, friends, Barry, Richard and the boys in the band who put up with Bruce and his search for "old dead things". Most of all I wish to thank Margot for her unfaltering support and putting up with all of this.
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INTRODUCTION

The Study

This thesis presents results of archaeological research undertaken in a vast forested portion of northeastern British Columbia. The main purpose of the work was to evaluate the extent and nature of heritage resources in the Northeast Coal Block (Fig. 1) as part of an environmental impact assessment and development design program. Overall the Northeast Coal (N.E.C.) study was organized and administered by the British Columbia government's coal committee on northeast coal development. The committee, formed by the government to oversee the study, is called the Environment and Land Use Sub-Committee (E.L.U.S.C.) on Northeast Coal Development. The archaeological work was under the auspices of the Resource Analysis Branch (R.A.E.) of the Ministry of the Environment and the Archaeology Division (now Resource Management Division) of the Heritage Conservation Branch. Individual programs of the N.E.C. study were jointly funded by the Ministry of Economic Development, government of British Columbia and the federal government's Department of Regional Economic Expansion.
Figure 1 The Northeast Coal study area.
LOCATION OF STUDY AREA

- N.E. Coal Study Area 1976-1977
- South East Extension 1977-1978
- Moberly Lk.
- Chetwynd
- Dawson Creek
- Prince George
- F. E. R.
- Wapiti R.
- B.C.
- Alta

Scale: 0 20 40 km
The N.E.C. study was undertaken "to acquire " . . . environmental baseline information on the entire Northeast Coal Block and to " . . . assess environmental impacts of potential road and rail corridor and townsit e developments" (E.L.U.S.C. 1978: xxvi). The study included 8 different research components and the results from these different programs provided information for government planning and evaluation purposes. The results of the study are contained in 2 volumes published by the E.L.U.S.C. (1977; 1978). A more detailed presentation of the archaeological research is contained in an unpublished report (Ball 1978) prepared as a supplement to the E.L.U.S.C. reports. This report is on file with the Resourse Management Division of the Heritage Conservation Branch of the Government of British Columbia.

Archaeological research in the Northeast Coal block was carried out during 1976 and 1977. Results of these efforts include inventory from general survey and sample survey as well as data from a site excavation. A total of 89 sites were recorded in the study area, including 58 prehistoric sites, 29 historic cabin sites and 2 burials. Excavation at GiRi 4 resulted in scant few diagnostic artifacts for comparative purposes but analysis does suggest some similarity exists with the Oxbow Complex of the northern Plains area. A date from the site of 3427 +/- 111 radiocarbon years supports this
interpretation. Artifacts from the eastern portions of the study block support the contention that the culture history of this part of the area is similar to that of the northern Plains region. The body of this thesis, however, is only concerned with the design, method and results of the formal sampling survey undertaken in 1977.

**Purpose and Scope**

The purpose of this thesis is to present an approach to regional heritage survey in forested areas and, to a lesser extent, to outline some of the difficulties associated with cultural resource management (C.R.M.)-like studies.

There exist a number of problems when attempting to carry out archaeological projects that are C.R.M. oriented. Notwithstanding the fact that most research projects are limited in some way, some of the most compelling problems with C.R.M related work concern potential limitations placed upon the research which are usually a function of contract requirements and schedules. These tacitly and profoundly restrict the type and amount of work that can be satisfactorily carried out. Such limitations compound problems usually accompanying archaeological research and it is felt by some that these limitations provide some basis for questioning the integrity of C.R.M. studies (cf. Plog et al. 1978; Dunnell 1979; Klippel 1979).
The N.E.C. project was implemented as an inventory, planning and evaluation exercise aimed at identifying and controlling any adverse impact of the proposed development on heritage resources. The objectives of the overall N.E.C. study, as defined by the E.L.U.S.C., were:

- to investigate the economic, social and environmental consequences of proceeding with various possible coal mine developments and of providing the transportation links, town facilities and other supporting infrastructural services which these mines would require (E.L.U.S.C. 1977:1).

Commensurate with these ends one of the primary objectives of the project was to evaluate the existence of heritage resources within proposed development zones of the Northeast Coal block. This particular concern provided the impetus for the research presented here.

The scope of this study includes theoretical, methodological and pragmatic aspects which entered into the design of the project. To facilitate an understanding of some of the problems encountered and to provide some general background, a review of the relevant legislation and the concept of cultural resource management is presented. Following this an overview of the results of the project is provided with emphasis placed upon results which were of primary interest to this study.
In the remaining pages of this chapter a general outline of the geographical setting is intended to: 1) Provide some understanding of the vastness and diversity of the study area; and, 2) Define it as a physiographic region (Berry 1968). Chapter II summarizes theoretical and methodological considerations pertinent to the study, along with a discussion of conservation archaeology and legislative guidelines of the provincial government. The research design is presented in Chapter III. In Chapter IV the survey sampling results are provided with a brief discussion of the statistics used. Chapter VI includes a summary and some concluding remarks.

Environmental Setting

The study area (Fig. 1) is a particularly large tract of land which displays great physical diversity while concomitantly retaining some integrity as a physiographic and climatic unit. The present section is meant to provide an overview of the physical nature of the study area as a means of understanding the problem of evaluating heritage resources within such a region. The study area as defined by the Environment and Land Use Sub-Committee (E.L.U.S.C.) comprises over 37,000 km². In 1977, this area was enlarged southwards to include the Southeast Extension study area (Fig. 1), covering
another 19,500 km². These areas are bounded by the Alberta-British Columbia border on the east, the Hart Highway on the north and the Yellowhead Highway in the south. The research presented here concerns only the northern section, referred to as the Northeast Coal study area.

The Northeast Coal block lies within parts of six physiographic regions (E.L.U.S.C. 1977): the Rocky Mountain Trench; the Rocky Mountains; the Rocky Mountain Foothills; the Alberta Plateau Benchlands; the Alberta Plateau Plains; and the Interior or McGregor Plateau (Fig. 2). All of the major rivers occupy valleys that were glaciated during the Pleistocene. These systems flow in a northeast direction and are part of the Arctic drainage system. They drain the eastern slopes of the Rocky Mountains and flow into the Pine or Smoky Rivers. From these systems, water flows into the Peace River, thence into the McKenzie and finally into the Arctic Ocean.

The study area lies within a broadly defined vegetation zone known as the Boreal Forest. This zone makes up the greater proportion of all forested land in Canada and is characterized primarily by coniferous trees such as white and black spruce, tamarack, fir and pine as well as such deciduous species as birch, aspen and poplar (Rowe 1972). In the study area this forest zone is divided into 3 major forest regions:
Figure 2  Physiographic regions of the study area.
1) Boreal Forest Region; 2) Subboreal Forest Region; and, 3) Interior Region (E.L.U.S.C. 1977:24-28). These are further sub-divided into 5 sub zones (Table I). The basis of the zonation is a system that links vegetation communities which are at various succession stages, but which exhibit similarities in climax potential (Westcoast Transmission 1977: 90-91). These major regions and their respective zones are shown in Table I.

The region is classified as having a cool continental climate with cold winters, warm summers and low precipitation. Storms occur both in summer and winter. The Rocky Mountains are the major factor influencing climatic conditions within the study area but the climate is also greatly affected by terrain; temperature varies with elevation, and the aspect and exposure of an area will influence amounts of precipitation, wind and insolation.

Several glacial advances occurred during the Pleistocene, but the two most recent advances account for most of the surficial deposits currently found throughout the study area. In general, the surficial deposits are classified as either glaciofluvial or morainal. The former are usually found in association with present river systems, while the latter occur between valleys. It is believed that during the Wisconsin glaciation, the glacial ice sheet modified the mountains in the study area,
**TABLE I**

Major forest regions and sub zones of the Northeast Coal study area

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<th>Region</th>
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<td>Boreal White Spruce</td>
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<td>Subalpine Englemann Spruce</td>
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<td></td>
<td>Subalpine Fir</td>
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<td></td>
<td>Alpine Tundra</td>
</tr>
<tr>
<td>Subboreal</td>
<td>Subboreal White Spruce</td>
</tr>
<tr>
<td></td>
<td>Subalpine Englemann Spruce-Subalpine Fir</td>
</tr>
<tr>
<td></td>
<td>Alpine Tundra</td>
</tr>
<tr>
<td>Interior</td>
<td>Interior Western Hemlock - Western Red Cedar</td>
</tr>
<tr>
<td></td>
<td>Subalpine Englemann Spruce - Subalpine Fir</td>
</tr>
<tr>
<td></td>
<td>Alpine Tundra</td>
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rounding the summits of some of the peaks as it moved in a
northeastward direction. This accounts for the distinctive
classic character of these mountains: "... a subdued alpine
topography which is most unlike the familiar Rocky Mountains of
the south" (Holland 1964:90).

The description presented here provides only a brief
review of a most formidable study domain for heritage resource
survey and investigation. Problems related to size and
physiographic diversity of the study region are compounded by
the fact that previous research in the area was non-existent.
More detailed descriptions of the region may be found in the
two environmental reports prepared by the Environment and Land
Use Sub-Committee on Northeast Coal Development (1977; 1978).
The description in this Chapter is meant only to provide
overall geographic orientation directed at providing a general
understanding of problems encountered in undertaking research
in the area.

From the above description it can be easily seen that
undertaking archaeological survey in such a large and
physiographically diverse area as the Northeast Coal block
presents problems. Difficulties encountered in evaluating
heritage potential within such a region are complicated by the
fact that the survey areas are covered by boreal forest and,
therefore, cannot be considered amenable to the usual methods
of pedestrian survey.
Chapter 2

THEORETICAL AND METHODOLOGICAL CONSIDERATIONS

Introduction

Explanation and predictions of actual events or phenomena are predicated upon knowledge expressed in sets of assumptions collectively known as theory. The two main bodies of theory relevant to the research undertaken in the Northeast Coal Heritage Project are contained in ecological anthropology and sampling theory. Further direction in the study came in the form of requirements outlined by the contracting agencies, along with the relevant legislation and the concept of cultural resource management (C.R.M.). These latter three factors will be discussed further to present the reader with an understanding of the scope of the project. The discussions on cultural ecology and sampling, on the other hand, are presented as considerations relevant to research design.

Cultural ecology has become one of the salient trends in modern anthropological studies (e.g. Hardesty 1977). It embodies a number of major concepts and topics which have
implicitly and explicitly been used in the study of prehistory. These include ideas about prehistoric ecological systems, cultural adaptation, population dynamics and carrying capacity (cf. Casteel 1979; Clark 1972; Hayden 1975; Jochim 1976; Sanders and Price 1968). Together these concepts have provided the archaeologist with new and potentially fertile avenues of enquiry toward understanding and explaining prehistoric lifeways.

Although principles of probabilistic sampling have long been known to archaeologists (Binford 1964; Ragir 1967; Rothenberg 1964; Vescelius 1960), widespread application of this approach in the study of prehistory is rather recent. The ultimate objective of sampling is to obtain information about a large entity by studying only a portion of it. The alternative to sampling, of course, is to look at the total entity or population. This is often impossible and is therefore the primary reason why statistical sampling strategies are useful. It has been clearly demonstrated in numerous cases that sampling works. Williams (1978) presents two "celebrated examples" to exemplify "the proof of the pudding". Both of these involve extracting reliable information from large aggregates by sampling and both are important, monetarily, to the companies involved.
The first example is a plan worked out by the domestic airlines for allocation of ticket revenues of passengers using more than one airline (Dalleck 1953). In such cases revenue accrues to each of the airlines involved, but the fare is collected only by one. Traditional accounting would call for a settlement on an item-by-item basis. But it is not done this way; instead it is done on a sample basis. The reason is that the cost reductions obtained by processing only a sample of the tickets outweigh the benefits to any of the airlines of processing every ticket. The sample is less than 10% of the total number of involved tickets and all the participants are happy with the scheme.

The telephone companies also use sampling techniques as a basis for their settlements. There seems to be little reason to suspect that any company would be involved in these plans if it were not in its own interest to do so (Williams 1978:48).

Ecological Approaches

One of the recent trends in archaeological research is the use of environmental variables in the delineation and explanation of past cultural manifestations. This approach is largely attributable to a current direction in anthropological theory referred to as ecological anthropology (Hardesty 1977). Although interest in cultural ecology is not a new phenomenon to archaeology (e.g. Flannery 1972; Sanders 1965; Sanders and Price 1968; Steward 1937; 1955) its influence has been most
noticeable in that portion of the archaeological literature referred to as the "new archaeology". The roots of ecological anthropology, however, lie within that theoretical expression of anthropology known as cultural materialism (Harris 1968; 1979), also referred to as neoevolutionism (e.g. King et al. 1977: 27). This is a view which has increasingly influenced archaeological researchers to stress economics and ecology.

The materialistic conception (Cultural Materialism or Neoevolutionism) increased interest in economics and ecology, and in this field the transition to a systematic mode of thought had long been prepared for.

... In the study of the economy and of ecology, the ground had been prepared for the systems approach by the environmental archaeologists of the school of Clark ... (Klejn 1977: 7).

Ecological anthropology includes several different traditions of environmental explanation, these include cultural ecology, population ecology, systems ecology and ethnoecology.

In anthropology environment has been used to explain cultural origin and diversity in at least three ways: environmental determinism, environmental possibilism, and ecology. In recent years the ecological approach has replaced the other two and today is one of the most popular kinds of anthropological explanations (Hardesty 1977: 17).
Following this, archaeology has attempted the explanation of past cultural manifestations by viewing both the site specifically as well as the site within its environmental context.

Such environmental components as climate, vegetation, faunal species, and various raw materials are integral aspects of the archaeological record and constitute an important portion of the cultural resource base. Archaeological and environmental information function symbiotically to provide the maximum interpretation potential for explaining patterns of human adaptation through time (Broilo and Judge 1977:2).

There exist numerous examples of this influence in archaeological research (cf. Baumhoff 1963; Birdsell 1953; Casteel 1973; Sanders 1965; Sanders and Price 1968; Sneed 1971; Washburn 1974). Perhaps one of the more influential figures to promote the ecological approach in archaeology was Julian Steward (Steward 1937).

To a marked degree, Steward's image of what archaeology should have been doing in the 1930's has come true in the fifties and sixties. The dominant orientation in contemporary American anthropological archaeology now conforms to Steward's understanding of cultural ecology (Harris 1968:684).

Current models of man-environment relationships see the environment as either an uncreative limiting factor
(possibilism) or "... that recognize complex mutual interaction between the two" (cultural ecology) (Hardesty 1977:3). Using the latter point of view, archaeologists have utilized environmental variables as a means of predicting or explaining prehistoric cultural patterns and lifeways. One criticism of this approach is that it represents an expression of environmental determinism, a view which sees cultural behaviour and biology as a direct result of environmental forces. But environmentalism sees the physical environment only as the "prime mover" whereas cultural ecology presumes mutual interaction. It is this interaction which justifies the utilization of environmental attributes to aid in the description and explanation of past cultural behaviour.

Survey Sampling

Sampling is a process of selecting a portion of an aggregate to obtain information about and make inferences about the whole of that aggregate. Examples of simple sampling procedures are found in many daily situations whereby small parts of a whole are taken to be representative of that whole. Sampling is more complex in some instances than in others and consequently different sampling designs exist. The ultimate objective of any sampling scheme is to acquire accurate and
precise information about the population under consideration. Success is largely dependent upon the application of an appropriate sampling design.

Kish (1965:18-19) identifies two different kinds of sampling, model sampling and probabilistic sampling. In the former, sampling is based on broad assumptions concerning the distribution of the survey variables, while in the latter, inferences regarding the population about which information is sought are based on statistical theory rather than assumptions. Parenthetically, it is interesting to note that survey sampling theory is different from classical sampling theory in that the populations in survey sampling contain finite numbers of units and in classical sampling they are not. "The methods to prove the theorems are different and the results [of survey sampling] are more complicated" (Cochran 1963:9) . . . than in classical sampling theory.

In model or non-probabilistic sampling, bias usually occurs as a result of poor selection methods (Cochran 1963: 10-11; Kish 1965: 18-21; Yates 1960: 9-17). But, while probabilistic sampling also contains errors, they are usually substantially less severe in that they may be identified or estimated. For example, if a simple random sample of projectile points shows that the average length is 7.5 cm with a standard error of 2.06 cm at 95% confidence (Thomas 1976:
the chances are 95 in 100 that the interval:

\[ 7.5 \text{ cm} + (1.96)(2.06) \text{ cm} = 11.54 \text{ cm} \]

and

\[ 7.5 \text{ cm} - (1.96)(2.06) \text{ cm} = 3.46 \text{ cm} \]

will encompass the true average length of projectile points in the population, assuming a "sufficiently large" sample of points.

This implies that if the same formal sampling scheme were repeatedly applied to these data, 95% of the resulting mean estimates would lie within 3.46 cm and 11.54 cm and 5% would not (cf. Cochran 1963; Deming 1960; Hansen, Hurwitz and Madow 1953; Kish 1965).

The primary advantages of sampling over complete inventory are usually identified as: 1) Reduced cost; 2) Greater speed; 3) Greater scope; and, 4) Greater accuracy (Cochran 1963:2; Kish 1965:18). Expressed another way, the primary purposes of probabilistic sampling are: 1) To obtain an unbiased sample of elements; 2) To estimate population parameters; and, 3) To estimate the probable error of the parameter estimates. In archaeological survey, as in other types of survey, these provide a number of advantages over non-probabilistic procedures.
In sampling, two distinct groups are of interest: the sample and the population. The population consists of the aggregate of units about which information is sought and from which the sample is chosen. A further distinction is possible between the sampled population and the target population. The target population represents that aggregate of units about which information is sought and the sampled population is that which is actually available for sampling. The target population may be either real or hypothetical but more importantly, it must be definable. Ideally, the two should be the same if the target population is accessible, but if this is not the case then inferences must apply to the sampled population alone (Cochran 1963: 6).

In some instances the terms universe and population are interchangeable. However, there exist some problems in that the universe usually refers to a more hypothetical set of elements (Kish 1965: 7; Chenhall 1975: 5-6). The use of the term universe should therefore be restricted to a hypothetical infinite set of units, different from the population.

The members of a population are termed elements. Kish defines the population jointly with the elements: "... the population is the aggregate of the elements, and the elements are the basic units that comprise and define the
population" (Kish 1965: 7). The element is therefore the basic unit about which information is required.

In some instances the element may be the same as the sampling unit. However, it is useful to make a distinction between the two in that the elements usually belong to the sampling units: "Sampling units contain the elements, and they are used for selecting elements into the sample" (Kish 1965: 8). Cochran notes that the sampling units "... must cover the whole of the population and they must not overlap, in the sense that every element in the population belongs to one and only one unit" (1965:7). It is possible to have sampling units which contain several elements. When the sampling procedure involves selection of sampling units containing more than a single element, the elements are selected by cluster sampling.

In element sampling, each sampling unit contains only one element, but in cluster sampling, any sampling unit called a cluster may contain several elements. For example, a sample of students may be obtained from a sample of classrooms, or a sample of dwellings from a sample of blocks. The same survey may use different kinds of sampling units, and in multistage sampling a hierarchy of sampling units is used, so that the element belongs to one sampling unit at each stage. For
example, a sample of persons in a province may be taken by successively selecting districts, municipalities, townships, dwellings and finally persons. The population is also an aggregate of the sampling units, specified for each stage (Kish 1965: 8).

These distinctions can be illustrated by the following. If an archaeological survey is required in an area to determine number of sites present, the decision might be made to employ formal sampling procedures through examination of randomly selected quadrats, for example. The basic unit about which information is sought is the site and the site is therefore the element. The target population is the aggregate of sites within the specified sample area. However, because it is the area which will be sampled a distinction is made between the elements (sites) and the observational units (quadrats) and between the target population and the sampled population. The target population comprises the sites about which information is sought and the sites actually found are cluster samples from the population, if random samples of quadrats are drawn. The elements are the sites actually found within the observational units. The sampling units will be observed to obtain information about the elements (sites) and ultimately the target population.
The target population would be the totality of all sites within the defined sampling area. The sampled population would be those sites that are actually accessible for sampling. For instance, sites which are covered by glacial deposits would be inaccessible for surface survey. In such a case the target population would not contain the same set of elements (sites) as the sampled population.

There exist three different spatially defined units of observation: 1) Points; 2) Lines or transects; and, 3) Small areas or quadrats (Berry 1962; Berry and Baker 1968). Of these, the transect and quadrat types have been used most frequently in archaeological research (cf. Judge et al. 1975; Matson and Lipe 1975; Mueller 1974). Point sampling has been used more often in geographical research where the variables under consideration are continuous variables such as land uses or field crops (e.g. Yates 1962; Berry 1962; Berry and Baker 1968).

In probabilistic sampling each element has a known probability of selection and the basic selection process is known as simple random sampling. There exist many different versions of this basic process which may be used to provide more "... practical, economical, or precise designs" (Kish 1965:21). And, sampling schemes are usually designed to
meet very specific problems. In this respect, Williams notes that "... the art of sampling is to pick a sampling scheme to fit the specific characteristics of the target population (Williams 1978: 148).

Stratification is a technique often used in sampling to improve the efficiency of the sampling design. The purpose of stratification is to insure "... that the full variability that exists within a survey area is expressed in the sample" (Mueller 1974: 33). The population of sampling units is divided into subpopulations using criteria which are related to the objectives of the study, for example environmental criteria. The basis for stratifying an area may be prior knowledge of the area, or an assumption that each of the strata are internally more homogeneous than the population taken as a single unit. In a stratified sample, each of the strata must be non-overlapping, that is, each unit can belong to one and only one stratum and each stratum is sampled independently.

Another technique commonly used to increase sampling design efficiency is subsampling or multistage sampling. Although subsampling has not seen widespread use in the archaeological community, it is used extensively elsewhere. Subsampling is useful when elements within sampling units
produce similar results; "... it seems uneconomical to measure them all" (Cochran 1963: 270). The procedure is quite straightforward. Sampling units which have been selected from a population are further divided into subsampling units. The sample is then selected from these secondary or subsampling units. The first stage sampling units are called "primary units" and the second stage units are referred to as "subsampling units".

This process may be carried to a third stage, however, this appears to be the extent to which statisticians like to take it (cf. Kish 1965; Cochran 1963).

Kish provides 4 justifications for subsampling and notes that it is generally used "... to divide larger clusters into smaller clusters" (Kish 1965: 156). Following Kish then, the 4 reasons are: 1) When natural clusters are too large to be economically sampled; 2) When one wishes to avoid the cost of creating smaller clusters; 3) If larger clusters have lesser "roh" values in computation of the effect of clustering; and 4) When sampling compact clusters offers practical difficulties.

In the design of any sampling exercise there exist a number of important decisions which must be made. These include determining the size, number and type of sampling units.
as well as sample size. Perhaps one of the most useful bits of
information to know prior to making these choices is the
population variance (cf. Kish 1967: 49-52; Cochran 1963:
71-86). This would seem to be a difficult piece of knowledge
to obtain given the fact that the reason you wish to sample is
to obtain such information. There are, however, ways by which
gross approximations of population characteristics may be
obtained prior to sampling. One of these is known as a pilot
survey.

...there are many points on which
decisions can only properly be reached after
preliminary investigation in the form of a
"pilot survey" have been carried out (Yates

Pilot surveys have a number of functions. /Yates (1960)
describes the 2 most important of these: 1) To provide data on
the components of variability the sampling population may be
subject to; and, 2) To test the operation of the sampling
scheme. He also notes that a pilot survey may provide
important information about survey costs, the most effective
sampling unit to use, or its size, or approximate
characteristics of the population.

While Yates seems quite positive about pilot surveys Kish
(1967) is much more reserved about their usefulness:
Most studies are too small and too hurried to support a large enough "pilot sample" to yield useful estimates of $S$ (unit variance), of variance components, and of cost factors (Kish 1967: 256).

and,

. . . we cannot afford large enough pilot studies to provide better estimates than we can guess with the aid of past experience and expert advice. The pilot studies I know about are mostly "feasibility studies", testing the survey operations . . . (Kish 1967: 277-278).

Cochran (1963) appears to agree in part. He notes that the pilot survey can be useful in providing advance estimates of population variances to determine acceptable sample size. However, he cautions that if the pilot survey is restricted to a few clusters of units an underestimate of the population variance may result.

It would appear that while the pilot survey could be useful its cost might be too great in terms of both time and money. Cochran (1963) lists 3 other methods for obtaining data about the population in question: 1) By breaking the sample into 2 steps; 2) By using previous survey sampling results; and, 3) By making guesses about the structure of the population. He notes that the first of these gives the best results, but is not often used because it is time consuming. The second option is, of course, contingent upon the existence
of a previous sample survey. The third technique, while obviously providing gross information, appears most appealing, especially for areas not previously sampled. Cochran (1963) and Deming (1960) suggest that if the population distribution is known and if a range can be estimated, a rough approximation of the variance may be calculated which in turn may be used to provide information for the design of a survey sample (cf. Cochran 1963; Deming 1960; Kish 1967).

Conservation Archaeology

Introduction

Recent public concern for environmental quality and a general awareness of a steady depletion of various resources due to exploitation and development of the natural landscape has fortuned the archaeological community with additional funding sources and opportunity for practical application of its method and theory. Legislation specifically dealing with heritage resources has been enacted and environmental impact projects have increasingly included archaeological or heritage studies within their groups. Heritage resources, including both historic and prehistoric, have come to be widely recognised and are referred to as non-renewable: a resource
that may be totally destroyed either intentionally by the archaeologist or unintentionally through land development or natural land modification processes. One of the major outgrowths of this interest in protecting the natural landscape and its cultural heritage has been the rather rapid development of the concept of cultural resource management (C.R.M.) Dunnell 1979. This has become popular of late, and universities and colleges in both Canada and the United States currently offer courses or degrees specializing in C.R.M.

Policies have now been formulated aimed at management of cultural resources and attempting to control unmitigated environmental modification. As well, a general philosophy for heritage conservation has been established (cf. King et al. 1977; McGimsey and Davis 1977; Schiffer and Gumerman 1977; Schiffer and House 1975; 1977). The following discussion reviews some of the problems inherent in cultural resource management studies. In addition, this section strives to present the general philosophy currently espoused in C.R.M. studies and outlines their bases in British Columbia.
Conflicts in Cultural Resource Management Studies

Archaeology implemented under C.R.M. agreement, variously termed rescue, salvage, emergency, crisis, highway, corporate, conservation and public archaeology (Benson, 1976), has frequently been criticized as inadequate, the result of insufficient funding or inexperienced researchers (Broilo and Judge 1977: 2). This criticism has also resulted in an apparent dichotomy in the discipline, between "contract" workers and those who espouse "pure research" or science. King (1971) has succinctly outlined the central issue:

In short, the problem was not that salvage was intrinsically bad, unscientific, or useless for explanatory research, but that the support agencies' orientation toward the reactive redemption of uncoordinated data, and the organizational structure appropriate to this orientation, operated counter to the needs of explanation (King, 1971: 259).

The solution, he suggests, lies in careful organization. On a somewhat different level, others have promoted the establishment of comprehensive research designs (e.g. Schiffer and House 1975; 1976).

The historical division between "salvage" archaeologists and "academically oriented" archaeologists is no longer tolerable. Archaeology is archaeology whether it be conducted within the academic field school or
in less tranquil atmosphere of contract obligation. The need for innovative and elegant research strategies incorporating multistage programs, and the implementation of such projects, involves the articulation of all forms of archaeological specialists (Broilo and Judge 1977:3).

However, concern about the quality of recent C.R.M. work continues to appear in the literature (cf. Goodyear et al. 1978; King et al. 1977; Plog et al. 1979) and claims regarding the value of C.R.M. research to the discipline are largely voiced by one group, those actively engaged in conservation studies (cf. Mayer-Oakes and Portnoy 1979; Glassow 1977; Schiffer and Gumerman 1977). While it is true that recent C.R.M. work has resulted in research contributions (eg. Schiffer and House 1975; 1977; Schiffer and Gumerman 1977; Spurling 1978), it is also true that contributions have been made in the past, before the resurgence of inspired interest in making contract work a redeeming vocation. Doing research under the guise of conservation archaeology is by no means a new phenomenon. And, it is also true that significant contributions to the discipline have not always come out of "pure research"; witness the "Ugly" of Thomas' "The Good, Bad and the Ugly" (Thomas, 1978). It could be considered a stand-off but the fact that contract work under the philosophy of C.R.M. has produced some results coupled with the knowledge that pure research efforts do not always result in significant contributions does not quell the
arguments. There are still major difficulties in C.R.H. work which stand to clearly distinguish it from the other more traditional research endeavours.

The fact that C.R.H. contract work is done for money cannot be ignored.

Much contract work is done by people primarily interested in financial gain or security of employment; as a result, both price-gouging and "whitewashing" of destructive projects occur (King et al. 1977: 189).

Another problem is the level of competence of the personnel who run agencies which oversee and regulate heritage resources. King et al. (1977: 180-191) have described this as a long range malady; a potential problem of over-regulation produced by those not capable or imaginative enough to deal more realistically with the problems at hand and whose solution will be to develop regulations which will inhibit research rather than promote or facilitate it.

Competition is another aspect of cultural resource management studies which may be considered a limiting factor. In competing for contracts, budgets may be cut too low in an effort to win. This has the obvious effect on the end product that only minimal results can be expected. Also, time spent by
contractors seeking follow-up contracts is time not spent on analysis or research. Contractors cannot afford to continue research on a problem after a job is finished. It is imperative that they begin a new contract in order to preserve their existence as a viable contracting agency.

Schiffer and Gumerman (1977) dogmatically argue that such views about cultural resource management studies do not hold substance.

Not only can the irrelevance of these allegations be easily shown, but we can go on to list the unique advantages that are held by conservation archaeology research (Schiffer and Gumerman, 1977: 81).

They note that: 1) Restricted study area boundaries dictated by contract requirements do not necessarily restrict the ability to carry out meaningful research; 2) Problems of designing research to suit the data rather than the other way around may be dealt with through compromise; and, 3) That the funding and time arguments are "... ludicrous, given the chronic underfunding of academic research" (Schiffer and Gumerman 1977:81-82). Their first two responses are well taken. However, the third is difficult to accept. The fact that pure research is underfunded does not settle the issue. Schiffer and Gumerman (1977) admit that "... time
constraints on many projects are sometimes debilitating" (1977: 82). Their response to this is that the situation will get better in the future:

But we can expect that as cultural resource management studies move out of the catch-up stage . . . this problem will resolve itself satisfactorily (Schiffer and Gumerman 1977: 82).

However, time and funding limitations are difficulties which cannot be easily ignored, indeed, they are not the only problems facing C.R.M. studies (cf. Dunnell 1979; Portnoy 1978). Together these restrictions stand to limit the contributions cultural resource management studies can expect to provide the discipline. But C.R.M fills a need which can not be neglected or disregarded by the archaeological community. Notwithstanding the limitations and criticism of C.R.M. work, it represents a conscious effort towards controlling the quality and quantity of archaeological work necessitated by environmental concern and land development. The fundamental purpose of this effort is conservation and preservation of the archaeological record which, in total, has been termed a new approach.
The New Approach

Anthropologists working on contract survey projects should regard their work as legitimate research, not just a way to support themselves or their graduate students. Planning a contract project, defining and implementing a field methodology, and evaluation properties should be recognised as exacting intellectual exercises, not mere bureaucratic requirements (King et al. 1977: 193).

One approach to cultural resource management studies which appears to be gaining widespread acceptance calls for the most up-to-date methods of inquiry within the requirements of the funding or contracting agency. While this approach may seem simplistic and straight-forward on the surface it has been proposed only recently, necessitated by the amount of C.P.M.-related work being carried out. As well, the approach must be evaluated in light of problems with the quality of some previous work. It is an attempt to bring together all archaeological work done within a cultural resource management framework under one philosophy; an attempt to organize and manage conservation work rather than allow it to be carried out on an ad hoc basis. This tack also calls for the establishment of explicit research goals for each project rather than simply attempting to satisfy the contract company’s requirements, which may not necessarily be consistent with those of the archaeological community. This approach has been termed "contract archaeology" (Schiffer and House 1975; 1976), "public
archaeology" (McGimsey 1972), "Conservation Archaeology" (Gumerman and Schiffer 1977) and "cultural resource management" (Lipe and Lindsay 1974; McGimsey and Davis 1977). McGimsey and Davis (1977: 28) identify it as "New Directions" in the discipline. The general philosophy of the "new direction" is concerned with the "management" of archaeological (heritage) resources through judicious and innovative means of research and conservation:

... the emphasis is not on simply excavating to "save" the sites, but rather on protecting and utilizing the cultural remains to their fullest scientific and historic extent (Schiffer and Gumerman 1977: xix).

The implication is that very little decent work was carried out prior to recent revelations. This seems a bit of an overstatement; I am sure few researchers believe this to be true. However it does serve to stress a need which has not always been satisfied. In general, conservation archaeology or cultural resource management strives to extract maximum amounts of data and information from contract activities through the recognition that archaeological resources are a non-renewable commodity. Since it is unrealistic to attempt to prevent land modification projects, cultural resource management or conservation archaeology can best be undertaken within specific problem oriented frameworks rather than on an ad hoc basis. More precisely, the trend appears directed towards more
organization and judicious and careful planning which together are expected to provide the best results for the money and effort expended. Dunnell cautions, however, that this may cause the discipline to become overstructured by "... administrative regulations and bookkeeping conveniences" (Dunnell 1979:448-449) rather than by method and theory.

The Working Situation

The concept of cultural resource management in British Columbia and, indeed, Canada is not new but its practical application is. This is not only reflected in the fact that the legislation is relatively recent but in the nature of the legislation as well. There exist two specific references regarding the assessment of cultural resources in British Columbia. These are contained in the Environment and Land Use Committee's "Guidelines for Coal Development" (1976) and "Guidelines for Linear Development" (1977). They are, respectively:

Archaeological and Historic Sites which will be lost to society in general, or a community which places special value on them, should be identified (E.L.U.C. 1976:20).

Both of these are provided as descriptions of the "... types of information and analysis to be included in the description, evaluation and management of impacts" (E.L.U.S.C. 1977: 13). These are rather broad descriptions of what is required in an assessment. In addition to these requisites, more specific terms of reference and guidelines are often required by the government agency in charge of a respective resource (e.g. Heritage Conservation Branch). Finally, specific terms of reference are outlined by the contracting agency itself. These usually echo the requirements of the government agency in charge, and, as well, specifically define the area of study and kind of information wanted. Some danger is inherent here in that the work could be oriented towards the goals and requirements of the agencies rather than what might be considered by the archaeologist to be desirable.

At the present time Alberta is the only province in Canada which has legislation stipulating that environmental assessment must be carried out prior to development projects (Land Surface Conservation and Reclamation Act 1973). Whereas this is not the case in British Columbia, there are, however, a number of
Acts which deal specifically with protection and conservation of the resources (eg. Heritage Conservation Act 1977). While these Acts may require consideration of impact assessment they do not make it a requirement (cf. Crook 1976). This situation has been referred to as a "working situation" (Crook pers comm.). Generally speaking, environmental assessment in Canada occurs only when it is deemed by an appropriate government agency to be necessary. Here the danger is that environmental concerns could be conveniently overlooked in the face of rising costs or expected opposition to projects which are instrumental to government policy. In such instances as these it becomes apparent that environmental concern is not always as strong as the needs or wants that are perceived by society or political groups to be of economic necessity.

In order to carry out archaeological work in British Columbia the Heritage Conservation Act requires a permit, issued by the Minister of the agency responsible. This permit allows a researcher to initiate survey or investigations. The Act attempts to protect heritage resources with the following:

6 (1) No person shall remove, or attempt to remove, a designated object from the Province without the prior consent of the minister.

(2) No person shall, except as authorized by a permit under section 5, knowingly
(a) destroy, desecrate, deface, move, excavate, or alter a Provincial heritage site, or a heritage object, designated under this Part, or

(b) destroy, desecrate or alter a burial place of historic or archaeological significance or remove skeletal remains from it, or

(c) destroy, deface or alter a North American Indian kitchen-midden, shell heap, house-pit, cave or other habitation site, cairn or fortification (Heritage Conservation Act 1977: 2).

And in section 7:

(2) Where in the opinion of the minister, land contains a heritage site, he may order a site survey, or, where he considers circumstances warrant, a site investigation.

(3) Where, in the opinion of the minister, a heritage site may be altered, damaged, or destroyed or is likely to depreciate or become delapidated, he may order

(a) a site survey, or, where he considers circumstances warrant, a site investigation, and

(b) the owner of the heritage site

(i) to pay for the site survey or site investigation, and

(ii) to preserve the heritage site until the site survey or site investigation is completed.

(4) Where a site survey or site investigation is ordered under this section, it shall be taken forthwith and in a manner that will not cause undue hardship to the owner of the land.

(5) Where necessary to make a site survey or site investigation ordered under this section, a person may enter land and no action for loss, damage, or trespass shall be brought for anything done or omitted by him in good faith under this section (Heritage Conservation Act 1977: 3).
The purpose of the Act is "... to encourage and facilitate the protection and conservation of heritage property in the Province" (Heritage Conservation Act 1977: 1). In this Act "heritage" refers to the following:

... "heritage" means of historic, architectural, archaeological, paleontological, scenic significance to the Province or a municipality ...

... "heritage object" means, whether designated or not, personal property of heritage significance;

"heritage site" means, whether designated or not, land, including land covered by water, of heritage significance. ... (Heritage Conservation Act 1977: 1).

There exist several difficulties in the practical application of the "working situation". Simple enforcement of the legislation is difficult because it is almost impossible to oversee the activities of people over an entire province. Problems in legal interpretation of the Act further complicate conservation attempts. Inconsistencies within the method and theory of the discipline itself tend to confuse matters as well (cf. Goodyear et al. 1978; Plog et al. 1979). For example, significance is not defined in the Act and therefore some ambiguity exists in its interpretation. However, the definition, applicability and usefulness of the term in the
study of prehistory remain a major difficulty. The
"assessment of significance" is one of the current problems in
cultural resource management studies (cf. Lynott 1980). It is
primarily a definitional problem. While a statement of
significance is generally considered necessary in cultural
resource management studies, it is difficult to operationalize
the concept because the criteria required to describe
significance do not lend themselves to quantification easily.
Significance cannot be measured directly like temperature or
weight. In fact, there exists no ultimate set of criteria
which would allow the assessment of significance for all types
of heritage resources.

... there are many different site
c characteristics ... that may be used in
significance evaluation - so many, in fact,
that choices must inevitably be made. How do
we go about selecting those attributes whose
importance will always be high? In fact, there
is no sure way of knowing whether the attribute
we might select today will continue to be
important, or will exhaust the number that
could become important. All we can do is to
identify those attributes that have been and
are now important to archaeology ... ...
(Glassow, 1977:418).

\( A \)

In summary, the working situation provides controls for
heritage resources through the Heritage Conservation Act, 1977.
Like other environmental legislation, this Act empowers
government to undertake protective measures, such as impact
assessment and mitigation projects, but only where it is viewed
necessary. The totality of problems, conflicts, new concepts and legislative guidelines linked with C.R.M. studies stand to distinguish them from other heritage or archaeological research free of these concerns. However, the necessity of C.R.M. work cannot be underrated as it attempts to contend with the problem of conserving and preserving a non-renewable resource. It is perhaps more profitable to view the development of C.R.M. as a legitimate and inevitable response of the discipline necessitated by natural economic growth and development. Perceived within this framework, the problems and criticisms of C.R.M. may be elevated beyond presumption and renunciation and ultimately benefit the discipline as a whole.

The Northeast Coal Study In Context

A predictive survey sets out to identify the types of historic properties present in a study area, and to determine the relationships between property types and easily identifiable features of the natural or cultural environment, such as altitude ranges, drainage characteristics, and transportation routes. From these observations it is possible to extrapolate to the entire study area, with some degree of accuracy, thus predicting where different types and numbers of properties will occur throughout the area. For planning purposes, these predictions can be used much as can absolute data on specific properties, as a basis for identifying preservation opportunities and as a way of recognizing potential conflicts between preservation needs and modern land-use requirements before they become actual (King et al. 1977:147).
In the Northeast Coal study ecological anthropology provided the bases for attributing interactive relationships between environmental variables and cultural manifestations. Ultimately the environmental variables are employed to extrapolate heritage potential to proposed development zones of the study area. To facilitate the acquisition of heritage resource information, a formal sampling design was chosen, primarily because of the size and forested nature of the area. The research was carried out within the context of cultural resource management philosophy and, therefore, is dependent upon the implicit limitations dictated by requirements of the funding agencies and the existing legislation.
Chapter 3

RESEARCH DESIGN AND METHODS

Introduction

Attempting to sample the lowland Maya jungle by .5Km² quadrats would border on lunacy. Even if you succeeded in actually doing it, no one would ever believe you (Flannery 1976:159).

In the Northeast Coal study the primary interest of the Environment and Land Use Sub-Committee (E.L.U.S.C.) was to gain information from the survey about heritage resources in the proposed development areas to facilitate assessment and planning decisions. Essentially, the E.L.U.S.C. wished to know the likelihood that heritage resources exist or do not exist within parts of a very large region. Originally, the agency wished to know where all the heritage resources were within the study area; an impossibility given the size and nature of the area and time allowed for survey. It is not always clear to non-archaeologists why it is impossible to determine exact locations and populations of heritage resources.
For these reasons a sampling scheme was devised, designed specifically to produce statistically valid information for a regional evaluation process. Other aspects of the project were secondary to these concerns.

The use of a formal probabilistic sampling procedure for archaeological survey in forested areas seems most appropriate for the simple reason that only a portion of the total area requires actual survey. Initially the advantages would seem obvious. These advantages are, however, lessened by the fact that vegetation cover in forested areas is usually too dense to allow for unrestricted surface visibility. This makes sampling both appealing and difficult because one of the implicit requirements for successful sampling is that the sampling unit be completely examined. The decision to utilize sampling procedures in forested areas becomes dependent upon the ability of the researcher to adequately cover the sampling unit.

At the time of this study examples of probabilistic survey in forested areas were few in number (e.g. Lovis 1976). Lovis (1976) sampled forested areas utilizing an observation technique similar to that used here. Using one foot square test units placed systematically at 100 yard intervals, quarter section sampling units were surveyed. He reasoned that by digging test units systematically throughout the sample unit it
would be adequately covered. One criticism of this systematic placement of excavation units is that it does not take into account periodicities which may occur in the data and therefore contribute bias to the results (Berry, 1962). Nance (1979) discusses several other problems with this study. These include: 1) Failure to acknowledge the design as a subsampling technique; 2) Failure to deal with cluster sampling when cluster sampling was in fact in use; 3) Incorrect use of chi-square statistic on cluster samples; and, 4) Using chi-square with samples which were too small in number (Nance 1979: 172-176).

The idea of digging test units within a survey area is not new in archaeology. The utility of this technique may be maximized, however, through careful consideration of their placement and sampling facilitates this.

**Sampling Design and Methods**

The N.E.C. study area was first stratified into smaller regions (corridors). Each of these regions was characterized by a set of environmental attributes (Table II) and then further subdivided into smaller areal units (Fig. 3). The
## TABLE II

Environmental attributes used to describe corridor regions of the study area.

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<thead>
<tr>
<th>Major Vegetation Zones</th>
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<tbody>
<tr>
<td>1. i) Boreal White Spruce, Balsam Poplar Subzone</td>
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<td>2. ii) Boreal White Spruce, Black Spruce Subzone</td>
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<td>Vegetation Types</td>
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<td>3. iii) Trembling Aspen</td>
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<td>4. iv) White Spruce</td>
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<td>5. v) Lodgepole Pine</td>
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<td>6. vi) Willow</td>
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<tr>
<td>Fish Species</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7. i) Grayling</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>8. ii) Mountain Whitefish</td>
<td></td>
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<tr>
<td>9. iii) Dolly Varden</td>
<td></td>
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<tr>
<td>10. iv) Others (eg. suckers)</td>
<td></td>
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<td></td>
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<td>Geographical Features</td>
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<tr>
<td>11. i) Major River</td>
<td></td>
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<tr>
<td>12. ii) Major Creek</td>
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<tr>
<td>13. iii) River - Creek Confluence</td>
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<tr>
<td>14. iv) Creek Confluence</td>
<td></td>
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<tr>
<td>15. v) Lake</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>16. vi) Lake Creek Confluence</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>17. vii) Lake River Confluence</td>
<td></td>
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<td></td>
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<tr>
<td>18. viii) River Confluence</td>
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<tr>
<td>Known Heritage Resources</td>
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<tr>
<td>19. i) Archaeological Sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. ii) Historic Sites</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Figure 3 Corridor regions of the study area.
CORRIDOR REGIONS
OF THE
NORTHEAST COAL
STUDY AREA
environmental attributes provide the bases for subsequent regional comparison and heritage potential predictions. One of the corridor regions was selected for sampling (Fig. 4). This sampling area represents the population from which predictions about the whole study area (universe) are made. The sampling area is also referred to as the control region. This procedure is based upon a sampling technique used by geographers in regional studies. (cf. Berry 1962; 1968; Berry and Baker 1968).

Data on the presence and absence of environmental attributes within the sub-regions of the study area were obtained from Provincial Government resource maps, with the exception of cases 19 and 20. It should be noted that at the time this study was conducted resource information for some parts of the study area was incomplete and not available.

Observation in the forested sample area was facilitated by digging a series of test units throughout each sampling unit. Locations of these test units were chosen using a stratified, systematic, unaligned sampling technique (Berry 1962). This appears to be a satisfactory method of solving the problem of adequately covering a forested sampling unit (cf. Nance in press a and b; Spurling 1978). This technique takes into
Figure 4 Control corridor survey sampling area.
account any inconsistencies or periodicities in data within the sampling unit and is therefore preferred over other systematic selection methods. A pilot survey area (Fig. 5) was selected near the base camp in order to: 1) provide a test for the sampling technique, that is, the observational technique of digging holes throughout the sampling unit; and, 2) provide information which would be useful in the final choice of sample size in the control sample area.

To facilitate sampling the Martin Creek to Gwillim Lake control region (Fig. 4), each stratum of the corridor was first divided into N sampling units of equal size, 500 m on a side, and a simple random sample of n of these was chosen within each stratum. These units are referred to as primary sampling units. Because the area was so densely forested and therefore difficult to search using traditional techniques, the primary sampling units were subdivided into m subunits, each 50 m on a side, and a sub-sample of size m selected. As noted above, examination of these forested areas consisted of digging small test or observational units throughout each sample unit. A schematic representation of this sampling scheme is shown in Figure 6.

Thus, the sampling procedure employed may be described as a disproportional stratified cluster sample design. The
Figure 5  Pilot survey sampling area.
Figure 6 Sampling scheme.
Primary Sampling Unit

Sampling Scheme

500 m sq.

Excavation Unit

50 m sq. Sub-Sampling Units
primary units (all of equal size) were subsampled and the subunits surveyed systematically using excavated test units (25 in each subunit). It was estimated that 25 test units placed within the confines of a 50 m square subunit would allow adequate and reliable coverage and the forested sampling unit would then be effectively and satisfactorily surveyed. Although this assumption has not been tested, Nance (in press, a and b) and Spurling (1978) have had success with units spaced even wider apart, 20 m and 100 m respectively. The test units were excavated using shovels and .64 cm mesh screens, and where cultural material was encountered, trowels were used for the remainder of the excavation.

Due to the nature of the terrain, it was not possible to cover all sample units adequately. In some instances, sampling units occurred in areas that were less than desirable for observation, not to mention prehistoric habitation. Such areas included steep slopes, cliffs and stream channels. These areas were observed to hold no evidence of cultural occupation.

Because of the nature of the survey (i.e. forest sampling) the research was designed to permit only the location of cultural material. Therefore, it was necessary to define a site to be any cultural items encountered within a sampling unit or survey area, be it an historic structure or a single
flake. As well, a limited time schedule restricted further
determination of the extent of sites located; ideally this kind
of investigation would be included in subsequent site specific
work or other mitigation procedures.
Chapter 4

RESULTS OF SURVEY SAMPLING

Introduction

Results of the survey sampling are presented in this chapter. These include 2 sets of data: 1) From the Gwillim Lake pilot survey (Fig. 5), wherein the sampling technique was tested; and, 2) From the Martin Creek to Gwillim Lake sampling corridor (Fig. 4). These data are used to provide probability statements or predictions about the other regions of the study area.

Statistical Analysis

Estimates from the sampling exercise are of proportions of areas containing cultural material rather than actual numbers of sites. This is so because it was only possible to identify cultural material within subsampling units and not define the actual number of sites within any of the sampling units. Archaeological survey sampling has in the past been primarily
concerned with making estimates of site numbers (cf. Mueller, 1974; 1975; Matson and Lipe, 1975, Judge et al., 1975). This is usually a relatively simple matter and all that is required, after design and selection of a sampling approach, is to survey the sampling unit and record the occurrence or non-occurrence of sites. The greater number of examples of surveys of this type originate in areas where the ground is not covered by dense vegetation and survey is straightforward; usually a simple process of visually searching the sampling unit.

The process is somewhat more difficult in forested situations where the search involves digging test units throughout the sample unit. The excavation of test units within the sampling unit results in observations of either the presence or absence of cultural material. Therefore, because estimates of numbers of sites cannot be made results are best presented as "Estimates of Proportions"; that is the proportion of the area estimated to contain cultural material as determined by the presence or absence of cultural material within subsampling units.

The estimate of the proportion \( \hat{p} \) is obtained by:

\[
\hat{p} = \frac{\varepsilon x_i}{\varepsilon m_i}
\]
where:

\[ x_i = \begin{cases} 1 & \text{if cultural material is present in a subunit} \\ 0 & \text{if cultural material is absent from the subunit} \end{cases} \]

\[ m = \text{the number of subunits examined in a primary unit; and,} \]

\[ n = \text{total number of primary units selected into the sample.} \]

An estimate of the variance of \( \hat{p} \) is:

\[
S^2 \hat{p} = \frac{1 - f_1}{n(n-1)} \sum (p_i - \hat{p})^2 + \frac{f_1(1-f_2)}{n^2(m-1)} \sum p_i q_i
\]

where:

\[ f_1 = \frac{n}{N}; \]

\[ f_2 = \frac{m}{M}; \]

\[ p_i = \text{the estimate of the proportion for each of the } n \text{ primary units; and,} \]

\[ q_i = (1 - p_i). \]

Estimates of sample size may be obtained from information gained in previous samples (eg. Pilot surveys) or, when this
is not possible, from "... guesswork about the structure of the population" (Cochran 1963: 77) under consideration (see also Deming 1960). These estimates of sample sizes for an infinite population are provided by

\[ n = (\text{Desired Confidence}/\text{Desired Precision})^2 \hat{p}q \]

where:

\[ n = \text{the estimated sample size}; \]

\[ \hat{p} = \text{the estimate of proportion}; \] and,

\[ q = (1 - \hat{p}). \]

The 'Desired Confidence' is the confidence limits (eg. 2.58 and 1.96 for 99% and 95% confidence respectively) and the 'Desired Precision' is the expected error (eg. +/- .01 or +/- .05) (cf. Cochran 1963: 71-84).

This estimate assumes that the subsampling procedure employed provided an adequate assessment of the presence/absence of cultural materials in primary units.
Pilot Survey Results

In order to choose a sample size which will provide reliable results it is desirable to first know something about the population under consideration. As noted above, information about the population may be obtained from previous survey data. Even nonprobabilistic survey data can provide gross information. Sample size estimates for the Gwillim Lake pilot survey are shown in Tables III. These primary unit sample size estimates were obtained from the Fellers Heights area (Fig. 2). Placing a grid network of 500 m units over a portion of the Fellers Heights area which had been surveyed previously in 1976, known site locations were plotted within the grids. The result of this was that a total of \( x = 6 \) sample units out of a possible \( n = 33 \) contained cultural material. The estimate of the proportion from this information is:

\[
\hat{p} = \frac{x}{n} = \frac{6}{33} = .182
\]
### TABLE III

Sample size estimates for the Gwillim Lake pilot survey area.

<table>
<thead>
<tr>
<th>% Confidence</th>
<th>99</th>
<th>95</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>.05</td>
<td>10</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>.10</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Precision</td>
<td>.15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>.20</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

A sample size of 7 primary units was chosen for Gwillim Lake pilot survey. The results of this survey are shown in Table IV.

### TABLE IV

Sampling results from the Gwillim Lake pilot survey.

<table>
<thead>
<tr>
<th>Population Size</th>
<th>69</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>7</td>
</tr>
<tr>
<td>$x$</td>
<td>2</td>
</tr>
<tr>
<td>$\hat{p}$</td>
<td>.286</td>
</tr>
<tr>
<td>Variance of $\hat{p}$</td>
<td>.034</td>
</tr>
</tbody>
</table>

The exercise was completed over a period of 9 days, with 8 people working on it intermittently. This works out to about 1.3 days for a sampling unit in which 25 test units are excavated. From this it was estimated that a maximum of 30 subsampling units (each 50 m square) could be completed in the control survey sampling area.
Control Corridor Results

Estimates of sample sizes for the control survey sampling area, based on the results from the pilot sample, are shown in Tables V, VI, and VII. The population sizes for the 3 strata in the control corridor survey area were: 26 in stratum 1, 67 for stratum 2 and 18 for stratum 3. Within these, a total of 36 subsampling units were surveyed. This included: 6 in stratum 1, 14 in stratum 2, and 16 stratum 3. The results of survey sampling in the control corridor are shown in Table VIII.

### TABLE V

<table>
<thead>
<tr>
<th>% Confidence</th>
<th>99</th>
<th>95</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>.05</td>
<td>20</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>.10</td>
<td>12</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>.15</td>
<td>7</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Precision</td>
<td>.20</td>
<td>.5</td>
<td>.3</td>
</tr>
<tr>
<td>.25</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>.30</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>.35</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>.40</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
### TABLE IV

Estimates of sample size for Stratum 2 of the control survey sampling region.

<table>
<thead>
<tr>
<th>% Confidence</th>
<th>99</th>
<th>95</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>.05</td>
<td>39</td>
<td>29</td>
<td>24</td>
</tr>
<tr>
<td>.10</td>
<td>17</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>.15</td>
<td>9</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>.20</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Precision</td>
<td>.25</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>.30</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.35</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.40</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### TABLE VII

Estimates of sample size for Stratum 3 of the control survey sampling region.

<table>
<thead>
<tr>
<th>% Confidence</th>
<th>99</th>
<th>95</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>.05</td>
<td>15</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>.10</td>
<td>10</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>.15</td>
<td>6</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Precision</td>
<td>.20</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>.25</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>.30</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.35</td>
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<tr>
<td></td>
<td>.40</td>
<td>1</td>
<td>1</td>
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</tbody>
</table>
Table VIII

Sampling results from the control survey sampling area, Martin Creek to Gwillim Lake.

<table>
<thead>
<tr>
<th>Sample Stratum</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Size (N)</td>
<td>26</td>
<td>67</td>
<td>18</td>
</tr>
<tr>
<td>Number of Primary Units Selected (n)</td>
<td>3</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Total Number of Subsampling Units Selected (nM)</td>
<td>6</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>ΣXi</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>$\hat{p}$</td>
<td>.167</td>
<td>-</td>
<td>.125</td>
</tr>
<tr>
<td>Variance of $\hat{p}$ ($S^2\hat{p}$)</td>
<td>.078</td>
<td>-</td>
<td>.022</td>
</tr>
<tr>
<td>Standard Error of $(S.e.\hat{p})$</td>
<td>.28</td>
<td>-</td>
<td>.15</td>
</tr>
</tbody>
</table>

Resource Potential Predictions

Determining heritage resource potential within the study area is achieved by applying the results of the survey sampling area to the other corridor regions. To do this it is necessary to first determine similarity among the respective regions. Comparisons were made between the 3 control corridor strata and the other corridor areas based on the presence or absence of the environmental attributes (Table VIII) scored for each area. Similarity measures were computed using a distance coefficient (ie. $1 - S_j$) ($S_j$ = Jaccard's Coefficient, see Sneath and Sokal 1973:131). The computations were made using a cluster analysis program (NT-SYS) on the IBM 370/55 computer facilities at Simon Fraser University. Results are shown in Table IX.
**TABLE IX**

List of similarity measures obtained from comparing control strata with the other corridor regions of the study area.

<table>
<thead>
<tr>
<th>Area</th>
<th>Stratum 1</th>
<th>Stratum 2</th>
<th>Stratum 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 CHET</td>
<td>0.214</td>
<td>0.667</td>
<td>0.471</td>
</tr>
<tr>
<td>5 TWID</td>
<td>0.375</td>
<td>0.600</td>
<td>0.500</td>
</tr>
<tr>
<td>6 DICK</td>
<td>0.071</td>
<td>0.533</td>
<td>0.353</td>
</tr>
<tr>
<td>7 BRSH</td>
<td>0.250</td>
<td>0.467</td>
<td>0.294</td>
</tr>
<tr>
<td>8 BRNT</td>
<td>0.313</td>
<td>0.625</td>
<td>0.444</td>
</tr>
<tr>
<td>9 SKET</td>
<td>0.267</td>
<td>0.600</td>
<td>0.412</td>
</tr>
<tr>
<td>10 MENG</td>
<td>0.471</td>
<td>0.385</td>
<td>0.313</td>
</tr>
<tr>
<td>11 MESO</td>
<td>0.375</td>
<td>0.385</td>
<td>0.313</td>
</tr>
<tr>
<td>12 BUWS</td>
<td>0.600</td>
<td>0.667</td>
<td>0.706</td>
</tr>
<tr>
<td>13 BUSS</td>
<td>0.533</td>
<td>0.583</td>
<td>0.647</td>
</tr>
<tr>
<td>14 TUNE</td>
<td>0.444</td>
<td>0.467</td>
<td>0.389</td>
</tr>
<tr>
<td>15 2CRK</td>
<td>0.375</td>
<td>0.250</td>
<td>0.412</td>
</tr>
<tr>
<td>16 WOL1</td>
<td>0.500</td>
<td>0.273</td>
<td>0.529</td>
</tr>
<tr>
<td>17 WCL2</td>
<td>0.563</td>
<td>0.615</td>
<td>0.667</td>
</tr>
<tr>
<td>18 WOL3</td>
<td>0.533</td>
<td>0.300</td>
<td>0.467</td>
</tr>
<tr>
<td>19 FLT1</td>
<td>0.600</td>
<td>0.400</td>
<td>0.533</td>
</tr>
<tr>
<td>20 FLT2</td>
<td>0.467</td>
<td>0.364</td>
<td>0.400</td>
</tr>
<tr>
<td>21 HAMB</td>
<td>0.556</td>
<td>0.500</td>
<td>0.412</td>
</tr>
<tr>
<td>22 UPFL</td>
<td>0.647</td>
<td>0.364</td>
<td>0.400</td>
</tr>
<tr>
<td>23 TMSO</td>
<td>0.333</td>
<td>0.462</td>
<td>0.471</td>
</tr>
<tr>
<td>24 MURY</td>
<td>0.471</td>
<td>0.600</td>
<td>0.500</td>
</tr>
<tr>
<td>25 KINS</td>
<td>0.500</td>
<td>0.417</td>
<td>0.529</td>
</tr>
<tr>
<td>26 IMPR</td>
<td>0.444</td>
<td>0.467</td>
<td>0.389</td>
</tr>
<tr>
<td>27 MONK</td>
<td>0.786</td>
<td>0.727</td>
<td>0.643</td>
</tr>
<tr>
<td>28 PRT5</td>
<td>0.500</td>
<td>0.417</td>
<td>0.529</td>
</tr>
<tr>
<td>29 PRSP</td>
<td>0.533</td>
<td>0.692</td>
<td>0.722</td>
</tr>
<tr>
<td>30 PREM</td>
<td>0.688</td>
<td>0.545</td>
<td>0.706</td>
</tr>
<tr>
<td>31 HOMK</td>
<td>0.714</td>
<td>0.700</td>
<td>0.813</td>
</tr>
<tr>
<td>32 HOHK</td>
<td>0.875</td>
<td>0.917</td>
<td>0.813</td>
</tr>
</tbody>
</table>
The low values in Table IX indicate the greatest similarity between any of the strata and a corridor area. Rearranging these data slightly, the areas displaying the greatest similarity to each of the respective strata are shown in Table X. Figure 7 is a heritage potential map of the Northeast Coal study area graphically presenting the data shown in Table X.

### Table X

<table>
<thead>
<tr>
<th>Stratum 1</th>
<th>Stratum 2</th>
<th>Stratum 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 CHEET (.2)</td>
<td>15 2CRK (.3)</td>
<td>10 MENO (.3)</td>
</tr>
<tr>
<td>5 TWID (.4)</td>
<td>16 WOL1 (.3)</td>
<td>11 MESO (.3)</td>
</tr>
<tr>
<td>6 DICK (.1)</td>
<td>18 WOL3 (.3)</td>
<td>14 TUMB (.4)</td>
</tr>
<tr>
<td>7 BRSH (.3)</td>
<td>19 FT1 (.4)</td>
<td>21 HAMB (.4)</td>
</tr>
<tr>
<td>8 BURNT (.3)</td>
<td>20 FT2 (.4)</td>
<td>26 IMPR (.4)</td>
</tr>
<tr>
<td>9 SKET (.3)</td>
<td>22 UPFL (.4)</td>
<td>27 MONK (.6)</td>
</tr>
<tr>
<td>10 BULWS (.6)</td>
<td>25 KINS (.4)</td>
<td>32 HOMK (.8)</td>
</tr>
<tr>
<td>11 BULWS (.6)</td>
<td>28 PRTB (.4)</td>
<td></td>
</tr>
<tr>
<td>12 MURY (.5)</td>
<td>30 PRHM (.5)</td>
<td></td>
</tr>
<tr>
<td>13 TUMBS (.3)</td>
<td>31 HOMK (.7)</td>
<td></td>
</tr>
</tbody>
</table>
Figure 7   Heritage potential within development corridors of the study area.
HERITAGE POTENTIAL WITHIN DEVELOPMENT CORRIDORS OF THE NORTHEAST COAL STUDY AREA

LEGEND
Sampling Area (1, 2, 3)
Regions Similar to Area 1
Regions Similar to Area 2
Regions Similar to Area 3

Chetwynd
Plym R.
Gwillim Lake
Stony Lake
Table R.
Hocene R.
Moukie R.

0 5 10 15 20 25 km
Chapter 5

SUMMARY AND CONCLUSIONS

Overview

This study has been concerned with a regional sampling design aimed at providing information about heritage resources in the Northeast Coal study area. This information is meant to provide input for heritage resource evaluation in the region. A sampling design is presented which allows predictions to be made about heritage resources within a very large forested region. The use of probabilistic sampling is considered the most appropriate technique for approaching a regional cultural resource evaluation as required for the Northeast Coal study. Ecological anthropology and probabilistic sampling provide the theoretical basis for the study. A discussion of cultural resource management and conservation archaeology outlines some of the problems facing these types of heritage studies.

One of the difficulties confronting cultural resource management studies concerns the limitations placed upon them by virtue of their nature as a practical application of the method and theory of archaeology. Time and budgetary limitations
defined by aspects of C.R.M. work, such as the type of development (i.e., large or small scale), size and shape of study area (pipeline or coal lease area), contract competition and the need to acquire future contracts to ensure continued income and company profit, place it apart from other archaeological research, often referred to as "pure research". This is not to say that "pure research" projects are not confined by problems but that the limitations are quite different. Their success is perhaps more closely aligned with the skill of the researcher, both in securing funds and carrying out the research.

Although cultural resource management work is encumbered by restrictions it remains the best means to approach conservation and protection of that portion of the archaeological record endangered by various land modification projects. In many ways its problematical character may be ascribed to its recent and rapid development. Many researchers have found it difficult to deal with C.R.M. because it is new and operates in some respects counter to the accepted canons of archaeological method and theory. Continued development of the natural landscape will ensure cultural resource management studies maintain an important position in the study of prehistory. Its ultimate success in contributing to the discipline, however, lies perhaps more with its critics than with its practitioners and supporters.
The rapid development of CRM has to a certain degree upset the normal progress of disciplinary development because it threatens to make permanent the condition of the discipline at a time in which rigidity is least warranted. The burden of the next few years is not, however, with CRM but with the profession as a whole which must resolve basic issues so that CRM can effectively insure the discipline's future (Dunnell 1979: 449).

In summary, the regional sampling design presented in this thesis provides information for heritage evaluation within a rather formidable study area. Results from the sample survey show that nineteen portions of the study region exhibit some heritage potential. Twelve of these show greatest similarity to stratum 1 of the sample area and 7 to stratum 3. Those areas displaying optimum similarity with stratum 2 are believed to hold little or no potential for containing heritage resources. Figure 16 is a heritage potential map of the Northeast Coal study area based on the information from the sample. It is estimated that 17% +/- 28 of the sample area in stratum 1 contains cultural material. A more precise estimate comes from stratum 3 with the results indicating that about 12.5% +/- 15 of the sample area contains cultural material. In this sense, the research contributes information useful for assessing environmental impact, planning for road, rail and other developments, as well as designing further heritage studies in the study area.
Results of this study also provide information useful for researchers undertaking survey in areas with similar forested conditions. The sampling scheme presented is a successful method of treating forested survey tracts.

**Evaluation of N.E.C. Project**

Archaeological survey in forested areas is difficult and no less so utilizing a formal sampling strategy. One of the main objectives of the archaeological research in the Northeast Coal study was to evaluate heritage resource potential within defined areas. To the extent that this objective was accomplished the research may be considered successful. Success may also be measured in the utility of the predictive model and the sampling scheme for future research projects. However, there are some important practical considerations which should be made.

Logistics is always a major concern in the initiation and operationalization of any archaeological project. Problems encountered with survey in areas where access is minimal are complicated when the region is covered by forest. This becomes especially true when formal sampling schemes are to be employed. Difficulties may be experienced in locating sampling...
research results provided in this thesis are presented as a modest contribution to those heritage conservation efforts and the study of prehistory.
REFERENCES

Alberta Government
1973 Land Surface Conservation and Reclamation Act, Bill 47, Charter 34.

Ball, B. P.

Baumhoff, M. A.

Benson, C. L.

Berry, B. J. L.


Berry, B. J. L. and B. Baker

Binford, L. R.

Birdsell, J. B.
1975 Some environmental and cultural factors influencing the structuring of Australian aboriginal populations. American Naturalist 87: 127-207.

British Columbia Government
Broilo, P. J. and W. J. Judge

Casteel, R. W.

Chenhall, R.

Clarke, D. L.

Cochran, W. G.

Crook, R. L.

Damas, D.

Deming, W. E.

Dunnell, R. C.

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Goodyear, A.C., L.M. Raab and T.C. Klinger
1978 The status of archaeological research design in cultural resource management. American Antiquity 43: 159-173.

Gumerman, G.J. (editor)

Hansen, J.A., W. M. Hurwitz and G. Madow

Hardesty, D.

Harris, M.


Hayden, B.
Jochim, M. A.

King, T. F.

King, T. F., P. P. Hickman, and G. Berg

Holland, S. S.

Judge, W. J., J. I. Ebert, and R. Hitchcock

Kish, L.

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Klippel, W. E.

Lee, R. and I. Devore (editors)

Lipe, W. D. and A. L. Lindsay Jr. (editors)

Lovis, W. A.

Lynott, M. J.
Matson, R. G. and W. D. Lipe
1975 Regional sampling: a case study of Cedar Mesa, Utah. In Sampling in Archaeology, edited by
J.W. Mueller, pp. 124-143. University of Arizona
Press, Tucson.

Mayer-Oakes, W. J. and A. W. Portnoy
1979 Scholars as Contractors. Interagency Archeological
Services Division, Heritage, Conservation and Recreation
Service, Washington, D.C.

McGimsey, C. R. III

McGimsey, C. R. and H. A. Davis (editors)
1977 The Management of Archaeological Resources. The
Arche House Report. Special publications of the
Society for American Archaeology.

Mueller, J. W.
1974 The use of sampling in archaeological survey.
American Antiquity, Memoirs 29.

1975 Sampling in Archaeology (editor). The University of
Arizona Press, Tucson.

Nance, J. D.
1979 Regional subsampling and statistical inference in

in Lower Cumberland Project: 1978 Southeast

in Non-site sampling in the Lower Cumberland Valley,

Ploq, S., F. Plog and W. Wait
1978 Decision making in modern surveys. In Advances in
Archaeological Method and Theory, Vol. 1, edited

Portnoy, A. W. (editor)
1978 Scholars as Managers. Interagency Archeological
Services, Heritage, Conservation and Recreation
Service. Washington, D.C.

Psagir, S.
1967 A review of techniques for Archaeological sampling.
In A Guide to Field Methods in Archaeology, edited by
Press, Palo Alto, California.
Reher, C. A. (editor)

Rootenberg, S.

Rowe, J.S.

Sanders, W. T.
1965 The cultural ecology of the Teotihuacan Valley. Department of Sociology and Anthropology, Pennsylvania State University.

Sanders, W. T. and B. Price

Schiffer, M.B. and G.J. Gumerman (editors)

Schiffer, M.B. and J.H. House


Sneath, P.H.A. and R.R. Sokal

Sneed, P. G.

Spurling, B.E.
1978 The Site C Heritage Resource Inventory and Assessment. Department of Archaeology, Simon Fraser University.
Steward, J.


Thomson, D. H.


Veselius, G.S.

Vita-Finzi, C. and E.S. Higgs

Washburn, D.K.

Westcoast Transmission

Williams, B.

Yates, F.
1960 Sampling Methods For Censuses and Surveys (third ed.). Chas Griffin and Co., London.

Zubrow, E. B.