# PRODUCTIVITY AND PREDICTABILITY OF RESOURCE YIELD: ABORIGINAL CONTROLLED BURNING IN THE BOREAL FOREST

By Theresa A. Ferguson

Master's Thesis, Department of Anthropology
University of Alberta, Edmonton, Alberta

ABSTRACT

This paper focuses on the use of a controlled burning technique by the Slave of northwestern Alberta. Based on ethnohistoric interviews, the manner in which controlled burning aided the productivity and predictability of resource yield during the early 1900's and the manner in which the application of this technique changed due to social and economic transformations is delineated. The technique of palynology is then tested as a means of tracing the vegetational trends which resulted from the changes in the controlled burning technique followed by its virtual cessation with fire suppression.

# ACKNOWLEDGEMENTS

For their helpful comments and advice, I owe a debt of gratitude to my committee, Dr. C. E. Schweger, Professor P. Murphy and most of all my chief advisor, Dr. H. T. Lewis without whom this thesis would not be. For their generous financial support, I would like to express my appreciation to, first, the Boreal Institute for Northern Studies which funded all the fieldwork and to, secondly, the Province of Alberta and the Department of Anthropology of the University of Alberta, both of which funded my studies and lab research. For access to unpublished material, I would like to acknowledge R. Miyagawa, Fire Research Director of the Alberta Forest Service, Edmonton; the Hudson Bay Co. Archives, Winnipeg; the Provincial Archives of Alberta, Edmonton; and Ducks Unlimited, Edmonton. For his excellent draughting and continuing moral support, I owe a debt of gratitude to my friend, R. Henriet. For their unfailing cooperation during my fieldwork, I would like to thank the Footner Lake District of the Alberta Forest Service, especially the former Supervisor, N. Rodseth, and the former Fire Control Officer, J. Skrenek; the Administrative Office of the Slaves of the Upper Hay River, especially the former Band Manager, R. Henriet; and most of all, my Deneth'a interpreters and the Deneth'a people who were unstinting of their patience and hospitality.

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# INTRODUCTION

One of the major concerns of human groups everywhere lies in maintaining a sustained yield of resources. For aboriginal groups of the boreal forest wherein faunal resources are highly dispersed and subject to cycles in population, the sheer overall number of animals in an area as well as the ability to predict their location assumes great importance. Anthropologists have often emphasized the detailed knowledge that natives possess concerning the local environment and animal behaviour, particularly concerning animal use of habitat. However, the native use of controlled burning to maintain productivity and predictability of resource yield has received little anthropological attention despite the demonstration by modern day wildlife managers that a direct influence on animal number and distribution can be exerted through the use of fire to create predictable changes in the habitat.

As did other native groups in the western boreal forest, the Slave of northwestern Alberta used controlled burning as part of their traditional technology to aid in the maintenance of a sustained yield of resources in accordance with their economic goals. However, since the late 1800's and the 1900's have been times of dramatic economic & political change for the Slave, the use of the technique of controlled burning also underwent transformations. The most radical of these changes, of course, was the cessation of burning with the onset of total fire suppression in the 1940's.

The purpose of this paper is twofold: first, it will serve to delineate the role that controlled burning played in the economic life of the Slave during the early 1900's and its effect on the regional vegetation; secondly, it will attempt to test the technique of palynology as a means of tracing the changes in regional vegetation which occurred as the pattern of controlled burning changed and then ceased.

Chapter I examines some of the recent trends of studies in ecological anthropology in general and specifically some trends in such studies of boreal forest groups. The ethnohistoric and ethnographic literature on the native use of fire to manipulate the environment is introduced and interpreted with the aid of the current literature on the effects of different kinds of fires and on the use of controlled burning by forest and wildlife managers.

Chapter II provides an outline of how both the ethnographic and palynological fieldwork and the palynological analysis were carried out.

Chapter III presents the background data with a summary of the literature available on the flora and fauna of this part of northwestern Alberta and a brief history of the Slave people in this area.

Chapter IV outlines the economic context of the use of controlled burning in the early 1900's by the Slave of northwestern Alberta. As well as presenting the native informants' comments on the environmental effects of controlled burning, the results of various current experiments in controlled burning are outlined to provide some quantitative data on these effects.

Chapter V delineates changes in the use of the native burning technique since the early 1900's and speculates on the transformations which may have occurred prior to the 1900's. Corresponding changes in the regional vegetation are outlined, based both on inference and on informant observations, and the technique of palynology is tested as a means of revealing such trends.

Chapter VI is a concluding chapter which outlines some of the long-term implications of the use of controlled burning and elaborates on some points requiring future research.

This paper is, in essence, a perspective paper designed to provide a general context for inquiry and to facilitate the process of arriving at determinate hypotheses. The alternative of doing a perspective paper rather than one based on a specific problem is the result of the lack of prior detailed research from which to formulate a specific problem. Neither the environment of the area, nor the relationship of fires to the specific community of plants and animals of this area nor even the native use of controlled fire elsewhere in the boreal forest has been extensively researched. In addition to being forced into generalities through lack of detailed ecological work, or for that matter, through lack of ethnographic context, this paper is frankly experimental in terms of its palynological work. Its utility lies solely in the attempt to construct a framework from which to orient further research.

# CHAPTER I

# THE ECOLOGICAL PERSPECTIVE IN BOREAL FOREST ANTHROPOLOGY: PRODUCTIVITY AND PREDICTABILITY

## The Ecological Perspective

> the totality or pattern of relations between organisms and their environment (Odum 1971:3).
>
> the science of the interrelation between living organisms and their environment, including both the physical and biotic environments, and emphasizing inter-species as well as intra-species relations (Allee 1949:1).

All definitions of 'ecology,' whether short or long, focus on relationships and process. This systemic aspect of the ecological perspective has performed a considerable service for anthropology in placing the old controversy of environment vs. culture as explanations for cultural phenomena within a non-determinist framework. The first step towards this solution was made by Steward (1955) who defined technology and economy as major variables interposed between environment and culture. In fact, the culture core was defined as the constellation of features which are most closely related to subsistence activities and economic arrangements (ibid.:37).

The three fundamental procedures of cultural ecology, as Steward (1955:40-41) defines them are the analysis of the inter-relationship of exploitative or productive technology and the environment; the analysis of behaviour patterns involved in the exploitation of a particular area by means of a particular technology; and the ascertaining of the extent to which the behaviour patterns entailed in exploiting the environment affect other aspects of culture. Despite this comprehensive procedural statement, many studies based in this school of thought have started at the terminal point by first considering some social feature and attempting to define how it is adaptive to the environment and whether its origin can be best explained by historical or environmental factors. This procedural emphasis on entities rather than on processes defeats the utility of the ecological perspective. A concern with the level of social structure often gives short shrift to basic ongoing ecological processes. In some of the early work, one receives the impression that these latter processes are reduced to a basic statement of how many people per square mile can be supported by a certain set of subsistence techniques in a certain environment and what implication these demographic factors have for social organization, or in evolutionary terms, 'level of sociocultural integration' (cf. Steward 1955: 40-41). In addition, the degree of influence of the technoeconomic sector in the culture core represents a restrained form of techno-economic determinism, still a knotty problem in anthropological theory.

There have, of course, been advances in the use of the ecological perspective in anthropology since the mid-fifties. Geertz (1963) formulated an ecosystemic approach which has brought a more processual approach to the topic than that implied by the culture core. This position paper has served to orient many of the current ecological studies. Vayda and Rappaport (1968) continue this systems emphasis but advocate the literal application of ecological principles to human activity. However, there has yet to be produced a work generally acknowledged as successfully carrying out these ideas in a specific case. Rappaport's (1968) analysis of ritual-environmental relationships in a New Guinea society illustrates best the utility of an equilibrium systems model, rather than any ecological principles per se, for the analysis of a small traditional society. The use of general ecological principles and laws operates, as does the consideration of social structure, on a level of inference, and one can seriously question their utility in the analysis of human activity. Rappaport's (1968) use of basic ecological data has been criticized as inadequate (Bennett 1975:284), but it still remains one of the better studies. The need for detailed ecological data and, just as importantly, long term ecological data remains one of the major problems for studies in ecological anthropology today (Netting 1971:24).

Bennett's major critique of Steward's and Vayda and Rappaport's work is that the operation on such a high plane of inference not only is not useful for the analysis of human activity but actually tends to distort it:

> interest is displaced towards an evolutionary frame of reference ... actions are seen as component parts of larger configurations of natural events (Bennett 1976:25).

Bennett sees the element of choice as the one neglected factor in Steward's cultural ecology, in Geertz's 'ecosystemicism' and in Vayda and Rappaport's 'ecological anthropology.' Bennett, thus, attempts to add to Geertz's basic ecosystemic model "the adaptive behavioural process involving decision-making and choice, which may or may not be under the control of the systemic processes" (ibid.:166; the emphasis is Bennett's). The question of systemic processes thus depends a great deal on human decision and determination, although Bennett acknowledges the role of environmental feedback. For one thing, this permits him to suggest that the degree to which the techno-economic core prevails - prevalence of any sector being impossible, one would think, in a fully integrated system - depends upon the alternatives and opportunities provided by the environment. He maintains that a true ecological perspective would, however, consider ongoing processes that were similar in all societies regardless of the variability in technoeconomic cores.

In summary, the essential thrust of Bennett's argument is that the level of inquiry has definite theoretical implications as to how human activity is viewed. An approach on the level of general eco-systemic or systemic principles can create a fatalistic attitude towards current human activity. As has been noted, culture concepts can distract from social issues. At a time when anthropologists are increasingly called upon to justify their research, such an attitude can be fatal to the recognition of the benefit of anthropology by the public which funds it. Bennett (1976) particularly stresses the value of the role anthropology can play in the devising of economic and ecological policy. To this end, it is the knowledge of ecological process and how this may be used for human purposes which must become the focus of inquiry.

Boreal Forest Anthropology

The development of ecologically-oriented anthropological studies in the boreal forest has paralleled the trends outlined above, but with a persistence of the cultural ecology studies. This is due perhaps to the initially close relationship between the development of the Stewardian model and Speck's early studies on the social organization of boreal forest groups (Cox 1973:14) or perhaps to the well-established focus in Algonquian social structure studies, the hunting territory. It is also certainly true, if, as mentioned above, the influence of the techno-economic core does prevail to the greatest extent in cultures inhabiting environments which offer the fewest alternatives, that the boreal forest would appear to be the ideal locale in which to illustrate the utility of the Stewardian method of cultural ecology. This biotic zone has been characterized as unproductive and unpredictable in terms of resource yield (eg. Feit 1973). It is perhaps the unpredictability of resources, the recurring cycles of abundance and famine, that especially distinguishes the boreal forest from other 'unproductive' areas such as the Kalahari desert in which the indigenous peoples have been demonstrated to lead comparatively secure lives. No anthropologist would, I fear, be tempted to describe the boreal forest hunter-fisher-trapper, despite his limited wants, as belonging to the "original affluent society." Thus, the role of choice in adaptation to an environment which offers little in the way of alternatives may be questioned:

> But is choice in fact possible in the subarctic region known for its relatively large unpredictability?...
>
> But given the low productivity of subarctic ecological systems can decisions on the time and place of resource utilization actually manage the resource system? (Feit 1973:119, 122)

Steward's (1936) initial ecologically-based analysis of boreal forest groups' social structure generated little further research. However, the concept of the hunting territory was kept in the foreground of ecological studies by the allure of the implication of private property among hunters and gatherers. Despite Hallowell's (1949:36) warning that the variability of that feature should alert investigators to the importance of the underlying ecological data, this ecological data continued to be neglected in the controversy over whether or not this territorial system was an aboriginal (Speck 1915) or a post-contact adaptation (Leacock 1954) and in Leacock's further suggestion that historic shifts in type of territoriality were dependent on changes in the acculturative process. Some of this ecological perspective was restored in Knight's (1965) analysis in which he attempts to refute

Speck's thesis by demonstrating that, given the unpredictability of boreal forest resources, rigid family territoriality would have been, over the long run including 'minimal' conditions, a disastrous adaptation in precontact times. Furthermore, he provides a historical framework of ecological changes in the eastern boreal forest into which to fit the shifts in economic and social organization accounted for by Leacock (1954) as the results of a changing acculturative process. With the renewed recognition of the importance of ecological data in the structural variability of the hunting territory, and the view that structural flexibility is, in fact, the counterpart of mobility, interest has veered from structure to process.

> Although we may conclude with more questions than answers about Montagnais-Naskapi band organization, some things can be said with certainty. I have spoken of the wide latitude afforded the individual for choice of movement and group affiliation and have suggested it is not a recent breaking down of a structure but an old adaptive pattern that takes place within a structure, one that, in fact enables the structure to exist (Leacock 1973:98).

In a similar vein Slobodin (1973:140) stresses the cultural value attached to the mobility/structural flexibility duad among the Peel River Kutchin; and Fisher (1973:130) even goes so far as to imply that in the analysis of the adaptation involved in the Cree westward expansion, the importance of the set of subsistence techniques held in common has been obscured by an emphasis on social structure which in the end has proven ephemeral. Feit (1973) is able to answer his own question (cited above) about the role of choice in an unproductive and unpredictable environment by demonstrating that Waswanipi hunters can control aspects of their resources: by choosing to harvest each at its period of maximum vulnerability and efficiency; by adjusting the proportion of alternate resources to supplement the major species in the diet, moose and beaver, if scarce; and by the rotational use of territories. One of the critical points entertained in this study, and in Nelson's (1973) work with the Kutchin is the concept of knowledge as technology, not merely material culture as technology. Knowledge of terrain, of animal behaviour and of ecological relationships are all used to arrive at productive decisions. Like other current studies with less of an ecological focus (Rushforth 1977; Asch 1976), Feit's work is a creative response to native involvement in the threatened ecological and social crises accompanying the expansion of southern industry into the Canadian north. As well as benefiting from the ecological data generated by the interdisciplinary task forces created for such situations of risky expansion, anthropological studies involved in these issues can have some immediate practical results for the peoples on whom they are focused.

Productivity and Predictability

Thus, for the most part, ecologically-oriented anthropological studies in the boreal forest are moving away from a structural focus, and are concentrating instead on the duad of physical mobility/social flexibility, decision-making based on ecological knowledge and the use of this form of technology to increase productivity and predictability of resource yield in an otherwise unfavourable environment. If a true ecological perspective does, as Bennett suggests (1976:222), focus on processes that are common to all societies regardless of variability in their technoeconomic cores, surely the strategies to increase the productivity and predictability of resource yield would comprise two of these processes. Mobility and the other forms of resource management discussed above by Feit (1973) would illustrate these strategies but these are, nevertheless, basically passive forms of adaptation. Regardless of the traditional anthropological characterization of hunter-and-gatherer adaptation as essentially passive, the importance of choice and awareness lies in the capacity to use one's knowledge creatively. In what way could the native groups of the boreal forest use their knowledge of ecological relationships within the boreal forest in an innovative way to increase productivity and predictability in relation to their own subsistence goals?

In answer to this the nature of the boreal forest offers its' own clue. The one agent which is most influential in creating those early successional stages characterized by the high photosynthesis/biomass ratio which is the formal ecological definition of productivity is fire. Furthermore, repeated fire can create the mosaic of microenvironments which forms a productive landscape for mobile organisms. The evolutionary importance of the relationship between fire and the other organisms of the boreal forest is attested to by the adaptive characteristics of many of the species which can be called "fire-followers" (Heinselman 1971; Rowe and Scotter 1973). As Mutch (1970) has suggested, the boreal forest may even be predisposed to burn due to the evolutionary development of flammable characteristics, so dependent is that ecosystem on fire for its renewal.

Although a 'giant step' for anthropologists, in terms of an ecological perspective, it is a short distance from the 'natural' role of fire in maintaining productivity in the boreal forest ecosystem to the creative use of fire by hunters and gatherers for increasing both productivity of resource yield in relation to their economic goals as well as predictability of resource yield since the location of these more productive areas would be planned. Sources referring to the native use of fire in the western boreal forest are disappointingly devoid of detail but they do document the use of fire by natives to fulfil certain goals related to subsistence:

a) reduction of underbrush to facilitate (i) travel (Petitot 1876: xxv; Duchaussois 1923:32-2; Seton-Karr 1891:95; Guédon 1974:27) and (ii) hunting (eg. Wentzel 1889:77-8; Stefansson 1913:10; Camsell and Malcolm 1919:49; Guédon 1974:27). The use of fire in the boreal forest to drive game has been generally denied (eg. Russell 1898:9).

b) improvement of browse to attract game animals (eg.

McKenna 1908:28-9 cited in Lutz 1960; McKennan 1959:49).

c) destruction of dead grass and the provision of new grass on hay meadows and around settlement areas to (i) provide grazing for horses (eg. Maclean 1896:78; Brooks 1911:206); (ii) fulfill an aesthetic value associated with grassy vistas (Guédon 1974:27), and to (iii) discourage insects (Schwatka 1885:168; Guédon 1974:27).

d) encouragement of the growth of strawberries, raspberries and rosehips (eg. Hearne 1958:452).

e) provision of a supply of fire-wood (Duchaussois 1923:32-2; Petitot 1876:xxv).

What is not even implicitly recognized in these references from the ethnohistoric and ethnographic literature is that to achieve these stated goals consistently, the use of fire must be controlled in some manner and, furthermore, must be used consistently. The lack of understanding by the European observers of the principles of controlled burning led to a neglect in the above references of the details as to how this burning was controlled. Instead, native burning was regarded as haphazard and occasionally as purposeless.

It is only relatively recently that game and wildlife managers have come to recognize that fire has a very important role to play in natural ecosystems. It has been observed that complete fire suppression can result in decadent forests which are disease-prone, unattractive to wildlife and, under certain conditions, a dangerous fire hazard (eg. Cummings 1969:254). Although the need to protect settlement areas and stands of valuable timber ensures the continuity of fire suppression programs, the controlled use of fire is being advocated in specific circumstances for the purpose of wildlife management (eg. Cummings 1969), silvicultural management (eg. Cayford 1970) and fire hazard reduction (eg. Swanson 1974). Central to the concept of controlled burning is the realization that what is critical for subsequent events in a burned area is the nature of the fire, not the mere fact that a fire occurred. It is the lack of emphasis given to this variable of the nature of fire which accounts for some of the apparently confusingly contradictory summaries of 'fire effects' (eg. Kelsall et al 1977). Although lightning fires can be of the type to produce all the results sought after by practitioners of controlled burning, there is no guarantee, of course, that lightning-fires in any area will be of the desired type or occur with the desired frequency.

The aspects of fire behaviour which need to be manipulated to produce the desired environmental effects are intensity and rate of spread. These are, in turn, affected by certain characteristics of the area to be burned, by the fuel to be consumed and by the weather. The size and topography of the area to be burned will affect ease of control and probable size. Fuel quantity, size, arrangement, moisture content and type are all variables. Weather variables include atmosphere instability, temperature, humidity, windspeed and wind direction on the day of the burn and drought which affects fuel moisture (Kiil 1969;

Fischer 1978). Seasonality alone is one of the major ways of controlling these variables since it affects characteristics of both weather and fuel. In temperate and northern regions, for instance, spring and late fall are frequently advocated as the best times to carry out a controlled burn of light to medium intensity since fuels are apt to have a high moisture content (eg. Smith 1968:54). Fire frequency affects the production of specific environmental effects.

Recently one study has examined native techniques of burning in light of the principles of controlled burning which are now accepted by most forest and wildlife managers. This seminal paper by Lewis (1977) provides a systematic presentation of the techniques of controlled burning as practised by natives of the boreal forest of western Alberta in the early 1900's. Lewis (1977) describes and discusses the use of fire to create and maintain hay meadows, to maintain trail, to create productive areas of secondary succession to attract the large herbivores which were game animals and to attract the small herbivores which in turn attracted fur-bearing predators, to provide firewood, to clear deadfall and to fire-proof campsites.

It was apparent from the response of the northern Alberta natives that they also recognized seasonality as the crucial control over fire behaviour; burns were most safely and productively performed in early spring and late fall. General weather and fuel conditions were both taken into account. The size and kind of area to be burned would determine whether the firing would be accomplished in several stages or not; on large hay meadows a partial burn done one day would serve as a fuel-break at a later time; deadfall areas might be burned out over several years. The frequency of fires was also important as a means of eliminating fuel build-up. Hay meadows would be burned over every year; but different bush areas would be burned every year. It is important to point out that, in reference to native burning, 'control' refers to the use of environmental variables solely to influence the fire behaviour. Fires were not watched over or put out unless the burning was carried out unusually late in the season. In this respect, 'control' has a broader meaning than that implied by the Forest Service definition.

Thus, Lewis' (1977) paper served above all to establish two important points. First, it revealed native burning as a controlled, not an indiscriminate, use of fire. Environmental factors were carefully evaluated so that the variables of fire intensity, size and frequency could be planned to produce the desired effects. Secondly, the paper demonstrated that the native use of controlled burning was not occasional or haphazard but patterned. As an integral part of a subsistence strategy, it served along with other more passive tactics such as the rotational use of different areas, as a form of wildlife management. As Lewis (1977:16-20) points out, the idea of the hunter-gatherer exerting such a direct influence on the environment is in contradiction to many stereotyped anthropological views of hunters and gatherers despite the lip service paid to the concept of reciprocal relationship between culture and environment. Lewis suggests that the source of this stereotyping lies in the linking of ecological and evolutionary studies wherein a hunting-gathering 'type' is placed in conceptual opposition to an agricultural 'type.' The dynamics of agricultural groups are thus depicted as progressive in terms of certain potentials beyond those of hunters and gatherers. For instance, Cohen (1968:48) characterizes hunters and gatherers or foragers as "relying primarily on muscular energy for their exploitative activities ... they do not assume responsibility for the presence of food; essentially they merely stoop to pick up what is available and can do nothing to replenish the stock." This is contrasted with non-foragers who can harness other forms of energy and have direct control over their food sources. These kinds of statements are obviously refuted by the above illustration of the environmental effects and the economic uses of controlled burning as performed by boreal forest "foragers." The native use of controlled burning is, in fact, a striking example of the use of environmental knowledge as part of an active, rather than a passive, technology.

# CHAPTER II

# RESEARCH OBJECTIVES AND METHODS

## Objectives

The research reported on here is an off-shoot of Lewis' regional examination of native burning in western and northern Alberta. It attempts first to outline the role that controlled burning played in the economic life of one people in one area, the Slave of northwesternmost Alberta, and the effect that this activity had on the regional vegetation. Secondly, it outlines the changes which occurred over time in the use of controlled burning and the effects both observed and inferred, which these changes had on the regional vegetation. The technique of palynology is then tested as a means of illustrating these vegetational changes.

## Methods

The intent of the remainder of this chapter is to outline briefly how the research was carried out. It describes the sources of the data including fieldwork and lab aspects and discusses some of the problems encountered.

## Archival Work

Archival work played a very small role in this research. Isolated from the main fur-trading routes, this portion of northwestern Alberta received little attention in the past century. Even as late as 1912, Footner (1912) could describe it as virtually unexplored. As a result, historical sources on this area are minimal and only tantalizing glimpses are afforded by journals from peripheral areas. The journals of the Hudson Bay Company trading post at Fort Vermilion, despite gaps, form the longest record for this area.

Ethnographic Fieldwork

Two summers were spent interviewing the people of the Upper Hay River Slave band, now the Deneth'a, of northwestern Alberta. Ten weeks were spent at the largest community, Assumption, in 1976; six weeks were spent at the smaller community of Meander River in 1977. During this time forty individuals who were born prior to 1920 were interviewed at least once. Although an interpreter was used, the approach attempted otherwise to be informal and conversational. Questionnaires were not used.

Information on two topics was elicited: firstly, the who, where, when, why and how of controlled burning; secondly, the economic life of the Slave at the turn of the century. Specific comments were elicited as to where people travelled in their yearly round and what resources were emphasized at particular times of the year. I would like to briefly expand upon some of the problems encountered in doing this type of interviewing, problems which contributed to variability in response.

One technical difficulty involved the need to use interpreters. Young people in their late teens acted as interpreters during interviews.

However, the older people complained that the young no longer knew their own language. There is a marked difference in language skill even between the fifteen year olds and the twenty-five year olds. To reduce interpreter error, all interviews were recorded and then later translated into English. This gave the interpreters an opportunity to listen to difficult constructions and rare vocabulary and to thus translate long passages more accurately. This transcription was remarkably tedious and also occasionally meant that interesting details might be revealed only after the visit was over when it would have been preferable to follow them up immediately.

The attitude of the people themselves also was sometimes a stumbling block both in terms of their feelings about an interview situation and their feelings about the subject of controlled burning. Currently burning is, of course, an illegal activity if performed without a permit. Although fire suppression was not comprehensive throughout this area until 1960 (R. Miyagawa pers. com.),[1] the earliest records available, those documenting the activities of the Fort Vermilion ranger, make it clear that by 1942 at least, fines and jail sentences were the penalty for unauthorized burning. The Fort Vermilion ranger's influence at that time reached as far north and west as Meander River. The penalty then for illegal burning was a $25.00 fine or 40 days in jail, as mentioned in the Forest Service Record of 1942 for the Boyer River Crossing fire (Alberta. Department of Lands and Forests. Forest Service. Individual Fire Report. 30-Boyer River Crossing--42).

Currently the penalty is a minimum of $100.00 (J. Skrenek, pers. comm.).[2] Naturally, informants were suspicious, at least at first, of my motives for these interviews despite repeated assurances that I wished to talk of the times "before the ranger came." Interestingly enough, the women were more suspicious than the men and often went to great lengths to deny that their fathers, brothers or husbands had ever burned when these same men talked quite willingly about such activities. The women's greater suspicion may be caused by memory of the hard times suffered by the women and children when a man was jailed and there was no one to hunt for the family.

As Lewis (1977:32) has pointed out with respect to our understanding of traditional burning, ethnohistoric interviews are no alternative to ethnographic context. Although there was comparative ease in eliciting broad statements about the practice of burning, it was difficult to elicit detailed descriptions and comparisons of controlled burning situations without running the danger of putting words in the informant's mouth. Also central to a reluctance to be detailed and forthcoming, was a resentment of a social situation which consisted of a series of direct questions from a total stranger. This was complicated by the growing resentment on the reserve of the questionnaire-based censuses which were part of a summer make-work program for the native students. This dilemma was only partially resolved by trying to pay 'visits' as opposed to setting up interviews, letting questions and comments follow the informant's comments rather than continual abrupt returns to the major focus of interest, and attempting in general to use a technique of directed conversation. Needless to say this study owes much to the patience and courtesy of the Slave people.

While these problems may have contributed to some variability in informant response, it was eventually realized that on certain points, information varied consistently with the age of the informant. This was interpreted as evidence for differences over time in controlled burning practices. Since the practice of controlled burning did obviously affect the regional vegetation, this evidence for change in the pattern of burning stimulated the use of palynological techniques to see if a corresponding change in regional vegetation could be traced.

## Palynological Fieldwork and Lab Analysis

Palynology is that technique which attempts to reconstruct the regional vegetation history through the analysis of pollen deposited in lake or bog sediments. In studies of this nature, meromictic lakes which are quite deep are preferred coring localities since the sediments are annually varved and therefore can be easily dated. Anaerobic sediment-burrowing organisms are also absent under these conditions and this eliminates one source of contamination. Unfortunately no such deep lakes exist in the study area. Even the large lakes of the area are quite shallow. For instance, Bistcho, the largest lake of the region with an area of 158.31 square miles has a mean depth of only one meter.

Two lakes, Hutch Lake (T112 R20 W5M) and Footner Lake

(T111 R19 W5M) were selected for coring. Both these lakes are in the Meander River drainage, some 22 km. apart, and both are shallow with mean depths of around 2 meters.

Hutch Lake (Plate 1) is located at 58° 37' latitude and 117° 11' longitude at an elevation of 358 meters above sea level. The lake is oriented northwest and is roughly 3 kilometers long and slightly less than 1/2 kilometer wide. On the west shore is a fully stocked stand of 31-60 foot (about 10-20 meter) deciduous and white spruce (Picea glauca) stand as well as one of medium stocked deciduous species not over 30 feet (less than 10 meters). At the south end of the lake there is muskeg and on the southeast side there is a medium stocked stand of 61-80 foot (about 20-26 meter) deciduous trees and white spruce. On the east shore further to the north there is a medium stocked stand of deciduous species not over 30 feet (less than 10 meters) (Alberta. Department of Lands and Forests. Forest Cover Series - 84K14). The recorded fire history of the immediate vicinity of Hutch Lake comprises a fairly large fire in 1942 of unspecified acreage to the north and west of the lake, a second large fire (1994 acres) to the north and west in 1955, spot fires[3] near the lake in 1958, 1966 and 1967, and a 500+ acre fire in 1965 to the south and east of the lake on the Meander River. No fires occurred in the immediate vicinity between 1968 and 1977 (Alberta Forest Service. Footner Lake District. Fire Records).

Footner Lake (Plate 2) is located at 58° 45' latitude and 117° 21' longitude at an elevation of 361 meters above sea level. The lake is

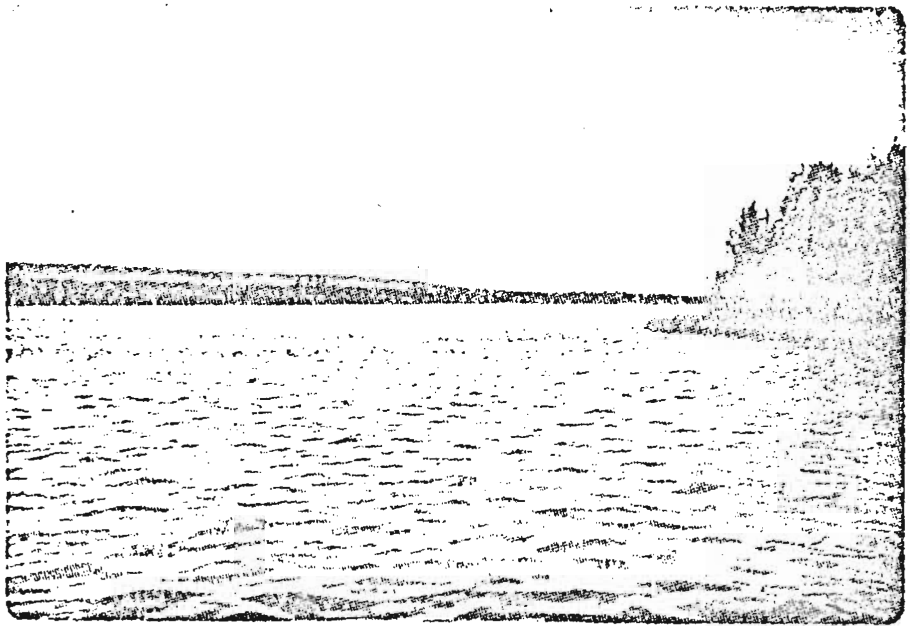


Plate 1. ~~Figure 3~~. View of Footner Lake towards the northwest.

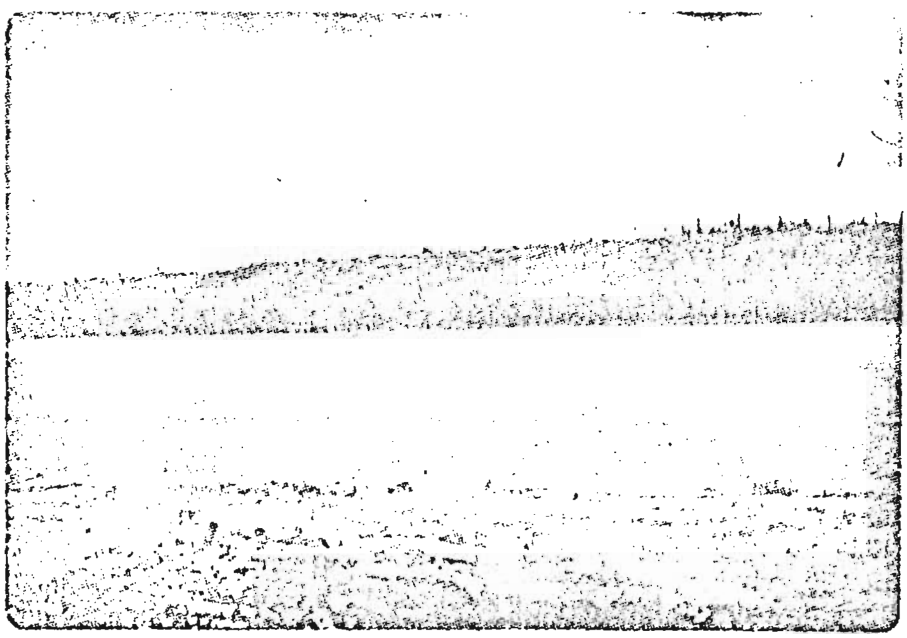


Plate 2. ~~Figure 4~~. View of Hutch Lake ~~from the east~~ towards the southwest.

roughly 3-1/2 kilometers long and widens from .8 kilometers at the south end to slightly over a kilometer at the northern outlet. The shore vegetation is characterized by marsh around the outlet to the north and treed muskeg around the inlet to the south; brushland and a stand of 31-60 foot (about 10-20 meter) deciduous trees are situated on the western shore; a stand of sparsely stocked 31-60 foot (about 10-20 meter) aspen (Populus tremuloides) occurs on the northeast and the remainder of the east shore is mostly occupied by residential area (Alberta. Department of Lands and Forests. Forest Cover Series - 84K11). Recorded fires in the immediate vicinity of the area include only spot fires in 1969, 1970 and 1972 (Alberta Forest Service. Footner Lake District. Fire Records).

The coring of these two lakes was done in late March of 1977 through a meter of ice. Cores using a Livingstone piston corer sampler of 5 centimeter diameter were attempted but the upper portion of the first meter of sediment was too watery to stay in the core barrel. An alternate technique was used which involved filling the core barrel with dry ice and allowing the barrel to stand in the sediment. The upper meter of sediment then froze onto the core barrel and was kept frozen until sampled.

The upper meter of sediment from both lakes was a dark brown gyttja. Samples of this were taken at every centimeter for the top eleven centimeters, then at every five centimeters down to the 40-41 centimeter sample and thereafter at every 10 centimeters to 90-91 centimeters. A sample from 95-100 centimeters was taken for the purpose of radiocarbon dating.

Treatment of these sediment samples for pollen analysis proceeded by methods similar to those described by Faegri and Iversen (1975) and included steps involving the application of 10% NaOH, 10% HCl, concentrated HF, acetolysis solution and fuchsin stain. The residue was mounted in glycerin.

The pollen and charcoal counts were made at a magnification of 40X using a plans-achromatique objective and 10X peri-plan eyepieces. A minimum pollen sum was established at 200, a count which excluded Pinus (a minor element in the vegetation but over-represented in the pollen spectra) and the indeterminates. Charcoal particles were also counted and divided into six size classes using an eyepiece graticule grid. The size classes were 5-10 microns, 10-15 microns, 15-20 microns, 20-25 microns and 25+ microns. The charcoal/pollen ratio was established after 50 grains of pollen were counted. Opaque, black spherules which have sometimes been included in charcoal particle counts were counted separately as there is now an indication that these are in fact pyrites, an iron sulphide residue formed by bacterial action (Vallentyne 1963). Transverses were selected from both the middle and the edge of the slide to minimize sampling error in counting pollen types and charcoal particles both of which may be distributed differentially over the slide depending on their size.

# CHAPTER III

# NORTHWESTERN ALBERTA: ITS ENVIRONMENT AND PEOPLE

## Geography

The geographical focus of the study comprises sheet numbers 84K, 84L, 84M and 84N of the 1/250,000 (Ed. 3MCE, A 502) map series (Figure 1). This area covers some 20,000 square miles (520,000 square kilometers) and lies between 58° and 60° latitude and 116° and 120° longitude. This comprises the region in which the Slave people of the Upper Hay River band now have reserves and is essentially the territory throughout which the Slave families travelled in the first part of the century. The map area also includes some country around Fort Vermilion in the Peace River valley where Beaver reserves are now located. Certainly in the southern portion of this arbitrarily delineated region, the history of these two peoples, the Beaver and the Slave, is intertwined.

The northwestern portion of Alberta is flat and plateau-like at one to two thousand feet (303-607 meters) above sea level and is actually a topographic extension of the plains. This relief is broken by the Cretaceous outcrops of the Cameron Hills, the Caribou Mountains and various smaller bedrock ridges. The drainage of this area is dominated by the Hay River and its tributaries of which the major one is the Chinchaga River; however, to the north the Petitot River flows in from British Columbia into the very large Bistcho Lake and north again to the

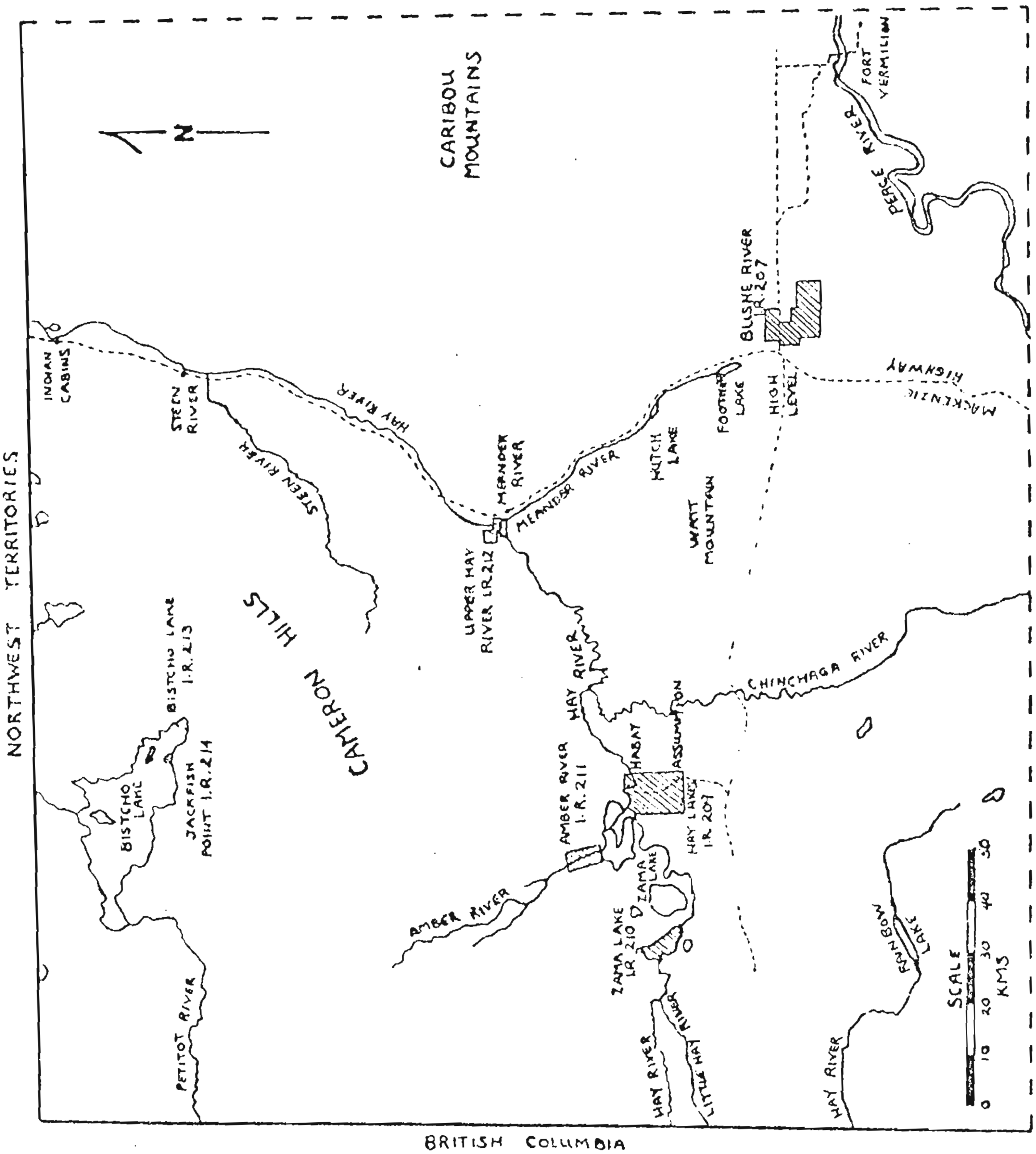



Figure 1: Northwestern Alberta

Northwest Territories. Also, the Peace River curves through the southeasternmost corner. Throughout the area are numerous sloughs and lakes of which Bistcho and the Hay-Zama lakes are the most prominent. The latter are a remnant of an extensive proglacial lake. The extensive lacustrine deposits around Hay-Zama and stretching north along the Hay River are bounded on the northwest by the coarser morainic soils, on which the drainage is poorly developed and muskegs abound.

The map area lies in the southern fringe of the discontinuous permafrost zone. Here permafrost occurs in several types of terrain such as peatland, north-facing slopes and in isolated patches in forested stream banks where there is little snow cover and the area is well-shaded during the summer (Brown 1970:8-9). Lindsay and Odynsky's (1965) permafrost study of this area delineated an east-west boundary of permafrost occurrence running just north of Hay Lake to just north of Fort Vermilion. North of this line was a zone of intermittent permafrost in character similar to the description given by Brown (1970) above. South of this line was a zone of climafrost which is defined as an area in which ice is temporary but can last for more than a year. The major difference between the two zones is that in the latter, ice occurs mostly under shade in forested bogs, whereas in the former ice occurred in both shaded and open areas.

North (1976) summarizes the climatic data for this area. In general it is characterized by cooler temperatures, lower precipitation and a shorter growing season than the rest of Alberta. The total annual precipitation is around the 16 inch (40 centimeter) cline; the mean January temperature (1931-60) is -10°F (-23°C); the mean April temperature (1931-60) is between the 28° and 32°F (-2°-0°C) clines; the mean July temperature (1931-60) is 60°F (12°C); and the mean October temperature (1931-60) varies between the 32°and 34°F(0-2°C) clines.

Simard (1973; 1975) summarizes the data on fire occurrence and fire behaviour in the map area. Most of the region is characterized by low fire occurrence, ranging from .5 to 2 fires/1000 sq. mi./yr.. There is one small area of 'moderate' fire occurrence in the Indian Cabins vicinity (see Fig. 1) which averages 4-7 fires/1000 sq. mi./yr. and there are stretches of 'very low' fire occurrence along the northwest border of Alberta adjoining British Columbia and the Northwest Territories (Simard 1975). Fire behaviour is very much related to weather, fuels and topography. Simard (1973) outlines forest fire weather zones and describes the fire behaviour in each. These zones are based on weather data from June, July and August and are considered to be representative of relative fire weather severity. The western 2/3 of this area lies in Zone 4, the 'moderate' forest fire weather zone, and the eastern 1/3 lies in Zone 5, the 'high' forest fire zone. The major difference between these two is that in the latter zone on 3% of the days fires will be potentially uncontrollable with occasional conflagrations and fire storms developing, whereas in the former these conditions will be reached for brief periods once every few years.

The Vegetation

La Roi (1967) particularly stresses the role of naturally caused fire in creating the mosaic of vegetation in this area and suggests that this mixedwood forest would exemplify well Mutch's (1970) hypothesis of an evolutionary adaptation to fire at the community level of biological organization. The vegetation of this area comprises the western half of Rowe's (1972:37) "Hay River" forest (B. 18 B) category. It is described as a

> northern extension of the mixedwood forest, somewhat modified by a more rigorous climate (colder and drier) and a more level terrain than obtains in the Mixedwood proper to the south and east . . .
>
> The quality of forest growth is not as good as that to the south, and the abundance of white spruce in mixture with trembling aspen is less. Black spruce covers a large part of the land commonly forming stands on the plateau-like uplands as well as the lowland habitats where it is usually found.

Lodgepole pine (Pinus contorta var. latifolia) and jackpine (Pinus banksiana) are found on the fringes of the map area but elsewhere are a minor element in the vegetation.

Detailed vegetational studies of this area were undertaken by Moss in the period spanning the early 1930's to 1950 in conjunction with studies in more central portions of western Alberta. In Moss' (1953a) paper dealing with forest communities in northwestern Alberta, the arboreal vegetation of this map area is sampled at two localities, Steen River and the Northwest Territories/Alberta boundary on the MacKenzie highway (see Fig. 1). What seems to be evident in the arboreal communities at these localities is a great deal of variability in the roles and associations of the three major arboreal species, white spruce (Picea glauca), black spruce (Picea mariana) and trembling aspen (Populus tremuloides). Table I, drawn from Moss' (1953a) data attempts to illustrate this variability. Although Moss works within a Clementsian typology of association (dominant community) and faciation (a major variant of an association), he acknowledges its inadequacies in classifying this variability. For instance, the examples given as numbers Ia and Ic in Table I are, under examination, communities which are actually intermediate to the formulated types and he does state that this is commonplace.

Moss (1953a) has drawn some correlations between type of aspen-white spruce association and fire history. In fact, the entire gamut of white spruce-aspen proportion in any one stand, from the needle-cover faciation of the white spruce association to the aspen poplar consociation could be interpreted as the result of fire. The needle-cover faciation, characterized by crowded white spruce with very little aspen is not represented in any of the localities described in Table II, but presumably it does exist in the area. It arises from prolific white spruce regeneration following a complete intensive burn. The feather-moss

## Table I

Dominant Plant Species and Associated Species (drawn from Moss 1953a)

| Species | Association | Role | Associated Species |
|---|---|---|---|
| I. *Picea glauca* | a. white spruce<br>(NWT/Alta) | dominant | locally frequent: *Populus tremuloides*<br>occasional: *Populus balsamifera*, *Salix bebbiana*<br>rare: *Betula papyrifera*<br>abundant: *Vaccinium vitis-idaea*, *Hylocomium splendens* |
| | b. black spruce - feather moss<br>(Steen R.) | scarce-locally dominant | abundant to locally dominant: *Picea mariana*, *Doering bryophytes*, *Hylocomium splendens*<br>locally abundant: *Populus tremuloides*<br>occasional: *Salix*, *Betula* and *Alnus* spp.<br>abundant: *Ledum groenlandicum*, *Vaccinium vitis-idaea*<br>rare: *Larix laricina* |
| | c. aspen poplar consociation<br>(Steen R.) | occasional | dominant: *Populus tremuloides*<br>occasional: *Pinus banksiana*, *Amelanchier alnifolia*<br>scattered: *Salix bebbiana*<br>rarely: *Larix laricina*, *Cornus stolonifera* |

Table I (cont'd.)

| Species | Association | Role | Associated Species |
|---|---|---|---|
| II. Picea mariana | a. black spruce -feather moss<br>(Alta/NWT) | dominant | occasional: Salix bebbiana, Salix glauca, Populus tremuloides<br>abundant to locally dominant: Hylocomium splendens |
| | b. black spruce -feather moss<br>(Steen R.) | abundant-locally dominant | associations as described in Ib. |
| | c. black-spruce-bog moss | abundant-locally dominant | frequent to locally abundant: Larix laricina, Salix myrtillifolia<br>frequent: Salix glauca, Hylocomium splendens, Aulacomnium palustre<br>rarely: Salix discolor, S. rbusculoides, Alnus rugosa<br>abundant: Ledum groenlandicum, Vaccinium vitis-idaea |
| III. Populus tremuloides | a. aspen-poplar consociation<br>(Steen R.) | dominant | association described in Ic. |

Table I (cont'd.)

| Species | Association | Role | Associated Species |
|---|---|---|---|
| | b. aspen-poplar consociation<br><br>(Alta/NWT) | dominant | occasional: *Populus balsamifera*, *Salix spp.* *Betula papyrifera*<br>rare: *Prunus virginiana*, *Pinus contorta*, *Amerlanchier alnifolia*<br>frequent: *Rosa acicularis*, *Viburnum edule* *Pylaisia polyantha* |
| | c. white spruce<br><br>(Alta/NWT) | occasional -locally frequent | association as described in Ia. |
| | d. black spruce-feather moss<br><br>(Alta/NWT) | occasional | association as described in IIa. |
| | e. black spruce-feather moss<br><br>(Steen R.) | occasional -locally dominant | association as described in Ib. |

faciation in which aspen is of "occasional" frequency exists at localities which have not been burned for a long time. The locality at the Northwest Territories /Alberta boundary is a mix between this faciation and a third one, the shrub-herb faciation. Although not represented at any of the localities chosen by Moss in this area, he does regard the latter as most frequent throughout western Alberta as a whole. It has a prominent shrub stratum characterized by Viburnum edule, Rosa spp and Ribes spp. and exhibits the greatest intermixture of white spruce, aspen, balsam poplar, willows and paper birch. Moss (1953a:215) derives this faciation from "partial or occasional burning of the area, the poplar being thus perpetuated and yet tending to favour a large measure of spruce regeneration." Presumably he refers to a fairly intense burn which would provide the mineral soil necessary for white spruce seedling establishment. Moss also notes that in the aspen poplar consociation represented at the Steen River locale, white spruce, in the absence of fire, is beginning to dominate. One can predict that this community will become a faciation of the white spruce association before long. In the locale at the Northwest Territories/Alberta boundary white spruce is not represented at all in the stand.

In terms of the black spruce associations and their relationship with fire, Moss (1953a:222) notes that the black spruce-feather moss association is maintained by prevailing edaphic conditions and periodic burning on a time scale of sufficient length to permit the trees' maturation. Moss observes that burned-over areas are characterized by bog birch, willows, grasses, sedges and broad-leaved herbs. The black spruce-bog moss association is a stage of development of the Sphagnum bog and this, when altered by fire, returns to a similar productive stage only if the peat is burned to a considerable depth (Moss 1953b:465).

Communities of the water's edge are characterized by various species of Salix, Cornus stolonifera and Alnus rugosa as well as the dominants Picea glauca and Populus balsamifera and their associated understory (Moss 1953b:453). Swamp marsh vegetation as illustrated in a Boyer River example (Moss 1953b:454) is common around the many ponds and shallow lakes of the region. Moss (ibid.) describes the continuum of vegetation back from the water edge as reed swamp dominated by Scolochloa festucacea and Carex atherodes, marsh dominated by Calamagrostis inexpansa, Carex spp. and Glyceria grandis; and wet meadows dominated by Calamagrostis canadensis with Poa palustris as a common associate. Clumps of willow also occur, particularly on the marsh margin and locally willow swamp and alder-willow swamp occur. Tamarack, balsam poplar and white spruce are common elements in these swamps.

The above description of the wet meadow of Calamagrostis canadensis and Poa palustris brings us to a botanical phenomenon of northern Alberta of which the history has long formed a topic of interest and speculation for explorers and botanists alike (Dawson in Macoun 1882; Petitot 1884; Raup 1935; Moss 1952), the Peace River grasslands

(Figure 2). Raup (1935:60) defines two types of these grasslands: a 'wetter' association of Calamagrostis canadensis, Poa pratensis and Carex trichocarpa; and a 'drier' association of Agropyron trachycaulum, Koeleria cristata, Stipa comata and Carex siccata/obtustata. Moss (1952) divided the latter association (which he appears to define as the true Peace River grassland as opposed to the wet association (ibid.:100)) into three faciations, Agropyron-Stipa, Agropyron-Carex and Stipa of which only the first two are present in the map area. Once again a great deal of variability is evident in the plant associations at the locales representative of these types (Table II). Moss also defines a third type of meadow, the saline meadow which is perceived to be related to but distinct from the prairie grassland. There are shared species, such as Agropyron trachycaulum, but in general the high salt concentration of the soil in the saline meadows prevents all but the most resistant grasses and sedges from growing. Other leading species are Hordeum jubatum var. caespitosum, Distichlis stricta, Elymus macounii, Muhlenberg richardsonis and Puccinellia nuttalliana.

In fact, the salinity of the soils developed on the lacustrine clays of this area has been advanced as an explanation of the origin of these grasslands. It has been known since the 1950's that solonetzic soils characterized by a high content of exchangeable sodium or magnesium are widespread in western Alberta (Reeder and Odynsky 1964). In most places these soils are becoming less saline as a result of leaching, a process known as "solodization." The origin of the saline nature of

Table II

Grassland Associations (drawn from Moss 1953b)

| | |
|---|---|
| Agropyron-Carex (Boyer River | frequent-locally abundant - Agropyron trachycaulum, Carex atherodes, Rosa woodsii, Amelanchier alnifolia<br><br>frequent - Schizachne purpurascens, Symphoricarpos spp., Galium boreale |
| Agropyron-Stipa (Boyer Prairie) | frequent - Agropyron trachycaulum, Stipa spartea, Koeleria cristata, Geum triflorum, Cerastium arvense<br><br>occasional-locally abundant - Symphoricarpos occidentalis, Rosa woodsii, Amelanchier alnifolia |
| Agropyron-Stipa (Meander River) | frequent-locally abundant - Schizachne purpurescens, Agropyron dasystachyum<br><br>frequent - Agropyron trachycaulum, Koeleria cristata, Carex siccata, Carex heliophila, Galium boreale, Thalictrum venulosum, Cerastium arvense<br><br>occasional-locally abundant - Symphoricarpos occidentalis, Amelanchier alnifolia, Prunus virginiana |

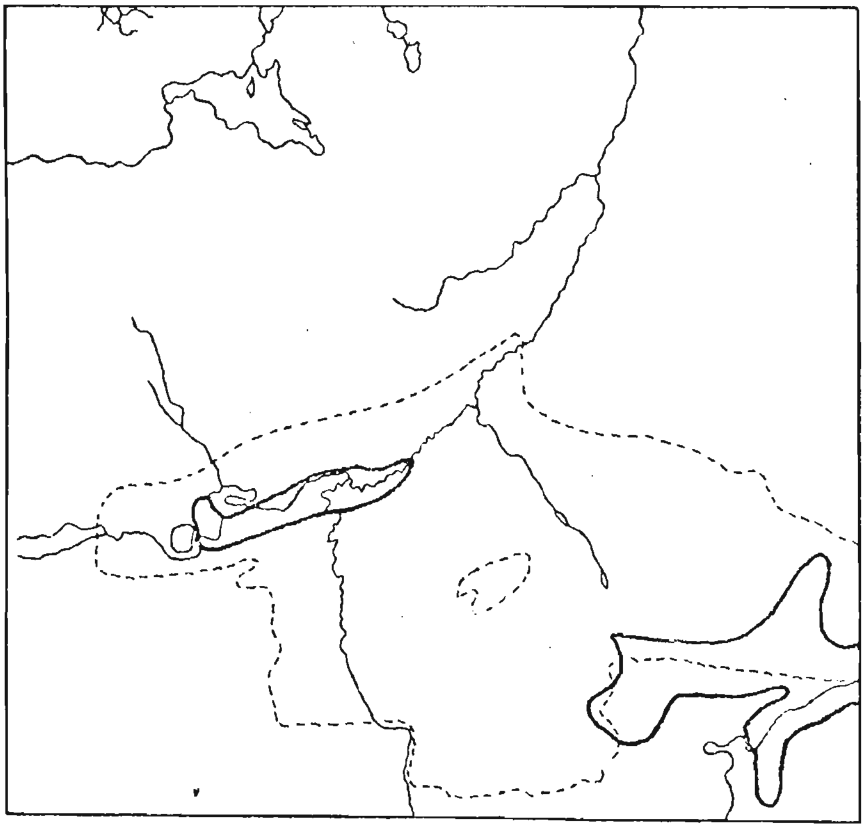
these soils has been variously attributed to derivation from underlying marine shales (Reeder and Odynsky 1964), to leaching under arid conditions where evapo-transpiration exceeds precipitation, and, more recently, to the effect of capillary rise of groundwaters high in salts (Leskiw 1971; Maclean 1974). Studies by the latter two authors have demonstrated a correlation between soil type and the groundwater flow patterns as influenced by topography. Solonetzic soils tend to be common in areas of groundwater discharge.

Current speculation (S. Pawluk pers. comm.)[4] combines all of these factors to suggest that the Peace River soils may have been salinized by groundwater discharge from the higher elevations to the west immediately after deglaciation. The effects of groundwater discharge would be enhanced by such critical factors as the salinization of the groundwater by the underlying marine shales, the occurrence of a high water table such as must have existed during deglaciation and the possible occurrence of a xerithermal period. Solodization or leaching would then operate at a rate dependent on both local and regional factors such as the amount of stream erosion, the height of the water table, development of an integrated drainage and the distribution of precipitation.

The discovery of solonetzic soils in northwestern Alberta would tend to support Raup's (1935:61) hypothesis that these grassland developed in situ on lacustrine deposits from late glacial tundra through subarctic grass-sedge stages rather than Hansen's (1952:34) hypothesis that these grasslands are the remnants of a very large prairie extending into the north of the province during the Xerothermic period. In a further development of Raup's hypothesis, North (1976:46) suggests that if the draining of the post-glacial lakes corresponded with the Hypsithermal, the only plants that could successfully colonize those lacustrine deposits would be those adapted to a dry, fine shifting surface, and that once established, such plants as the fast-growing grasses would continue to out-compete tree seedlings.

It is obvious from the comments of native informants that former prairies have rapidly been forested in localities where there is neither agriculture nor flooding. Elsewhere in the Peace River area, a similar process has been observed. For instance, Peace Point in northeastern Alberta was re-studied by Jeffreys (1961) some 26 years after Raup (1935) described and mapped it as an Agropyron prairie. During that time over 3/4 of the open area had either undergone a transition to closed aspen forest or was at an intermediate forest stage. Of the remaining prairie, 50-75% of the surface area was covered by invading shrubs.

It would be difficult to estimate the former extent of the grasslands in this area. According to Moss' (1952:100) data, two main areas of continuous grassland existed at the time of his research from 1931 to 1947 (see Fig. 2). The larger of the two areas extended from Fort Vermilion west along the Boyer River and its tributaries; the second area surrounded the Hay-Zama lakes and ran north along the banks of



------ extent of Solonetzic soils (after Reeder and Odynsky 1964)

_____ extent of grassland areas (after Moss 1952)

Figure 2. Extent of Grassland and of Solonetzic Soils in Northwestern Alberta

Hay River up to the confluence of the Meander River. Native informants state that these mixed parkland-grasslands were much closer to being continuous throughout this area in the early 1900's. According to Reeder and Odynsky's (1964:23) data, the extent of the areas of Solonetzic soil tends to confirm this observation by showing continuous Solonetzic soil throughout this area.

Bog vegetation is quite common throughout this area. Moss (1953b: 457) defines two associations: the Drepanocladus-Carex bog, which develops in basins from aquatic vegetation and marsh, and eventually may lead through a shrub stage to a Larix laricina or to a Sphagnum-Ledum-Picea association; and the Sphagnum bog developed as above or without the marked intermediate Drepanocladus phase.

Drepanocladus-Carex bogs are not represented at any of the localities chosen in our map area, although the black spruce-bog moss (as outlined in Table I:II:c) is a further development of this stage. Open Sphagnum bog is represented here by only one locality (Moss 1953b:463) in which the black spruce bog has been reduced to an open condition through burning. As mentioned previously, Sphagnum bogs will return to a shrub stage, if the peat is burned deeply enough, releasing nutrients.

Wildlife

This portion of the mixedwood forest is part of the Canadian biotic zone. The large herbivores comprise the ubiquitous moose (Alces alces alces), and the woodland caribou (Rangifer tarandus caribou) which is confined to the most northwesterly portion of this area around Bistcho Lake. Among the small herbivores, the beaver (Castor canadensis canadensis) and the hare (Lepus americanus macfarliani) are perhaps the most prominent. The hare is an important link in the food chain between the plants and the carnivorous animals; the beaver plays an important ecological role through their construction of dams. The resulting reservoirs improve the area in general for mink, otter, muskrat and wildfowl and provide excellent watering places for large game. Other small herbivores include the woodchuck (Marmota monax canadensis), the red squirrel (Tamasciurus hudsonicus preblei), the muskrat (Ondatra zibethicus spatulatus), the porcupine (Erethizon dorsatum myops) and the skunk (Mephitis mephitis hudsonica). There are also various mice and voles.

The small carnivores in this area mostly belong to the family Mustelidae - the marten (Martes americana actuosa), the fisher (Martes pennanti), the ermine weasel (Mustela erminea richardsonii), the least weasel (Mustela nivalis rixosa), the mink (Mustela vison energumenos), the wolverine (Gulo gulo) and the river otter (Lontra canadensis preblei). The fox (Vulpes fulva abietorum) is now somewhat rare since the rabies epidemic in northern Alberta in 1968. The other major predators are the lynx (Lynx canadensis canadensis), the wolf (Canis lupus occidentalis), the coyote (Canis latrans incolatus) and the omnivore black bear (Eurarctos americanus americanus) (Soper 1964; Banfield 1974).

In terms of Aves, northwestern Alberta is highly productive in waterfowl. The marshes and reed swamps around the Hay-Zama lakes area serve as a major breeding and staging area for some 12 species of ducks and 3 species of geese (Macauley and Boag 1974). The migratory geese are the white-fronted goose (Anser albifrons) and the snow goose (Chen hyperborea). The Canadian goose (Branta canadensis) does breed in northern Alberta but does not do so in marsh areas. The ducks which arrive earliest in the season, i.e. by early or mid-April, are the mallard (Anas platyrhynchos) and the pintail (Anas acuta). Following these species are the American widgeon (Anas americana), green-winged teal (Anas crecca), blue-winged teal (Anas discors), gadwall (Anas strepera), common goldeye (Bucephala clangula), bufflehead (Bucephala albeola), redhead (Aytha americana), canvasback (Aytha valisneria), lesser scaup (Aytha affinis), American coot (Fulica americana) and northern shoveler (Anas clypeata). The gadwall normally breeds in the southern half of the province; the marshes of the Hay-Zama lakes and those of the Athabasca Delta form isolated breeding areas for this species with no breeding locales recorded in the intermediate area. Most of the above birds nest in cattail marshes along the lake shores or around the sloughs in the hay meadows. The Bucephala spp. seem to be the only ones which nest in trees and to whom arboreal vegetation is therefore important (Salt and Salt 1976).

The other game birds in this area are the grouses of which there are three species: the spruce grouse (Canachites canadensis), an inhabitant of spruce woods and muskeg; the ruffed grouse (Bonasus umbellus), an inhabitant of mixedwood areas; and the sharp-tailed grouse (Pediocetes phasianellus), an inhabitant of brushy areas (Salt and Salt 1976).

There are few large fish species in the lakes and rivers of this area. The Hay River drainage contains Arctic grayling (Thymallus arcticus), lake whitefish (Coregonus clupraformis), northern pike (Esox ducius), burbot (Lota lota), and walleye (Stizostedion vitreum vitreum) locally referred to as pickerel. The Petitot drainage contains all of these large species with the exception of the Arctic grayling (Paetz and Nelson 1970). These drainages also contain smaller fish of which the only one eaten by the natives is the medium-sized white sucker (Catostomus commersoni). Rainbow Lake, in the Hay River drainage, and Bistcho Lake in the Petitot River drainage were considered to be the good fishing lakes. Currently Bistcho Lake supports commercial whitefish fishing. Bistcho Lake people stated that they caught eel from this lake as well. Paetz and Nelson (1970) record that Arctic lamprey (Lampetra japonica) are possibly present in the Hay River drainage within Alberta. Perhaps this can be extended to the Petitot River system as well.

The distribution of wildlife has changed considerably in northern Alberta within the past hundred and fifty years. The wood bison (Bison bison athabascae), so common in the late 1700's in the Peace country was almost exterminated by 1875. Soper (1941:404) attributes this to abnormally heavy snowfalls. He points out that the Hay River basin itself was once a center of concentration for bison. As for the remaining herds, the stocking of Wood Buffalo Park with plains buffalo has since resulted in a high rate of inter-breeding as well as the possible introduction of tuberculosis and brucellosis (Choquette et al. 1961). Anthrax, a newly introduced disease, also affects buffalo. Soper (1964:366) comments that the woodland caribou formerly ranged throughout all of northern Alberta down to the southern limits of the mixedwood forest; and Banfield (1974:400) designates northern Alberta as part of the former territory of the elk (Cervus elaphus manitobensis) as well. According to Banfield (1974:390) mule deer (Odocoileus hemionus) are now moving into northern Alberta and his distribution maps show them as already present in our designated map area. Native informants suggest that the deer only occasionally come from B. C. as far east as Hay Lake. Other changes in animal frequency are the decrease in fox since the 1968 rabies epidemic and the gradual decrease in wolverine (Soper 1964:317).

## The People

MacKenzie (1801:238) offers one of the first comments on the history of the Slave in this area. He suggests that the group known as the Slave had been neighbours to the Beaver in the area west of Lake Athabasca up until the time of the Cree invasion of the 1700's. Some anthropologists have speculated that prior to this invasion, the Slave and

Beaver were one people (Osgoode 1932:35; Goddard 1916:209). Under the increasing pressure of the Cree the Slave were forced to retreat north along the Slave River and to the area west of the Great Slave Lake. According to the story of Chief Montagnais as related to Godsell (1938:203-7), the Slave were already established in the MacKenzie River Valley when they were called upon by the Beaver to assist in the battle against the Cree which ended in the peace treaty at Peace Point ca. 1760. Honigmann's (1946:22) informants related the oral history that intense fighting between Cree and Beaver-Slave occurred as far west as the area of Hay River and the Hay-Zama Lakes. Thus there is reason to believe that the aboriginal occupation of northwestern Alberta was by some people ancestral to the Beaver and Slave and that the Slave after their 'retreat' north and west still recognized the Hay River as part of their hereditary hunting grounds.

In 1820-21, George Simpson, the Governor of the Hudson's Bay Company commented on this area as a desirable location for a post:

> it (Hays sic River) is a Rich Country and is visited by the Chipewyans from Great Slave Lake and the Slave Indians belonging to McKenzie's sic River. The NorthWest Compy. had a post at this place for several years but withdrew it last season...the Country is well-stocked with Buffalo and Deer and there are Lakes in the neighbourhood which produce Fish (Rich 1938:387).

The editor notes that the North West Company post on the Hay River had been developed during the struggle with the Hudson Bay Company but had been destroyed in 1818 by a gun-powder explosion. It was never re-established by the North West Company and efforts by the Hudson's Bay Company to establish a post were frustrated. An unpublished manuscript by A. MacKenzie (1908) shows two Hudson's Bay Company posts in this area: one built at the confluence of the Hay and Chinchaga Rivers, marked 1801 on the accompanying map, and a second located at the modern day community of Meander River. The second is a relatively late establishment. The early 1801 post may have been actually the North West Company post. MacKenzie (1908:22) suggests that the post was abandoned in 1821 "on account of it being occasionally outflooded and on account of the McKenzie River Indians resorting thereto, the frequent visits proving injurious to the trade of that district."

Despite these above references to the Slave use of this district in the early 1800's, the journals of the Hudson's Bay post at Fort Vermilion do not document the presence of the Slave on the Upper Hay River until 1843. These journals commence in 1826 but there are large gaps in the early years. Prior to 1843 it would appear from their statements that the Upper Hay River was occupied chiefly by the Chipewyan, whereas Hay Lake and the country surrounding Peace River were occupied chiefly by Beaver. The Hay River basin seems to have been particularly rich in furs, and the Chipewyans particularly co-operative in trapping furs and cacheing dried meat for the post. In 1827 the number of Chipewyan individuals owing debt to the Fort

Vermilion post was estimated at 17 and the entire population at 62 (HBC B/224/a/3; entry of April 22). In 1843 the Slave began to appear in some number at this post. The movement was greeted by the factor with consternation and the incident is well marked in the journal:

> Arrived early this morning 16 Slave Indians/ men/with some furs with five others before is now 21 men of that tribe who have come in with their furs and provisions - I have according to instructions delivered the message sent to me that they should never come here again, but nothing will ever induce them to go back, saying that they have adopted this Country as their home, having for that purpose formed alliances, by intermarriage with the Beaver Indians (HBC B/224a/9; entry of August 26, 1843).

From this date on there is mention of the Slave people on the Hay River and at Hay Lake. It is obvious, though, that the Chipewyans are still very much on the Hay River at least as late as 1880. It is interesting too that the above quotation specified intermarriage with Beaver rather than with Chipewyan, since most of the succeeding references to Slave do locate these people on the Hay River.

By 1871 a winter establishment was put up at the 'Horse Track,' a term used to refer to the trail running from Fort Vermilion to its' terminus at what is now called Meander River (HBC B224a/15; entry of November 24, 1871). This latter location at the confluence of the Meander River and the Hay River had been formerly used by the Chipewyans as a cache area for the dried meat left for the men of the Fort Vermilion post. Asch (1976:9) has noted that once the Hudson's

Bay Company monopoly was broken in 1870, the company attempted to make trade more advantageous to the natives and intensified its efforts at outfitting the Slave for trapping. The building of the winter post at the 'Horse Track' was probably one means of making trade with the HBC more advantageous to the natives. Certainly the people had been requesting a post there for some time (HBC B224a/2; entry of October 4, 1826) and the Fort Vermilion establishment may well have been worried about competition from an American trader who had selected an advantageous locale on the Hay River the previous year (HBC B224a/14; entry of October 13, 1870).

The Horse Track winter post proved to be popular and the Fort Vermilion journal entry for April 29, 1876 (HBC B224a/16) states that a Mr. Reid from the MacKenzie River district felt it necessary to travel to the Horse Track to persuade natives to return to the areas and the posts where they had formerly traded. Thus it is likely that the Slave were continuously drawn into this area throughout this time period. Petitot visited the Lake Bistcho Slave in 1878 and comments that (1891:351):

> Ces gens-là ne devaient absolument rien au fort Providence. Ils étaient beaucoup plus rapprochés du fort des Liards. Plusieurs même se rendaient au Fort Vermilion, sur la rivière la Paix.

Petitot was accompanied by a Company man who was, in fact, soliciting the Bistcho trade for Fort Providence and in this he was eventually successful. At least, it is obvious from McConnell's (1891) report on geological fieldwork done 1888-9 when he visits Lake Bistcho that he is accompanying a fur trade expedition from Fort Providence.

In June of 1900 the Slave Indians of the Upper Hay River "and the country thereabouts" met at Fort Vermilion to sign Treaty Eight. The people of this group were represented by Alexis Tatatechay, Francois Tchatee, Giroux Nahdayyah, Koka and Kachweesala. Little appears to be known of these people in the recorded history although Alexis Tatatechay is again mentioned by Footner (1912:214) as "Tatateecha Cadetloon, the patriarch of the Meander River people."

Asch (1976:10) suggests that in the last thirty years of the 19th century, the Slave in general had responded to the Hudson's Bay Company's attempt to increase their interest in trapping and had focused more and more on a way of life in which the trade post played an important role. By the first decade of the 20th century in what was a fairly rapid economic change the Slave had come to depend on such trade items as tea, tobacco, sugar, flour, lard, percussion rifles, steel traps and European clothing. The trade post became the focus of the summer aggregations and increased winter sedentarism was aided by food provisioning. Small game, berries and fish were thus still collected using the aboriginal techniques but big game was no longer snared and fur-bearing animals were no longer trapped by means of the deadfall.

The degree of fit between this model and the statements of informants about their life during this time varies according to who the individual is and where they are from. For instance, Bistcho Lake people are known as "old-time" people who held onto their traditional self-sufficient ways longer than those groups which were less isolated; and the conservativism evident in the stories of their early lives does not really accord with Asch's general model. Too, other individuals stated that they had been orphans and could not afford a lifestyle dependent on trade items; hence, they used deadfall traps and snares much more extensively. Again, although there were families who summered at Meander River, others did not. Often only the men would go for a short period of time to the post and the women and children would stay on the hay meadows around Hay-Zama or Bistcho Lakes.

It is obvious from the few sources that there was a great deal of contact between different groups at this time. The Anglican Mission diaries from the town of Hay River, N. W. T., on Great Slave Lake show that the natives of this area were continually in contact with the Slave at the Horse Track and with those on Beaver River just north of Bistcho Lake. In other respects these diaries offer little information about these more southerly groups, although they note with chauvinistic flair the occurrence of a devastating spring epidemic of pneumonia among the Meander River people: "but many of the 'Horse Track' Indians have died, 20 Adults besides women and children" (Hay River Anglican Mission Diary. MR 4/5:96; entry of April 23, 1914). In respect to group movements, Honigmann (1946:66) also records that the Fontas River Slave often travelled to the Horse Track trading post via Hay Lake in the early portion of the century. Indeed, among the oldest people now living in the communities of Assumption and Meander River together, the men frequently came from Fort Providence, Fort Nelson or Hay River, whereas the women were either born locally or came from Eleske, a major Beaver settlement just west of Fort Vermilion.

The Slave subsistence schedule of the first part of the 20th century in this area, as related by individuals born between 1890 and 1920, focused on hunting and trapping. The seasonal rounds were usually described as based around a lake of the region although there were some informants who were raised in the area bounded by Meander River, Indian Cabins and the Caribou Mountains. Hay-Zama and Bistcho lakes were the major focal points of these yearly rounds. The most common cycle related by the informants was one which moved in the fall from the Hay-Zama Lakes up the Hay River which curves into British Columbia and then back into Alberta to Rainbow Lake for the winter and then back by spring to Habay which lies at the outlet of the Hay River from Hay Lake. However, other families also travelled north and east from Hay-Zama Lakes. A smaller number of people were centered around the east end of Bistcho Lake at the outlet of the Petitot River and on the southeast shore as well.

Both men and women hunted and trapped. Women hunted small game and fur animals - hare, quail, squirrel and muskrat - within a short radius of the camp. Men, on the other hand, hunted the larger and highly mobile game, moose and caribou, and hunted the less densely distributed "big fur," beaver, marten and lynx. Thus, the hunters operated within a much greater distance from the camp. It was also quite common for the men only to make the trip to the trading post. While men's hunting and trapping enjoyed greater prestige, it was the results of the women's labour that tided the family over critical periods.

Controlled burning, as shall be seen, was definitely a male-associated task. Informants particularly stressed that this activity was carried out when the women and children were not accompanying the men, when the latter were out hunting or on a trapping trip. The reason given was that if there was an accident and the wind suddenly changed, a family group with small children and elderly individuals would not be able to travel very quickly. In terms of artisan work, canoe- and drum-making, wood and bone-working were male-associated tasks. Prophets, medicine men, drummers and singers for teadances and handgames were roles normally performed by men. Today in Meander River, however, there is one woman who drums and sings.

Making snowshoes is one occupation which appears to have been done by both men and women. Gathering can also be done by both sexes, but as an activity it had little economic importance. The women and children would go berry picking in the summer more as a social diversion. Other plants which were collected are consumed as snacks rather than collected for an evening meal. The root of the cattail (Typha sp.) and the wild parsnip (Heracleum lanatum) could be boiled;

the root of the fireweed (Epilobium angustifolium) could be squeezed to yield a potable juice; the seeds of white grass (Leersia virginiana?) could be eaten. In spring, the sap of poplar trees was a favourite treat for the children.

Plants were probably most extensively used in a medicinal capacity. The most commonplace were yarrow (Archillea millefolium) and wild mint (Mentha arvensis) teas for colds; the broth from the boiled willow or poplar bark for stomach disorders; breathing the smoke from a smouldering fungus of the type common to willows (Polyporus sp.) for a headache; dried ratroot (Acorus calamus) for colds and stomachaches. Two other medicinal plants are the 'tsaletone,' a pond plant with large leaves which are useful to treat a fever; and the 'tutsetone' the root of which if chewed helped toothache. The leaves of this plant were also useful as a poultice for a wound.

Besides the usual duties of cooking and child care, the women were responsible for the making of birchbark utensils, the working of hides, sewing and decorative work. As mentioned previously, the collection of berries was considered a female activity, although primarily a social one. In this area, raspberries, saskatoon, chokecherries, cranberries, mooseberries and bearberries are available.

During spring-burning on the large hay meadows where the group was camped, women and children would act as fire-guards. Once log houses became more common, the women might help in burning around the house to fire-proof it and to aid a garden.

Although informants' statements indicate that the people of the area were receiving occasional visits from Roman Catholic, and perhaps also Anglican missionaries from at least the late 1800's, no Oblate mission was established here until the building of the one at Meander River in the early 1930's. During this decade the current chief, Harry Chonkolay was selected by the people to succeed his uncle and he chose a council of elders. From the early 1940's on, the pace of the European cultural intrusion began to accelerate and the events of this decade and the one to follow served to change radically the life-style of hunting and trapping as described above. The intensification of fire suppression, the required registration of traplines, the extension of the MacKenzie Highway up to Meander River, the establishment of a residential school at Assumption and the sharp drop in fur prices after the second World War all contributed to restricting hunting and trapping as an economically viable lifestyle and the trend towards wage employment and sedentarization. More than anything else, the establishment of the residential school drew the extended family camps away from their traditional locations around the Hay-Zama Lakes and concentrated them at the east end of the lakes on what is now the Hay Lakes reserve.

In 1950 the seven reserves now belonging to the Slave band (see Fig. 1) were given over by the government. Oil prospecting activities were expanded throughout this area in the 1950's and the opening up of the Zama oilfields created considerable outside interest in the area (Moccasin Telegraph 1951:19; 1952:17). The MacKenzie Highway was widened; the railroad was extended up to the town of Hay River, N. W. T.; the New Towns of High Level and Rainbow Lake were incorporated (Moccasin Telegraph 1959:26; 1961:29). These developments did little to benefit the native residents of the area and in 1964 representatives of the band travelled to Edmonton to outline their grievances, specifically poor housing conditions and lack of employment, to the Premier of Alberta. At least partially as a result of this action the Gun River sawmill was set up on the Hay Lakes reserve to mill wood for houses and the new town of Assumption began construction in 1965 (R. Henriet, pers. comm.).[5] By 1969 there was a new government-run school in the town and an all-weather road connecting Assumption to the highway (Moccasin Telegraph 29:1:13). During the late 1960's the Rainbow Lake oil fields came into production. A study on waterfowl harvest during this period (Macauley and Boag 1974) suggests that dependence on waterfowl fell to one quarter the previous amount with this new subsistence alternative of wage labour in the Rainbow Lake oil fields.

Wage labour has definitely not taken the place of hunting and trapping as a full-time means of support, however. As has been observed in other areas where oil and gas reserves are being exploited, the companies need semi-skilled and professional workers most of whom they hire from the south. The unskilled native has little opportunity for more than occasional employment. Too, rents away from the reserves are exorbitant and the distances from the reserves to the towns of Rainbow Lake and High Level great enough that commuting is still a problem.

Currently the native livelihood is derived from some combination of winter trapping and of casual labour most of which is available in the summer. The older men tend to rely more heavily on trapping which once again has become lucrative. The younger married men tend to be less knowledgeable about the bush and rely on casual labour. The summer months bring brushing contracts mostly for oil company seismographic lines, the Forest Service work of fire-fighting and work for the Highways Department. Moose and waterfowl are still intensively utilized natural resources. There are few employment opportunities for the women. Some jobs are available on the reserve with the band store and band office and with the government establishments such as the nursing station and RCMP offices. Most women make handicrafts to sell to the band store or to stores in High Level. Government subsidies supplement these subsistence sources.

Currently the Slave band numbers 1252 people. Most of this population is concentrated in the community of Assumption. There is a smaller community at Meander River and a few families on the Bushe River Reserve (see Fig. 1).

# CHAPTER IV

## NATIVE CONTROLLED BURNING: THE ECONOMIC CONTEXT AND THE ECOLOGICAL EFFECTS

This chapter delineates the role of controlled burning in the Slave subsistence schedule as it occurred in the early 1900's. First, the effects of this use of fire on the vegetation of the area will be discussed with reference to the experiments on controlled burning published in the literature. The results of these experiments will add some quantitative data to the native informant's qualitative comments. As well, the relationship between the timing and the structure of burning activities and this effect on plant communities will be discussed. A second section will outline the effects of this form of environmental manipulation on the animal and plant resources exploited by the natives. The effect of burning on a specific resource will be discussed at the point in the native yearly schedule that it is emphasized. Although a particular resource may be most intensively utilized at one time of the year, this does not mean that it is not utilized the rest of the time that it is available. Thus the actual benefit of the burning in respect to that resource and ultimately to the native may continue year round.

### Influence on Plant Communities

The Slave defined two areas that were the focus of controlled burning:

> go 'leyde' - that means where you burn and all the little branches come out, where the moose eat. And the other is 'klo'degogedaleyde' - that's the prairie where you grow hay for the horses (female Slave informant born 1951).

The above 'bush' areas were most often localities associated with aquatic environments whose own high productivity was attractive to many game and fur-bearing animals, and thus to humans as well. Trails often ran along streams and beside sloughs where hunting and trapping was good, and the placing of a campsite depended on the availability of water as well. According to informants doing a surface burn in such a locality maintained the trail, promoted the type of vegetation which would attract economically useful animals and protected these areas to some extent from the dangers of naturally-occurring fire. More intense burning within the bush areas was applied when deadfall had to be cleared or firewood produced. As mentioned previously, Lewis (1977) provides details of some of the technical features involved in maintaining safety during some of these more intense fires. Lewis (1977:42) also mentions burning as particularly important for maintaining trail in muskeg or bog areas. Burning not only kept back encroaching shrubs and mosses but the exposure of the surface to the sunlight helped to keep the trail dry. However, the informants that I interviewed expressed great concern about burning in these areas, stating that one had to be careful that the fire did not go underground. This may be a concern generated more by employment with the Forest Service than a true representation of pre-fire suppression attitudes. Controlled burning in muskeg has long been thought to be risky in forest management (Vogl 1967:82).

As outlined in Chaper II, the major trees in this area are the spruces Picea mariana and Picea glauca, and the aspen Populus tremuloides. Secondary in importance are Populus balsamifera, Larix laricina, Betula papyrifera and shading into the large shrubs are Alnus spp., Salix spp., Cornus stolonifera and Betula species. Those plant species which respond best to light spring burning are those which are capable of vegetative reproduction. Foremost among these are the poplars, especially Populus tremuloides.

Horton and Hopkins (1965) have attempted to measure the effects of varying intensities of fire on aspen suckering in an Ontario stand. Heavy burning, which removed all duff and exposed mineral soil, produced 3900 suckers/acre in comparison to 1100 suckers/acre in the unburned control plot and in comparison to 5000 suckers/acre in the plot treated with light burning. The advantages of the light burning are obvious. The authors also compare light with moderate burning: the former kills only part of the vegetation and removes the litter and top duff area in patches; the latter kills all canopy and underbrush stems, removes the litter and much of the duff layer and exposes mineral soil in spots. In an area where the control plot produced 300 suckers/acre, the light burn plot produced 7,000 and the moderate burn plot 16,000 suckers/acre.

Betula papyrifera, if young (Lutz 1956:27), and shrubs, commonly Alnus, Salix, Betula and Cornus species in this area, also reproduce vegetatively and are favoured by controlled burning (eg. Gordon 1976; Leege 1968). However, in general, few experiments have been done to quantify the increase in productivity in these species (Wright 1972).

The other tree species of the forest, Larix laricina, Picea glauca and Picea mariana and Betula papyrifera (if older), although fire-followers propagate by seeding and are favoured by those greater heat intensities of burning that produce mineral soil in which seedlings can be established (Ahlgren 1974). There are differences in the adaptiveness of these species to the more intense burns, but in terms of spring burning, the poplars and shrubs will be favoured over the spruces, tamarack and arboreal birch.

This adaptiveness to different types of fire would be crucial in the consideration of the white spruce-trembling aspen association of northwestern Alberta. Although Moss categorizes most of the variability within the proportion of white spruce to aspen according to the local occurrence of fire, he offers no comment on the relationship of fire to the aspen poplar consociation. It would seem likely that this consociation would occur as the result of repeated fires. It may even be that the high proportion of aspen to white spruce in this area in general as noted by Rowe (1972) may be influenced by the later date of fire suppression as well as by the drier climate. It should also be pointed out that the poplar stands on the former hay meadows as described by

Jeffreys (1961) also contain white spruce only infrequently and thus, represent a second, post fire-suppression origin of the aspen poplar consociation. Jeffreys does comment that the former prairie aspen stand is somewhat different in composition than other aspen stands in the area but the two are not directly compared. Jeffreys states that the former prairie stands have little white spruce and that some prairie plants still exist in openings between the coalescing poplar groves.

The replacement of black spruce by shrubs after fire is also described locally by Moss (1953a:221) for the Steen River locality, some 147 kilometers north of High Level (see Fig. 1). This plant community was recently burned and "the lower, wetter areas show a retrogression to Betula glandulosa, Myrica gale, Salix, Larix laricina, Rubus acaulis, Calamagrostis and Carex " (ibid). The fire at this locality may or may not have been a spring/fall burn. The fire prescription for a similar bog association in Wisconsin required intense fires which could be set in late summer, fall or winter (Vogl 1964). Moss (1953b:465) suggests too that peat must be burned to a considerable depth before there is a reversion to sedges, grass and shrubs, whereas if only the tree cover is burned, cone serotination ensures a fairly quick reversion to bog forest. Repeated burning of mature Sphagnum bog, on the other hand, tends to produce an open bog phase. Viereck (1973) remarks that repeated burning on the drier sites of Alaskan black spruce muskeg will result in a nearly permanent grassland of Calamagrostis canadensis and on the wetter sites, in a shrub thicket of Alnus, Salix spp. and

*Betula glandulosa*. Obviously the effects of intense versus repeated burning in bog associations needs to be further investigated. Vogl (1964) notes that, aside from the seral retrogression, fire also reduces the active sphagnum layer permitting the drying out of the exposed layer and the opening up of small ponds in areas where the watertable is high.

According to informants, hay meadow areas were burned over to improve the natural forage for the horses by eliminating horsetails (*Equisetum arvense*) and by returning the nutrients of the litter and of the potentially bacteria-carrying dung to the ground; to retard poplar growth; to maintain trail and to create a pleasing grassy vista for one's summer camp. As previously mentioned, the majority of these meadows existed on the solonetzic soils of the area; other small ones were located on the deposits built up at the confluences of rivers or at outlets and inlets of lakes. Lewis (1977:33) mentions that on the rare occasions that informants spoke of burning forest in order to create a hay meadow, they were aware of the necessity to look for a "rich dark" soil on which a good meadow could be created. Moss, however, mentions a locality on the Meander River where an *Agropyron-Stipa* meadow extends over both an area of "alluvial soil" and one of morainic till which one would ordinarily expect to be treed. It is obvious that recurrent burning and recolonization by grasses permitted such growth on a seemingly unsuitable substrate, as has been demonstrated elsewhere in the Peace River country (Lavkulich et al. 1964). Wet hay meadows on lake shores also grade into marsh and reed swamp areas and these were affected by meadow fires as well although no one spoke of burning the marshes per se.

In these reed swamps and marsh areas fire acts to favour grasses and other early succession species such as Scirpus; and to eliminate the dead litter which impedes growth, constitutes a fire hazard and obscures open water (Schlichtmeier 1967: Ward 1968).

For the two types of grassland, wet and dry, the dominant plants respectively are Calamagrostis canadensis, Poa pratensis and Carex atherodes; and Agropyron trachycaulum, Agropyron dasystacum, Carex atherodes, Koeleria cristata and Stipa spartea. Again the reported variability of effects of burning on these species is strongly related to the type of fire and when it occurs. Thus, Coupland and Brayshaw (1953) reports the negative effects of an August burn on the productivity of an Agropyron spp. grassland in the mixed prairie in Saskatchewan. Bailey and Anderson (1978) report the effects of two spring and one fall controlled burn on a Stipa cristata-Festuca scabrella plant association in central Alberta. This is vitiated for our purposes by one of the spring burns taking place after the growing season had started with the added drawback that precipitation in the month prior to all the burns was only one fifth to one half that of normal. Bailey and Anderson (1978) can only conclude that mean annual herbage production was not reduced when burning occurred outside the growing period. They also observed a considerable increase in perennial forbs, among which Achillea milleflorum which is used, as we have observed, for medicinal purposes by the Slave. A study by Corns and Schraa (1962) to determine the yields of Calamagrostis canadensis from fertilized and unfertilized plots of land provides some incidental information on the effects of spring burning on that species. In the first year of the experiment a mid-April burn was carried out merely to clear the plots of litter. The experimenters noted that the unfertilized but burned control plot produced in that first year, 1959, 3452 pounds/acre dry yield compared to 1960 yields of 2384 pounds/acre and 1961 yields of 3160 pounds/acre both from fertilized but unburned plots of land. On burned over Calamagrostis spp. meadows on Hay Lake, the Slave also observed that the perennial forb species mentioned above were quite abundant.

Vogl (1965) describes the effects of a spring burning on an analogous grassland community from Wisconsin. Some of the grass species are identical to those known from the northern grasslands but the woody plants were more typically southern. Vogl (1965:202) notes the earlier and better growth and comments that in this area the high productivity of grasses and forbs was maintained over the second year, whereas the woody perennials were the first to lose that stimulus. Biennial burning decreased woody plant yields despite the fact that some woody perennials were fire-adapted through their ability to resprout. Again this suggests that it is frequent, light burning rather than intense, infrequent burning which may be the key to more productive results.

Although the origins of the Peace River grasslands may lie in the time prior to the arrival of man in the area, their subsequent maintenance can as surely be related to the native pattern of controlled burning as the recent forestation can be related to an absence of fire through fire suppression. This relationship has always been recognized to a certain extent by explorers and botanists. Dawson (1882:125), for instance, notes that:

> whatever theory be adopted and may have been advanced to account for the wide prairies of the western portion of America further to the south, the origin of the prairies of the Peace River is sufficiently obvious. There can be no doubt that they have been produced and are maintained by fires. The country is naturally a wooded one, and where fires have not run for a few years, young trees begin rapidly to spring up. The fires are, of course, ultimately attributable to human agency, and it is probable that before the country was inhabited by the Indian, it was everywhere densely forest-clad.

In his discussion of the means of grassland maintenance in the Peace River area, Moss (1952) cites local edaphic factors such as poor drainage, the existence of claypans and the influence of fire. In fact, Moss (1952:120) specifically states that native burning has been a particularly important means of grassland maintenance in the area north and west of Fort Vermilion. However, in the discussion of the means through which forest is claiming grassland, Moss (ibid:122) inclines to climatic change as an explanation rather than to fire suppression. Jeffreys (1961), on the other hand, suggests that both climatic change and the suppression of "the use of fire by northern aboriginal man and his carelessness towards forest burning" (ibid:444) may be responsible for this rapid forestation.

Although the above scientific references recognize that native burning has had an important influence on the local landscape, the implication that this should hold on the regional scale has been weakened by continued portrayal of native burning as haphazard and unfocused. Only the realization that native burning was a patterned activity which had express ecological and economic purposes can bring about a willingness to consider realistically the ways in which such a powerful tool has been used in the past to modify the environment.

Timing of the Controlled Burning

There were two times of the year when controlled burning was considered safe by the natives. These were the spring and the fall, both seasons in which the people were highly mobile. In the spring the men were occupied with the spring beaver hunt and carried out burning activities during late April or early May. At this time they were on the way back from their trapping to the trading post or to their families on the large hay meadows where they summered. In the fall the families were out in the bush on an intensive moose hunt to store meat for the winter. The men burned as they travelled, usually in October when the first ephemeral snow had fallen.

> Burning is good around May. When it's hot and the big snow has almost all gone except for some in the woods, then we have to burn. Long ago

> people used to do that in late winter around April or May (male Slave informant born 1899).
>
> When we were still hunting and travelling in the fall when the plants were dried up, then we would let the fires go. We would build a campfire for tea, then just leave it and continue on our way ... it had the protection of the snow. (male Slave informant born 1903)

It is generally conceded that burning during spring stimulates immediate growth by removing the litter which physically hinders new growth and by returning the nutrients locked up in the litter to the soil to aid growth (eg. Vogl 1974:158). Since fire blackens the soil surface and aids heat absorption, the increased warmth hastens seed germination. All of these phenomena are of considerable importance given the short growing season of the boreal forest environment.

Most informants agreed, as Lewis (1977:34) has noted, that autumn was the more dangerous since it was the drier time of the year to burn. Fall burning could, however, be a safeguard against a spring that was too wet for burning. In a comparison of controlled fall and spring burning in Idaho in a shrub area, Leege and Hickey (1971:511-13) observe that fall burning appears to cause greater mortality in shrub species and has the disadvantage of eliminating fresh browse during the following winter season. However, the fall burning meant that plants would start sprouting earlier the next spring. Sprout production was greater after spring burning but the sprouts produced the spring after fall burning were heavier and had more linear growth, thus remaining available to animals longer. Specifically, willows (Salix scouleriana) were significantly taller and wider after fall burns. Bailey and Anderson (1978) note that coverage and seed head production of Stipa cristata are favoured by spring burning but decrease with fall burning. Other species may display the same variable response.

As well as reducing the winter food resources for even those mammals which are fire-followers, another negative effect of fall burning is to reduce the amount of cover, an equally important factor in the winter survival of animals in the north. Furthermore, this removal of vegetation through fall burning lessens the amount of drifting snow which can be caught and retained to add to the water run-off in the spring (Ward 1968: DeJong 1975). This could be critical in such an area of low precipitation as northwestern Alberta, where in the past, for instance, waterfowl production has been threatened by dessication of the Hay-Zama marsh system.

Role of Burning in the Slave Subsistence Schedule

In the spring of the year migrating and breeding waterfowl, beaver and muskrat served as the foci of native resource exploitation. The appearance in April and May of these three resources marked a welcome change from the late winter starvation diet. Also, since the latter two animals retained their primeness of pelt until spring, these were sought for trade. Controlled burning helped to maintain areas attractive to all these resources.

The lush growth created by burning provided materials for nest construction as well as protection from predators for such species as the mallard, pintail, gadwall, widgeon, shoveler and the blue-winged and green-winged teal. In maintaining open water through the elimination of litter build-up, burning also favoured breeding pairs. Patterson (1976) has emphasized the size of these ponds as regulating the distribution of breeding pairs; essentially, the greater the water surface, the more breeding pairs will be supported.

It has often been the concern of wildlife managers that spring burning would affect the newly hatched young of waterfowl as well as of other species. The native response to this was that the burning was generally done too early in the year to have adverse effects. A problem does arise, however, with the early nesters, the mallard and the pintail, who usually make use of dead overwintered vegetation for nest construction. In a survey dealing with a recent 'early' spring in the Hay-Zama Lakes, Hennan and Pelletier (1973) suggest that there is evidence that some mallards were nesting as early as April 3 and pintails and canvasbacks as early as April 6. Since natives say that now late April is usually the time to burn, there is no doubt that these species may be affected. Salt and Salt (1976) comment on the same problem in southern Alberta but observe that the birds seem to survive quite well. There may be some behavioural mechanism for dealing with fire.

Early historic references to the timing of spring burning must be interpreted with the prevailing climate in mind. It is as well to remember that although informants speak of burning into May in the first part of the century (the Hay River Anglican Mission diary actually refers to burning hay meadows on May 24th and May 29th in 1914), the climate at that time was colder and perhaps snowier (Longley 1954:209). In other words, one would expect ideal burning conditions to occur later.

Although beaver is considered a fire-follower, this is definitely from the long term perspective that, after a fire occurs, aspen will grow more profusely and the area will attract beaver (Nash 1951). Native informants agree with this but stress that if the beaver are already there, they will leave the area if the aspen is burned. Although shoot growth increases, the beaver themselves require the standing biomass. The natives, thus, profess to having been more interested in burning in locales where the short term effect of increased productivity was beneficial. They didn't burn for beaver in the way that they burned for moose. In the same way the natives felt that burning in an area which the muskrat already occupied was dangerous although seral retrogression eventually did favour Scirpus species, the muskrat's principal food.

By June the spring hunt was finishing and the family groups were all established on the large hay meadows. Early July was the time when the moulting ducks were an 'easy catch' and communal hunts on foot or by boat were organized. Not only were the natives harvesting a resource, the productivity of which has been favoured by spring burning, but the preferred habitat of the moulting ducks, the emergent cover of bulrushes (Scirpus sp.), is also favoured in the long run by fire. Despite ethnohistoric references to summer burning in other areas of the boreal forest (Lutz 1960), the natives of this region all denied that anyone burned in the summertime during the early part of the nineteenth century.

By the end of July, families were cutting hay in the meadows for the horses to eat in the winter. It is uncertain when horses became a native possession in northern Alberta. From the Fort Vermilion post records, it is obvious that the traders did not have horses in 1802 (B224 a/1, entry for Nov. 2/02) but did at least by 1826 (B224 a/2, entry for July 19/26). Two or three out of the forty informants said that their parents did not own any horses; others stressed the wealth of their parents in possessing many; and still others spoke of the herds of wild horses which had lived year-round in the early 1900's on the large hay meadows on the margin of Hay-Zama Lake.

Berries were also ripening at this time. Informants suggested that, like beaver, the results were not sufficiently immediate that one could say that one burned 'for berries.' On the contrary, the immediate effect of fire on a patch of berry bushes (not strawberries) was to make it barren for at least 3 years. Strawberries might be one pleasant result of burning around one's campsite, though. Also people were very much aware of the relationship between old burn, berries and bears in the summer and this was certainly exploited.

In late August the summer aggregration began breaking up as the fall moose hunt began. Moose hides and dried meat were cached for the winter ahead or were sold to the trade post. This activity continued up until late November or early December. Areas of the bush which were known to have been burned were heavily utilized:

> If you burn in the spring, the moose will be there in the fall. When it has been burned some place, the people all say 'I will hunt there.' And they all argue about it because they know it will be good hunting (male Slave informant born 1908).

Much research has been done on the use of fire to create favourable habitat for browsing game animals. The attractiveness of a burned area lies in the increase in browse productivity as described in the discussion of spring burning; the increase in browse availability through the reduction of shrub crowns (eg. Leege 1968:247); the increase in browse nutrition as defined generally for early succession plants (Cowan et al. 1950) and as defined specifically for some shrubs after controlled burning (DeWitt and Derby 1955); and an increase in palatability, not just of the new sprouts but also of the scorched twigs (Leege 1968:249). Native informants also suggested that moose would avoid areas of deadfall and 'thick bush' because the dense vegetation served as cover for predators.

Although this is a difficult phenomenon to prove, some researchers have suggested that old burns may not only increase moose densities in the area by being highly attractive to them, but may permit actual increases in calf productivity, either in terms of birthrate or in terms of survival of the young (LeResche et al. 1974).

At this time of year, late September and October, migrating waterfowl were also abundant. The last of these are now usually gone by early November (Hennan and Pelletier 1977:22).

The men usually started fur trapping in December. Several informants mentioned brief returns to Habay or Meander River over the Christmas and New Year period. As the winter progressed there were major interruptions of trapping to replenish the supply of moose meat, or, if hunting was unsuccessful, for trips to the post for groceries. It was in the critical period of late winter that the hitherto secondary activities of the women assumed great importance. Hare, grouse, squirrel and fish, although exploited throughout the year for variety in the diet, now were often the only available resources. During the very cold spells when people did not travel, the need to be able to benefit from increased productivity and predictability of resource yield without employing the strategy of mobility was crucial. Camping on the edge or near an old burn was an ideal solution. The burn provided firewood and attracted game and fur-bearing animals. Natives always emphasized its importance for hunting first; trapping was second in priority.

> It's good to sleep where there's an old burn. It's good for the firewood. In wintertime the moose come to the burn to eat the new trees that grow and the old dry leaves on the dead trees. The moose sleeps in the little bushes and when we go hunting we can see him

> clearly (male Slave informant born 1903).
>
> When it burns all the animals like it, like the rabbit, fox, lynx and mouse. They all like it there. We could go trapping for lynx and fox there in the winter because there were many rabbits and mice (male Slave informant born 1908).

The natives who had lived near Bistcho Lake noted that caribou were not found on old burns but went to eat lichens on the open muskeg. In the ecological literature there has been much debate over whether their avoidance of old burns is due to snow quality (Pruitt 1959) or to the loss of a food resource, the lichens (Scotter 1964). The effects of wind would be another factor and the solution lies perhaps in some combination of these. None of this work dealt with the relationship between caribou and areas of controlled burn simply because prescribed burning is now a phenomenon of more southerly forests.

Of the small game exploited, hare benefits most by controlled burning. Their diet is much like that of the moose - grasses, forbs and leaves in the summer and aspen, willow and birch twigs, bark and buds in the winter. It has been suggested in some areas that these two mammals in fact may be competitors (Bergerud and Manuel 1968). Hare, as have other herbivores have also been known to come to newly burned areas in order to eat the ash which is rich in calcium, potash, phosphate, trace minerals (Komarek, E. V. 1969:194). In turn the abundance of hare in a burn will attract lynx.

The relationship between aspen and ruffed grouse has been described as nearly 'obligatory' in areas where the snow cover is of long duration. However, the grouse, like the beaver, is dependent on mature stands of aspen. Gullion (1970;1977) had defined for the Wisconsin ruffed grouse stands of 25-40 year old aspen as top feeding areas and stands of 10-25 year old aspen as top areas for wintering and breeding. Gullion suggests since this optimum mosaic of older and younger stands must be encompassed within the small space of a grouse's range, that controlled burning is the best means of producing it.

Red squirrels are a creature of the conifer forest and are essentially at a disadvantage in a burned area. In turn, the fisher which feeds mostly on red squirrel is also restricted to these areas. Marten, too depend on red squirrel and other small mammal species of the forest and are thus disfavoured by burning (Lensink et al. 1955; DeVos 1951).

Although the immediate result of a fire may be to kill some of the small herbivores such as mice and voles, re-invasion of the area is accelerated by the attractiveness of the lush growth of grasses and forbs. Studies both in forested areas and in grassland areas suggest that seed-eating mice are particularly favoured in the first year following a fire (Ahlgren and Ahlgren 1960; Cook 1959). In turn, fox and the small mustelids will be attracted to such areas.

In terms of burning within bush area, the differences in environmental effect between native controlled burning and natural burning lie not only in the former's determination of fire intensity and location, but also in its relative smallness of scale in terms of frequency and space. Several comments have already been made about the role of repeated fires in the creation and maintenance of certain early seral communities, and in the modification of the occurrence and behaviour of wildfire. Frequent fires and, moreover, fires which are small spatially contribute to the staggering of plant communities at different levels of maturation. The edge effect of this vegetation mosaic provides increased productivity for mobile organisms through the greater availability of a variety of food resources, and the proximity of cover to the feeding areas.

Certainly in winter the openness of a burn exposes supranivean mammals to the hardships of deeper, denser and more crusted snow and greater wind chill. Except for the subnivean mammals all of those animals cited in the preceding paragraphs use burns only to feed in the winter. By late winter when the snow is deepest and most crusted and dense, moose may be forced to stay in forested areas all the time and resort to food resources in that area (Le Resche and Davis 1973). This snow and wind effect is amplified with the size of the burn. Spencer and Hakala (1964) state that small burns on the other hand may serve as winter concentration yards for moose. Although the amount of edge and the smallness of the burn is perhaps most critical for animals in the winter, there is also a need for cover next to feeding areas during the summer for the protection of the young (eg. Le Resche et al. 1974;

Gullion 1970;1977).

In summary, the above delineation of the role of burning within the native subsistence schedule illustrates how this technique was used to increase productivity and predictability in terms of native economic goals by intensifying the natural vegetational mosaic in such a way as to have predictable local and regional effects on animal distribution. The use of this knowledge was a basic part of their technology and as such, a critical factor in the viability of the hunting-trapping way of life. Hopefully, such anthropological misrepresentation of native burning as Michea's (1960) "sans autre but que celui de se distraire" will adjust its perspective on native technology in face of informants evaluation of the economic contribution of this technique:

> I didn't set the forest on fire just for the sake of burning but so that I could return to hunt the next year and live (male Slave informant, born 1898).

## CHAPTER V

# THE HISTORY OF THE USE OF CONTROLLED BURNING

### Historic Changes in Controlled Burning

The previous delineation of the role of controlled burning in the economic life of the Slave in the early 1900's may seem, spotlighted as it is, very stable. Nevertheless, the application of the technique was, and undoubtedly had been, undergoing change. In general there are three factors which influenced the use of controlled burning in the historic period. Direct effects on the application of this technique would have been made by a) climatic fluctuation, b) changing economic goals and c) sociopolitical constraints which first discouraged and then actively suppressed fire.

Prior to the ethnographic present of the 1890's and early 1900's there occurred a climatic fluctuation which may well have had an effect on controlled burning. This mid-1800 peak of the Little Ice age was characterized by cooler and probably wetter conditions (Denton and Porter 1970). One of the effects of this was the unusually heavy snowfalls which it has been speculated (Soper 1941) was partly responsible for the diminution of buffalo herds in this area. Other effects of this climatic fluctuation such as a shortening of the growing season may well have been compensated for by an intensification of native burning practices. Petitot's (1876, 1884, 1891) narratives from the mid-1800's frequently refer to the effects of extensive native burning on the spruce landscape of the MacKenzie Valley. Too, the presence of bison and elk in northwestern Alberta until the mid-1800's would have provided economic reasons for the maintenance of extensive grassland even prior to the introduction of the horse. Present day Slave informants have no memory of the local presence of elk and only remember stories about bison in the area, so they cannot provide details about burning undertaken specifically to favour these animals. Data provided on the seasonal distribution of buffalo in northeastern Alberta and the Northwest Territories may offer some clue, however. Reynolds (1976) reports that the Slave River Lowland bison herds winter on small localized meadows where they are protected from the effects of the wind. Not only is the wind chill lessened but the snow is not crusted and can be easily trampled down. The rest of the year is spent on the large meadows where the effect of the wind acts positively to keep away insects. With this scheduling of the bison in mind, it can be hypothesized that native burning patterns would have involved the fall burning of large meadows and the spring burning of small meadows. The loss of winter forage on the large meadows would be of no consequence since these are not utilized by bison in the winter; on the other hand, the advantage of earlier spring growth on these meadows would be of considerable importance at this critical time of year. The spring burning of small meadows would provide lush forage for the following winter (cf. G. W. Arthur 1975:30 for a similar pattern of burning on the Plains). Once large herds of feral and domesticated horses were established in the area, the same pattern may have continued.

The Slave economy underwent a period of rapid economic change in the late 1800's as outlined in Chapter III. In response to favourable trading conditions, native economic emphasis shifted from hunting to trapping within a general hunting and trapping context, and specifically to the trapping of the highly marketable "big fur." Asch (1976) points out that marten was the favoured "big fur" of the MacKenzie Valley at this time and northwestern Alberta, also a good area for marten, probably experienced a similar trend. Unlike many of the other desirable animals in terms of game and fur, the marten is a denizen of climax boreal forest. The mainstay of its diet is the red squirrel, also an inhabitant of closed conifer forest. Bush-burning, therefore, did not aid the predictability and productivity of the marten yield. In fact, if there were any chance that a fire could escape, bush burning would become a negative influence. Thus, in response to the increasing economic stress on marten, bush burning appears to have become more restricted, and in particular, fall bush burning was phased out. Those native informants who were born at the turn of the century or who lived in an isolated area speak of both spring and fall burning in both the bush and on the hay meadows. In contrast, slightly younger individuals who lived in less isolated areas speak of bush burning only in the spring and of fall burning only on the hay meadows. That natives of this general area were conducting less bush-burning after 1900 is commented on by Camsell and Malcolm (1921:230):

> ... through the efforts of the Dominion Forestry department, however, the waste by fire is by no means as great now and the natives are being educated to see the folly of allowing fires to spread.

Part of this "education" may have been through propaganda but economic factors would have proven a more powerful argument. In addition to the emphasis on a resource not particularly favoured by bush burning, the increasing use of steel traps in the 1900's favoured using wooded locales for trap-setting where animals sheltered rather than open locales where animals fed. Out in the open steel traps were easily drifted over. Hunting was, however, still socially and economically important and bush burning continued but on a much more restricted scale. On the other hand, open area burning was not affected by these changing economic goals. Hay meadows were still burned over to produce horse-fodder; and now the areas about cabins were burned as well as about camps to fire-proof the locality and later, to encourage gardens. Although open area burning continued to be of economic importance, as the yearly round became more circumscribed, the actual number of acres affected may have decreased.

By the 1940's, hunting and trapping as a way of life, and with it the technique of controlled burning came under a great deal of pressure. With the crash of fur prices after the second World War, trapping was no longer economically viable. The economic alternatives of wage employment and family allowance which necessitated the enrollment of children at school acted as forces for sedentarization as did the registration of traplines. Success in hunting was adversely affected by the settlement configuration of population distribution and by a policy of total fire suppression. Native burning was no longer a practice to be suppressed by "education": it was actively forbidden by law. Hunting, as a source of subsistence suffered greatly as a result:

> Today hunting is mostly done by boat along the rivers and the moose we kill are just those we see along the banks, because it is very difficult to hunt in the bush when the underbrush is thick. You make a noise and the moose is frightened. Now all the people live off the store because it is no longer possible to kill game. A long time ago when we used to burn the bush you could return to that spot and it was easy to hunt. If we make fire now, we might have to suffer for it so we are afraid (male Slave informant, born 1892).

A minimal amount of bush burning did continue, however. Since fire-fighting for the Forestry Service was highly acceptable wage employment for the native, "job fires" were occasionally set at one time. Too, it has been reported that when the men of the community of Upper Hay River (now Meander River) thought that the women were becoming too financially independent on the proceeds of red squirrel trapping, they burned areas of climax forest near the settlement to decrease the squirrel populations (R. Henriet, pers. comm.).[5] Hay meadow burning also continues in some forms. The Forest Service burns on some of the large meadows to reduce the fire hazard. The natives burn to create winter forage for horses both illegally and under permit. Similarly some fire-proofing of cabins is carried out. These forms of open area burning, however, are not of comparable extent or frequency to that outlined for the early 1900's or even up until 1940. Informants remark that the old grass now so prevalent on hay meadows is bad for the horses:

> The new grass was good for the horses. There used to be a lot of wild horses around, and we used to burn the grass. After we stopped burning, the horses caught sickness from the dead grass and it caused horses to die. So the meadows should be burned every year (male Slave informant, born 1898).

Effects of Changes in Burning on Vegetation

In Chapter IV, the effects of the early twentieth century pattern of controlled burning on the regional vegetation were outlined. Grassland communities were maintained and a high proportion of deciduous and shrub communities to conifer communities were favoured. As burning techniques changed, the relative proportions of these vegetation types would also have changed. Grasslands may well have been more extensive at the time the native inhabitants were burning for the bison herds and elk relative to their extent at the time these meadows were used for horses. However, a non-economic factor must be considered here: the cultural value attached to wide open grassy spaces as a good place to live in the summer may have affected the maintenance of these areas above and beyond any strict economic need.

Grassland burning remained important up until the 1940's. Even relatively young informants were aware of its uses. The activity may have become more concentrated in fewer areas as the population became more sedentary. One result of such a constriction of burning would have been the succession of shrub and aspen communities in small meadows distant from the main population centers and the main trails.

Changes in bush-burning, on the other hand, involved a gradual decrease throughout the 1900's, particularly in terms of burning in the fall, in response to changing economic goals. One result of a decrease in bush burning would have been a decline in the ratio of sprouters (aspen and shrubs) to conifers in the forest communities.

After 1940 and the institution of fire suppression, these vegetational trends would have gradually accelerated as would have the forestation of any former open areas which were not maintained by flooding or agriculture. Sources from other areas (eg. Komarek 1968), as well as the comments of informants would also lead us to expect an increase in the number and intensity of naturally-caused fires since the beginning of fire suppression. The lack of comprehensive fire reports prior to 1960 means that the long-term data necessary to discern any such intensification other than that caused by the natural cycle of incidence of lightning-caused forest fires is not available.

The question of how long the area has been inhabited by a native population using controlled burning techniques remains to be seen. Lewis and Schweger (1973) propose on the basis of high charcoal frequencies in sediments analysed for pollen that man has been present and involved in controlled burning since the end of the Pleistocene over most of the North American continent. In the discussion of the peopling of the New World the concept of knowledge as technology has been mentioned as a significant factor for a mobile population (Irving 1978). It may well be that controlled burning was part of the essential toolkit that early peoples brought with them into the New World.

## The Technique of Palynology and the Delineation of Fire History

As mentioned previously, palynology is one of the techniques which attempts to reconstruct the regional vegetation history. Since the pattern of native burning is seen to have affected the regional vegetation of northwestern Alberta, it was decided to undertake palynological work in the area in an effort to see whether the historical changes in vegetation could be elucidated by this method. Although formerly the vegetation history revealed through pollen analysis was interpreted as illustrative of climatic change only, recently human and pyrrhic influences have received some attention as explanations for changes in the vegetative record (eg. Oldfield 1969; Smith 1970; Boyko 1973; Cwynmar 1975). In fact, palynology is among those techniques which served to establish the importance of fire in the history of the boreal forest by the recording of charcoal fragments as well as pollen grains from sediments (Wright & Heinselman 1973:321).

Interest by palynologists in fire histories began with the realization that there were more identifiable entities than just pollen grains in the processed sediment under the microscope. Black, angular fragments were identified as charcoal. Since fire is a major source of charcoal and also a major modifier of local vegetation, some palynologists became interested in documenting fire history. Local fires were correlated with peaks in the representation of charcoal particles whether these were derived relatively as a ratio of charcoal to pollen or "absolutely" as an influx of charcoal/$cm^3$ of sediment. However, comparison of documented fire histories and palynologically derived fire histories (eg. Cwynmar 1975) soon revealed that the palynological record was presenting only a minimal number of the local fires. In consequence, some palynologists began to look for other indicators of local fires. Swain (1973), for instance, attempts to correlate charcoal/pollen ratio peaks with increased varve size, on the premise that peaks in erosion would occur after a fire. For similar reasons, Cwynmar (1976) also attempts to correlate increased charcoal influx with relatively sharp increases in aluminium/vanadium influx, varve thickness and charcoal/pollen ratio. Swain (1978) now interprets small peaks in birch and aspen as evidence for local fires even in the absence of charcoal/pollen peaks on the basis that these peaks represent post-fire succession.

Size classes of charcoal particles were first suggested as a means of distinguishing the amount of long-distance versus local charcoal present in a sample (Swain 1973). Davis (1967) for instance uses particles over 50 microns in size as designators of local fires. However, this concept has also come under some criticism. One palynological study, Mehringer et al. (1977) suggests that large particles of charcoal are easily broken down and, thus, the size distribution seen under the microscope is a false one. The above authors thus recommend that only particles over 25 microns should be counted as a gauge of fire proximity (ibid:52).

Furthermore, data produced by researchers interested in smoke and air pollution from bush-burning note that charcoal production is a function of the amount and type of fuel consumed, the fuel's moisture content, and the rate of fire spread (eg. Schaefer 1974). For instance, Komarek et al. (1973) note from experiments that grass fires do not produce as much charcoal as bush fires; and that the particulates of low to moderate temperature fires are larger and more varied than those from high temperature fires. It is just as well to remember that this air pollution research deals with a population of charcoal particles the majority of which are far too small to be observed at the level of magnification used by palynologists. In pollen diagrams the recorded charcoal particles are usually 5 microns and over. In contrast, Vines (1974) states that for a prescribed burn in the Australian bush, the majority of smoke particles were 0.1 microns in diameter; and Schaefer (1974) comments that it would be necessary to use the coldest, wettest, slowest fire possible in order to produce a size distribution of charcoal particles in which the majority were larger than 1 micron.

Thus, the palynological charcoal data represents only a small fraction of the charcoal that a fire actually produces; and the size distribution of the charcoal particles seen under the microscope involves other considerations than proximity of the fire to the coring locality.

Much of the fire history work in palynology still involves a climatological focus. Since climate does influence the frequency of lightning-caused fires, Swain (1978), for instance, correlates changes in charcoal representation with the frequency of dry- or moist-associated plants in order to define moist or dry climatic periods. For example, the lowering of charcoal levels after 1550 A. D. in a lake core from northern Wisconsin is interpreted as marking the onset of the little Ice Age.

Although this study has chosen to work with the tools of quantity and size classes of charcoal particles and quantities of pollen grains, its interests are not very similar to the interests of the majority of the fire-history studies. Rather than focusing on the palynological documentation of local fires and their effects on local vegetation as well as the relationship between local fire occurrence and climate, this research is interested in a regional pattern of burning and its effects on regional vegetation. Two palynological studies are available which can make a contribution to this point of view. Mehringer et al. (1977) is a record of the pollen and charcoal deposits in a bog in Montana. In their interpretation of the charcoal deposition, the authors attach no special importance to individual charcoal/pollen peaks but interpret the "presence of charcoal in all samples rather than occasional charcoal lenses or sporadic high abundances as evidence for frequent small or low to medium intensity fires" (ibid:53). This attention to the high background of charcoal in a sample rather than to peaks of charcoal representation only is of interest. Pertinent also is the authors' observation that while charcoal representation during the Altithermal was relatively high, the deposition over the past 2000 years was greater. The authors suggest that this may be due, not to climatic factors, but to changing aboriginal patterns of land use. A second study which bears upon this research is an experiment (Wright 1976) in which nutrient influx to a lake was measured after a major (5900 hectare) spring fire. It was observed that there were some increases in phosphorous and potassium influx but no increase in nitrate influx to the lake. The author judges there to have been no significant enrichment of the lake at all, an unexpected result in light of the data from similar research on other lakes and other fires. Wright suggests that the reason for this lack of significant enrichment of the lake was that erosion was impeded by the abundance and speedy recovery of the new growth and by the protection of the duff litter by moist, cool burning conditions. One might add that the presence of snow would act to catch particulates and thus retard erosion and that the moist conditions of the burn produced particulates of such a size that they were not easily transported. It would be expected that these burning conditions would act in a similar manner to impede the removal of charcoal particulates from the fire site.

In summary the above studies provide certain points for our consideration. The charcoal particle representation in the palynological samples is obviously a small and biased sample of what has been produced by the fires in the region. Charcoal representation in the pollen diagrams may well represent bush fires to a greater extent than grass fires, and fall and summer fires to a greater extent than spring fires. Given the tendency of large particulates to remain on the ground, the frequency of large charcoal particles in lake deposits is seen to be of some significance. In terms of general charcoal representation, attention will be focused on the background rather than on the peaks alone.

Presentation and Interpretation of the Palynological Data

The data are presented in two diagrams. Figure 3 presents the analysis of upper meter or lake sediment; Figure 4 is an enlargement of the results of the upper six samples which represent the historic period. In neither of these diagrams is the data presented as they conventionally are in terms of the relative frequencies of individual pollen grain types. In contrast, in order to better illustrate this research focusing on vegetational change due to changes in controlled burning, assemblages of pollen types were defined in terms of the vegetational groups the proportions of which changed as patterns of burning changed. These vegetational groups were, as may be recalled from the previous section, Conifers, Sprouters and Open Area plants.

In addition to presenting the relative frequencies of these three groups, ratios of Sprouter/Conifer, Sprouter/Open Area and Conifer/Open Area were employed to maximize these relationships. For this data, the group Conifers comprises the pollen types, *Picea*, *Larix* and *Pinus*. Since *Pinus* is habitually over-represented in pollen diagrams, the vegetation groups percentages and the ratios have been calculated both with and without *Pinus*. The group Sprouters comprises the pollen types *Populus*, *Betula*, *Salix*, *Alnus*, *Corylus*, *Shepherdia* and *Myricaceae*. The *Betula* pollen type includes both arboreal and shrub birch of which the former sprout only infrequently. Arboreal birch is not common at all in this area, however, so *Betula* has been included with the Sprouter group. The Open Area group refers to those plants which are found in open areas such as hay meadows. Some of these non-arboreal pollen types are classified so broadly that they subsume many different species with different environmental requirements. These are excluded from the diagrams. The pollen types selected for the Open Area group of this area are *Gramineae*, *Equisetum*, *Artemisia*, *Ambrosia*, *Galium*, *Caryophyllaceae*, *Rumex* and *Chenopodiiaceae* (cf. Moss 1959).

Any pollen types which did not fit into these groups, eg. aquatic plants, were not presented in the diagrams, but their frequencies are listed in Appendix I. As well as the vegetational groups and ratios, two charcoal indicators are presented in the diagrams: the ratio of charcoal particles to pollen grains; and the percentage of the charcoal population which was 25 microns or greater in size.

The basal carbon-14 dates for these cores are 5020± 150 BP (I-10,423) for Hutch Lake and 3470± 100(I-10,424) for Footner Lake. An arbitrary rate of deposition is assumed with the top of the core representing the present. This dating reveals an unexpectedly slow rate of deposition. This is unfortunate since the late historic period for which the ethnographic and historic records offers the most detailed outline of vegetation changes is documented by only a few samples; it also means that the action of mud-burrowing organisms at any one time over a certain depth of sediment would mix material from a greater time period than if the deposition had been fairly rapid.

Figure 3 presents the results of the analysis of the entire upper meter of sediment. The Footner Lake diagram is at the top and the Hutch Lake diagram is at the bottom. On the left hand side are recorded first the depth and then the interpolated age of that sample. For each lake the first three columns illustrate the relative percentages of the three vegetational groups, Conifers, Sprouters and Open Area plants. The succeeding three columns portray the three ratios, Sprouter/Conifer, Sprouter/Open Area and Conifer/Open Area. For each of the diagrams of the relative percentages and for both of the ratios involving conifers, two values are shown resulting in a double line for each profile. The two values are derived from considering the relative frequencies or ratios both with and without Pinus sums. These profiles are marked at the top as to whether they represent the values with or without Pinus. Following these ratios of vegetation groups is

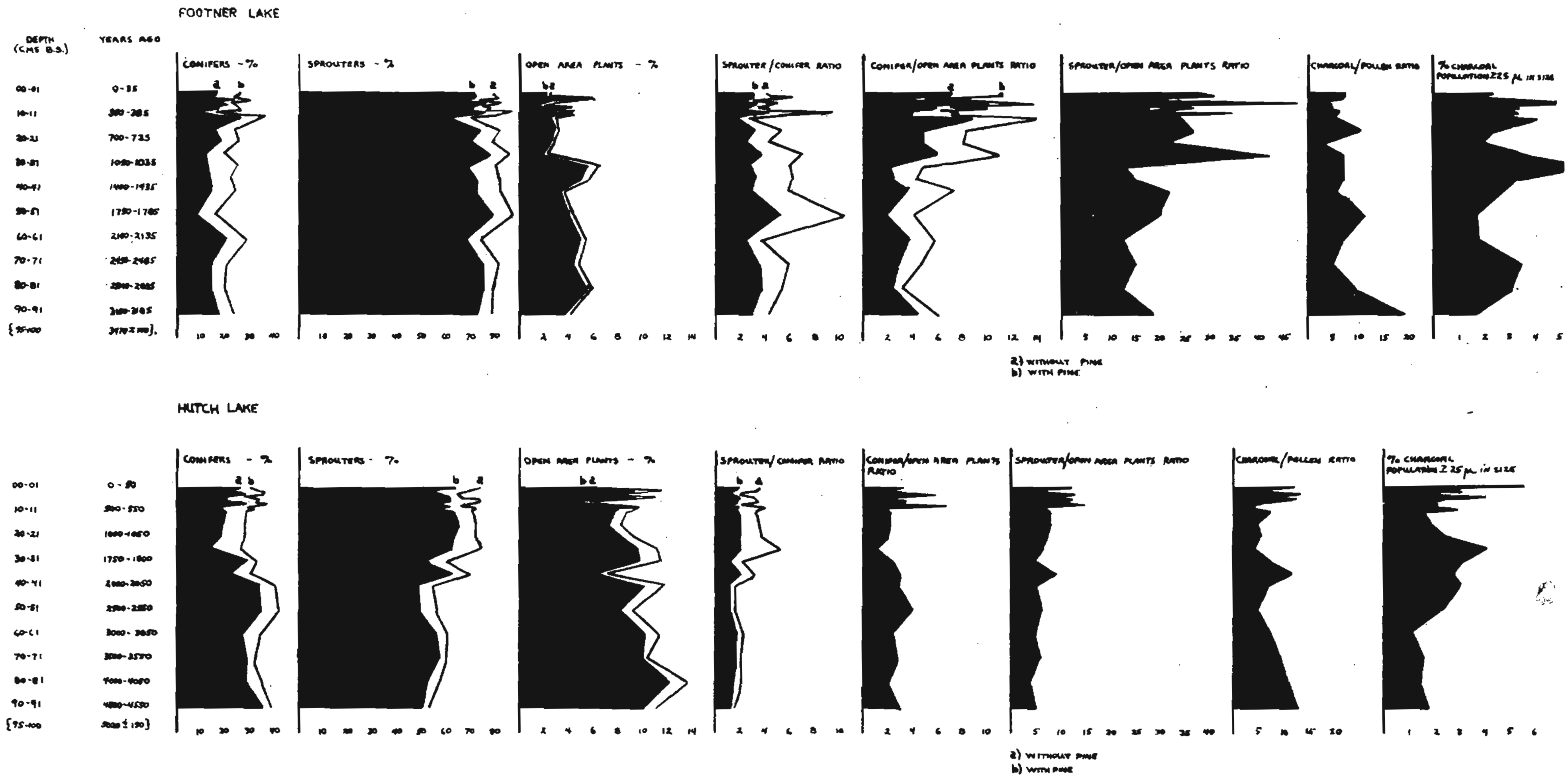



Figure 3. Hutch Lake and Footner Lake Pollen Diagrams

the charcoal/pollen ratio and the percentage of the charcoal population which is greater than or equal to 25 microns in size. At the base of the individual profiles is the scale of the values. On the Hutch Lake diagram a dotted line runs across the 3500 year level which represents the base of the Footner Lake core.

Figure 4 represents the samples covering the historic period from present back to 245 years ago. In this diagram the profiles of the individual vegetation group or ratio from each lake are placed side by side to facilitate comparison. The top row illustrates the relative percentages of the three vegetation groups for both lakes. The bottom row illustrates the three vegetation ratios, the charcoal/pollen ratio and the diagram of the percentage of the charcoal population which was greater than or equal to 25 microns.

The major task of the palynologist is the interpretation of the variability evident in the pollen diagram. The origins of this variability may be seen to lie in a) temporal aspects including climatic change and/or community succession and b) spatial aspects or varying proximity of the coring locality to the sources of the pollen or charcoal. The variability in the pollen diagram is expressed in terms of long-term changes, isolated events and fluctuation from sample to sample. Conventionally, long term changes in the pollen taxa frequencies with the consistent dominance of some taxa have been interpreted as a persistence over time of a certain vegetational composition. This is usually referred to as a pollen zone. Mehringer et al.'s (1977) and

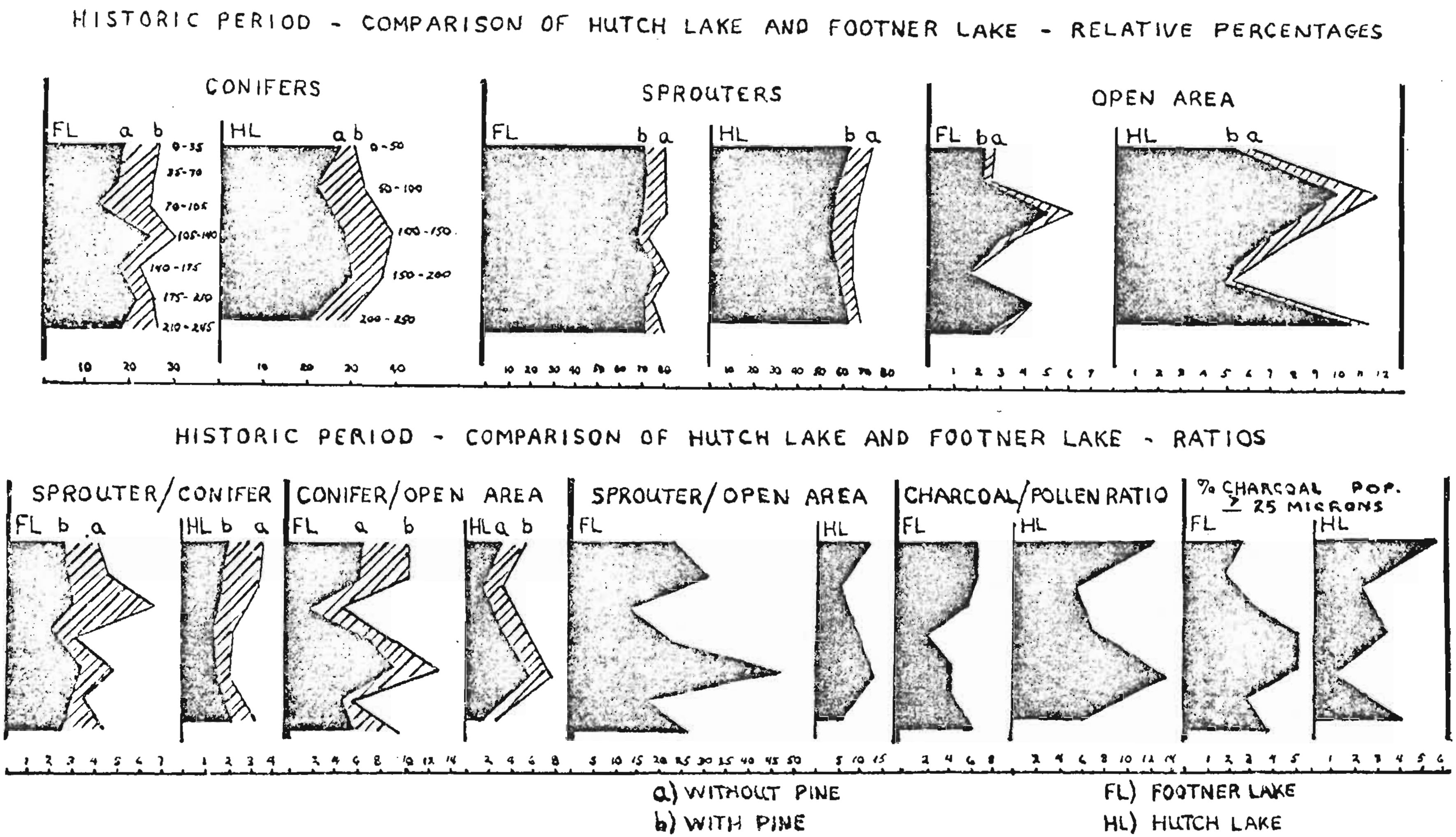

HISTORIC PERIOD - COMPARISON OF HUTCH LAKE AND FOOTNER LAKE - RELATIVE PERCENTAGES
CONIFERS
SPROUTERS
OPEN AREA
FL
HL
a b
b a
0-35
35-70
70-105
105-140
140-175
175-210
210-245
0-50
50-100
100-150
150-200
200-250
HISTORIC PERIOD - COMPARISON OF HUTCH LAKE AND FOOTNER LAKE - RATIOS
SPROUTER/CONIFER
CONIFER/OPEN AREA
SPROUTER/OPEN AREA
CHARCOAL/POLLEN RATIO
% CHARCOAL POP. ≥ 25 MICRONS
a) WITHOUT PINE
b) WITH PINE
FL) FOOTNER LAKE
HL) HUTCH LAKE

Figure 4

Lewis and Schweger's (1973) observations suggest that one may also define charcoal zones which may be related to human activity. Periodic peaks and troughs of certain pollen types or of charcoal particles within this pollen zone are normally attributed to isolated events. Interpretation of these events from a temporal point of view would include such explanations as a minor climatic fluctuation, successional changes following a fire, etc. From a spatial point of view, a peak might indicate a local fire or proximity to a pollen source. Fluctuation from sample to sample is rarely interpreted since this type of variability, compared to the above two, is most likely to be open to errors of a statistical nature and to error through contamination. Although these three levels of variability are encountered in this study, the sources of variability will be interpreted in relationship to the major interest of controlled burning.

The data, as presented in Figures 3 and 4, reveal definite differences between the analyses from the two lakes, differences which prevail over the entire meter. Thus, a certain amount of local variability in pollen representation is introduced. In the Hutch Lake diagram, Conifers and Open Area plants are better represented, the latter at least twice as well represented as at Footner Lake. Too, the Hutch Lake diagram appears to experience some trends which are not obvious in the Footner Lake diagram. After a period of oscillation over the four samples between and including samples 25-26 and 40-41, the Hutch Lake pollen spectra undergo a decrease in conifers, an increase in sprouters and a minor oscillation and decline in open area plants. In contrast, the general appearance of the Footner Lake diagram is one of complacency. However, there is some congruency between the two diagrams for specific points of variation. In Hutch Lake the point of most marked change affecting all three vegetation groups and the charcoal/pollen ratio occurs at sample 35-36 which dates 1750-1785 years ago. These changes are paralleled in Footner Lake at the 50-51 cm. sample which dates 1750-1785 years ago. Again, one of the points of most marked change in Footner Lake, the 10-11 cm. point dating 350-385 years ago is echoed, save a difference in open area plant trends, by Hutch Lake's 7-8 cm. sample dating 350-400 years ago. Whether or not certain variations are replicated in both lake diagrams will play an important role in the subsequent interpretations.

## Long Term Changes

Long-term change in the pattern of controlled burning should be most obvious in the charcoal indicators. Consideration of the two diagrams reveals that these indicators do not duplicate each other at all, but there is expected to be some interplay. A high value for the percentage of the charcoal population greater than or equal to 25 microns in size could be the result of either controlled burning or a cool, wet climate. If it is the result of controlled burning, it should be accompanied by a charcoal/pollen ratio which remains constantly high, but which experiences few of the sharp peaks which indicate catastrophic fires. If this high value is the result of climatic factors, it would be expected that the charcoal/pollen ratio would be low, reflecting the low frequency of fires in general.

Comparison of the two diagrams (Figure 3) reveals that common to both is a decrease in the charcoal/pollen ratio from the base up to 2500 years ago and a peak in the charcoal/pollen ratio at 1750 years ago. There is no sudden long-term rise in this ratio from which can be inferred an initiation of controlled burning à la Mehringer et al. (1977). However, a significant increase does occur in the value of the percentage of the charcoal population which is greater than or equal to 25 microns in size. This is evident in the Hutch Lake diagram after 3000 years ago, but is not obvious in the Footner Lake diagram the base of which does not date to much earlier than this time. However, Footner Lake does maintain in general the higher percentage.

The charcoal/pollen ratio for these 3000 years does seem to experience few peaks and in general maintains a high background of charcoal. The Footner Lake diagram reveals two major peaks and two major troughs over the 3000 year period; the Hutch Lake diagram reveals four major peaks and one major trough over this period. Three of these sharp peaks occur in the top eight samples and this distribution reflects in part the closer sampling of the top 11 centimeters.

However, there has been stated that a cool, wet climate did exist at 3000 years BP. in the western interior of Canada. Ritchie (1976:1793) observes that "at about $3x10^3$ the southern limit of the forest extended to the south, apparently in response to a climate with cooler and (or) wetter growing seasons." Although the grassland to transitional forest/ parkland trend is dated at 3000 BP. for 3 sites in southern Manitoba (at 49°-50°N. latitude), sites further north experience a transitional forest to boreal forest change at a variety of earlier dates. Basal dates on peat initiation in two bogs in the area of northwestern Alberta substantiate a 3500 BP. cool and wet climatic fluctuation (Nichols 1969).

Thus this data suggest that the 3000 BP. date marks the completion of some of the results of a cool, wet climatic fluctuation, rather than the beginning of such a climatic change. It can now be hypothesized that this significant increase in the values of the percentage of the charcoal population greater than or equal to 35 microns in size at 3000 BP. marks the beginning of controlled burning in the area. This may represent either the entry of people into the area using this technique or the development by the indigenous people of a technique of fire use which closely paralleled that used 3000 years later. Archaeological research has yet to be initiated in this area so this means of substantiating these hypotheses is lacking.

<u>The Historic Era</u>

Figure 4 presents the results of the analysis of the samples covering the late historic period. The differences between the two lakes is even more marked at this magnification. Table III summarizes the comparison of the palynologically derived vegetation changes and the historically observed vegetational changes for the late historic period. The first column on the left-hand side of Table III provides the dates for two blocks of time within which certain trends may be discerned. The base-point for this analysis of change lies at the turn of the century. The pattern of native burning for this period was delineated in Chapter IV. Previously it was suggested that certain trends occurred from the ethnographic present up until 1940 after which these trends were accelerated up until the present. The second column from the left outlines those changes in the pattern of controlled burning; the third column outlines the resulting changes in the proportion of the three vegetation groups, Conifers, Sprouters and Open Area plants which were observed or are inferred to have happened; the fourth column details the changes in these vegetational groups as seen in the palynological record. Since the periodicity of the Footner Lake core samples corresponds well to the blocks of time within which changes occurred, the results of the Footner Lake core analysis will be used. The base of the Footner Lake 02-03 cm. sample will correspond to the ethnographic present. This, then, is the base-point sample.

It has been suggested that the results of the gradual decrease in

Table III

Late Historic Changes in Vegetation - Footner Lake

| Date | Burning Patterns | Expected Vegetational Changes | Results of Palynological Analysis |
|---|---|---|---|
| 1940-75 | cessation of controlled burning; increase in naturally occurring fires | 1. minor increase in conifers | 1. conifers increase slightly; fall in sprouter/conifer ratio |
| | | 2. dramatic decrease in open area plants | 2. open area plants remain stable |
| | | 3. increase in charcoal/pollen ratio | 3. charcoal/pollen ratio rises mildly |
| | | 4. decrease in percentage of charcoal population greater than or equal to 25 microns. | 4. increase in percentage of charcoal population greater than or equal to 25 microns |
| | | 5. ambiguous sprouter representation | 5. sprouters are stable |
| 1905-40 | decrease in bush-burning, particularly fall bush-burning; possibility that meadow burning became more circumscribed in the area | 1. slight increase in conifers | 1. slight increase in conifers; drop in sprouter/conifer ratio |
| | | 2. decrease in charcoal/pollen ratio | 2. rise in charcoal/pollen ratio |

(cont'd.)

Table III (cont'd.)

| Date | Burning Patterns | Expected Vegetational Changes | Results of Palynological Analysis |
|---|---|---|---|
| 1905-40 | (continued) | 3. decrease in percentage of charcoal population greater than or equal to 25 microns | 3. decrease in percentage of charcoal population greater than or equal to 25 microns. |
| | | 4. possible decrease in open area plants | 4. dramatic decrease in open area plants |
| | | 5. ambiguous sprouter re-presentation | 5. ambiguous sprouter re-presentation |

bush-burning and the possible decrease in the extent of meadow-burning from the time of the first decade of the 1900's up until 1940 would involve a slight increase in Conifers at the expense of Sprouters; a possible decrease in Open Area plants; and a decrease in both the charcoal/pollen ratio and the percentage of the charcoal population greater than or equal to 25 microns. Sprouter representation by itself is held to be ambiguous since decreases in burning would tend to decrease its frequency in the bush, but increase its frequency on the hay meadows.

In accord with these expectations, the interval between the 02-03 cm. sample and the 01-02 cm. sample of the Footner Lake core (Figure 4) does reveal a rise in Conifers and a drop in the Sprouter/Conifer ratio; and a drop in the percentage of the charcoal population greater than or equal to 25 microns in size. The fall in Open Area plants is unexpectedly dramatic. Contrary to the above expectations, the charcoal/pollen ratio rises slightly.

From 1940 to the present with the institution of fire suppression, it was expected that Conifers would increase slightly; Open Area plants would decrease markedly; charcoal/pollen ratio would rise slightly; and the percentage of the charcoal population greater than or equal to 25 microns in size would fall. This time it is expected that sprouters would decrease slightly. No longer favoured in the bush by controlled burning, sprouter representation would be now rising on many hay-meadows. However, the extensive agriculture that exists in the south-eastern quadrant of the map area should ensure at least some continuation of Open Area representation. In accord with these expectations, Conifer representation rises slightly; the charcoal/pollen ratio rises; and the Sprouter/Conifer ratio falls. Contrary to these expectations, Open Area plants remain stable and, thus, the Sprouter/Open Area ratio falls markedly; and the percentage of the charcoal population greater than or equal to 25 microns in size rises.

The first two samples of the Hutch Lake core cover the past 100 years. In this time it would be expected that Open Area plants would decrease markedly; Conifers would definitely increase; and the percentage of the charcoal population which was greater than or equal to 25 microns in size would drop. In accord with these expectations, Open Area plants decrease dramatically and Conifers rise markedly. Contrary to expectation, however, the charcoal indicator rises to a peak.

In general, then, it is only fair to conclude that the results of this pollen analysis did not justify any great confidence in the use of this technique to delineate small scale changes in vegetation and charcoal representation due to changes in controlled burning. Of the two vegetation groups which were expected to behave non-ambiguously, Conifers followed expectations consistently, but Open Area plants were unreliable. This may be due to the statistical problem with a small sample or it may also be that such pollen is from a highly local source and does not really represent the regional vegetation at all, a solution which is substantiated by the marked difference in Open Area plant representation between the two cores. If the Open Area pollen is from a highly local source, then even several years without burning in the immediate vicinity of the lake might result in a change in representation. Sprouters which underwent changes historically that could not be illustrated unambiguously in the pollen record are observed to be stable over the past 100 years in the Footner Lake core and to rise over the same time in the Hutch Lake core. The charcoal indicators were also unreliable which suggests that the interpretation placed upon them was too simplistic.

It was speculated earlier in the chapter that different patterns of burning may have occurred in the early historic period in view of the different economic resources available and the adjustment that must have been necessary to the mid-1800 cool and wet climatic fluctuation. The existence of large herds of buffalo and elk in the area would have provided an economic reason for the maintenance of hay meadows which were much larger than those at the time of the turn of the century. Although the Open Area plant profiles of both lakes peak at about 100 years BP., the violent changes evident in the Open Area plant representation are not as informative as trends would be. On the other hand, one would expect the climatic fluctuation of the mid-1800's to be reflected in a rise in Conifers, an increase in the percentage of the charcoal population greater than or equal to 25 microns, and a decrease in the charcoal/pollen ratio. These changes from the earlier period are evident in the Footner Lake sample 03-04 cms. which dates to 105-140 years BP. These are reflected in a subdued fashion in the Hutch Lake 02-03 cm. sample dating 100-150 BP. Obviously even intensified controlled burning patterns could not have compensated entirely for these climatic conditions.

## Conclusions

In conclusion, the palynological technique was not very useful for delineating small-scale changes in vegetation but did provide some indications for long-term trends in controlled burning that can be further investigated.

One of the problems already mentioned in the discussion of small-scale changes is that for Open Area plants, sample size was relatively small and even the increase or decrease by a few grains could cause a marked change in a relative frequency diagram or a ratio. The Conifers, on the other hand, have a relatively large sample size and the variation in their frequency did in fact correspond to the expected changes. A second possible source of error is the situation of the Footner Lake and Hutch Lake coring localities which were less than ideal for this type of study in terms of lake depth and rate of sedimentary deposition. A meromictic lake in which sediments can be dated by the year and in which there are no sediment-burrowing organisms may yet offer more conclusive palynological evidence of human influences in the environment over small periods of time. An alternative might be to analyze a series of cores from one locality such as a hay meadow or former hay meadow to provide a history of controlled burning in that area.

Future research on the prehistory of controlled burning in this area may be approached through some combination of archaeological and palynological work. It would not be possible of course to say at an archaeological site that any one charcoal layer represented a man-caused fire. However, an unusually high fire frequency or the maintenance of a vegetation type which otherwise would change with succession could lead to an inference of the local use of the technique of controlled burning. Again, a hay meadow would be the ideal locality for this.

Finally, one of the major problems in dealing with question of this type lies in the lack of resolution inherent in the technique of palynology itself. The opportunities for error in relating what is seen under the microscope to the environmental source of these microfossils are numerous. It is not surprising that most of the innovative work in palynology today focuses on these introspective problems of pollen production, dissemination and preservation. It is imperative for fire-history work that similar studies be undertaken for the processes charcoal undergoes. More experimental work like Wright's (1976) study is needed to avoid any simplistic interpretations of charcoal indicators.

# CHAPTER VI

## SUMMARY AND SPECULATION

In summary, this paper has served to delineate one way in which the technology of a foraging group may manipulate the natural environment. Specifically it has been demonstrated that the use of this technique in northwestern Alberta affected a) regional vegetation by 1) maintaining grassland on areas where soil changes over time should have favoured forestation, 2) creating grassland on areas where the soil was particularly suitable for grass and 3) maintaining a high ratio of 'edge' within forested areas; b) the distribution as well as the number and health of many species of animals; and c) the distribution and intensity of naturally occurring fires.

The demonstration of the potential of this particular use of energy to change aspects of the natural environment serves as a direct refutation of the evolutionist stereotypes of either the passively adapted hunter and gatherer (eg. Cohen 1968) or, at best, of the human organism which can cause local disturbance much as any other species can but which still remains outside of the 'human' strategy of creating areas of high productivity and low biomass (Polgar 1975). The distinction between causing and creating is important: only the latter specifically implies the kind of planned, controlled effort such as has been demonstrated in the instance of the Athabaskan use of fires. In addition, the evolutionist correlation between amount of energy capture and complexity of the organization of social relations within the group can be challenged. The energy captured in the use of controlled burning is high; the cost is low in terms of physical effort and, since the application is generally by an individual, it is also low in terms of social organization.

Further comparative work on the use of controlled burning by hunters and gatherers is needed to combat some of the generalizations about hunter and gatherers which are so firmly entrenched in anthropology. As Lewis (1977) has suggested, in the past ethnographers have been very much hampered by their own ethnocentric biases in the investigation of native burning. Natural fire has been considered to have only deleterious effects and ethnographers, with this a priori assumption have been reluctant to investigate the use of fire by native groups (eg. Michéa 1960) if that use was in fact there to be observed. It is also certain that the elimination of controlled burning from the native technology with the introduction of fire suppression provides another striking example of the ways in which native life-ways have changed since European contact. Since direct observation of this technique is no longer possible, researchers must resort to historic records or, in the more northerly areas, to ethnohistoric interviews such as provided the basis for this paper.

One study (Loscheider 1977) uses historic records from the northern Plains to document the use of fire to manipulate primarily the social rather than the physical environment for economic reasons.

Loscheider suggests that this socially-oriented use of fire took precedence over the environmentally-oriented use of fire in the historic period since the introduction of the fur trade accelerated inter-tribal contact and provided the new contact of the trading post. Large-scale fires were used to drive buffalo from the vicinity of a post so that the economic value of provisions traded by the natives would increase; and to force intruders to return to their own hunting grounds. Fires were used as a tool in warfare and as a means of communication.

Such social uses of fire were much less common further north. There is mention of the use of fire in one Athapaskan-Cree battle in the southern Peace River grasslands (Godsell 1938); and, of course, spring or fall fires set by individuals on the way back to camp, or even confined campfires could act as a means of signaling one's location.

In addition to these uses of fire in two different areas is the ethnohistoric report of the native use of fire on the tundra. House (1909:389-390) comments on the use of grass fires during caribou hunts to obscure the scent of the approaching humans; Auer (1916:36-37) records the use of fire to drive caribou between fences.

The temporal aspect of the use of controlled burning in different geographical areas also needs to be documented. In this paper it has been suggested that patterns of controlled burning changed over time with changes in economic goals, in climate and in socio-political systems. Similarly, Loscheider (1977) notes that on the Northern Plains the socially oriented use of fire, as revealed by historic records, peaked in the late 1700's with the initial contact with traders and again in the period of 1850-70 when European immigration onto the Plains was at its maximum just prior to the establishment of reservations.

For the boreal forest area, the cessation of controlled burning and the loss of its environmental benefits may have had repercussions in other than economic spheres. Lack of resource predictability in the boreal forest has, for instance, been interpreted as an underlying basis for certain modern forms of social interaction among the Beaver Indians of the Upper Peace (Ridington 1968). An individual's ability to predict resource location is linked to supernatural powers and is the main focus of 'dreaming' and medicine fights. Ridington suggests that prior to the extermination of the buffalo in this area, this interaction might have been different. Equally, it might be expected that prior to the beginning of fire suppression, the predictability of resource capture might have assumed less importance in this type of interaction.

In this instance, palynology proved inadequate to trace short-term changes in vegetation and charcoal representation. This was a failure perhaps due to the quality of the coring localities but it very definitely reflected the need for more research on the processes between the production of charcoal and its deposition in sediments. However, one interpretation of the long-term data hypothesizes that 3000 BP. dates the beginning of the use of this technique of controlled burning. Some suggestions as to how this hypothesis may be further examined through combined palynological and archaeological studies have been offered in the previous chapter. This thesis has concentrated on the short-term effects of controlled burning but it should still be pointed out that this technique may have had influences on the environment over the long term. Some studies have been initiated and hypotheses put forward that pertain to the general relationship between fire and the boreal environment. In an earlier chapter, for instance, mention was made of Mutch's (1968) hypothesis that plant communities of the boreal forest evolved in the presence of recurrent fire to the extent that many plants are now pre-adapted to burn. Similar implications are made in recent studies investigating the effects of environmental heterogeneity, such as fire creates, on the genetic characteristics of faunal populations. Bendell (1974:121) speculates that there may be a relationship between the small number of species in the boreal forest and the fact that this environment is fire-prone. He suggests that there is selection under these conditions for species which are highly adaptable. Geist (1971:122-4) points out some specific population characteristics of the moose, a typical 'fire-follower,' which he suggests are crucial in the exploitation of new areas: high and variable birth rate, a high dispersal rate, a population limited by food supply and therefore prone to fluctuations in size. Relevant to this latter factor is the suggestion that populations which are characterized by fluctuations in abundance have a greater potential for microevolution (Yesner 1977).

Environmental heterogeneity is also positively correlated with polymorphism in biological populations (Levins 1962;1963; Levins and Paine 1974; Loucks 1970). Most of these studies have dealt with patchiness of environment on a small scale and examining resident organisms which spend their life in one patch. One observation of a relatively large and mobile animal under these conditions of "patchiness" outlines how variability in pelage colour is maintained in an area characterized by recurrent fire (Guthrie 1967). One subspecies of ground squirrel, Citellus undulatus osgoodi, inhabits areas of secondary succession and old burns in the Yukon. Their pelage colour exhibits a black phase (melanics) as well as considerable variation in the pigmentation of the non-melanic. Guthrie's analysis suggests that in terms of predation, the survival of the melanics is favoured in the first few years following a burn, whereas the survival of the non-melanics is favoured as succession advances. Certain situations, despite succession, may continue to be adaptive for melanics eg. charred stumps. Thus, both pigmentation alleles are maintained in the population in a balanced manner through the continuing occurrence of fire.

The summary of this literature on the genetic implications of environmental heterogeneity deals essentially with "natural" fire as the cause of heterogeneity. However, since controlled burning and its modifying effect on natural fire acts to intensify the natural vegetational mosaic, the above genetic effects may well be intensified also. Environmental heterogeneity and its potential for genetic variability may reach its zenith under the impact of controlled burning relative to what is produced either by the current regime of fire suppression and its modifying effect on "natural" fire (Howe 1976), or possibly by some hypothetically "pure" pattern of natural fire which may yet be defined on the basis of electrical disturbance in the atmosphere (E. V. Komarek 1967).

This research brings up some interesting ecological questions other than the long-term effects of controlled burning. One of these is the interaction between fire and snow, an ecological relationship which has not been extensively researched (eg. Billings 1969). This paper has mentioned some aspects of this interaction in relation to spring and fall burning: the use of snow-covered areas as fire-breaks; the effect of snow in retarding post-fire erosion by "catching" some of the ash; and the role of exposed burned areas in accelerating the melting of snow in the surrounding locality. This paper has also discussed the nature of snow in open areas. It tends to be deeper than in forested areas and crusts more readily particularly as spring approaches. If the burn is large, wind activity may drift and crust the snow more markedly. Even chionophiles or snow-adapted animals such as the moose and caribou will avoid these areas. There is some evidence that the Athapaskans took advantage of this natural pound in hunting. Game was driven into such areas of deep crusted snow so that further flight was impossible (Franklin 1969:134; Jenness 1937:2). One unanswered question relates to the effect of fall-burning on the structure of the snow, and particularly on the structure of the lowermost layer of snow in which the subnivean creatures live. If fall bush-burning were to change the snow structure or deplete forage, these subnivean animals which are the prey of some fur-bearers might not be able to survive a winter there. From the trappers point of view, this would then be an unproductive area.

In reference to anthropology's role in regional and social and economic planning, I should like to point out that this research is not merely an exercise in ethnohistory but has some practical implications. Controlled burning is now carried out in northwestern Alberta to reduce the fire hazard on large hay meadows near native settlements. Elsewhere, however, controlled burning is becoming an integral part of fire management programs (eg. Tall Timbers Fire Ecology Conference and Fire and Land Management Symposium, 1976). Nevertheless, this does not imply that fire suppression is becoming any less important. As pressures on natural resources increase and resource management becomes more intensive, fire suppression continues to play an important role by ensuring that the only fires are those which are controlled as to timing, extent and nature.

The benefit of a fire management program in northwestern Alberta in which controlled burning plays a greater part should be obvious. Restoration of former hay meadows might in time permit the re-introduction of bison from the expanding populations in the provincial and federal parks. Controlled burning is also one means of destroying the animal feces and dead grass which are easily contaminated by anthrax spores and thus act to infect bison and horses. The use of controlled burning in bush areas can act to reduce fire hazard, a traditional Forest Service concern, by clearing out dangerous accumulations of deadfall. The increased environmental heterogeneity derived from such a program would favour wildlife in general, a benefit both in terms of tourism and of traditional native subsistence. Too, the existence of an expanded controlled burning program would extend the potential employment period for the native into the spring and the fall from the usual summer source as fire-fighters. This is not unimportant since the Forest Service provides the form of wage employment which is most acceptable to the native from among his limited alternatives. In short, a fire management program combining fire suppression and controlled burning could serve various interests in the community - the Forest Service, recreation and tourism, and most of all, the native interests.

## FOOTNOTES

1. R. Miyagawa is the Director of Fire Research, Forestry Service, Edmonton, Alberta.

2. J. Skrenek was, at the time of my fieldwork, Fire Officer for the Footner Lake District of the Forest Service.

3. Spot fires refer to those fires which are less than 1/4 acre in size.

4. S. Pawluk is the Chairman of Soil Sciences at the University of Alberta, Edmonton.

5. R. Henriet was, at the time of my fieldwork, band manager for the Slaves of the Upper Hay River.

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APPENDIX I

PALYNOLOGY: RAW DATA

A. Raw Pollen Counts

| Footner Lake | 90-91 | 80-81 | 70-71 | 60-61 | 50-51 | 40-41 | 34-35 |
|---|---|---|---|---|---|---|---|
| Picea | 29.5 | 29.5 | 29.5 | 37.5 | 15 | 25.5 | 28 |
| Pinus | 12.5 | 14 | 19 | 19.5 | 17.5 | 26.5 | 24.5 |
| Larix | 1 | - | - | - | - | - | - |
| Populus | 1 | 1 | 1 | 1 | 3 | 2 | 3 |
| Betula | 60 | 83 | 68 | 66 | 62 | 68 | 56 |
| Alnus | 50 | 58 | 85 | 54 | 72 | 61 | 89 |
| Salix | 23 | 19 | 13 | 11 | 16 | 16 | 20 |
| Corylus | - | - | - | - | 1 | - | 1 |
| Shepherdia can. | - | - | 2 | 1 | 1 | 2 | - |
| Myricaceae | 2 | 2 | 4 | 6 | 6 | 5 | 4 |
| Gramineae | 6 | 12 | 7 | 8 | 8 | 6 | 10 |
| Equisetum | - | - | 1 | - | - | - | - |
| Artemisia | - | - | 1 | 1 | - | 1 | - |
| Tubiflorae | - | 1 | - | 1 | 1 | - | - |
| Ambrosia | - | - | - | - | - | - | - |
| Chenopodiaceae | - | - | - | - | - | - | - |
| Chenopodiineae | 1 | - | - | 1 | - | - | 2 |
| Caryophyllaceae | 1 | - | - | 2 | 1 | - | 2 |
| Umbelliferae | 3 | 5 | 2 | 4 | 3 | 2 | 9 |
| Cornus can. | - | - | - | - | - | - | - |
| Galium | - | - | - | - | - | - | - |
| Ranunculaceae | 1 | - | - | - | - | - | - |
| Ericaceae | - | 1 | - | - | 1 | 1 | 1 |
| Cyperaceae | 3 | 3 | 2 | 1 | 3 | 1 | - |
| Typha lat. | 7 | 9 | 10 | 8 | 4 | 3 | 5 |
| Sparganium | - | - | - | - | - | - | - |
| Myriophyllum | 2 | 5 | 3 | - | 1 | 2 | 3 |
| Hippuris | - | - | 1 | - | - | - | - |
| Potomogeton | - | - | - | - | 1 | - | - |
| Indeterminate | 6 | 3 | 5 | 4 | 7 | 4 | 6 |
| Total | 209 | 245.5 | 253.5 | 226 | 223.5 | 226 | 263.5 |

| Footner Lake | 30-31 | 26-26 | 20-21 | 15-16 | 10-11 | 9-10 | 8-9 |
|---|---|---|---|---|---|---|---|
| Picea | 25.5 | 23.5 | 39 | 34 | 53 | 28.5 | 19 |
| Pinus | 30.5 | 20 | 55 | 24 | 30.5 | 32.5 | 20 |
| Larix | - | - | - | - | 1 | 1 | - |
| Populus | 4 | 3 | - | 4 | 5 | 1 | 2 |
| Betula | 58 | 68 | 70 | 75 | 49 | 46 | 68 |
| Alnus | 71 | 81 | 73 | 83 | 59 | 76 | 76 |
| Salix | 11 | 10 | 14 | 15 | 11 | 23 | 21 |
| Corylus | 6 | - | - | 3 | 10 | 6 | - |
| Shepherdia can. | 1 | 1 | 2 | - | - | - | - |
| Myricaceae | 2 | 5 | 9 | 8 | 9 | 5 | 7 |
| Gramineae | 8 | 3 | 8 | 6 | 7 | 5 | 4 |
| Equisetum | - | - | - | - | - | - | - |
| Artemisia | 4 | - | - | 1 | - | 2 | 1 |
| Tubiflorae | - | - | 2 | - | 1 | - | 1 |
| Ambrosia | - | - | - | - | - | - | - |
| Chenopodiaceae | - | - | - | - | - | - | - |
| Chenopodiineae | - | - | - | - | - | - | - |
| Caryophyllaceae | - | - | 1 | 1 | 1 | - | - |
| Umbelliferae | 5 | 4 | 1 | 4 | 3 | 2 | 6 |
| Cornus can. | - | - | - | - | 1 | 1 | - |
| Galium | - | 1 | - | - | - | 1 | - |
| Ranunculaceae | - | - | - | - | - | - | - |
| Ericaceae | - | - | - | - | - | - | - |
| Cyperaceae | 8 | 1 | - | 2 | 4 | 1 | 2 |
| Typha lat. | 2 | 2 | 2 | 3 | - | 3 | 1 |
| Sparganium | - | - | - | - | - | - | 1 |
| Myriophyllum | - | 1 | 3 | 5 | 3 | 1 | 5 |
| Hippuris | - | - | - | - | 1 | - | - |
| Potomogeton | 5 | - | - | 2 | 1 | 1 | 3 |
| Indeterminate | 10 | 5 | 8 | 6 | 18 | 4 | 6 |
| Total | 251 | 228.5 | 287 | 276 | 267.5 | 240 | 243 |

| Footner Lake | 7-8 | 6-7 | 5-6 | 4-5 | 3-4 | 2-3 | 1-2 | 0-1 |
|---|---|---|---|---|---|---|---|---|
| *Picea* | 34 | 34 | 42.5 | 40 | 51 | 43 | 32.5 | 34.5 |
| *Pinus* | 23 | 23 | 9 | 15 | 16.5 | 27.5 | 22.5 | 20 |
| *Larix* | - | 2 | 2 | - | - | - | 1 | - |
| *Populus* | 1 | 2 | 2 | 3 | - | 4 | 1 | 1 |
| *Betula* | 64 | 73 | 53 | 91 | 68 | 59 | 66 | 56 |
| *Alnus* | 60 | 54 | 70 | 67 | 61 | 51 | 53 | 71 |
| *Salix* | 17 | 18 | 15 | 25 | 14 | 20 | 17 | 15 |
| *Corylus* | 3 | 6 | 1 | - | 1 | - | 3 | - |
| *Shepherdia can.* | 2 | 1 | 1 | - | 1 | 1 | 1 | - |
| *Myricaceae* | 5 | 6 | 12 | 6 | 6 | 14 | 16 | 6 |
| *Gramineae* | 8 | 4 | 7 | 4 | 5 | 7 | 5 | 2 |
| *Equisetum* | - | - | - | - | - | - | - | - |
| *Artemisia* | 1 | 2 | 1 | - | 2 | 2 | - | 1 |
| *Tubiflorae* | - | - | - | - | - | - | 1 | - |
| *Ambrosia* | - | - | - | - | - | 1 | - | - |
| *Chenopodiaceae* | - | - | - | - | - | - | - | 1 |
| *Chenopodiineae* | - | - | 1 | - | - | - | - | - |
| *Caryophyllaceae* | - | - | - | - | 1 | - | 1 | - |
| *Umbelliferae* | 4 | 1 | 2 | 2 | 1 | 4 | 1 | 3 |
| *Cornus can.* | - | - | - | - | - | - | - | - |
| *Galium* | - | - | - | - | - | - | - | 1 |
| *Ranunculaceae* | - | - | - | - | - | - | - | - |
| *Ericaceae* | - | - | - | 2 | - | - | - | - |
| *Cyperaceae* | 4 | 2 | 2 | 2 | 2 | - | 4 | - |
| *Typha lat.* | 4 | 2 | 2 | 8 | 1 | 3 | 3 | 5 |
| *Sparganium* | - | - | - | - | - | - | - | - |
| *Myriophyllum* | - | - | 2 | 1 | 2 | - | - | - |
| *Hippuris* | - | - | - | - | - | - | - | - |
| *Potomogeton* | - | 1 | 1 | 1 | - | - | - | 1 |
| *Indeterminate* | 2 | 4 | 5 | 3 | 13 | 5 | 7 | 9 |
| Total | 235 | 235 | 230.5 | 270 | 245.5 | 241.5 | 235 | 226.5 |

| Hutch Lake | 90-91 | 80-81 | 70-71 | 60-61 | 50-51 | 40-41 | 35-36 |
|---|---|---|---|---|---|---|---|
| Picea | 64.5 | 49.5 | 63 | 53 | 67 | 61 | 42 |
| Pinus | 12 | 16.5 | 9 | 19 | 21 | 24 | 22 |
| Larix | 2 | 2 | - | - | - | 1 | 1 |
| Populus | 8 | 6 | 7 | 2 | 8 | 6 | 2 |
| Betula | 28 | 43 | 27 | 35 | 31 | 39 | 50 |
| Alnus | 44 | 30 | 72 | 59 | 51 | 43 | 63 |
| Salix | 13 | 11 | 19 | 20 | 9 | 8 | 21 |
| Corylus | 5 | 10 | 1 | 1 | 3 | 6 | - |
| Corylaceae | - | - | - | - | - | - | - |
| Shepherdia can. | - | - | 1 | - | 1 | - | 1 |
| Myricaceae | 3 | - | - | - | - | - | - |
| Gramineae | 11 | 16 | 18 | 17 | 12 | 17 | 9 |
| Equisetum | - | - | - | - | - | 1 | - |
| Artemisia | 2 | - | - | 1 | 2 | 2 | - |
| Tubiflorae | 1 | - | - | - | - | - | - |
| Menyanthes | - | - | - | - | - | - | - |
| Chenopodiineae | 8 | 8 | 4 | 4 | 3 | 2 | 4 |
| Carycphyllaceae | - | - | - | - | - | - | - |
| Umbelliferae | 3 | - | 4 | - | 2 | 1 | - |
| Cornus can. | - | - | 1 | - | - | - | 2 |
| Galium | - | - | - | 1 | - | - | 1 |
| Rumex | - | - | - | - | - | - | - |
| Ericaceae | - | - | - | - | - | - | - |
| Cyperaceae | 9 | 13 | 5 | 1 | 6 | 7 | 2 |
| Typha lat. | 3 | 4 | 6 | 2 | 3 | 3 | 2 |
| Sparganium | - | - | 1 | - | - | - | - |
| Myriophyllum ex. | - | - | 2 | 8 | 2 | 2 | 3 |
| Myriophyllum alt. | - | - | - | - | - | - | - |
| Hippuris | - | - | - | - | - | - | - |
| Potomogeton | 4 | 4 | 2 | 1 | 2 | 4 | 1 |
| Indeterminate | 8 | 20 | 11 | 1 | 9 | 12 | 7 |
| Total | 228.5 | 233 | 253 | 224 | 232 | 239 | 233 |

| Hutch Lake | 30-31 | 25-26 | 20-21 | 15-16 | 10-11 | 9-10 | 8-9 |
|---|---|---|---|---|---|---|---|
| Picea | 52.5 | 28 | 35.5 | 38 | 42 | 35.5 | 38 |
| Pinus | 29 | 40 | 27 | 22 | 23.5 | 34.5 | 34.5 |
| Larix | 1 | 1 | - | - | - | - | - |
| Populus | 8 | 1 | 3 | 7 | 2 | 6 | 1 |
| Betula | 39 | 62 | 65 | 57 | 66 | 51 | 66 |
| Alnus | 42 | 72 | 54 | 54 | 61 | 51 | 61 |
| Salix | 13 | 15 | 14 | 19 | 17 | 18 | 21 |
| Corylus | 2 | - | - | 2 | - | 1 | 1 |
| Corylaceae | - | - | - | - | - | - | - |
| Shepherdia can. | 1 | - | 1 | - | - | - | 1 |
| Myricaceae | - | 2 | 1 | 1 | - | - | - |
| Gramineae | 13 | 21 | 12 | 14 | 17 | 14 | 18 |
| Equisetum | - | 1 | - | - | - | - | - |
| Artemisia | 4 | - | 4 | 1 | - | 2 | 1 |
| Tubiflorae | - | - | - | 1 | - | - | - |
| Menyanthes | - | - | - | - | - | - | - |
| Chenopodiineae | 4 | 1 | 1 | 1 | 1 | 1 | 1 |
| Caryophyllaceae | - | - | - | 1 | 1 | 1 | - |
| Umbelliferae | - | 3 | 1 | - | 1 | 1 | 1 |
| Cornus can. | - | 1 | - | - | - | 1 | 1 |
| Galium | - | - | 1 | - | - | - | - |
| Rumex | - | - | - | - | - | - | - |
| Ericaceae | - | 1 | 1 | - | - | 1 | - |
| Cyperaceae | 9 | 7 | 3 | 3 | - | 6 | 4 |
| Typha lat. | 1 | 2 | 6 | - | - | 2 | - |
| Sparganium | - | - | - | - | - | - | - |
| Myriophyllum ex. | 11 | - | 8 | 1 | 6 | 3 | 4 |
| Myriophyllum alt. | - | - | - | - | - | - | - |
| Hippuris | - | - | - | - | - | - | - |
| Potomogeton | - | 1 | 1 | 5 | 1 | 2 | 1 |
| Indeterminate | 18 | 5 | 9 | 7 | 14 | 4 | 5 |
| Total | 247.5 | 264 | 247.5 | 233 | 253.5 | 236 | 259.5 |

| Hutch Lake | 7-8 | 6-7 | 5-6 | 4-5 | 3-4 | 2-3 | 1-2 | 0-1 |
|---|---|---|---|---|---|---|---|---|
| Picea | 59 | 39 | 39 | 42 | 58.5 | 45 | 38 | 38 |
| Pinus | 29.5 | 29 | 37 | 21.5 | 19.5 | 30.5 | 35 | 25.5 |
| Larix | 1 | - | 1 | 2 | 1 | - | - | - |
| Populus | 3 | 2 | 3 | 7 | 6 | 4 | 2 | 2 |
| Betula | 68 | 60 | 52 | 52 | 52 | 43 | 48 | 54 |
| Alnus | 50 | 45 | 62 | 51 | 58 | 42 | 64 | 62 |
| Salix | 8 | 17 | 22 | 23 | 8 | 16 | 14 | 17 |
| Corylus | 2 | 1 | - | 9 | 3 | 1 | - | - |
| Corylaceae | - | 1 | - | - | - | - | - | - |
| Shepherdia can. | 1 | - | - | 1 | 1 | - | - | - |
| Myricaceae | - | - | - | 1 | - | - | - | - |
| Gramineae | 8 | 10 | 11 | 16 | 9 | 12 | 21 | 8 |
| Equisetum | - | - | - | 2 | - | - | - | - |
| Artemisia | - | 1 | - | 3 | 1 | - | - | 3 |
| Tubiflorae | - | - | - | 2 | - | - | - | 2 |
| Menyanthes | - | - | - | - | - | 1 | - | - |
| Chenopodiineae | 1 | 1 | - | 2 | - | 2 | 1 | - |
| Caryophyllaceae | - | 1 | - | 1 | - | - | - | - |
| Umbelliferae | 1 | 2 | 2 | 2 | 3 | - | - | 1 |
| Cornus can. | - | - | 2 | - | - | - | - | 1 |
| Galium | - | - | - | 1 | - | - | - | - |
| Rumex | - | - | - | - | 1 | - | - | - |
| Ericaceae | - | - | - | - | - | - | 1 | 1 |
| Cyperaceae | 5 | 6 | 5 | 2 | 3 | 4 | 3 | 14 |
| Typha lat. | 1 | - | 1 | - | - | 2 | 2 | - |
| Sparganium | - | - | 1 | - | - | - | - | - |
| Myriophyllum ex. | 2 | 1 | 5 | 4 | 5 | 7 | 1 | 4 |
| Myriophyllum alt. | - | - | 2 | - | - | - | - | - |
| Hippuris | - | - | - | - | - | - | - | 1 |
| Potomogeton | 3 | 2 | 2 | - | - | 2 | 1 | 1 |
| Indeterminate | 8 | 2 | 2 | 4 | 7 | 3 | 2 | 9 |
| Total | 250.5 | 220 | 249 | 248.5 | 236 | 214.5 | 233 | 243.5 |