Short Title:

MISTASSINI HUNTERS OF THE BOREAL FOREST

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Abstract:

MISTASSINI HUNTERS OF THE BOREAL FOREST

Ecosystem Dynamics and Multiple Subsistence Patterns

by Harvey A. Feit

Presented to McGill University in partial fulfillment of requirements for the Degree of Master of Arts, March, 1969, Department of Anthropology.

This thesis applies an ecosystem analysis in a hunting and gathering culture for the first time, namely the pre-contact Mistassini Indians of the sub-arctic boreal forest of Quebec. It shows how ecosystem analysis makes possible the resolution of long standing debates unresolved by previous Stewardian cultural ecological analyses; in particular, the debates over the aboriginality of the family hunting territory system and over the primary aboriginal subsistence base. On the basis of an extensive review of current biological knowledge on the boreal forest ecosystem an attempt is made to reconstruct the pre-contact strategy of adaptation, with particular stress on 'feast or famine' as a mechanism for maintaining human population density equilibrium. In addition, a hypothesis is proposed as a possible guide for further research on the ecosystems of hunters and gatherers: that in hunting and gathering societies the socio-cultural subsystem will respond to the variability, both spatial and temporal, of the environmental subsystem.

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PREFACE

The research for and preparation of this thesis was done while the author was a research assistant with the Cree Developmental Change Project (formerly the McGill-Cree Project), Programme in the Anthropology of Development, McGill University. This Project was supported by the Canada Department of Forestry and Rural Development (ARDA, grant No. 34002), le Centre d'Etudes Nordiques of l'Universite Laval, and the Northern Research Committee, McGill University. The writer thanks these institutions for their support, and also the Department of Anthropology, McGill University for a research assistantship, and the Faculty of Graduate Studies and Research at McGill for a Steinberg Summer Research Fellowship.

This thesis was initiated through the encouragement and personal support of Dr. Norman A. Chance, Director of the Project. Dr. Chance's frequently expressed confidence in the value of this research and his willingness to let the researcher's own interests and aptitudes formulate and accomplish the task in his own way were vital to its successful completion.

The formulation and presentation of this thesis have benefitted from the invaluable assistance of Professors Bruce G. Trigger and Peter S. Sindell. Dr. Trigger offered considerable advice and significantly clarified my thoughts during the critical stages of formulating the questions under study and outlining the research program.

Dr. Trigger began a leave of absence during the writing of the first draft, and was replaced by Professor Sindell. He read the drafts critically and made numerous suggestions which clarified the logic of the arguments and improved the quality of presentation. Unfortunately, last minute revisions have not had the benefit of his suggestions. Both advisors are represented on the pages that follow in many unfootnotable ways - but neither is responsible for the final product.

The initial idea of an ecological study of Mistassini was suggested by Roger Pothier, Field Director of the Cree Developmental Change Project. He and other members of the Project staff - including Ignatius LaRusic, Adrian Tanner, Dr. Ronald Wintrob, Bernard Bernier, and Dr. David Holden - first introducted me to the Mistassini and regularly acted as sounding boards for my ideas.

Dr. P.F. Maycock of the Botany Department at McGill generously made his advice and his extensive research bibliography on the boreal forest available at the beginning of this study, while Dr. W.D. McLaren of the Zoology Department similarly provided advice and initial leads into the literature. Dr. Jacques Rousseau read an earlier version of Chapter III and made a number of valuable comments which we have incorporated.

A note of thanks is also due to the Department of Anthropology which allowed me to undertake this research while I was still completing my M.A. course requirements, and to complete the thesis while beginning my Ph.D. studies..

Finally, it should be noted that this thesis is based entirely on library research.

Harvey A. Feit
Montreal, March, 1969.

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CHAPTER I : INTRODUCTION

The purpose of our thesis is to explore, by means of ecosystem analysis, the dynamics of the sub-arctic boreal forest and its relationship to population dynamics and subsistence patterns of the Mistassini Indians in the period immediately preceeding white contact. Our analysis will, in particular, examine: a) the claim for the aboriginality of the family hunting territory system; b) the claims by Algonkianists that large game was the primary aboriginal subsistence base; and c) the likely aboriginal "strategy of adaptation", particularly, the population density equilibrium mechanisms. The aim, however, is not only to contribute to these debates, now primarily of interest to Algonkianists, but also to contribute theoritically and methodologically to the development of ecological anthropology.

A - Ecological Anthropology and the Ecosystem Analysis of a Hunting People

The study of human ecology has been a part of anthropology from the early years of the discipline. In the first three decades of this century two theoretical formulations of the relationship of culture and environment were available: anthropogeography and environmental possibilism. The former approach was an investigation of the degree and manner in which culture was shaped by environmental conditions. The latter approach did not see the environment as a determining factor but merely as limiting.

According to Clifford Geertz, the theoretical inadequacy of both approaches lay in their total separation of the contepts of 'culture' and 'environment' (1963:3).

Julian Steward (1955) made the first attempt at bridging the gap between 'culture' and 'environment' by analysing the exploitative pattern, that is, the interaction of resources and technology. Geertz considers that the distinctive feature of Steward's approach was to limit the area of ecological focus to those elements of environmental processes and of human socio-cultural activity that are in closest interaction, i.e., those elements involved in the exchange of material and energy between the natural environment and the human economy. "The sharpness of the division between analysis from the side of 'man' and analysis from the side of 'nature' therefore disappears, for the two are necessarily alternative and interchangeable conceptualizations of the same systemic process" (Geertz, 1963:8).

The analytic structure of the explanations provided in this framework was outlined by Walter Goldschmidt (1965:403): environment is the independent variable, a repertoire of techniques is assumed, subsistence patterns are the intermediate variables, core behavior patterns of the society are the primary dependent variables, and other social institutions and cultural attitudes are the secondary dependent variables.

Steward's major contribution to the development of human ecological theory is his focus on the reticulation of 'culture' and 'nature' which has laid the foundation for ecosystem analysis in anthropology.

An ecosystem is defined as a community of inter-related organisms together with their non-organic environment. As such, the concept of ecosystem brings together within a single view point selected human activities, biological transactions, and physical processes. The ecosystem is thus conceived of as a particular level of organization - that which integrates a biotic community with its habitat. Ecosystem analysis is a generalized model for analysing ecosystems; in short, it is a different level of model. The development of ecosystem analysis in the biological sciences in the last two decades has been based on a number of techniques of analysis, particularly the study of: food chains (trophic structures), the cycling of material (biogeochemical cycles), the cycling of energy (energy flow), and development (succession, climax and equilibrium) (Eugene Odum, 1963)[1]. In ecosystem analysis there is no point-to-point cause and effect. The focus is on the integration of the system, on an assumed circular cause and effect, on effect and feedback, and on the relative degree of influence of variables or sub-systems. As Geertz indicates, the analysis studies "the pervasive properties of systems qua systems" (1963:10) - composition, structure and dynamics. The questions are: How is it organized? What mechanisms regulate its functioning? What is the quality and quantity of its stability?

Because man is dependent on resources taken from the physical habitat and the biological communities of the earth he can always be analysed as a part of some ecosystem. Man is unique in that he carves his ecological niche with cultural tools rathar than biological specializations, but this does not prevent him from entering a network of relationships with other organisms of his biotic community and constituents of his physical environment, although this network is "woven of cultural threads" (Charles Frake, 1962:54).

Given its applicability and usefulness, the progress of ecosystem analysis within ecological anthropology has been surprisingly slow. Frake has suggested that cultural ecology be redefined as "the study of the role of culture as a dynamic component of any ecosystem of which man is a part" (1962:53). There have been a number of other theoretical contributions to the approach as well as brief ecosystem studies: Andrew Vayda (1965), Morris Freilich (1965), Robert McC. Netting (1965), Marvin Harris (1966), David Damas (in press), and some of the papers in F.R. Fosberg (1965). To date, however, only two full monographic studies have utilized the method to my knowledge, Geertz (1963) and Roy Rappaport (1968). Rappaport's study focusses on the role of ritual in maintaining the ecological equilibrium of a New Guinea horticultural people. Geertz studied the economic development of colonial Indonesia.

Stewardian cultural ecology and ecosystem analysis are presently the two major analytical tools available to ecological anthropologists, and a dialectic presently taking place in the field is an exploration of the respective potentials and limitations of these tools.

Ecological anthropology is still in the early phases of it development, although that development is accelerating. As a result most of this testing takes the form of applying these analytical tools to new and varied situations, and discovering the powers and limitations of the assumptions of each analysis. For us, the application of ecosystem analysis to man is theoretically and methodologically the most powerful appraoch to human ecology. We view our study as an exploration of the use of ecosystem analysis.

We apply ecosystem analysis for the first time, to our knowledge, to a hunting and gathering society. Previously ecosystem analysis has been applied to horticultural and agricultural societies, apparently because many of its analytical assumptions - circular causality, dynamic systems and equilibriums, and complex environmental system variables - all fit these societies so well. In horticulture, or agriculture the importance of stressing causal links between human activity and its environmental consequences, as well as links from environment to man, are clear for agricultural man plays a significant role in making his ecosystem;;he creates the swidden, the terrace or the field and affects the outcome in many other ways, eg. use of irrigation and/or fertilizers. That the system is dynamic is also apparent as swidden and agricultural cycles involve several year long crop rotations which attempt to maintain an equilibrium with nature and also, most agricultural and horticultural societies have undergone rapid and extensive changes in the colonial period up to the present. Further, it has become clear that the environment must be studied intensively in order to make clear how successful horticulture or agriculture requires extensive knowledge and successful manipulation of soils, climate, plants, vegetational regeneration, and many other environmental variables all of which are systematically related. Despite its relevance to horticultural and agricultural societies, the application of ecosystem analysis to hunting and gathering peoples does not necessarily appear as an improvement over the use of Stewardian cultural ecology. The analytical assumptions of the latter - lineal causality from the environment to man, basically static adaptations, and a limited core of readily apparent environmental features - all seem reasonable, adequate to the task, and parsimonious. On the other hand, the analytical assumptions of ecosystem analysis appear unnecessary, or even untrue. Hunting and gathering peoples have little powers to affect the productivity of their environments, they are essentially only consumers. Recent studies have suggested a number of ways men at the hunting and gathering level of culture could affect their environments - eg., repeated burning could prevent climax vegetation from establishing itself over a large area and maintain the vegetational cover of an earlier successional stage, and introduction of alien species to a new environment could significantly alter it - but undisputable instances are not available, and in general it would still remain true that hunters and gatherers have no significant effect on their environments. That is, causality in hunting and gathering adaptations is lineal, from the environment and technology to social and cultural organization. Secondly, hunting and gathering adaptations, particularly in the pre-contact period, are assumed to have been essentially stable and conservative. Change was due to climatic, or outside human interference, and it is reasonable to explain these changes through unique historical events, and assume stability without further explanation, without postulating a dynamic equilibrium and maintaining mechanisms. Finally, and especially for hunters who depend primarily on animal resources, it is assumed that the quantities and distribution of these resources are related to other environmental variables in a fairly simple and lineal way. This analytical assumption is a consequence of the methodological priority given to core features of the human economy, whose causes are then sought in environmental features. These limited environmental features are treated as an adequate environmental description. Thus in the subarctic it is assumed that the primary conditioning factor is the cold - i.e. limited solar input - which limits animal populations, disperses them over wide areas and thereby requires sub-arctic hunters to distribute themselves widely over the territory. No one would dispute these facts, but we note the method by which environmental features are discovered and the way an environmental description is constructed: without studying it in its totality. In summary then, hunting and gathering cultures, particulary in pre-contact times, appear to be eminently suited to analysis by Stewardian cultural ecology, and less suited, or even unsuited, to study by ecosystem analysis.

Our study is particulary relevant to comparing these two analytical tools at the level of hunting and gathering peoples because the aboriginal human ecology of the sub-arctic has been extensively analysed using Stewardian cultural ecological assumptions, and conflicting conclusions have been reached. Steward himself has played only a minor role in these analyses, but his methodology has influenced nearly all participants. In the analysis that follows we will establish the main features of the aboriginal ecosystem of the sub-arctic Mistassini Indians of Quebec, and show how these features help to resolve the long standing debates over the territorial organization and the subsistence base of these people, and further help us to formulate a reasonable reconstruction of their basic "strategy of adaptation". In particular, we will show that the assumption of a basically static adaptation has underlain the previous studies and that precisely this assumption has prevented a clear-cut resolution of the debates. Further, our analysis indicates the value of intensive study of environmental variables as part of an ecosytem as a method that can reveal previously unsuspected, and not immediately apparent, linkages to the human economy. Preconceived mental "sets" developed in the temperate environments have plagued attempts to understand sub-arctic human ecology, especially the logic of the "feast or famine" life style. Methodologically, the ecosystem analysis of the sub-arctic boreal forest led us to recognize a number of elements of the human adaptation that had not been seen by earlier studies. In short, we consider the study that follows as a demonstration of the use of ecosystem analysis to resolve conflicting Stewardian cultural ecological analyses in circumstances where it has been assumed that ecosystem analysis would be less useful than Stewardian cultural ecology.

Furthermore, we do not consider this study as unique, but rathar see our discovery of considerable variation and flexibility over time in the adaptation of sub-arctic hunters as being in keeping with a general trend in studies of hunting and gathering peoples. We propose to formulate this trend as an explicit hypothesis.

The recently published papers and discussions of the conference on "Man the Hunter" (Richard B. Lee and Irven DeVore, 1968) reveal parallel dicoveries, in many culturs, of much greater flexibility in hunter and gatherer adaptations, subsistence patterns, mobility and social organization than had been noticed before. For example, it is being reported from many cultures that hunters and gatherers are actually involved in subsistence activities for only a small percentage of their time, and that they utilize only a percentage of the resources available to them, and that in times of failure of a basic resource they often have a number of options open to them. Recent comparative studies of archaeological, ethnohistorical and ethnological data have further shown that hunting and gathering adaptations were highly responsive to local variation and changes (eg. George MacDonald, 1968; Fred Eggan 1966; Wayne Suttles, 1962). These studies have generally stressed spatial variations in adaptations. Our own work is an example of the comparatively underdeveloped aspect of temporal variations. These findings, in total, are reshaping the basic view of hunting and gathering cultures, stressing the flexibility of its adaptations, as opposed to the former stress on the rigours of its adaptation and environment. There is a tendency to consider this new variability as an indication of a looser fit between hunting and gathering cultures and their environments. While there may be some truth in this claim, it seems to us to be more profitable, from the point of view of future research, to note that the environment itself is not rigid, static or invariable, and hence to focus research on whether the increased variability of hunting and gathering cultures can be explained in terms of environmental variability, both spatial and temporal. We present this hypothesis, as a guide for future research, and note that if it proves useful it implies a growing role for ecosystem analysis in studies of hunting and gathering peoples:

In propositional form:

Given (1) : That a hunting and gathering society can be analysed as a socio-cultural subsystem of an ecosystem; and

Given (2) : That the environmental subsystems of ecosystems are variable in time and space;

and

Given (3) : That in a hunting and gathering society there are no techniques for restructuring the environmental subsystem;

and

Assuming : That given sufficient time a society will seek to efficiently exploit the resources available to it with a given technology; then we propose

Hypothesis (1): In hunting and gathering societies the socio-cultural subsystem will respond to the variability of the environmental subsystem; and

Hypothesis (2): In hunting and gathering societies subsistence patterns, territorial organizations and population densities, among other features, will be variable in space and time in order to utilize variable resources.

The first given is arrived at by the definitions of the terms involved that were proposed above. The second given is an empirically established statement from the biological sciences. The third given is a formulation of the results of previous research on the cultural ecology of hunting and gathering societies. It is a reformulation of the statement that hunting and gathering societies, given their technologies, have little influence over their environments in the light of recent research and in terms appropriate to ecosystem analysis. The following assumption is one that underlies most studies in cultural ecology and human geography, although it is infrequently stated. There is a growing body of evidence supporting its general validity, so long as "efficiently" is understood within its present meaning in economic anthropology, i.e. implying maximization without assuming goals. As yet the research is not sufficiently detailed or extensive to put this assumption to the test. A number of exceptions to the assumption may have to be recognized in the end, but in the test case used here it does not appear to be in need of qualifications.

The two hypotheses will be tested on the basis of data concerning the aboriginal ecosystem of the Mistassini Indians, and in particular the issues raised by the debate over the aboriginality of the family hunting territory system. It should be noted that the boreal forest ecosystem is possibly unique in the extent to which local regions vary over time, and hence it makes our case exceptionally clearly. We do not however think that temporal variation of environments or adaptations is unique, and expect further studies to reveal the commonness of these phenomena.

Before reviewing the hunting territory debate it is best to briefly explain our use of terminology for various levels of social organization in the sub-arctic. It seems likely that in aboriginal times the Mistassini were differentiated from neighboring groups in self-perceptionon the basis of slight linguistic and cultural differences, and on the basis of geographical proximity. For the 'Mistassini' and comparable ethnogroupings we have used the term 'people'. The Mistassini were probably divided during the summers into a number of large, fluid 'fishing camps'; the entire people only coming together at a single site for very brief periods, if at all. In winter the Mistassini clearly broke up into smaller groups, the size of which is one of the points of debate. However, whatever the size, we have used the term 'band' when referring to these winter hunting groups.[2]

B - The Hunting Territory Debate and Current Views of the Human Ecology of the Boreal Forest Region

The family hunting territory debate began with Frank Speck's papers (1915a, 1915b, 1915c). A review of the debate, from the ecological point of view, is especially appropriate now since a general consensus on resolution of the issues has been emerging for over a decade; and, theoretically at least, the debate seems to be at an end.

The family hunting territory system had two prominent substantive aspects, the legal-territorial and the ecological-conservational. Speck defined the family hunting group as a kinship group based on consanguineal and affinal ties which had "the right to hunt, trap, and fish in a certain inherited district bounded by some rivers, lakes, and other natural landmarks" (1915c:290). These hunting districts, or territories, were "owned from time immemorial by the same families and handed down from generation to generation" (1915c:290). Informants knew and recognized almost exact bounds of the territories, in some instances could map the area, often had local names for the territories, and claimed trespass was punishable (1915c:290). Ecological considerations, particularly native conservation of game resources, were also an important part of Speck's early description of the hunting territory system. Territoriality allowed owners to keep close account of the resources. Killing game was "definitely regulated so that only the increase is consumed, enough stock being left each season to insure a supply for the succeeding year. In this manner the game is 'farmed', so to speak...." (1915c:293).

Over the two decades that followed the original description of the system, Speck developed and supplemented his claim for its aboriginality.

A variety of evidence was put foward: direct traditions going back one and a half centuries (1931:573-4); ethnohistorial records interpreted as implying the existence of hunting territories (1918:90); distributional evidence of the ancient status of the system (1928:329-330); and; Indian and Euro-Canadian claims of the necessity for conservation under aboriginal ecological conditions (1928:330).

Early critics of the claim for aboriginality questioned mainly the first three historically based agruments. The claim for aboriginal ecological conservation was only casually questioned. Diamond Jenness and Steward demonstrated that the old, but post-contact, traditions of the Indians in eastern Canada could not be projected back to aboriginal times without justification as ethnographic studies among western Indians demonstrated that trapping territory systems had emerged recently among them under the influence of the fur trade (Jenness, 1932:124; Steward, 1941).. Jenness and Alfred Bailey quoted ethnohistorial documents which contradicted Speck's ethnohistorial interpretation and supported claims for the post-contact origins of the hunting territory systems (Jenness, 1932:124; Bailey, 1937:86; Bailey, 1942:37; Bailey, 1938). Steward alone however, addressed himself, though peripherally, to the ecological argument, saying that: social and economic security required the unity of several families; sub-divided family hunting tracts would rarely provide sufficient varieties of foods; and, realignment, adjustments and many practical difficulties were inherent in defined territories (1936:332-3).

Speck and Loren Eiseley, starting in 1939, modified their position considerably in response to these criticisms (1939;1942). They increased the flexibility of their interpretations and incorporated many of the most telling historical and ethnographic points of their critics into their position. Simultaneously they extended the ecological arguments and made them the foundation of their claim for aboriginality of the hunting territory system. In particular, they acknowledged that the hunting territory system was not the most archaic. They accepted that it emerged under population pressure from a period where land was an economically free good, and they even postulated an intermediate period during which an allotment system probably existed (1942:239-9). They admitted that "in modern times true family ownership has been stimulated by the intensive exploitation of fur-bearing animals" (1942:240). By admitting that the family hunting territory system was strengthened, at least initially, by the coming of the fur trade Speck and Eiseley virtually insulated their claims for aboriginality from ethnohistorical argument. Henceforth, no amount of argument on how the system could have emerged as a result of contact was relevant to Speck and Eiseley's claims; only proof that it did not exist at first contact or earlier would be to the point. Speck and Eiseley implied that it was the very adaptation of the family hunting system to exploitation of fur-bearing animals that was a basic reason for believing it to be aboriginal. Distributional evidence confirmed the delicate adaptation of the system to ecological conditions. The family hunting territory system is not found in the tundra or in the Athapaskan areas, where aboriginal subsistence depended primarily on the caribou and bison respectively; (1942:240-1). The family hunting territory system was highly adapted to the forest zone which is not very rich in large game, but has small fauna which can be husbanded by small family groups (1942:241; 1939:277). The beaver in particular, which is free from the influence of major population cycles, which is easily located (even in winter) and which is non-migratory, was ideal for the operation of this more efficient and intensive hunting economy. Speck and Eiseley came to claim that "...the very fluidity of the adjustment (of the hunting territory system) itself suggests its intimate and sensitive reaction to factors far more heavily natural and environmental than traditional" (1942:242; see also 1939:276). In summary, their main argument for aboriginality became ecological, very possibly stimulated by the contemporary studies of Steward (1936; 1938; 1940). Further, Speck and Eiseley's argument had been insulated from ethnohistorical evidence. This position was adopted by other supporters of the claim for the aboriginality of the system.

In 1939 John Cooper wrote: "...there was nothing in the environment or cultural setting of the Algonkians of the times immediately preceding the coming of the European and the fur trader that would conceivably have militated against the rise or maintenance of a system of land holding in severalty; on the contrary the setting was favorable for the rise and maintenance of such a system, whether along family hunting ground or along allotment lines. This setting cannot therefore be appealed to as evidence against the pre-Columbian existence of the family hunting ground system, and so far as it goes may lend some slight corroboration to the other evidence for the aboriginality of the system" (Cooper,1939:88). Cooper, who speaks with some reserve of ecological factors in his 1939 article, became even more committed to a position akin to that of Speck and Eiseley in his later work (1941:59-60; 1946:294). In 1946 he considered the family hunting territory system "intimately dependent upon ecology" (294-5). Hallowell however made the ecological argument most explicit three years later by calling for a detailed analysis of the ecological data, while explicitly denying the adequacy of analysis based purely on historical and cultural grounds. The ecological hypothesis he said "calls for a more dynamic type of analysis than has previously been undertaken. Instead of concentrating on cultural description, the facts of geographical distribution, and problems of historical depth and continuity, the major question becomes in effect: What are the actual determinants or controlling factors involved?" (1949:36). He went on: "Within this frame of reference, however, we are forced to take new data into account, data of a <u>non-cultural</u> nature. For we can hardly pursue an ecological hypothesis without giving due weight to relevant demographic facts, as well as those pertaining to the character, incidence, and fluctuations of fauna or other important information. Perhaps in this case, as well as in others, our very devotion to cultural description and historical explanation, on the implicit, if not explicit, assumption that culture is a phenomenon <u>sui generis</u>, has blinded us to the relevance of some of the very data that are needed if the actual dynamics of the hunting territory system is to be fully understood and explained"

(1949:36; italics in original). In short, Hallowell called for new research along ecological lines that he considered would be relevant to the debate, i.e. a detailed study of the distribution of fauna in space and time, and an analysis of the impact of the distribution on human populations.

It is our contention that this call has not yet been fulfilled. Since Hallowell's article a number of major criticisms of the hunting territory system have been published, but none has given extensive detailed attention to aboriginal boreal forest ecology, faunal dynamics and human geography. Instead there has been a further development and clarification of ethnohistorical evidence and, recently, a shift to ethnohistorical-ecological evidence. These developments have failed to argue directly against the possibility of an aboriginal family hunting territory system, and have thus left us in the situation of having a contradiction between apparently equally valid ecological evidence of Speck and Eiseley and the ethno-historical evidence of their critics.

Eleanor Leacock outlined in detail in 1954 the contemporary emergence of the hunting territory system in central and south-eastern Labrador on the basis of ethnographic and ethnohistorical evidence. She convincingly demonstrates that the fur trade heightened individualization of economic activities and provides a sufficient explanation for the development of a family hunting territory system. She shows that "the strength of individualized land-holding patterns characteristics of the western Montagnais decreases *outward from the center of the earliest and most intensive fur trade*"(1954:6, italics in original). Leacock also claims that the importance of small game prior to the fur trade "has not been satisfactorily demonstrated" (1954:3). Her own claim, that the Montagnais were primarily big game hunters, is hardly demonstrated at all, resting on a few references in the *Jesuit Relations* to the importance of moose and woodland caribou (1954:3). Robert F. Murphy and Steward coherently summarized Leacock's position, agreed with it, added comparative data, but no new evidence (Murphy and Steward, 1956: Steward, 1955:145).

Edward Rogers has made explicit a number of distinctions and variables implicit in Leacock. He formalized the separation, logical and historical, between hunting groups and hunting territories. Small hunting groups were aboriginal, but the family hunting territories were of post-contact origin (Rogers, 1963:88). Aboriginal hunting groups of the Mistassini Indians were small, but larger than the single nuclear family. Rogers estimates the size of aboriginal hunting groups on the basis of: the area utilizable by hunters who live together given the transportation availbale; the size of territory presently needed to support a nuclear family; and, the need for a local supply of firewood (1963:78). He concluded that the aboriginal hunting group usually consisted of more than one nuclear family (1963:81)and less than six(1963:78), or between five and forty-five members (1963:81). With respect to hunting territories Rogers claims that aboriginally a hunting area system existed (1963:83). Groups returned to the same areas, only roughly demarcated, each year but possessed no exclusive rights to resources (Rogers, 1963:82). More rigid systems are improbable because of the lack of a strong political authority structure and adequate active group cooperation. Less rigid systems, i.e. free wandering, were too inefficient (Rogers, 1963:83). Thus, Rogers describes the picture of aboriginal conditions that had begun to gain acceptance among Algonkianists after Leacock's paper, but offers no significant new ecological data.

A number of other authors have recently given accounts of ecological changes that <u>followed</u> introduction of the fur trade. These papers support the post-contact origin of the family hunting territory system. Rolf Knight (1965:40; 1968) has given the most extensive exposition in print, although as yet unpublished papers by Charles Bishop (1968) and Dean Snow (1968) also deal with the issue. Knight cities the effects of fires in creating conditions unsuitable for caribou but suitable for moose at Rupert House early in this century. Moose behavior - solitary, erratic, unresponsive to drives - plus the introduction of high-powered rifles led to the emergence of smaller hunting groups and laid the basis for the introduction of the family hunting territory system. Bishop claims there was a shift from big-game hunting to small fur-bearing mammal hunting observable in Hudson Bay Company records among the northwestern Ontario Chippewa. In total, these studies present a convincing series of ecological- historical explanations of how the hunting territory system could have emerged and/or the communal band land system broken down in each locality after contact. Like the earlier articles however, they fail to go to the heart of the ecological claim for aboriginality, for no amount of post-contact explanation can _prove_ that the family hunting system was not aboriginal. Occam's razor does, of course, provide a certain impetus for decreasing the value of claims for aboriginality. But the ecological arguments for aboriginality put forward by Speck, Eiseley, Copper and Hallowell have not been subjected to detailed analysis in the nearly three decades since their original presentation. Victor Barnouw,commenting on Harold Hickerson's article, remains essentially correct when he says of the family hunting territory system, "It seems likely to have been a post-contact development although it has not been conclusively demonstrated" (1967:329).

But the problem goes even deeper. Not only have the ecological claims of Speck, Eiseley, Cooper and Hallowell not been disproved, they continue to appear plausible, even to a certain extent powerful. There is a very real discrepancy between the ecological data presented by Speck _et.al._ and the economic - historical data of their critics. The continued apparent validity of Speck and Eiseley's thesis must cause considerable frustration in anthropological theorizing since most Algonkianists accept the post-contact origin of the hunting territory system. This frustration is suggested by Hickerson when he states that Speck and Eiseley in their 1939 article, "leave us merely with some entertaining chit-chat on the precise relationship between types of fauna and forms of tenure" (1967:317). He then immediately goes on, in a footnote, to tell us that the subject is "not unimportant" (1967:317). The apparent discrepancy between the economic historical data and the ecological data is particularly acute for a dialectical materialist, as the Russian scholar Averkieva's response suggests. She criticizes the "overestimation of the ecological factor (which) is a general phenomemon in the contemporary sociological schemes of American ethnographers and in texbooks on the subject..." (1962:53). A most unusual position for a dialectical materialist.

The tension between the ecological and economic - historical arguments is being resolved, after a fashion, by the growing consensus among Algonkianists that the primary aboriginal subsistence base was not small game, as Speck and Eiseley claimed, but rather large game, particularly caribou hunted in large communal drives. These claims, at least in so far as they refer to aboriginal conditions, are based on an impressive lack of relevant information. Rogers' recent study (1967), the best resumé of these efforts, notes the enormous variety of opinions among ethnologists on the basis subsistence of the Indian peoples of the region - both for the present and for the aboriginal periods. We quote some of his examples and add some others: Regina Flannery - moose, bear, beaver, caribou, and some small animals (1946:265); J. Allan Burgesse - "fish, rabbit, squirrel and other small fry" (1940:35-6); Alanson Skinner - "The great mainstay of the Indians of the north in the winter is the vast quantity of rabbits" (1910:85-6); Julius Lips - "The principal sources of meat for the Indian family are caribou, moose, bear and beaver" (1947:391); John Honigmann cites fish (1964:326). Ethnohistorical commentators show little less agreement. Charles Albanel cited fish as the main subsistence at Nemiscau in 1672 (Thwaites, 1896-1901, 56:183), but later on in his travels he cites bear, moose, beaver and porcupine (205). Père Laure cited caribou and fish in 1730 (Thwaites, 1896-1901, 68:47). In 1817 McKenzie wrote, "These Indians will sooner want than fish" (1960:427).

Rogers attempts to resolve these conflicts on the basis of geographical variations and changes in the contact period due to the introduction of the fur trade, European goods and White settlement. Rogers does not attempt to project his data back beyond the early contact period. For the period from 1600 to 1800, "Data are scarce or non-existent for most of the area. Those which exist can often be interpreted in several ways, since quantitative data were never recorded and therefore travellers' impressions must be relied upon" (1967:82). In short, the situation is one in which all the aboriginal ecological appraisals are subject to the suspicion Hickerson had of Speck and Eiseley,namely that the appraisals "were tailored to the ideas they held concerning systems of tenure" (1967:317, footnote 3). The growing concensus that aboriginal subsistence was largely big game hunting is, for us, subject to the same suspicion.

It is our intention here to address ourselves directly to the question of the aboriginal cultural ecology of a sub-arctic people. We feel, on one hand, that only such an analysis can meet Hallowell's call and go to the logical, polemical and factual core of the claim for the aboriginality of the family hunting territory system. Our study is a step towards resolving the apparent contradiction between economic - historical and ecological evidence in at least one region, Mistassini. We hope thus to contribute to the final resolution of the hunting territory debate. On the other hand we want to apply this same data to the question of the primary subsistence base utilized by aboriginal boreal forest hunters. We want to question the consensus that is emerging around this question, and to formulate a number of features of what we consider a better founded picture of the aboriginal cultural ecology of sub-arctic peoples. In order to undertake both these tasks it is necessary to note the basic assumptions made by both sides in the debate and analyze these assumptions critically.

The establishment of a family hunting territory system for the conservation of small mammal populations in order to support a larger human population than would otherwise be possible fundamentally assumes a geographical and temporal continuity of resources. From his earliest writings Speck recognized a certain variability in resources and in human population levels (1915a, 1918, 1931, 1933). Underlying these chance variations however was the assumption of continuity. Conservation depended on "pretty permanent" control of a territory (Speck and Eiseley, 1942:240). Conservation implies a permanent interest in territory (Speck and Eiseley, 1939:273, footnote 11), i.e. a permanent value of territory for subsistence (Cooper, 1941:58). In the subarctic forest such value was manifest in the fauna of the territory, especially the fur-bearers. It is implied that they are localized, limited in number, and, despite short-term chance variations, consistent in number (Speck and Eiseley, 1939:279). Cooper outlined the general ecological factors which were "responsible in large part for the systems of tenure in severalty..." in any geographical area. They were: "non-migratory and/or non-gregarious fauna, or fauna of relatively restricted home range; flora with at least fairly dependable yield; relative scarcity of fauna or flora or both; fauna and flora exploitable more or less uniformly over the whole or most of the tribal territory or in more or less evenly distributed sections thereof..." (1941:59-60). With the exception of the need for scarcity, and neglecting whether flora or fauna were referred to, Cooper essentially says that there must be a constant yield over time and a uniform geographical distribution of resources. In the subarctic these assumptions have underlain the entire debate. As Hallowell wrote: "so far as the Northern Algonkians are concerned, one of the conditions of such continuity is the fact that they have lived in the same faunal and climatic zone and no faunal catastrophe has occurred as in the case of the Sioux" (1949:38).

It will be our contention that faunal "catastrophes," that is from the human point of view, not only have occurred but are periodic, recurrent events. They are a product of the cyclical nature of the boreal forest ecosystem, which goes through a cycle of maturation, over-maturation, destruction by fire, and regeneration. We will show how large geographical areas of overmature forest were periodically attacked by spruce budworm and destroyed by fire. We will construct a hypothetical model of these temporal and geographic variations. The variation in fauna as a result of these cycles will be analyzed, stressing the immediate effects of fire in making the area uninhabitable for several years. This cyclically recurring period of unproductivity, from the point of view of human subsistence, was thus accompanied by a period of abandonment by men. Such abandonment, and the consequent periodic movement of human populations over significantly large areas militates against any possibility of an aboriginal family hunting territory system. Territory did not have a constant yield. Beaver, as well as all other game animals, large and small, were periodically subject to severe fluctuation of populations. Conservation, in the sense of regulating catches of animals, was not practicable given the size of the natural variations that were beyond human control under aboriginal conditions. And, all this in the main forest zone which Speck and Eiseley considered the center of the aboriginal family hunting territory system. This analysis will be presented in Chapter 3.

Similarly the assumption of geographical and temporal continuity of resources underlies the debate over the basic subsistence base in aboriginal time. <u>All</u> participants have assumed that <u>a</u> basic adaptation to one or another animal or class of animals was constant in the region over time. This is particularly true of the current consensus among those who reject the claim for aboriginality of the family hunting territory system, and view aboriginal subsistence as primarily based on big game hunting, especially caribou. As we have noted before, a number of authors have discussed changes in the subsistence base, but these have all been post contact (Knight, 1965; Rogers, 1967; Bishop, 1968). We will contend, in Chapter 4, that a regular cycle of subsistence patterns characterizes the aboriginal Indian adaptation, at Mistassini at least. After destruction of the forest in a region, a successional series of stages of vetetational regeneration occurs which is accompanied by a series of stages of reinhabitation of the area by fauna. We will construct a model of the distinct periods of resource availability and of the phases of both primary and secondary bases of human subsistence. An important role will be noted for small game, beaver, and varieties of large game. In short, we will show that subsistence patterns were variable over time, neither small game nor large game predominating permanently. We hope this may lead to a reassessment of the current view of aboriginal subarctic human ecology.

Biological materials will compose the major part of our analysis, so in the next chapter we provide a description and inventory of Mistassini.

C - Mistassini and the Family Hunting Territory Debate

Speck and Eiseley considered the main boreal forest the typical environment of the aboriginal family hunting territory system.

They specifically excluded the northern forest woodland (see description of flora) noting that animal life in the former, particularly the caribou, was "wide ranging and mobile," and not compatible with the family hunting territory system. Speck excluded also the bison-dominated plains (1926:327) and the Iroquoian agricultural areas (1926:329). The family hunting territory system was viewed "as the response to conditions in a forest region," and indeed the evolution of the family hunting territory system must have taken place "at some point within the forest regions inhabited by the Algonkians" (Speck and Eiseley, 1942:241). In particular it is in "the area between the Height of Land and the St. Lawrence waters, in other words, in what we might label as the Laurentian region, that segregated family hunting of the Montagnais type prevails most characteristically" (Speck and Eiseley, 1939:277). Mistassini lies just to the west of the region. Speck reported the Mistassini were a borderline people, in the northern part of the region the Mistassini were nomads following the caribou (1923:458). Those in the southern sectors are "representative" of the Algonkian family hunting territory system (Speck, 1918). In addition, the Mistassini, due to their greater isolation from the main centers of the fur trade on the St. Lawrence and James Bay, were particularly interesting, conservative and primitive (Speck and Heye, 1921:14). Among them the family hunting territory system was still "flourishing" in the first decases of this century (Davidson, 1928:50). Speck wrote three articles on the Mistassini (1923;1930;Speck and G. Heye, 1921). In summary, the Mistassini are a representative band particularly suited for present-day study of the family hunting territory system.

Mistassini as a region and a people has been the focus for study by scientists from a variety of disciplines, and is, for the sub-arctic, a comparatively well-known area. Only areas that have been studied in the last decade by large multi-disciplinary research teams are appreciably better known. For our purposes it combines two necessary conditions: a relevance to the hunting territory debate; and, a fairly extensive amount of published monographical data. We have focused on a single region in order to reduce the complexities of geographical variation in the sub-arctic. It has been recognized by biologists and anthropologists that the boreal forest zone is, compared to other regions of such great extent, relatively uniform and continuous across the North American continent. The outline of the analysis of Mistassini cultural ecology would probably hold, with minor modifications, over much of the boreal forest zone. This, however, remains to be determined.

CHAPTER II: MISTASSINI

Lake Mistassini lies two hundred miles up the Rupert River from James Bay and one hundred fifty miles northwest of Lake St. John, in the province of Quebec, Canada. Lake Mistassini is a large lake of approximately one hundred miles in length and twelve miles average width, between latitudes 50°30'N and 51°20'N and longitudes 72°45'W and 74°25'W. Lake Albanel to the east, formerly known as Little Mistassini, is approximately sixty miles long and five miles average width.

A - The People and the Region - Definitions

In a recent report on sub-arctic archaeology James Wright (1968) has suggested that the area east of James Bay was first inhabited 5,000 years ago from the western sub-arctic. Cultural and biological links to the Indians known in the contact period are somewhat uncertain, but likely. Edward Rogers, Murray Rogers, and R.A. Bradley conducted a series of archaeological reconnaissances at Lake Mistassini and to its south and west in the summers of 1947, 1948 and 1950 (Rogers and Rogers, 1948; Rogers and Rogers, 1950; and Rogers and Bradley, 1953). Summarizing his study of the first collection Frederick Johnson wrote: "It is impossible for us to apply to the Rogers' collection any of the terms being bandied about the Northeast. The place the Rogers' collection occupies in the culture history of the region is as yet quite unknown" (1948:98). Today, much of these collections are considered Boreal Archaic (W.E. Taylor, 1964:189). Pottery found in south-central Quebec had not penetrated as far as Mistassini before contact (Rogers and Bradley, 1953:144). This pottery is now identified as Boreal Woodland (Taylor, 1964:190). Taylor, in summary, suggests that "the culture of the Cree and Montagnais-Naskapi bands at the time of European contact fairly mirror the archaic pattern of the far Northeast as it has been reconstructed by archaeologists" (1964:185). In short, continuity between original inhabitants of the region and historical inhabitants is likely.

The early ethnohistorical information is equally limited. The main feature of these data is that they state that there was a band of people who called themselves 'Mistassini,' and who lived in the area of the lake of the same name, at the time of the first Euro-Canadian contact with the region. The demography and interband distributions of these people are, however, essentially unknown to us. Mistassini were probably first involved in the European fur trade through middle-men working along traditional trade routes to Lake St. John and the St. Lawrence, and later to Rupert House on James Bay. First mention of the Mistassini is made in 1942-3 (Thwaites, 1896-1901, 24:155). Smallpox spread through northern Quebec in the 1650's and may have preceded the white man into the region. First penetration by white men was in 1663 (Rogers, n.d. , 3). Contact was followed by quick invasion. Mistassini lay on the route from Tadoussac to James Bay and was in the middle of the English-French competition for control of the fur trade of the interior of the Quebec-Labrador Peninsula.

Two French forts were built on Lake Mistassini in the 1670's. All in all eight posts existed intermittently between Lake St. John and Nemiscau during the next 150 years, and on at least six sites on Lakes Mistassini and Albanel (Voorhis, 1930). Early published descriptive records include Albanel's journal of his trip to Mistassini in 1671-2 (Thwaites, 1896-1901, 68: 23-118). Albanel spoke of being told of a party of 150 Mistassini (Thwaites, 1896-1901, 56:207). This figure is probably a minimum. Laure reported that the Mistassini were "reduced to a small number of people" in 1730 (Thwaites, 1896-1901, 68:45). Later ethnohistorical records cannot be relied upon to tell us any more of their aboriginal composition, territory utilization, or the number of and nature of relations with neighboring peoples, than Albanel and Laure have. The speed with which trading posts were established and modified territorial use, group sizes, etc., precludes attempting to project demography back from ethnohistorical distributions. We therefore have almost no data on aboriginal demography.

Contemporary anthropological studies of the Mistassini have been made by Speck, Lips, Rogers, Rousseau,and members of the McGill Cree Project. Frank Speck worked with Mistassini informants at Lake St. John (1923,1927,1930, 1931). Julius Lips apparently did the same (1936, 1937, 1947a, 1947b). Edward and Jean Rogers worked at Mistassini in 1953, 1954 and have published a number of articles and monographs (Edward 1963, 1966, n.d.; and Jean 1959,1963, n.d).Jacques and Madeleine Rousseau made ethnographic observations while primarily engaged in botanical and ethnobotanical research at Lake Mistassini in the summers of 1944, 1945, 1946, 1947, and have published several articles (Jacques, 1945,1949, 1953; Jacques and Madeleine, 1948, 1952).

From these studies emerges a picture comparable to other eastern Algonkian sub-arctic peoples. The characteristic culture of these peoples has been recently reviewed again by Honigmann (1964), and the outline is sufficiently well known that we will not repeat it here.

The definition of the Mistassini region in contemporary anthropological accounts is of little relevance for establishing aboriginal boundaries as it is based on recent band composition and distribution.

For purposes of the discussions that follow we will define the region on the basis of the following considerations: that aboriginal bands were smaller than present bands; and that water, particularly lakes, not land - formed the central focus of summer band gatherings. We make the particular assumptions that there were more or less distinct groups: to the north at the Eastmain River and/or Lake Nichikun, to the west at Lakes Nemiscau or Evans, and to the south around Chibougamau or Rush Lakes. Further we assume that the height of land to the east was a significant social boundary. Thus, we define the aboriginal 'Mistassini Region' as: the height of land on the east, a horizontal line forty miles north of Lake Mistassini, a vertical line drawn through the Rupert River halfway between Lake Mistassini and Lake Nemiscau, and a horizontal line just south of Lake Mistassini. The region so defined comprises the Mistassini hunting territories as drawn by Speck in 1923 with the northernmost and westernmost regions trimmed off. It comprises only a small portion of the territory utilized by bands now gathering at Lake Mistassini Post (Rogers, 1963:21), which includes about 40,000 square miles; the region as we have defined it here represents approximately 15,000 square miles.

B - Physical Environment

Lake Mistassini is a large deep reservoir which receives the waters of a number of small rivers: Temiscamie, Wabissinan, Papaskwasati, Takwa and Chalifour, in addition to the waters of Lakes Albanel and Waconichi which flow through Mistassini (James Neilson, 1948:148). The Rupert River forms the discharge of Mistassini to James Bay, and because the Mistassini is such a large reservoir at the head of the Rupert, water levels on the river vary less than in other rivers flowing into James Bay from the east (A.P. Low, 1895:261). This increased the Rupert's importance as a travel route and Mistassini's importance as the center of the trade between Lake St. John and the North Shore of the St. Lawrence River on one hand, and James Bay on the other.

The entire region was glaciated during Pleistocene times, and summit areas were denuded and valleys partially filled. Relief is now several hundred feet over much of the area, the average altitude being 1300 feet, although to the north east the land rises 1000 feet to the Takwa Mountains. Drainage is highly disorganized and irregular, with many lakes of irregular shape and size (Neilson, 1948:146-7). The larger lakes, particularly Mistassini, are very deep and cold, and Low reported depths of over 400 feet in the lake, with common readings of over 300 feet. The water rarely rises above 50 degrees Fahrenheit in the main body (Low, 1895:681).

The area immediately surrounding Lakes Mistassini and Albanel is underlain by Precambrian limestone, now covered with glacial drift. The calcareous soils, a product of limestone disintegration, may be the partial cause of the heavy forest growth in the region (Austin Cameron and William A. Morris, 1951:121). The lower vegetation is markedly calcicole (Marcel Raymond, 1950:34). The Mistassini basin was apparently covered by an extensive glacial lake at the time of deglaciation (Ignatius, 1958:31-2).

Approximately fifty miles to the east of Lake Mistassini and parallel to it, is the height of land between the Hudson Bay and the St. Lawrence drainage systems. In this rather fluid region where no boundaries are of great significance physiographic, ecological and cultural boundaries do not necessarily coincide. The climate is continental with long, cold winters and short, cool summers. The mean temperature for January is -3.2 degrees Fahrenheit and the mean for July is 62.5 degrees Fahrenheit (Cameron and Morris, 1951:121). The absolute minimum recorded at Mistassini Post is -56 degrees Fahrenheit, the absolute maximum 95 degrees (W. Earl Godfrey, 1949:3). Frost may occur in any month (Rousseau, 1968: personal communication). Climatological maps for the southern regions of the Quebec-Labrador Peninsula give the following estimates: mean annual temperature, 32 degrees Fahrenheit; average length of frost-free period, less than eighty days; mean annual precipitation, forty inches (Oscar Villeneuve, 1946). It is a region of heavy snow: median maximum depth on the ground is forty to fifty inches; snow is continuous during December to March; one inch or more of snow covers the ground for a minimum of 150 to 180 days and a maximum of 210 to 240 days (T.G. Potter, 1965:41, 43, 44, 46). Total annual snowfall is 100 to 125 inches (Rogers, 1963:8). Freeze up occurs at the end of October or early November, and break up between mid-May and June.

The region has been studied in recent decades by a number of geologists, particularly G.W.H. Norman (1940), Neilson (1948), and Ignatius (1958). Economic geology has been studied extensively by the Provincial Government (Neilson, 1966; Murphy, 1966) and by private mining interests.

C - Biological Environment

Lake Mistassini and the surrounding region have been visited by biological scientists for over a century and a half. The earliest scientific visit was made by the French botanist André Michaux who travelled from Lake St. John to Lake Mistassini and part way down the Rupert River in 1792. Parts of his journal, including this trip, have been published (Michaux, 1889). Abbé Brunet has published an article where he quotes additional notes made by Michaux (1864). Notes Michaux made of the specimens he collected or saw in the region also occur in the *Flora Boreali-Americana* (1820) published under Michaux's name but apparently not written by him but by Louis-Claude Richard. François-André Michaux, the elder's son, also recorded some notes in his *Histoire des Arbres Forestiers de l'Amérique Septentrionale* (1910). These early records are temptingly interesting for the desolate and barren vegetation they depict, but because they are not sufficiently specific as to locations they are of limited use in our endeavor. Michaux's contribution was in his collections, not in his landscape description.

New scientific work in the region awaited the geographical and geological explorers of the last quarter of the nineteenth century and the first quarter of the present century. Mistassini was a region of considerable attention during this period for two reasons. Debate raged in scientific circles and in the daily press, over the actual size of Lake Mistassini which was generally recognized as a large lake by New Quebec standards and was claimed by some to be as large as one of the Great Lakes. The second is that the Mistassini region is near the boundary between the Grenville and Temiskaming subprovinces of the Canadian shield. The importance for geological science is accompanied by the economic potential of the faulting in the region. Mining interests have been actively interested in Chibougamau, sixty miles south of Mistassini, since the first decade of this century, on the basis of earlier geological surveys. A less important factor was the possibility of building a railway from southern Quebec to James Bay and then across the northern prairies to the west coast; however, a more southerly route was subsequently chosen.

As a result of these combined interests, geologists were common in the area for a number of years, as well as several recorded and presumably some unrecorded excursions by adventurers. The reports of these geological expeditions (McQuat, 1871-72; Richardson, 1872; Bignell, 1885; Low, 1885, 1888, 1889, 1890-91, 1895; and O'Sullivan, 1898, 1901) and those of adventurers (Chambers, 1896 - apparently based on a trip of Mr. Archibald Stewart in 1894) contained occasional reports on the flora and fauna. Only Low, accompanied by the biologist Macoun, made extensive notes for Mistassini and/or the peninsula as a whole. Low and Charles Macoun published lists of plants (Macoun, 1885a, 1888, 1892), birds (Macoun, 1885b;Low, 1895c), mammals (Low, 1895b), principal fishes (Low, 1895a), insects (Low, 1895d). This work is the baseline for modern studies. Extensive botanical and zoological studies were undertaken in a flurry of interest in the late 1930's and the 1940's.

1 - Flora

In 1943 Artheme Dutilly and Ernest Lepage made a flora survey from James Bay up the Rupert River to Lake Mistassini. Part of their results were published in 1945 (Lepage, 1945), and the full report appeared three years later (Dutilly and Lepage, 1948). In 1944 Jacques Rousseau began a four summer botanical survey of the Lake Mistassini region. He was accompanied in 1944 by Ernest Rouleau, a botanist, in 1945 by Jean-Paul Cuerrier, a zoologist, and in 1947 by Jean-Paul Vinay, a linguist. Rousseau has published a number of articles on anthropological questions but the detailed results of the botanical survey are as yet unavailable. Brief articles have appeared on some new plants discovered (Rousseau, 1957) and on the bryologic flora collected by Rousseau (Kucyniak, n.d.). In a series of recent articles Rousseau has described the biogeography of Northern Quebec (1961, 1964, 1967). His description of the temperate superior zone, or the temperate coniferous forest, is based on his studies at Mistassini (Rousseau, 1968, personal communication). Rousseau does not provide a standard phytosociological description in terms of associations and formations, but rather provides a classification of the forest landscape (1961:24-5). We follow him in the summary below, based mainly on the earliest of the three works (Rousseau, 1961:24-28). Supplementary descriptions of the flora are found in the introduction to the contemporaneous bird and mammal surveys of the region (Godfrey, 1949:4-12; Cameron and Morris, 1951:121-122).[3] Before presenting this summary it is useful to discuss the place of the Mistassini region in the forest regions of Canada and the Quebec-Labrador Peninsula as a whole.

a - Forest Zones at Mistassini

The forests of eastern Canada may be conceived as a series of latitudinal zones of irregular width. Most of southern Quebec is in the Great Lakes - St.Lawrence mixed coniferous and deciduous forest. The broad central band is in the Boreal Coniferous Forest, above which the tundra begins. Within the Boreal Forest a number of different zones are recognized, of primary interest to us are the main boreal forests and the open woodlands. In the most general terms, the former is characterized by close dense stands of trees with a "closed" canopy, while in the latter a more severe climate leads to an "open" forest with ten to fifteen feet between trees. All authors consider Mistassini a borderline region, transitional between the main boreal forest and the open woodlands to the north. The exact classification of the region has not yet been agreed upon. It is our contention that the Mistassini region from some forty miles north of the Lake and for some one hundred miles to the west are predominantly part of the main boreal forest. Halliday's 1937 regionalization of the Canadian forests placed the division through the middle of the north-south length of Lake Mistassini, nearly one hundred miles south of where we propose it. Rousseau, who dealt with zonation of the peninsula in an earlier work (1952) has recently proposed that the "bioclimatique" division falls in about the same area as W.E.D. Halliday's (1961). Villeneuve's (1948) climatic classification put the entire Lake and area to the east in the Taiga zone to the north. Ilmari Hustich (1949a, 1949b) included the entire Lake but excluded the areas immediately to the west from his "Southern boreal forests."[4] Of these authors only Rousseau has been to Mistassini and he speaks of it as temperate and as an advanced post ("avant-poste") of the more northerly sectors (Rousseau, 1964:35-46). Certain areas are clearly noted as of the woodland type - the islands in the center of Lake Mistassini and the highlands to the northeast. The only quantitative evidence we have on the distribution of the different forest types is from the photo-reconnaissance survey of the peninsula by Hare and Taylor in the 1940's and 1950's (Kenneth Hare, 1950; Hare and Reginald G. Taylor, 1956; Hare, 1959), and in their 1956 article they show the relative distribution of closed-crown forest and of lichen woodlands (Hare and Taylor, 1956:57, figure 3; :58, figure 4). The entire Mistassini region is in the ninety percent plus area of closed crown forest, and the ten percent or less area of lichen woodlands, except for a thin leg of eighty-to-ninety percent closed crown forest from the northwest bay of the lake north. Hare and Taylor comment that "the forest/woodland boundary is very sharp; the ratio of lichen woodland to total forest rises very abruptly from ten percent to above thirty percent in a short distance - ordinarily no more than twenty miles" (1956:67), above Lake Mistassini the change is from ten percent to fifty percent in less than twenty miles. We estimate the distance from the northernmost tip of the Lake to the ten percent line to be thirty miles and to the fifty percent line to be forty-five miles. J.S. Rowe (1959) appears to follow Hare and Taylor in his revision of Halliday, and the regions west of Mistassini are also indicated as ninety percent or more closed crown forest. Neilson gives a similar account (1948:157) from the ground. Hare and Taylor note their agreement with Rousseau "except near Lake Mistassini-where the McGill group's interpretation was in any case rendered difficult by snow cover..." (1956:67). Until further work is done we find it best, on the basis of the quantitative data of Hare and Taylor, to consider the Mistassini region from forty miles above Lake Mistassini and for a hundred miles west part of the main boreal forest with a number of small enclosures or advanced posts of woodland.

b - Forest landscapes (based primarily on Rousseau, 1961)

Relatively Dry Moss Forests. They are composed primarily of black spruce (Picea mariana),[5] which makes up seventy-five to eighty percent of the forest, and also white spruce (Picea glauca) and balsam fir (Abies balsamea). There is an extremely thick underbrush of ericaceous shrubs - laurel (Kalmia), labrador tea (Ledum), and blueberry (Vaccinium uliginosum), and others including Rubus, Lonicera, Viburnum, Salix, Ribes, Amelanchier, Taxus canadensis, Sorbus decora and Cornus canadensis. Mosses, (particularly Sphagnum) are thick - fifteen to twenty centimeters. This forest is separated from rivers, streams or lakes by tangled stands of alder (Alnus), willow (Salix), sweet gale (Myricia), shrubby cinquefoil (Potentilla fruticosa) and thorns (e.g. Rudus triflorus).

The Moist Forest. Willow shrubs and alders are more abundant and the soil is covered by a thick layer of moss.

Dense Forest with Sparse Undergrowth (Dry Forest). White birch (Betula papyrifera) and balsam poplar (Populus Balsamifera)mix with the trees of the first forest type. On the crests of ridges the birch and poplar may become predominant, especially the former. Moss usually covers the ground and is occasionally pierced by shrubs and herbaceous plants, and in some areas this forest supports lichens (particularly Cladonia alpestris). Where the soil is sandy stands of jack pine (Pinus banksiana) replace birch.

The Burn. Fireweed (Epilobium angustifolium)first covers the burned area. It is soon invaded by the blueberries (Vaccinium) and raspberries (Rubus idaeus),while white birch, aspen (Populus tremuloides), cherries (Prunus pensylvanica) and dwarf maple (Acer spicatum) are the first trees to reforest the burn. The first two species are abundant and occasionally form pure stands in the unshaded burns of ten to twenty years. They are then joined by the spruces and fir which grow in the shade of the deciduous trees and soon overtake them.

The Bog. Sub-arctic ponds are slowly converted to land by rings of vegetation which deposit their organic matter on the bottom and slowly extend the shorelines in to fill up the pond. The innermost ring or disc of vegetation, floating on the water, is composed of bladderwort (Utricularia), watermilfoils (Myriophyllum)and mosses. Then come other herbaceous plants, first aquatic, then semi-aquatic and terrestrial, including arrow-leaf (Sagittaria), pipewort (Eriocaulon), sundew (Drosera) and cottongrass (Eriophorum). These are followed by the shrubs: laurel, labrador tea, blueberry, rosemary (Andromeda), leather-leaf (Chamaedaphne), and others. Stunted larch (Larix laricina) and black spruce trees dot the outermost bands, with some willow and alder.

2 - Fauna

a - Mammals

The mammalian fauna of the Mistassini region was studied extensively by Morris, Godfrey and Roger O. Standfield in the summer of 1947, and Cameron made the taxonomic study of the animals collected; results were published by Cameron and Morris (1951). Rogers (1963:10-11), Rousseau 1967:13-16), and Neilson (1948:154-5) have made occasional notes on mammals. Francis Harper has included in his survey of the peninsula a number of notes from otherwise unpublished sources or personal communications (1961b;see also 1964). Useful data is found in mammal surveys of Lake St. John (Cameron and Philip Orkin, 1950), the peninsula (Outram Bangs, 1913; Wilfred Grenfell, 1913; and Rudolph M. Anderson, 1939), Eastern Canada (Raldolph Peterson, 1966), and Canada (Anderson, 1946).

Cameron and Morris summarized their results by reporting that the "mammal fauna was found to be rather poor, both in species and numbers of individuals" (1951:122). In Table I we list the mammal species of the of the Lake Mistassini region primarily on the basis of Cameron and Morris. Two species are added, to fill a surprising gap in their list, the fisher and the wolverine. Both have been definitely reported for the region by Neilson (1948:154) and Rogers (1963:10-11).

TABLE 1 - MAMMALS OF THE LAKE MISTASSINI REGION

		Source
Woodland Caribou*	*Rangifer tarandus caribou* Banfield	1
Moose*	*Alces alces americana* (Clinton)	1
Canada Lynx*	*Lynx canadensis Kerr*	1
Ungava Land Otter*	*Lutra canadensis chimo* Anderson	1
Skunk*	*Mephitis mephitis*	1
Wolverine	*Gulo luscus luscus* (Linnaeus)	2,3,4
Ungava Mink*	*Mustela vison lowii* Anderson	1
Richardson's Ermine (Weasel)	*Mustela erminea richardsoni* Bonaparte	1
Eastern Fisher*	*Martes pennanti pennanti* (Erxleben)	2,3,4
American Black Bear*	*Euarctos americanus americanus* (Pallas)	1
Pine Marten*	*Martes americana* (Turton)	1
Arctic Fox	*Alopex logopus*	1
Red Fox	*Volpes fulva* Merriam	1
Wolf	*Canus lupus* Schreber	1

TABLE 1, cont.

		Source
Porcupine*	*Erethison dorsatum* Linnaeus	1
Northern Woodland Jumping Mouse	*Napaezopus insignis abietorum* (Preble)	1
Quebec Meadow Jumping Mouse	*Zapus hudsonius canadensis* (Davies)	1
Muskrat*	*Ondatra ziberthicus* (Linnaeus)	1
Rock Vole	*Microtus chrotorrhinus chrotorrhinus* Miller	1
Hudsonian Red-backed Vole	*Clethrionomys gapperi hudsonius* Anderson	1
Cooper's Lemming Mouse	*Synaptomys cooperi cooperi* Baird	1
Labrador White-Footed Mouse	*Peromyscus maniculatus maniculatus* (Wagner)	1
Canada Beaver*	*Castor canadensis* Bailey and Doutt	1
Flying Squirrel	*Glaucomys sabrinus* (Shaw)	1
Ungava Red Squirrel*	*Tamiasciurus hudsonicus ungavensis* Anderson	1
Quebec Chipmunk	*Tamias striatus quebecensis* Cameron	1
Woodchuck*	*Marmota monax* (Erxleben)	1
American Varying Hare*	*Lepus americanus americanus* Erxleben	1
Bat	*Myotis* (Le Conte)	1
White-Lipped Water Shrew	*Sorex palustris albibarbis* (Cope)	1
Common Masked Shrew	*Sorex cinereus cinereus* Kerr	1
Star-Nosed Mole	*Condylura cristata cristata* (Linnaeus)	1

Key to Sources:

1. Cameron and Morris, 1951
2. Neilson, 1948
3. Low, 1895b
4. Rogers, 1963

* - Animals eaten (Rogers, 1963:33)

Cameron and Morris give notes on the commonness or the abundance of the species of the region, and also review Low's comments. The terminology used can be grouped into two sets:
A - 'common,' 'plentiful,' 'abundant,' 'on the increase,' 'not uncommon,' 'declining,' 'relatively scarce,' 'nearly vanished,,' 'vanished,' 'few,' 'very scarce;' B - 'uncommon,' 'unusual,' 'rather uncommon.' Category A is characterized by 'commonness' to the region or by former 'commonness,' Category B by 'uncommonness.' We have classified the mammals of the region into these categories, placing no species in Category B if it was reported common at any time by Cameron and Morris, Low, or any recorded Indian reports. Included in Category B however are species whose presence was noted but for whom no other comments were available. Category B includes: mole, shrews, bats, flying squirrel, and lemming mouse. All other species on Table 1 are in Category A. On the basis that our data covers at least eighty years, we will consider the species in Category B sufficiently uncommon to the region to warrant omission in the following discussion - even for aboriginal times. While confident that our list includes all species important in aboriginal times, the question of it containing too much is more complex. We will return to this question in the section on "Temporal Dimension" after completing our inventory of the fauna.

For purposes of shortening our later discussions we propose an ad hoc classification of mammals as follows: 'small herbivores' - the hare, squirrel and the small rodents (mice, shrews, voles); 'large herbivores' (including omnivores) - beaver, muskrat, otter, porcupine; 'primary carnivores' - mink, ermine, fisher, marten and skunk; 'secondary carnivores' -

lynx, wolverine, wolf and fox; and 'ungulates' - moose and caribou[6]. Bear is classed by itself.

b - Birds

The first full study of the avifauna was made by Godfrey, Standfield and Morris in 1947, and reported by Godfrey (1949). Murray and Edward Rogers made observations on the water fowl of the region in the summer of 1946, 1947, and 1948 while carrying out an archaeological survey. Their results were published by Harold C. Hanson, Rogers and Rogers (1949). Rousseau has also made some notes (1967:16). Occasional notes are to be found in surveys of the birds of the Lake St. John region (Godfrey and A.L. Wilk, 1948), the Quebec-Labrador Peninsula (Harper, 1958), Eastern Canada (P.A. Taverner, 1919), and Canada (Macoun and Macoun, 1909; and Godfrey, 1966).

Godfrey concluded from his survey that the "bird fauna of the region was found to be rather poor both in species and in numbers of individuals" (1949:12). The rocky shores of lakes and the limited marshy areas make the region unattractive to water fowl or migrating shore birds. Hanson, Rogers and Rogers reach similar conclusions. The pre-cambrian sheild lakes are unattractive to game ducks because the lakes lack shallow water, are generally deficient in plant nutrients and organic soils necessary to support larger invertebrate populations, and have little marshy vegetation (1949:201). The only species of ducks they found present in any numbers at Mistassini were the black duck and the common merganser (1949:190-193), but Godfrey considers the common golden-eye probably the most numerous summer duck (1949:15).

Godfrey's list of the birds of Lake Mistassini includes ninety-five species. Of these, forty were considered "common" either by Godfrey or by Macoun. We list these species in Table 2, with terminology updated according to Godfrey (1966). Eight species which, though not common, are actively sought for food by Indians when they are available, are also included in the list. A number of other species could have been added as probably common on distributional evidence, but this was not done as the list is more than ample for our purposes. Most species migrate through the region or are summer residents only. Only eight are winter residents. Of the winter residents, six are are permanent residents: Hudsonian Spruce Grouse, Northern Ruffed Grouse, Canada Jay, Hudsonian Chickadee, Newfoundland Pine Grosbeak (<u>Pinicola</u> <u>enucleator</u> <u>eschatosa</u> Oberholser), and the White-winged Crossbill; and two winter in the region: Willow Ptarmigan, and Snowy Owl.

c - Fish

L.R. Richardson recorded the fish of Lake Mistassini and the lakes immediately to its south in 1937 (Richardson, 1944). No scientific surveys have been published since to our knowledge. Rogers has made occasional observations during his anthropological fieldwork (1963:11-12), Neilson during his stay (1948:153), and Rousseau during his (1967:16). Harper has reviewed Low's data and has made a survey of the whole peninsula (196a). In addition there are a number of more general studies of relevance to the area: Erhard Rostlund, 1952; V.C. Wynne-Edwards, 1952; and W.B. Scott, 1954.

Fish make up the largest portion of the limited cold-blooded

TABLE 2 - COMMON BIRDS OF THE LAKE MISTASSINI REGION

		Source
Common Loon*	*Gavia immer* (Brunnich)	1
Canada Goose*	*Branta canadensis* (Linnaeus)	2
Black Duck*	*Anas rubripes* Brewster	2
Common Golden-eye	*Bucephala clangula* (Linnaeus)	1
Surf Scoter*	*Melanitte perspicillata* (Linnaeus)	2
Common Scoter*	*Oldemia nigra americana* Swainson	2
Common Merganser	*Mergus merganser americanus* Cassin	1
Red-Breasted Merganser	*Mergus serrator* Linnaeus	1
Eastern Red-Tailed Hawk	*Buteo jamaicensis borealis* (Gmelin)	1
Hudsonian Spruce Grouse*	*Canachites canadensis canadensis* (Linnaeus)	1
Northern Ruffed Grouse*	*Bonasa umbellus obscura* Todd	2
Willow Ptarmigan*	*Lagopus lagopus* (Linnaeus)	3
Spotted Sandpiper	*Actitis macularia* (Linnaeus)	1
Herring Gull	*Larus argentatus smithsonianus* Coves	1
Common Tern	*Sterna hirundo hirundo* Linnaeus	1
Great Horned Owl*	*Bubo virginianus* (Gmelin)	2
Snowy Owl	*Nyctea Scandiaca* (Linnaeus)	2
Common Night Hawk	*Chordeiles minor minor* (Forster)	1
Belted Kingfisher*	*Megaceryle alcyon* (Linnaeus)	2
Yellow-Bellied Flycatcher	*Empidonax flaviventris* (Baird and Baird)	1
Traill's Flycatcher	*Empidonax traillii traillii* (Audobon)	1
Olive-sided Flycatcher	*Nuttallornis borealis* (Swainson)	1

TABLE 2, continued

		Source
Tree Swallow	*Iridoprocne bicolor* (Vieillot)	1
Canada Jay	*Perisoreus canadensis canadensis* (Linnaeus)	1
Eastern Crow	*Corvus brachyrhynchos brachyrhynchos* Brehm	1
Hudsonian Chickadee	*Parus hudsonicus hudsonicus* Forster	1
Brown Creeper	*Certhia familiaris americana* Bonaparte	1
Eastern Winter Wren	*Troglodytes troglodytes hiemalis* Vieillot	1
Black-backed Robin	*Turdus migratorius nigrideus* Aldrich & Nutt	1
Eastern Hermit Thrush	*Hylocichla guttata foxoni* Bangs & Penard	1
Swainson's Thrush	*Hylocichla ustulata swainsoni* Tschudi	1
Eastern Golden-crowned Kinglet	*Regulus satrapa satrapa* Lichtenstein	1
Eastern Ruby-crowned Kinglet	*Regulus calendula calendula* (Linnaeus)	1
Tennessee Warbler	*Vermivora peregrina* (Wilson)	1
Northern Yellow Warbler	*Dendroica petechia amnicola* Batchelder	1
Magnolia Warbler	*Dendroica magnolia* (Wilson)	1
Eastern Myrtle Warbler	*Dendroica coronata coronata* (Linnaeus)	1
Grinnell Water-thrush	*Seiurus noveboracensis notabilis* Ridgeway	1
Northern Yellow-throat	*Geothlypis trichas brachidactyla* (Swainson)	1
Wilson's Warbler	*Wilsonia pusilla pusilla* (Wilson)	1
Eastern Purple Finch	*Carpodacus purpureus purpureus* (Gmelin)	1

TABLE 2, Continued.

		Source
Eastern Pine Siskin	*Spinus pinus pinus* (Wilson)	1
White-winged Crossbill	*Loxia leucoptera leucoptera* Gmelin	1
Slate-colored Junco	*Junco hyemalis hyemalis* (Linnaeus)	1
Eastern Chirping Sparrow	*Spizella passerina passerina* (Bechstein)	1
White-throated Sparrow	*Zonotrichia albacollis* (Gmelin)	1
Lincoln's Sparrow	*Melospiza lincolnii lincolnii* (Audubon)	1
Northern Swamp Sparrow	*Melospiza georgiana ericrypta* Oberholser	1

Key to Sources:

1 - Species considered common by Godfret or Macoun (Godfrey, 1949)

2 - Species not considered common by Godfrey, 1949, but added to the list because they are commonly sought for food by the Mistassini (Rogers and Rogers, n.d.: 97-B; Rogers, 1963: 35, Table 2).

3 - Species considered common by Godfrey (1949), and sought after for food by the Mistassini (Rogers, 1963: 35, Table 2)

* - Species sought for food. This list is probably incomplete, as Rogers states, "There is hardly a species of bird that is not considered edible, although in general only the larger ones are utilized" (1963: 33). Our own field work in the nearby Waswanipi region does not confirm so sweeping a statement, but the possible utilization of *some* other species is correct.

vertebrates of the region (the few amphibians and reptiles will be described in the next sub-section). There are of course no fish in the shallow ponds and lakes which freeze to the bottom in winter. The ice which churns the shores of all lakes prevents the development of any significant littoral fauna (Charles W. Johnson, 1909:453).

Comparing the far north to the rest of the continent Rostlund considered the production of food fishes per unit area very low (1952:70). Mistassini was in a zone having an average annual production of 101 to 200 pounds per average square mile of territory (1952:303, map p.45). Wynne-Edwards reports that the low temperatures retard growth and development (1952:2). The rocky bottoms of the larger deeper lakes make them unproductive. Plankton production is meagre, but insects fed on at the surface provide a significant energy input into northern lakes (Wynne-Edwards, 1952:4). The impression one receives from local data is that Mistassini is a generally well stocked lake for the region. Low reported lake trout as large as forty pounds and whitefish of fourteen pounds (1895a) but average sizes are much smaller.

A list of the fish of the region is provided as Table 3. Based primarily on Richardson, it updates terminology and makes a number of additions on the basis of other notes available. Most important of these is the lake sturgeon, not found in Lake Mistassini, but found in the western half of the region we are considering. Several other fishes may be limited to only part of the region.

TABLE 3 - FISH OF THE LAKE MISTASSINI REGION

		Source
Lake Trout*	*Cristivomer namaycush* (Walbaum)	1
Brook Trout*	*Salvelinus fontinalis* (Mitchell)	1
Lake Herring; Cisco	*Leucichthys artedt* (Le Soeur)	1
Common Whitefish*	*Coregonus clupeaformis*(Mitchell)	1,3,4
Northern Pike*	*Esox Lucius* Linnaeus	1
Common Sucker*	*Catostomus commersonii commersonii* (Lacépede)	1
Red Sucker*	*Catostomus catostomus catostomus* (Forster)	3
Plumbeous Minnow	*Couesius plumbeus plumbeus* (Agassiz)	1
Ling*	*Lota lota maculosa*	2,3,4
Pike-perch; Doré*	*Stizostedium vitreum*(Mitchell)	1
Great Bear Lake Sculpin	*Coltus cognatus*	1
Lake Sturgeon*	*Acipenser fulvescens*	3,4
Fallfish	*Semotilus corporalis*	1
Northern Creek Chub	*Semotilus atromaculatus atromaculatus* (Mitchell)	1
Black-Nosed Dace	*Rhinichthys atratulus* (Hermann)	1
Long-Nosed Dace	*Rhinichthys cataractae*(Cuvier & Valenciennes)	1
Trout Perch	*Percopsis omiscomaycus*(Walbaum)	1
Brook Stickleback	*Eucalia inconstanis* (Kirtland)	1
Nine-Spined Stickleback	*Pungitius pungitius* (Linnaeus)	1

Key to Sources:

1. Richardson, 1944
2. Rousseau, 1967
3. Rogers, 1963
4. Low, 1895

* Species definitely utilized for food by the Mistassini (Rogers 1963:33-34)

d - Amphibians and Reptiles

The sub-arctic in general and Mistassini in particular are generally poor regions for Amphibia and Reptilia. Occasional notes have been made by biologists in the area (cf. Godfrey, 1949:8, Rousseau, 1967:16). The only comprehensive data however is given in J. Sherman Bleakney's zoogeographical review of the whole of eastern Canada (1958). Harper had previously published a brief review of the Quebec-Labrador Peninsula (1956).

Summarizing the data available: There are no turtles or lizards at Mistassini. The lake is roughly on the northern limit of salamanders and the last of the snakes, the garter snake. Only frogs continue through the more northern sectors of the Quebec-Labrador peninsula. In total, five species of amphibia and reptiles have been identified in the region, and five are possible on the basis of distributional evidence. There are no reports of amphibians reptiles being used for food by the Mistassini, and they are generally, treated with some suspicion or even avoidance.

TABLE 4 - AMPHIBIANS AND REPTILES OF THE LAKE MISTASSINI REGION

Recorded:		Source
Common Toad	_Bufo_ _americanus_ Holbrook	1
Wood Frog	_Rana_ _sylvatica_ Le Conte	1
Leopard Frog	_Rana_ _pipiens_ _pipiens_ Schreber	1
Jefferson's Salamander	_Ambystoma_ _jeffersonianum_ Green	2
Eastern Garter Snake	_Thamnophis_ _sirtalis_ _sirtalis_ Linnaeus	1
Predicted on Distributional Evidence:		
Red-backed Salamander	_Plethodon_ _cincereus_ _cincereus_ Green	1
Two-lined Salamander	_Eurycae_ _bislineata_ _bislineata_ Green	1

TABLE 4 (cont'd)

		Source
Green Frog	Rana clamitans Latreille	1
Mink Frog	Rana septentrionalis Baird	1
Spring Peeper	Hyla crucifer crucifer Wied	1

Key to Sources:

1 - Bleakney, 1958

2 - Rousseau, 1967

e - Intervebrates

Only occasional notes are available on the invertebrates Rogers (1963:12) and Rousseau (1967:16-17). These species emerge in late May and remain until September. It has been said that they are the predominant animal life in the forest in summer. The diptera mosquitos, deer flies, sand flies and black flies (Simulium) particularly, are numerous, with the last named predominating. Other invertebrates of concern to man are head lice and fish tapeworm. Also, it is worth noting again that insects are a major food source for fish during the summer.

3 - The Temporal Dimension

Projecting present descriptions of the forests and inventories of animals back several centuries presents a number of problems. First, a number of authors have commented that there has been a gradual warming in the eastern subarctic, amounting to a change rate of three degrees Fahrenheit per century (M.K. Thomas, 1957:74). This has been accompanied by a general extension of the ranges of various birds and mammals northward at least since 1915 (Anton de Vos, 1964:490; Peterson, 1957:43). Harper claims there has been a northward shift of the total life zones (1961e:22). The extent to which the present changes require modification of our data for aboriginal times must be assessed. On the basis of pollen-profile analysis, Grayson has concluded that much of the Quebec-Labrador region was deglaciated 8,000 years ago, and practically all by 6,000 years ago (1958). Following deglaciation Paul Sears outlined a sequence of spruce, pine (plus deciduous) and spruce as the sequence of forest types for southern Quebec, but attaches no dates to the sequence (1948:328). Thomas suggests that between 1000 B.C. and 500 B.C. a "climatic optimum" was reached "when southern Ontario was probably covered with a rich deciduous forest and northern Ontario with a spruce-fir forest," and the mid-latitudes, we assume, with mixed forest (1957:60). After 500 B.C. there was a rapid and drastic change to a wetter and cooler climate (Thomas, 1957:60). A slight warming occurred in the early Christian centuries but in the thirteenth century the climate swung back to colder, wetter conditions. Thomas quotes A.A. Miller (Climatology, 8th ed., 1953, London: Methuen & Company) who states that there are "no records of weather after the Christian Era which might not apply to a single, perhaps abnormal, year of the present time" (in Thomas, 1957:61). In short, recent changes have been slight compared to earlier changes. If we define our primary aboriginal conditions as particularly the period from 1300 to 1500 and a less certain period as extending back another 1000 years, floral and faunal inventory is probably comparable to that of the period from Low's studies in 1885 to the present; and probably varied no more than has occurred in the last fifty years.

A second temporal problem relates specifically to the moose. An expansion of range of the moose has generally been noted over the last fifty years (Peterson, 1955:16). Peterson suggests that the moose range extension may be a part of its post-glacial dispersal. Despite some oscillation on the fronts he states that "all available evidence seems to discount any earlier major immigration into these unoccupied areas, at least within historic time" (1955:16). Recent discoveries have been made of moose bones that are clearly post-glacial in regions where moose have not been known in historic times (David Sanger, 1968: personal communication; A.W.F. Banfield, 1968; personal communication). Our own analysis of boreal forest ecosystem cycles would lead us to expect a continuous decline and then rise of local moose populations. New discoveries may in the end support this conclusion. For the Mistassini region the often quoted reference on the historic absence of the moose is Low. He wrote, "It is very doubtful if this species enters the south-west limits of Labrador from the head-waters of the Ottawa River, where it is found abundantly" (1895b:317L). Yet, earlier in the same report he wrote, specifically of Mistassini, "Caribou and moose, once plentiful in the region, are almost extinct, and can no longer be relied on as a source of food by the Indians, who now live wholly on fish, rabbits and the fur-bearing animals" (1895b:70L). Albanel refers to moose and caribou being abundant at Mistassini in 1672 (Thwaites, 1896-1901,56:179). Pending further evidence we prefer to consider the moose a recurrent resident at Mistassini.

A final aspect of the temporal dimension is the introduction of new species. Rousseau reports discovering only a single introduced weed, buttercup (Ranunculus acris) at Mistassini and this was limited to the extremities of the portage between Lakes Albanel and Mistassini (1966:67). Godfrey reports an introduced grass (Poa pratensis) in the clearings around the post. The dog is the only mammal possibly in this category; it is discussed later. Some insects may be introduced, particularly the larch sawfly which took a heavy toll of larch at the end of the last century (Low, 1895:36L). In summary, the basic biological inventory presented has not been affected by the very limited number of introduced species.

D - Sub-arctic Ecological Systems

It is proposed to close our review of the biological environment with a summary review of general knowledge on sub-arctic ecology. The subarctic is delimited primarily by temperature, or some more complex climatic variable. Climate is the main control underlying circumboreal unity. Conifers can withstand the cold winters, and are adapted to the short supply of unfrozen water in winter (Maud Haviland, 1926:198). They however require a warm period for growth. Agriculture of any proportion or security is impossible under aboriginal conditions (Alfred G. Spaulding, 1946:146). The number of species of plants and animals that have adapted to the rigorous conditions of the north is quite limited, and among them are no nut trees or other high nutritive value plants. The forest is composed of few species. There are seventy-five tree species in southern Ontario, fifty at Ottawa-Montreal, twenty-five at Timiskaming, and twelve near James Bay (Rowe, 1966:18). The surface of the earth itself is young, less than 10,000 years old. The numbers of animals too are limited, and in general only homoiothermal land animals can be active in winter Richard Hesse, 1937:439), hence the most important mammals are the ungulates, the rodents, and the carnivores. The uniformity of northern forests is broken by streams, lakes, bogs, burns, etc. These forest edges provide a greater variety of vegetation and niches for animals than the unbroken forest (S.C. Kendeigh, 1961:137; I.H. Blake, 1927:92). Most animals are associated with the forest edge, living and/or feeding there (Hesse, 1937:439; Blake, 1927:18). Animals, especially those of the climax, are shy and retiring. Due to the limited inputs of solar radiation, the sub-arctic is generally poor in productivity per areal unit. Productivity of dry matter per year is one-sixth to one-tenth what it is in more southerly zones (Hustich, 1966:5). The limited number of species present means that the structure of the natural community of the sub-arctic is fragile and unstable (William O. Pruitt, 1966). Many species are pertually near their tolerance limits for one physical factor or another. When these are exceeded the population of that species is adversely affected. The fewer inter-relationships of species, because of the small number of species, limits the responses the community as a whole can make to the disturbance. That is, few species makes for simple communities with a limited number of regulatory mechanisms. Sub-arctic communities are unstable. The best known instability are the nine to ten year cycles of herbivores, rodents, grouse and hare (Charles Elton, 1942; Lloyd B. Keith, 1963). As a consequence, carnivores dependent upon these species naturally have parallel cycles. The nine to ten year cycle is characteristic of the northern coniferous forest above 45 to 50 degrees north latitude; the four to five year cycle is characterristic of the tundra. The cause of these cycles are not yet clear. Our own studies will focus on other aspects of instability.

CHAPTER III DYNAMICS OF THE BOREAL FOREST ECOSYSTEM AND THE HUNTING TERRITORY DEBATE

At the core of the ecological arguments for the aboriginality of the family hunting territory system lies the assumption that any limited geographical area of the main boreal forest was continuously productive of game utilizable for human subsistence; and, that this productivity could be increased by careful husbanding of the kills, particularly of small game; and that the increased efficiency of this conservation suggested and necessitated that control over the resources of a territory be in the hands of a single hunter or his immediate kinsmen. In this chapter we will show that the underlying assumption of continuous subsistence productivity of limited territories is not valid. In the last two decades an overview of the dynamics of the boreal forest ecosystem has been emerging among botanical scientists, and we present this developing analysis here. As yet, there has been no comprehensive survey of these developments by botanists, so we summarize recent studies in a brief but wide-range survey of the literature. In particular we wish to show how these dynamics probably functioned in the Mistassini region in aboriginal times. Before entering into the analysis, we present here a brief introductory summary. The dynamics of a maturing boreal forest seen from the point of view of reproduction, tree growth, energy flow and biogeochemical cycles - reveals a slow down or deterioration as the system reaches maturity.

Forest fires are the kingpin in the successful transition from over-mature forest of declining growth and quality to vigorous new growth, and a new cycle of forest development. Despite a previous failure to recognize the natural and important role of forest fires in the boreal forest ecosystem, new studies are now discerning a history of extensive, periodic forest fires across the entire boreal forest belt. Lightening is a sufficient cause for explanation of the origins of these fires under aboriginal conditions. Periodic spruce budworm attacks often prepare the way for the forest fires, and are of particular importance to us because they occur over thousands of square miles, and thus make large areas of forest highly susceptible to fire at the same moment in time. At Mistassini it is possible to determine the likelihood of such outbreaks on the basis of a number of hypothesis. A tentative model of the 200 to 340 year-long cycle of boreal forest development is proposed, and an estimate of the geographical areas involved in extensive fires is made.

Periodic burning of thousands of square miles of forest is not of primary significance for animal populations through the direct effects of fire, but through the destruction of the vegetational food and shelter of the species common to the mature boreal forest. Some of the area escapes fire, and new vegetation begins to grow almost immediately on a portion of the burned area, but this vegetation is quantitatively limited, rapidly changing, and very different from the mature forest vegetation.

During the first winter after fire the populations of terrestrial animals are quickly reduced. Fish populations in lakes are the only animals important to human subsistence that are not very adversely affected. However, Indian population numbers that previously subsisted on terrestrial animals plus fish cannot now survive only on fish and widespread starvation, or migration, of the local population must have been common. Under these conditions it is impossible to conceive of a family hunting territory system being maintained. Family hunting territories were not permanently productive, careful hushanding of the kills could not prevent periodic decimation of the subsistence base and territories were then regularly abandoned - through death or possibly long migration - for several years.

A - Dynamics of the Maturing Forest

The most striking feature of the maturing spruce-fir forest is the absence of any adequate preparation to perpetuate itself. This feature, stressed by W.J. Bloomberg (1950:157) in his study of the eastern slope forests of the Southern Canadian Rockies, is the key to understanding the catastrophic nature of the developmental cycle of the boreal forests.[7]

In stands of 200 to 300 years of age, Bloomberg found spruce regeneration almost nil. Fir regeneration was higher, but still insufficient to fill sparce spots or gaps. Fir, however, increased its proportion in the stand relative to spruce with continued aging. Regeneration of all species was highest when the stands were 100 years old. Thereafter it declined in quantity and vigor.

The summer is the period of intense vegetal activity. Under forest stands, however, little sunlight reaches beneath the crown, and in the soil microclimate temperatures are appreciably lower than at the crown. This cooling effect intensifies as the forest matures and the crown closes. The low temperature reduces the activity of soil microorganisms and retards chemical decomposition of the humus layer of organic litter. The scarcity of soil animals, such as earthworms and large arthropods, results in the organic matter resting on the soil as a mantle rather than being incorporated with the mineral soil (H.J. Lutz, 1960:458). Under black spruce especially the humus may be 12 or more inches thick, and the deepening of organic debris is often accompanied by accelerated growth of mosses which add their debris to the mantle. The thickening humus and moss layer has a detrimental effect on reseeding; the seedling rootlets of the spruce are unable to penetrate to the mineral soil for nutrients. Balsam fir with a deeper tap root is only relatively more successful (Bloomberg, 1950:160). Under these conditions there is a decrease in stand density, and an increase in reproduction by layering (underground shoots) and hence an increase in poorer tree forms. Thus, a point is reached in the maturation of the forest where reproduction is minimal and continued maturation of the stand reduces the stand's quality.

In ecosystem terms, what is happening during this development is that the comparatively slow cycling of nutrients characteristic of the middle stages of the maturation of the boreal forest is brought almost to a standstill. The nutrients in the biogeochemical cycle are increasingly "stored" in the undecomposed humus. Here they are physiologically unavailable to the living vegetation. While few quantitative studies of the energy and mineral cycles of the boreal forest ecosystem have been made the roles of nitrogen and phosphorus have been singled out. Richard F. Watt and M.L. Heinselman report that among conifers the micronutrients (elements required in small amounts) seldom limit tree growth (1965:358). In contrast, both nitrogen and phosphorus levels were significantly and positively correlated with vegetation quality among a variety of sites in a Minnesota spruce bog (ibid.). The importance of these chemicals is understandable since phosphorus is very important in plant energy transformation and both nitrogen and phosphorus are found in nucleoproteins. Watt and Heinselman further found that in those sites where the peat layer was relatively thin and hence where organic decomposition was assumed to be more rapid, the nitrogen level was higher and vegetation better (1965:359). Similar results were found by Paul E. Heilman, working in Alaska. He found a significant reduction in total nitrogen in the soil, i.e. available nitrogen, with the development of moss layers; although, it is not clear how much of this response was due to a rise in permafrost under the moss cover (Heilman, 1966:829). At the extreme of maturation then humus and moss are well developed, the humus contains a large "store" of nutrients, decomposition is at a minimum, nitrogen and other nutrients are increasingly unavailable, and the forest quality drops. At this extreme, the forest floor is strewn with undecomposed refuse and an especially high fire hazard is created.

B - Dynamics of Forest Destruction

1 - Role of Forest Fires

When the forest floor is covered with litter fires are less likely to remain limited and any fire during a particularly dry season can explode into a major conflagration. Such a fire, often started by lightening, would be of severe intensity and vast extent. It sometimes results in 100 percent destruction of the old stands. This marks the end of a cycle. Fire is not just associated with the cyclical development of the spruce-fir forest, but is in fact the "kingpin" of the whole structure (Bloomberg,1950:160).

In terms of biogeochemical cycles fire "liberates" the mineral elements contained in the humus layers, making these materials quickly available (Lutz, 1960:459). Available nitrogen and phosphorus as well as exchangeable calcium and potassium may all increase several fold. H.Knight has stressed that, while the concentration of nitrogen in the residual material increases, the total amount of nitrogen decreases as much is lost in combustion (1966:152). Heilman however has shown the benefial effects of redistribution of the nitrogen in the soil. After the fire, the soil surface, which becomes the warmest portion of the soil and the layer in which regeneration of the vegetation begins, has a maximum nitrogen content (1966:831). Fire lays the foundation for the rapid growth of the early stages of regeneration in the boreal forest cycle. However the integral and effective role of fires in the boreal forest cycle has not been noticed or given sufficient importance in the past.

Bloomberg pointed out that since fir regeneration was greater than spruce in over mature forests; one would expect to find climax stands of pure fir if the forest were undisturbed. He found no such stands in his ninety square mile area of study (1950:160). Lutz on the basis of his studies in Alaska stated that all the evidence known to him leads to the conclusion that fire has always been common in the forests of the Alaskan interior (1960:454). W.W. Jeffrey's studies in Alberta showed that many, and probably most, of the younger stands on the fluvial sites he studied followed fires. However he considered the evidence for the role of fire not "completely conclusive" (1961:19). J.B. Millar cruised some 2,000 square miles in Northern Ontario and estimated that seventy-eight percent of the area had been burned in the last 120 years. Further, he found evidence of at least seven extensive fires since 1820 (1939:93). In a classification of the forests of Labrador, W.C. Wilton recognized a Fir-Spruce/Feathermoss type which requires periodic burning to prevent degradation. Of it he says, "Fortunately for the future of this type...fire seems to have accomplished its task and very few extensive areas can be found that do not show evidence of burning" (1964:27). Numerous other references could be cited. In short, the role of extensive, destructive and periodic forest fires in the development of the boreal forest is discernable across the entire boreal forest belt from Alaska to Labrador.

The role of lightening in starting wild fires has been a point of considerable debate. Increasingly, the role of aboriginal man has been found important in understanding the effects of fires on the vegetation of a number of North American regions, e.g. the American prairies, the southern pine forests and the eastern deciduous forests (Omer Stewart, 1956; Gordon Day, 1953:340; and Carl Sauer, 1962:223). In the boreal forest region, while aboriginal man undoubtedly has had a considerable effect, natural causes, namely lightening, provide an adequate explanation and appear to have been at work prior to the presence of man. Lutz reaches this conclusion in the study of Alaskan forests. E.V. Bakuzis and H.L. Hansen, in their monographic review of knowledge of the balsam fir, refer to studies by Walter in Europe that indicate that spruce and fir, well known for the ease and intensity with which they burn, are the species most frequently struck by lightening. This, they suggest, may be a result of their acid sap and their preference for moist substrate which together "provide an excellent electrical conductor upward from the water table, whence comes the initial great discharge" (Bakuzis and Hansen, 1965:101). Unlike some other ecological complexes of the continent, natural fire plays an integral role in the boreal forests which man-made fire only supplements.

In their study of interior Alaska Hardy and Franks ("Forest Fires in Alaska," United States Forest Service Research Paper 5, cited in Roy Komarek, 1964) commenting on earlier statements that almost all fires were man-caused, state that "evidence now on hand show that these statements were in error...One-fourth of all fires between 1950 and 1958 were reported as lightening-caused, and they accounted for three-fourths of the total acreage burned."

The frequency and ease with which lightening starts fires under favorable conditions at Lake Mistassini were recorded from personal experience by Godfrey: "In the unusually hot, clear weather from late June to mid-July, 1947, the forest on higher ground became very dry. A ten-day period of dry weather was interrupted for three hours on July 12 by a violent thunderstorm. On July 14, the smoke of three forest fires could be seen from Mistassini Post and on the following day the air became very smoky. A bush pilot said that many such fires were burning" (1949:9).

Unfortunately, these rather lucky and pertinent observations on the forest at Lake Mistassini are unusual, and no intensive study of the fire history or relation of fire to forest development at Mistassini has been undertaken.

An intensive forest study has however been untertaken on the borders of Lake St. Pierre, Quebec, approximately 250 miles east of Mistassini. R.J. Hatcher found extensive evidence of the fire origins of the various stands he studied in the occasional dead fire-charred trunk or stump, the abundance of carbon deposits on the mineral soil surface, the absence of a thick humus layer and the low volumes of fir trees (1963:12). The entire B.1b section of Rowe which includes both Lake St. Pierre and Mistassini is known for its extensive fire history (Hatcher 1963:6; Rowe, 1959:13; Hare, 1959:31). In addition, Hatcher found strong, if inconclusive, evidence of the developmental cycle outlined in the west by Bloomberg.

On the forests at Mistassini itself and their relation to fire most of those who have been in the region for other reasons have made generally supporting, though limited, observations. Godfrey outlined a number of areas where evidence of burns was apparent in 1947 (1949:2, 4). Morris, who had accompanied Godfrey, gave a similar account (Cameron and Morris, 1951:121). The Rogers' archaeological reconnaissance found a number of sites where the subsoil showed distinct layers of charcoal which were apparently not caused by Indian hearths (1948). Neilson noted that this territory was reknowned for its extremely violent thunderstorms (1948:149). Low noted that summer thunderstorms were common in the region (1889:28). He also said the forests of the western watersheds of Ungava had been more than half burnt - apparently within the previous twenty-five or thirty years (1929:22). The earliest reference is by Dreulletes and Dablon at Necouba in 1661. They reported that forest fires "are very common here for a month or two in the summer" (Thwaites, 1896-1901, 46:279; cited in Rogers, 1963:8).

The most detailed and quantititatively precise data on fire at Mistassini is the photo-reconnaissance survey of the Labrador-Ungava peninsula by the McGill group under Hare. One of the maps they published shows the distribution of burnt-over areas (Fig.9; Hare & Taylor, 1956:65). The scale (100 miles = 1 inch) of the map limits its value, and does the fact that Lake Mistassini is just within the southern limits of the survey, and as a result the areas to the west of the Lake are incompletely mapped. Even so, the area surrounding the Lake shows a particularly heavy clustering of burns, especially along the shores of the northern half of the Lake where the burned area averages about fifty percent. R.N. Drummond reports that the map would indicate areas burned in the last fifty to seventy-five years (1968: personal communication). Although the data on the dynamics of the forest at Mistassini is quite limited it confirms the importance of fire and allows us to assume, with considerable confidence, that the forests at Mistassini go through the cycle of maturation, peak, decline and destruction that characterizes the boreal forest elsewhere.

2 - Role of the Spruce Budworm

Spruce budworm epidemics help prepare the way for forest fires by periodically defoliating enormous areas of the mature forests. These attacks, if not followed by fire, set off a cycle of regeneration of their own. The most immediate effect of the outbreaks however is the sharp increase in the susceptibility of the forest to fire. J.J. De Gryse describes the accumulation of dead needles, trees and general debris on the forest floor as "extraordinary" (1947:391). Somewhat dramatically, he states "It is humanly impossible to control a fire in an area littered with dead trees, nor is it usually possible to confine it to that area" (1947:390). The relationship between outbreaks and fire is supported by W.A. Delahey, secretary-manager of the Ontario Forest Industries Association (in Anonymous, 1944:544) and by A.W. Ghent, D.A. Fraser and J.B. Thomas who quote de Gryse (1957:186). J.R. Blais has summarized recent scientific studies. "In the primitive forest", he writes, "spruce budworm infestations almost certainly played a beneficial role, not only because they helped to prevent long persistence of overmature coniferous stands, but because they were very often followed by extensive fires which brought about a change in forest composition" (1959:72). Regarding the situation in New Brunswick, Flieger cited by Blais, says that there is not much doubt that all of the very large forest fires in the history of the entire region "have been made possible through the action of forest insects" (Blais 1959:72). Budworm outbreaks are important for an understanding of the spacio-temporal dimensions of natural forest fires because of the periodicity with which they occur and of the enormous areas affected by the outbreaks.

The earliest first-hand documentation of a spruce budworm outbreak in Canada is from 1807-1818 (de Gryse, 1947:389). Blais, however, using a tree ring analysis, has reviewed the history of the Laurentide Park, Quebec forests for the last three hundred years. He found evidence of five successive outbreaks, the earliest beginning about 1750 (1962:483). These studies are limited by the age of contemporary trees. The spruce budworm, Choristoneura Fumiferana (Clem.), is distributed widely in North America, but not elsewhere. It apparently does not occur in Europe, although there is a close relative native on that continent, the European fir budworm, Choristoneura muriana (Hb.) (Bakuzis and Hansen, 1965:155). The spruce budworm is primarily associated with the boreal forests of North America, in particular with the native balsam fir (Bakuzis and Hansen, 1965:2). It was previously thought that outbreaks of the budworm may have been a recent phenomenon triggered by extensive cutting and other Euro-Canadian influences on the forests. Outbreaks, however, have clearly originated in undistrubed stands (Blais, 1954:70; Bakuzis and Hansen, 1965:162). On the evidence, spruce budworm outbreaks have been an integral part of the dynamics of the boreal forest from aboriginal times, although no direct evidence remains.

Budworm epidemics are not sufficiently regular to predict their occurrence in a given area with certainty. Release of an outbreak appears to depend on two prerequisites: a period of drought and the presence of mature balsam fir (Blais, 1954:321). Studies by Wellington in the northeast, by Greenbank in New Brunswick, and by J.G. Pilon and Blais in Quebec all confirmed that with few exceptions, possibly explainable, outbreaks were preceded by three, four, or more years of early summer drought (Pilon and Blais, 1960:118). Mature or flowering balsam fir are critical in providing conditions favorable for budworm populations to increase to outbreak proportions and to spread (Blais, 1954:70). Despite the common name 'spruce budworm', Choristoneura Fumuferana (Clem.) is more dependent on and destructive of balsam fir than the spruces (Blais, 1954:62), and more on the white spruce than black. The minimum possible length of the cycle of outbreaks is tied to the regeneration of stands with a high percentage of mature fir (Blais, 1961:200). Once endemic populations of budworm have grown to epidemic proportions under suitable conditions they will spread to areas with significantly lower proportions of fir (Bakuzis and Hansen, 1965:164-5). Tree mortality is caused by several successive years of defoliation of at least all new growth. In northwestern Ontario balsam fir is able to stand five years of defoliation, on average, seldom more than eight (R.M. Belyea, 1952: 738; Blais, 1958:421). White spruce mortality starts a year or two later than fir. Severe outbreaks usually last long enough to destroy most fir of commercial size, but only a relatively small number of white spruce (Blais, 1954:62). In areas where black spruce are an important component of the forest they are infested by "overflow" from the fir, contribute to the maintenance of high levels of budworm populations, and are sometimes killed (Blais 1957:71). It is unlikely then that budworm outbreaks would originate in predominantly black spruce areas. In these areas an additional prerequisite to the occurrence of budworm outbreak would be the presence of an active epidemic in a neighboring region.

Mistassini is just beyond the region where spruce budworm outbreaks are definitely known to have occured. During the last sixty years of scientific study of outbreaks, western Quebec has recorded two major epidemics. The former, from 1909-1917, came within what we estimate, from the Gryse's small scale map, to be fifty miles of Mistassini, apparently just over the height of land (1947:opposite 390). This attack may not have occurred in the western watershed because of a lack of mature fir. Low reported that half the forests in the western watershed had burned only fifty to sixty years previous to 1911 (1929:22) and as fire or disturbance favors the regeneration of spruce (R.H. Candy, 1951:30), fir regeneration would not have been completed. The epidemic of 1945-55 remained in sections considerably to the south of Mistassini. On this occasion climatic conditions may have prevented the spread of the outbreak. Godfrey reported that while the summer of 1947 was warm and dry, spring was unusually late (1949:3). Once larvae begin feeding they are very susceptible to low temperatures (Bakuzis and Hansen, 1965:156). The late spring may have kept the budworms from the more northerly sectors of the closed-crown forest region.

Although budworm outbreak has not occurred at Mistassini in this century, pending decisive analysis of the forests in the region, it is our contention that neither stand composition nor climate preclude epidemics from the region. Further, we hypothesize that they likely did occur in the past. The B.1b forest section is distinguished from B.1a to the southeast by the predominance of black spruce as opposed to balsam fir on upland sites (Rowe, 1959:12). As the stands mature fir becomes more a prominent minor component in the B.1b forest. Dutilly and Lepage report that balsam fir is "frequent around Lake Mistassini" (1948:75). A map of the distribution of balsam fir places the line separating the 1- 10 percent and ten to thirty percent balsam fir by volume sections at Mistassini (Bakuzis and Hensen,1965:332). The map is based on evidence from recent decades during which the present forest is probably approaching maturity. Ten percent would be a quantitative estimate of the most balsam fir by volume ever at Mistassini (Rousseau, 1968: personal communication). This is within the range of percentages of balsam fir found in the forest sectors of the Lake Nipigon region of Ontario in the 1950's - 6.1 to 10.4 percent (Ken R. Elliot, 1960:64, Table 1). In this area which supported a heavy budworm outbreak in the 1950's, white spruce was also a minor component - 3.2 to 7.4 percent (Elliot, 1960:64, Table 1), probably comparable to the percentage of white spruce at Mistassini. In reviewing the climatic conditions at Laurentide Park in the B.1a forest section Blais concluded that the region provided marginal conditions for budworm development because of the short growing season and summer frosts (1964:316). Because of a difference in altitude the climates of the Mistassini region are more or less comparable to those in Laurentide Park. Mistassini altitudes are approximately 1300 feet above sea level, Laurentide Park is over 2,000 feet and in some regions over 2,500 feet above sea level. These differences in altitude cancel differences in climate caused by latitude. Lake Doré at Chibougamau sixty miles south of Mistassini Post is at latitude 49°,54' North and Lac Jacques Cartier, in the central area of Laurentide Park is at 47°,33' North. G. Oscar Villeneuve's maps and tables (1946) allow us to compare the two sites. Mean annual temperature is 32 degrees Fahrenheit at Lake Doré and 30 degrees Fahrenheit at Lake Jacques Cartier(1946). Mean temperatures for July are, less than 60 degrees Fahrenheit and 58 degrees Fahrenheit respectively. Mean monthly range of temperature in July is, greater than 54 degrees Fahrenheit and 54 degrees Fahrenheit. Mean temperature for the four warmest months is, less than 56 degrees Fahrenheit and 54 degrees Fahrenheit. Average length of frost free period is, less than 80 days and 60 days. Mean monthly summer precipitation is 3.81 inches and 5.81 inches respectively. Interpretation of the basic quantitites has a high built in error as they are made from maps. The basic comparatibility of the two climates is however clear. Villeneuve notes that the Laurentide Park region is comparatively cool for its latitude (1946:18, 20, 22, 23). Summarizing the Laurentide Park area he states, "Pure stands of black spruce and balsam fir evidently reflect a cold and moist climate, conditions favored by the high altitude of this section"(1946:58). On the basis of the climatic comparability of the two regions we conclude that Mistassini too provides marginal conditions for budworm development. It would not be a center of origin of an outbreak, but one could spread to that region from the southwest. An area need not permanently support indigenous endemic populations of budworms; it need only provide hospitable conditions for several years when epidemic populations are active nearby. At Mistassini outbreaks would be expected when the following conditions coincided: 1) the forest was over-mature with the proportion of fir increasing; 2) there were several years of early, warm and dry springs; 3) an epidemic was active to the southwest and/or south. Pending a quantitative determination of the factors limiting budworm epidemics and intensive field study of the limits of the outbreaks, it is most parsimonious to assume the limit coincides with the northern limit of the main boreal forest while recognizing a declining frequency of attack in the northern sectors, due to the occurrence of high percentages of fir only in the over-mature phase of the forest cycle of development.

3 - Model of the Cycle of Forest Destruction

There are no quantitative studies of the relationship of fire and spruce budworm epidemics to our knowledge, certainly not under aboriginal conditions. Even so, it is desirable to construct a hypothetical model of cycle of destruction of over-mature forests in order to integrate the botanical analyses we have made so far. In trying to temporally order and quantify the cycles we have been discussing it needs to be stressed that the analysis of this section goes somewhat beyond our present knowledge for heuristic reasons.

At Mistassini the decidedly secondary position of fir would probably preclude budworm outbreaks from occurring except in an over-mature forest. Bloomberg spoke of a rotation of 350 years for the forests of Alberta (1950:157). In the east, where regeneration is more rapid, a shorter cycle is present. Wilton considers mature stands of the Fir-Spruce/Feathermoss type in Labrador to be 250 years old (1964:27). He also reports black spruce ages in excess of 200 years are common (1964:49), but mentions no trees in the 400 - 500 years old class which Bloomberg found in the west (1950:157). At Mistassini then it probably takes 250 years for the forest to mature, if undisturbed, during 200 years of which budworm epidemics are uncommon.

Once the forest reached maturity outbreaks of budworm would be of considerable importance. Mistassini has both a high percentage of thunder showers and a relatively high precipitation. Many fires are set but most remain quite limited (Godfrey, 1949:9). In such a region debris left by a budworm epidemic makes a particularly important contribution to initiating extremely intense and extensive fires. In a mature forest occurrence of budworm outbreaks would depend on epidemics to the south and on climatic conditions. Budworm epidemics in areas with heavy concentrations of balsam fir are sometimes reported to have cycles of 30 to 35 years or of 50 to 70 years. These estimates are based on outbreaks during recent years. It seems likely that the control of forest fires in this century may have considerably influenced the frequency of budworm outbreaks, especially in the more southerly and easterly regions of their occurrence. Fires do not follow budworm outbreaks so extensively today. This allows the forest to enter a shorter regeneration cycle, increasing the frequency of outbreaks. Studies of Laurentide Park (Blais, 1962:479; Pilon and Blais, 1960:118; de Gryse, 1947: opposite 390) indicate that no outbreaks occurred in the ninety years before 1750. Two occurred between 1750 and 1850. And three have occurred between 1850 and 1950. A cycle of

70 years would appear the best estimate of aboriginal frequency of budworm epidemics. In southerly regions where fir plays an important part in the adolescent forests these outbreaks would occur several times during one cycle of adolescence, maturation and destruction of the forests. At Mistassini, over-mature forests could be threatened by outbreaks every 50 to 70 years, depending on weather conditions. Due to the wide geographical distribution of climatic cycles, it is likely that favorable conditions at Mistassini would coincide with favorable conditions to the south, although not vice versa. We might estimate then that on the average favorable conditions at Mistassini would be found during every second epidemic to the south.

The hypothetical model then provides a quantitative estimate of the average cycle of forest destruction at Mistassini. The expected minimum is the minimum time between one outbreak and fire and maturation of the forest to a point where another outbreak could enter the area. The maximum is this minimum plus twice the frequency of cycles to the south. The expected minimum time between destructions is 200 years. The expected maximum time is 340 years [(200) + (2 x 70)]. The average times are between 250 and 300 years. Such estimates will remain purely hypothetical until we know considerably more about the phenomena under discussion. The model does however allow us to develop a more integrated picture of the dynamics of the boreal forest at Mistassini.

4 - Size of Areas Destroyed

To estimate the area destroyed locally in these cycles we can be less hypothetical. Budworm outbreaks generally sweep across eastern Canada from west to east (Pilon and Blais, 1960:118). The enormous area involved is not uniformly affected.Pockets of heavy or severe attack are surrounded by regions of moderate or light outbreak.[8] Regions with no epidemic populations occur between the centers. Blais reports that the outbreak at Lac Seul in northwestern Ontario locally covered close to 10,000 square miles in 1952 (1954:62). Studies of an earlier outbreak, around 1867, indicated that it too had covered approximately 10,000 square miles. At Lake Nipigon, another center of attack to the west of Lac Seul, 20,500,000 acres (32,000 square miles) had been affected by 1955 (Elliot, 1960:63). Studies on the lower St. Lawrence and Gaspé Peninsula indicate that a total of 11,500 square miles was affected in 1912 (Blais, 1961:199). A more recent outbreak, beginning about 1950, covered an area of approximately 14,000 square miles. Attacks are not uniform in these areas. Elliot reported that during the greatest extent of the attack at Lac Seul, 1955, heavy to severe defoliation occurred in 9,122,000 acres (14,250 square miles) and heavy to severe mortality in an additional 1,985,000 acres (3,100 square miles) (1960:66).

An exceptionally high fire hazard over such a large area generates, under suitable conditions, an intense, fast moving forest fire that is able to cross streams and rivers and surround unburned pockets of wet bog.[9] Such fires are quite distinct from the numerous spot fires common in the coniferous belt. Few reliable records exist of the exact extent of and effect of such fires. Reports of previous centuries use vivid adjectives but infrequently give the actual size of burns. A partial exception is deCrepieul who wrote at Tadoussac in 1674, "There may also be seen the recent traces which cruel fires have left in these vast forest. The Savages say they have spread over more than two hundred leagues" (Thwaites, 1896-1901, 59:31, cited in Rogers, 1963:8).

Recent reports tend to show the effects of intensive fire control practices begun in the first decades of this century. Even so, some recent data are available. Lutz has listed some of the larger Alaskan fires of this century. The list includes: 1935 - 1,900,000 acres in one fire; 1940 - 1,250,000; 1941 - 1,000,000; 1950 - 1,800,000 (Lutz, 1956:15-17). For the Quebec-Labrador peninsula, turn of the century reports by explorers and geologists afford us the best information despite the possibility of some inaccuracies. These reports speak of fire in the coniferous forest as if it were a new phenomenon, attributable to the coming of the railway, forest cutting operations and settlers. These events clearly did have an effect, but on the whole the development of awareness of fires was newer than the frequency or extent of fires themselves. This awareness was a product of the growing lumbering and pulp industry, the beginning of professional forest management, and the continued professionalization of the biological sciences. The reports confirm the existence of fires that burned thousands of square miles. MacMillan and Gutches (1910:9) quote an apparently unpublished report of the Canadian Bureau of Mines by J.M. Bell from 1904, that one fire in eastern Ontario devastated an area of at least 3,000 square miles. Low travelling west from Lake Mistassini along the Rupert River in 1885 travelled for five days through an area that had been burnt and was covered with second growth. Totalling his daily reports he travelled 160 miles in the five days. Depth of the burned area is not known. Rousseau confirms the existence of this burn (1968:personal communication). In another report Low, a generally accurate observer, speaks of fires which "often burn throughout the entire summer, destroying thousands of square miles of valuable timber, to the south of the central watershed" (1929:21). Low specifically mentions a fire in 1870 or 1871, "the greatest fire of modern times" (1929:22), which destroyed hundreds of thousands of square miles of valuable timber. The area burned reached "from the St. Maurice River on the west to beyond the Bermises on the east, and from Lake St. John to the Height of Land" (1890-91:16). By conservative estimate the area covered is 40,000 square miles. Richardson confirms the existence of at least the eastern section of this burn which he traversed the year after it occurred (1872:279). Henry Y. Hind finds questionable, but possible, presumptive historical evidence of massive forest fires in the interior of the eastern part of the peninsula in 1785 and 1814 (1863:208).[10] One of the fires is believed to have covered 60,000 square miles (V. Tanner, 1947:401). In short, forest fires periodically occurred which were comparable in extent to the local center of an intense spruce budworm epidemic - from 3,000 to 10,000 square miles or more.

The unstable nature of the boreal forest has led some botanists to use the term "catastrophic climax". Blais considers this anthropomorphic and suggests "dynamic climax" (1959:12). From the point of view of nature the cyclical destruction of such enormous sections of mature forest has an object - ensuring the perpetuation of the species. From the human point of view these events are catastrophic. It is towards this view that we must begin to direct the analysis.

C - Decimation of Animal Life

1 - Immediate Effects of Fire on wildlife

The burning of a mature forest remains a hollow fact, for, our purposes at least, until we know what the effects of the fire itself and the weeks that follow have on animal life. The burning of animals by forest fires is less common and of less permanent significance than might be supposed. Deaths to individual animals do result through entrapment by the irregular front of a fire or by blow-ups, and through suffocation (Aldo Leopold, 1933:348). Several slow-moving species may suffer heavily, e.g. skunk and porcupine. The heaviest toll is among immature mammals and birds of most species. Any fire, even a light one, generally destroys all ground nests and helpless young (Lutz, 1956:81). This is especially the case as the fire season generally corresponds with the breeding season (Leopold, 1931:518). Mature game, however, ordinarily evade fire efficiently (Leopold, 1933:348), often finding protection in water or water-logged areas. Cringan has pointed out that the immediate effect of fire on individuals has a questionable influence on the whole populations. Natural mortality is high for all wildlife, e.g. 75 percent of ruffed grouse and one-third to one-half of the deer present in early summer will die within a year. "With such tremenduous mortality forces operating, mortality by fire may simply replace mortality by malnutrition, exposure, predation, or some other means" (A.T. Cringan, 1958:25). The most significant effects of fire on wildlife are not direct casualties, but the effect of the destruction of the vegetation, which is food and cover for the wildlife.

2 - Short-run Effects of Fire on Wildlife

To understand these effects we must look at the micro-distribution of unburned areas and quickly regenerating areas within the burn. Intense fires are able to destroy limited areas of younger stands within a mature forest, to cross streams and small to medium rivers, and to burn to the edges of the water. Such capacities are implied in the very fact that fire is able to extend over thousands of square miles of sub-arctic terrain. Some areas however escape destruction even in intense forest fires, especially lowland flooded bog or muskeg (Cringan, 1958:26; Lutz, 1956:21). The results are small islands of unburned land (Hind, 1863:221). But bog and muskeg can burn, as studies in Wisconsin confirm (Richard J. Vogl, 1964:317, 319). Lacking any more direct data, however, we accept the extent of bog and muskeg as an approximation to the extent of unburned land within the area. Around Mistassini, bog and muskeg generally comprise less than five percent of the surface area. They reach higher proportions, between five and ten percent only in a few local areas, and up to forty percent only at the very southern edge of the region (Hare and Taylor, 1956:61, Fig.6).[11] We would estimate then an average of 95 percent burned within the land area of the fire in this region. Of the bogs that remain unburned, de Vos has noted that black spruce swamps are the poorest environment for small mammals, for fisher, marten (1952:77), and we may add, for fur-bearers in general.

The use of burned land by the fauna depends on the succession of vegetation that follows a fire. Unfortunately, most regeneration studies, motivated by the economic importance of trees, have studied the middle stages of vegetational succession. It is known that the response of vegetation to burns is determined by a complex of factors including: pre-burn condition of the land, season of burn, seed supply, intensity, ash concentration, subsequent mineral nutrition, soil moisture, rainfall, humidity, soil and air temperature, animal populations, and plant competition (C.E.Ahlgren, 1960:434). In the sub-arctic soils are composed primarily of burnable organic matter. The foremost immediate effect on regeneration is the relative distribution of areas where the mineral substratum has been exposed by complete burning of the organic layer and areas where some organic soil or humus layers remain. In the former instance "lengthy periods of time are required before organic matter will accumulate on exposed surfaces and support important food plants" (George W. Scotter, 1964:75). In northern Saskatchewan, in woodlands, Scotter found that fires resulted in as much as 35 to 50 percent of the mineral-soil or bedrock being exposed. In his survey of Alaskan forest fires Lutz reported that the proportion of mineral soil exposed varied from 5 to 100 percent, but averaged about 35 percent (1956:32-3). Hind has given a vivid description of such a burned area in the Labrador interior, where he saw "myriads of boulders strewed over the hills and mountains without a green moss or a grey lichen to show that life had ever been there" (1863:221). Given that intense fires are by definition fires that considerably reduce or totally remove the organic soil, it is likely that such a fire would remove from one-third to one-half of the area affected from production for several years following the fire.

On the remaining land, regeneration would start almost immediately. There are no studies of the earliest stages of regeneration in the main boreal forest region, although there has been a study in Sweden(Uggla,1959). A few studies are available however in the mixed forest zone. In Nova Scotia, J. Lynton Martin found regeneration had begun two weeks after a fire had destroyed a mixed forest (1955:155). There were scattered specimens of fern, some herbaceous plants in the seed leaf state and some two-inch high lambkill and blueberry (Martin 1955:155). After six weeks they were six inches high.

All species had originated from underground stems. In the mixed forest of Maine, Alexander F. Skutch found similar results. Twelve days after an August blaze, and while the site was still smouldering in some areas, fungus had started to grow in tiny but well scattered patches (1929:178). A week later a few ferns and some hardwood sprouts were present, but little new growth appeared during the remainder of the month (Skutch, 1929:179). A year later Martin found herbaceous species predominant but lambkill and blueberry were spreading rapidly (1955:158). Deciduous suckers of several species made rapid and luxuriant growth, and others followed the next season (Martin, 1955:1959). On another year old burn Martin found ferns and herbaceous species predominating (1956:316). On a two year old burn he found the shrubs providing the dominant ground cover, herbs being the most abundant plants. Skutch reported that by the end of the first summer after the fire "the burnt area was well covered by vegetation, and had lost much of its desolate aspect" (1929:181). In Minnesota burned-over land was covered during the first _or_ second growing season with lush vegetation, primarily herbs (Ahlgren, 1960:444). To our knowledge there are no completely comparable descriptive studies in the Canadian boreal forest region. Hustich has listed the species he found growing on one and two year old burns in the woodland at Knob Lake. The herb pale corydalis (_Corydalis sempervirens_) was commonest on first year burns. Others were the depressed sedge (_Carex deflexa_), Canada weed grass (_Calamagrostis canadensis_),and wavy hair grass (_Deschampsia flexuosa_)and regrowth on the Labrador tea shrub (1954:44). We noted earlier that Rousseau found fireweed the first invader on burns at Mistassini.

General features then appear to stand out: during what remains on the growing season within which the fire occurred not all of the areas still covered with mineral soil will be rehabilitated by vegetation; those areas that are reinhabited support a vegetation initially of ferns, fungus, grasses, sedges, and only later of herbs and then shrubs. Thus, the reinhabiting vegetation is markedly different from the ground cover under the mature forest; the reinhabiting vegetation is of very limited persistence, changing rapidly; and, the quantitative production of vegetation is decidedly limited in area and type. These features are sufficiently general to apply probably to the boreal region as well as the mixed zone. In short, in the year or so after fire, less than one-half the burned area is carrying any vegetation whatsoever, those areas which are have a quantitatively limited vegetation, and, the classes of vegetation are decidedly different than formerly, and hence often unusable by animal survivors native to the mature forest.

The studies from more southerly mixed forest areas in Nova Scotia and Maine found the grass and herb stages lasted approximately two years. These must be considered optimistic figures for the higher latitudes. A better estimate for the length of these conditions at Mistassini would be four to seven years.

The wildlife that has escaped the fire itself then, finds a critical period for survival in the weeks and months that follow: especially the first winter. This period is marked by an enormous shortage of nutrition and cover - which causes the decimation of the existing local animal populations. Starvation may or may not be the immediate cause of death. I.D. Kiris has reported that nutrition plays a leading and decisive role in populations of fur-bearers (1953:11). Without adequate nutrition animals succumb increasingly to parasites, disease and predators (Kiris, 1953:9). In addition their reproductive systems, sexual activity, and survival of newborn are adversely affected (Kiris, 1953:8). Finally, individual and mass migrations to new ranges may occur.[12]

In short, destruction of the mature forest is accompanied by destruction of the local animal populations. This general pattern is attested to by all commentators (Lutz, 1956:81; J. Brown, 1922:2-3, Elton, 1942:300, Leopold, 1933:348; Hoyes Lloyd, 1938:1052). Large game species (moose, caribou and bear) are quickly starved or forced to migrate - the high intake requirements, thirty-five pounds of air dry food per day for a moose and ten pounds for a caribou (L.J. Palmer, 1964:49) are simply not available. In addition, the protective cover of the forest is no longer present. Thompson reports on his experience in a sixty-five mile burn in the Salmon River canyon, in which five percent of the total range was available. Big game species migrated in for the winter. By Christmas, he says, it was not uncommon when hiking to step on a boney, alive but helpless deer or elk (1964:109).

Of the acquatic mammals, the beaver is the most important. Fires that burn to the edges of streams and ponds destroy the aspen, alder and willow, the wooded stands upon which the beaver depends for its winter supply of food (Reuben Edwin Trippensee, 1953:72-3). With reduction of beaver numbers and the falling into disrepair of their dams the closely associated otter and muskrat find their habitat markedly deteriorated.

Among terrestrial fur-bearers, marten, fisher, ermine, mink, squirrels and hare, all are immediately adversely affected by destruction of the forests. Martens require overhead cover as protection (Malcolm W. Coulter, 1960:8). Mink depends on smaller mammals (Trippensee, 1953:118). Squirrels depend on the seed production of the conifers as their main source of food (B.A. Larkin, 1955:153). The hare requires young deciduous bark and buds - alder, willow, and aspen - for winter sustenance (Wm. Rowan and Lloyd B. Keith, 1959:224; Wallace Grange, 1965:118-119). The larger carnivores of course decline as big game and smaller fur-bearers. These carnivores include lynx, wolverine, fox, and wolf.

Bird populations, already limited in the region, decline further. Only the fish are partially isolated from the effects of fire.

In much of North America mineral soils exposed by fire are subject to extensive erosion. Rains beating directly on the soil muddy it and fill in pores so seepage is decreased and surface runoff increased (Trippensee, 1953:373). As there is no humus to obstruct runoff, velocities are higher and both erosion and flooding occur. These generally result in a destruction of part of the fish habitat in streams and small rivers. Spawning beds are silted up or washed out and bottom materials of streams are disturbed, destroying food organisms (Trippensee, 1953:372). In the boreal forest these effects are significantly less intense than in more southerly latitudes because soil erosion is not serious. Only light sheet erosion is common (Scotter, 1963:416; 1964:71). Gully erosion occurs locally on sandy soils (Scotter, 1964:71), and where an area has been burned twice in a short period. Other general effects of fire on fish habitat are the removal of streamside cover and reduction in the years that follow of organic matter - leaves, twigs, etc. - which enrich streams. The removal of cover affects summer water temperatures. In general then lake fish are fairly well insulated from effects of forest fires, but fish in streams in certain localities may be adversely affected by ash and other debris that pollute or obstruct the stream. The role of fish in human subsistence then is critical for understanding the effects of forest destruction on human populations.

D - Break-down of human subsistence: Starvation and Migration

Disagreements among various authors on the importance of fish in aboriginal or early-contact native subsistence in the region have already been cited. Most authors acknowledge the probable primary importance of subsistence fishing in summer, but extent of winter dependence on fishing remains problematical.

For our purpose it is only necessary to note that the human population numbers in the mature forest phase of the boreal forest cycle would be of a size supportable from the total subsistence base it was utilizing.[13] This base included both fish and mammals in significant, if not agreed upon, proportions. After the burning of the forest it is inconceivable that the same population could have been supported only on the fish resources. Indeed, it is questionable if any population could have remained in the burned area and lived off of the fish resources.

It is now possible to summarize the effect of the periodic destruction of the forest on the human inhabitants of the region. Following the fire, a brief period would occur during which subsistence was uncertain but possible. Fish would be available in numbers. Some animals would still be in the region, especially in the small islands of unburned forest, but these would soon be trapped out. Some preserved foods might be available. This period would give the population time to migrate out of the region. However, local conditions must have varied considerably and the direction to take for migration was not easy to determine. Groups that had not left by winter would almost certainly have starved. Resources would have been too widely spread for a hunting group to utilize an area large enough to support itself.

The exact effect of the destruction of the forest on human population sizes can only be guessed at. Most likely starvation and death took a heavy toll either in the burned area, or in surrounding regions where new immigrants pushed local populations above the level that could be supported on local resources. The one feature that is clear is that as a result of migration and starvation the region of the burn was essentially abandoned by its human population. Return to the burned region was delayed several years and depended on the reinvasion of the area by flora and fauna; which will be subject of our next chapter.

E - Summary

In summary, the ecological arguments of Speck, Eiseley, Cooper and Hallowell for the aboriginality of the family hunting territory system in the Mistassini region, and most likely in the entire main boreal forest region are based on the invalid assumption that territory had a stable productivity over long period of time. We have not only shown the invalidity of the assumption but have proven that territory was abandoned every 200 to 340 years, and the population either died or lived, elsewhere, possibly at some distance, for several years. Under these conditions a family hunting territory system with clearly demarcated lands passed on from generation to generation is clearly impracticable. It is hoped that this clarification of the ecological issues will facilitate a final resolution of the debate.

We have attempted to remove the apparent disagreement between recent Algonquionists ethnohistorical studies and the earlier ecological claims of Speck and Eiseley, by revising our view of the boreal forest ecology. This revision necessitates a revision of other contemporary views of the human ecology of the boreal forest region.

CHAPTER IV - DYNAMICS OF ANIMAL POPULATIONS AND VARIABLE SUBSISTENCE PATTERNS

Attempts to formulate the aboriginal subsistence base of subarctic Indian peoples have focussed on the relative importance of small carnivorous fur-bearers, beaver and ungulates. In recent decades the role of big game, particularly caribou, has been stressed at the expense of smaller game. This has occurred despite a considerable variety of opinions among ethnographers and ethnohistorical commentators, and despite extremely limited and inconclusive evidence. We propose an alternative hypothesis concerning the aboriginal subsistence base in the main boreal forest, namely: that during the cycle of development of the vegetation from burn to coniferous forest a succession of different resources were available in the environment and a succession of different subsistence patterns were adapted by the Indians in order to utilize these resources for human subsistence. Over a period of two or three centuries no single winter resource was primary and none secondary for the entire period. Further, that small fur-bearing carnivores were of primary importance in at least one phase of the cycle, and possibly of some importance at other points, and beaver were of considerable importance throughout most of the cycle.

We begin the analysis by determining the biomass of each individual species or group of species relative to the biomass of the same species or group of species in other phases of the cycle, i.e. we discover when each species will reinhabit the burn, when its population will reach a peak and when its number will decline. This we call the "model of the cycle of resources". To outline the analysis: the return of the small herbivores, particularly the vole, depends on snow conditions as the insulation of these herbivores from sub-arctic winter temperatures by snow is necessary for their arrival in the region. The insulating effectiveness of snow is considerably effected by the vegetation of the region which may intercept its fall to the ground, and/or alter the effect of wind and sun on the snow after it has fallen. The vegetational succession after a fire is thus correlated to vole and small herbivore populations, and further to populations of primary fur-bearing carnivores. All these species reinhabit the region in the shrub stage and become populous in the decidious forests. The beaver, which follows in the late shrub and early deciduous phases, is unique in the degree of stability which its populations experience and hence is important in both the deciduous and coniferous phases of the cycle as a secondary source of subsistence, particularly when primary sources fail. Moose and caribou each characterize a forest phase, the moose in the middle and later deciduous phase, the caribou in the coniferous forest stage. On this basis, a composite model of phases of the cycle resources is compiled from this data.

The second part of the analysis is to translate the cycle of resources into a cycle of utilization of resources. We see two steps are required: finding estimates of the comparative biomasses of the different species present in the same phase of the cycle in order to know what is available quantitatively, at least in terms of relative quantities. Secondly, finding which of the available resources are accessible given the technology, i.e. which are inaccessible, presumably because it takes more energy to capture them than they provide, or because they are a health hazard. In conclusion we propose a model the successional phases of aboriginal primary and secondary human subsistence in the Mistassini region, a model which we believe has considerable implications for likely aboriginal subsistence patterns across the entire Canadian subarctic boreal forest.

A - Model of the Cycle of Available Resources

1 - Snow and Populations of Small Herbivores and Primary Carnivores

Animals depend on vegetation for food and cover, hence as the vegetation regenerates on a burn and changes its forms and quantities, different species will be able to reinhabit the burn and their populations grow in accordance with their particular foraging and sheltering relationships to the vegetation. R.F. Morris, studying the size of summer populations of small mammals, concluded that "the foraging possibilities offered by the habitat are perhaps a secondary factor to cover" (1955:31). The same appears to be the case for winter populations of small rodents, especially voles. The red-backed vole is the predominant small mammal of the boreal forest region (William O. Pruitt, 1957:132; Morris, 1955:27-8). Voles eat rough greens (A.N. Formozov, 1946:59) which are readily available. Field mice are not common in regions of heavy snow (Formozov, 1946:60), and shrews are mass inhabitants only in the later forest stages of succession, when they depend on seeds (Formozov, 1961:22) and insects. The vole is therefore of prime importance and an approximation of the relative size of vole populations can be made by noting the relative suitability of the habitat. The prime element affecting the suitability of the winter habitat is snow.

Small rodents cannot survive sub-arctic winter air temperatures (Pruitt, 1966a:9). The body mass of the animal in proportion to its surface area is too low and so it does not produce enough heat to offset loss to the cold air (Pruitt, 1966a:9). Pruitt found that all animals smaller than squirrels cannot withstand exposure for any appreciable length of time (Pruitt, 1966a). The squirrel is borderline. Above -35 degrees Fahrenheit it moves about in trees. Below -35 degrees Fahrenheit the squirrel must seek protection from the cold. It and the smaller mammals find such protection under the snow cover.

Snow is a very poor thermal conductor. It permits only a very slow heat exchange between the soil and the atmosphere (G.D. Rikhter, 1954:22). When the snow cover is greater than 20 centimeters, brief cold spells hardly affect temperature at the soil level at all (Rikhter, 1954:22). Air temperatures of -50 degrees to -60 degrees Fahrenheit seldom drop the temperature at the moss level below +20 degrees Fahrenheit (Pruitt, 1960a:66). The temperatures under snow, in contrast to those above it, are characterized by a narrow range of variation and rather gentle fluctuations (Pruitt, 1957:137).

Snow then is a decisive factor in the presence of a large population of the small rodents. If it were not for snow, large areas of the northern taiga would lack small mammals (Pruitt,1966a:9). Yearly variations in the time of arrival, amount, and time of melting of snow are critical for survival of the small rodents. Three factors appear to be decisive. The most important is the time lapse between the beginning of frigid temperatures and the build-up of snow accumulation to the minimal thickness for adequate insulation at ground level. The former is apparently governed by the regular decrease in solar radiation, while the latter is governed by more "fortuitous" climatic conditions which vary greatly from year to year (Pruitt,1957:134). There are no records from Mistassini on the time of arrival of the twenty-centimeter minimum. Potter, however, notes that in this region unusually early or unusually late first snowfalls vary from the median by as much as one month (1965:11). In years when the interval is long, average air temperatures become colder before snow insulation is available and "cold starvation" of the small rodents is more likely. "If the autumnal period is short and dry, vegetation is quick-frozen and remains relatively nutritious and the animals are not exposed to great thermal stress" (Pruitt, 1966a:26). A second critical interval is in the spring : the period between the time the snow cover loses its insulating power and the period of more or less continuous moderating cool temperatures (Pruitt, 1966a:26). "If...spring comes late or is wet the animals may be in dire straits because of flooding and delayed onset of plant growth" (Pruitt, 1966a:26). The third factor is whether sufficiently thick snow is accumulated throughout the entire winter. Where the snow cover is not sufficiently thick the low temperatures will not only threaten the living population, but also inhibit ovulation and prevent the birth of winter brood, limiting reproduction (Pruitt, 1966a: 26). Sufficient snow for insulation always falls at Mistassini, even in the winters of lightest snowfalls, as we have indicated previously. Various factors, however, affect the micro-distribution of the snow cover and hence the percentage of the region actually suitable for small rodent habitation.

All these critical snow factors are considerably influenced by the vegetational cover of an area. Vegetation intercepts snow directly and affects wind and sunlight, the two major influences on snow after it has fallen. Hence, each vegetational phase in the cycle of boreal forest development has a distinctive effect on the snow cover, and on relative populations of small rodents. The main vegetational stages in the regeneration to a coniferous forest following a fire are : bare and grass stage, sedge and herb stage, shrub stage, deciduous forest stage, and coniferous forest stage.

The bare and grass, and sedge and herb stages are very poor winter habitat for rodents. In these open areas where snow is higher than all vegetation the wind is unbroken and snow has a stong liability to drift (Rikhter, 1954:14). Drifting results in a very uneven distribution of snow. It collects in shallows and around obstructions, and is blown thin on the flats and high ridges. The movement of the snow by wind breaks the delicate flakes, and the smaller snow particles pack together more densely than undisturbed snow. These snow crusts or nasts make burrowing more difficult, limit aeration at the lower levels, and reduce the insulating effectiveness of the snow layer (Formozov, 1961:16).

Solar radiation is not intercepted by vegetation and can melt the top snow layer, so that ice crusts form when radiation and/or air temperatures drop. The range of temperature fluctuations in the open leads to greater compacting and settling of the snow than is found in covered areas (Formozov, 1946:24). In Michigan, Pruitt found that in burns and bare areas soil freezing was "extensive both in depth and time" (1959:11), and with particular reference to the big short-tailed shrews (Blarina), he concluded that in the bare area some physical factor was in excess of the lethal limit nearly the entire winter (Pruitt, 1959:13). Under the general conditions available on recently burned areas, few small rodents can survive and no significant populations can be supported.

This situation changes when shrub growth becomes sufficiently high and dense to inhibit the movement of snow. The first substantial small rodent populations occur in such areas. The shrubs inhibit drifting, or at least collect drifts more evently over the land surface (Rikhter, 1954:18), they inhibit settling and compaction by limiting snow movement, and the high stubble itself tends to hold up the snow (Formozov, 1961:17). Under these conditions small mammals find a more congenial habitat. However, the openness of the landscape still leaves the sub-nivean environment open to severe variation. It is decidedly less stable than in the forest (Formozov, 1961:17), and it is in the deciduous forest that small rodent populations reach their peak.

The regrowth of forests, first deciduous and then coniferous, influences the snow cover appreciably. In the deciduous forest there is decidedly less drift and crusting than in the open (Rikhter, 1954:14; Formozov, 1946:24). The forest lessens the range of temperature variations (Formozov, 1964:24) and retards evaporation (Henry I. Baldwin, n.d.:19) because the ground is in partial shade,. Snow of the sub-arctic forest is known for its fluffiness (Formozov, 1946:23-4). Although forests intercept snow, tree accumulation is limited on deciduous trees which are leafless in winter and the stability of the accumulated snow probably offsets the slower build-up than in the open. Under the forests melting is considerably delayed, snow remains longer under trees than in the open, even where the initial depth is greater in the open (Baldwin, n.d.: 19) Rikhter reports that snow in the woods lasted from two to sixteen days longer than on cultivated land near Moscow (1954:36, Table 40). The effect of this delay is not entirely adverse as surface run-off is less in the forest because the slower melting allows more seepage (Baldwin,n.d.:19). Spring flooding may thus be less common in forests. The deciduous forest represents a prime habitat for large populations of small rodents. Voles are especially abundant in areas of old burns with high brush and intermixed forest (V.G. Krivosheev, n.d.:3).

Succession to primarily coniferous forests reduces the suitability of the habitat for small rodents. The conifers intercept considerably more snow than the deciduous species (Formozov, 1946:20). Build-up on the forest floor is slower, and not adequate everywhere. Under the conifers the snow never accumulates to any depth. Hollow bowls form, called qamaniq.[14] As the qali, or snow caught in the branches, melts or evaporates, blobs of it fall into the qamaniq, making it spongy, rough and compressed (Formozov, 1946:20). These areas afford little insulation for small rodents, which must frequent the regions between the conifers where the snow is thicker (Pruitt, 1966:10). The average ground accumulation in conifer forests is markedly less than in young deciduous forests or burns (Formozov, 1946:24-5). Fir groves, having the densest cover, are also the areas with the latest snow cover in the spring (Formozov, 1946:28). Rikhter reported that under fir thawing lasted from 23 to 28 days longer than on open cultivated land at Moscow (1954:36, Table 40). In short, under the conditions of the coniferous forests small rodents find suitable conditions in fewer years and over less of the land than in deciduous forests.

In review: substantial small rodent populations do not reinhabit the burned area until shrubs are common and overtop the snow, i.e. are two or more feet high; the populations increase through this later part of the shrub stage reaching prime conditions in deciduous forest stands; with the replacement of deciduous trees by conifers small rodent populations decline somewhat. Other small mammal herbivores, particularly the hare, have a relative population development parallel to that outlined for the rodents. Hares are associated with young deciduous species in the shrub or tree stages (Formozov, 1946:47; Grange, 1965:118-19). They are less populous in the mature coniferous forest (Victor E. Shelford and Sigurd Olson, 1935:390). The squirrel is an inhabitant of the seed-producing coniferous forests (Larkin, 1955:153), but never attains populations comparable to those of the hare. The small herbivores as whole thus maintain the relative abundances outlined for the rodents in the different stages of successional vegetation.

The primary carnivores are dependent on the small rodents for food (Formozov, 1946:115-116), and thus the snow and vegetational factors which influence the relative development of populations of small herbivores have an indirect influence on the populations of primary carnivores. Shelford and Olson have written that the small rodents form in "the northern coniferous forest, the bulk of the food of all flesh eating animals"(1935:391). An approximation of the relative variations in populations of primary carnivores can then be made on the basis of variations in small rodent populations.

Primary carnivore populations, particularly the ermine, marten, fisher, and mink, become abundant in the middle and later shrub stage and decline in the mature coniferous forests. This relationship of relative population sizes of primary carnivores holds, we believe, despite varying proportions of each individual species. Mink and ermine predominate in the brushy and deciduous stages (Trippensee, 1953:115-6; Larkin, 1955;155), marten and fisher in the coniferous forest (Larkin, 1955:153;, Vernon D. Howley and Fletcher E. Newby, 1957:178; Shelford and Olson, 1935:393). There is an overlapping between mink and ermine on one hand and marten and fisher on the other, the former continuing to inhabit early succession stages along the edges of streams, rivers and lakes (Trippensee, 1953:115-6) in the coniferous stage, the latter sometimes inhabiting the deciduous or brushy stages, especially if trapping pressure is light (Larkin, 1955:153; Malcolm W. Coulter, 1960:8) Despite variations between proportions of these species, they all depend primarily on the small rodents and the hare for subsistence and their own populations are significantly limited by the availability of their prey. Elton claimed that all the carnivorous mammals which feed upon the rodents, including ermine, mink, marten, fisher have cycles (1927:139). Recent re-studies of fur returns by Keith continue to support the existence of marten, fisher, mink cycles among others(1963). Whatever the ultimate significance of the cycles, the data collected supports the assumption that the relative abundance of small herbivores is a major limitation on the size of the total population of all species of first order carnivores. In short, primary carnivore total biomass follows the pattern of relative abundance outlined for small herbivores. Small herbivores, however have less influence the larger herbivores affecting them only indirectly through competition for some of the same vegetational resources. Populations of larger herbivores are influenced most directly during the phases of development of vegetation by the availability of vegetation rather than by competitors.

2 - Beaver Isolation and Stability

Of primary importance among the large herbivores is the beaver. The winter food of the beaver is the bark and twigs of most hardwoods (Ernest Thompson Seton, 1928;4, 483). Its preference however is for the barks of aspen, willow, birch, and alder. Trippensee suggests that optimum conditions are young deciduous stands with a high percentage of aspen varying from one to six inches in diameter (1953:72). Beavers would reinhabit an area then in the latter phase of the shrub stage and become populous in the young deciduous forest stage. The unique feature of beaver populations is their relative stability (Elton, 1927:138). Prime beaver conditions are comparatively constant in both the long and the short run for a number of reasons. Beaver utilize deciduous forests only within a few hundred feet of the stream or lake shore. These regions are permanently characterized by alders and willows. Spring break-up of the ice is accompanied by flooding of these regions which occasionally thins out old deciduous stands and opens the way for new deciduous growth (Haviland, 1926:201). Thus, deciduous trees predominate on the stream banks despite development of coniferous forest on the land away from the riverine habitats. In the short run too the beaver finds stable food supplies. Tree bark develops over a number of years and is not immediately subject to variation with annual climatic conditions; the supply tends to be constant (Elton, 1927:138). If the supply becomes exhausted, beavers move to new locations (Trippensee, 1953:72). The water habitat too is relatively stable. The beaver's ability to construct and maintain dams gives it control of the water levels and make it comparatively immune from annual variations in water supply (Elton, 1927:138). Finally, the beaver is relatively isolated from predators and from disease, although a variety of animals occasionally prey on beaver (Seton, 1928:4, 491 and 493), they "have no serious carnivorous enemies" (Elton, 1927:139), in addition the independent beaver colonies tend to limit the spread of disease and wide-spreading epidemics are unknown (Elton, 1927:139). In short, the beaver interacts with comparatively few components of the ecosystem, and is neither affected by nor affects them. Its isolation is keynoted by its stability. Beavers repopulate an area in the latter part of the shrub stage and are present more or less constantly until the next intense forest fire.

The only animals particularly associated with the beaver are the muskrat and otter. Both find stable habitat after beavers establish constant water levels. The muskrats apparently never reach the phenomenal population levels known in other regions because the rocky lakes at Mistassini provide limited acquatic vegetation or marsh conditions (Cameron and Morris, 1951:128). Otters have a considerably lower density than beaver, on a ratio of at least 1:16 in good habitats (Trippensee, 1953:74,144), thus for our purposes the subsistence potential of the muskrat and otter in the Mistassini region is decidedly secondary to that of beaver, and we consider them supplementary to it. Porcupines are limited to the forests where their winter food is bark of hardwoods (Seton, 1928:4, 616-7).

3 - Forest Stages and the Moose and Caribou

Largest of the herbivores are the ungulates, moose and caribou. Studies have been made for each, correlating vegetational succession after fire with the population of each species. Each is common to one of the forest stages.

During spring, summer, and early autumn moose feed primarily on water lilies, sedges, grasses, pondweeds, and twigs of alder, willow, birch and aspen (Shelford and Olson, 1935:384). In these seasons some of its food is found in very early successional stages, and the moose is probably one of the earliest visitors to burns. Winter browsing is on twigs and branches of coniferous and deciduous woody plants (Peterson, 1953:15). Moose apparently prefer areas producing a great variety of food (Peterson, 1953:35). Howard A. Miller has suggested that the growth of willow, aspen, and birch beyond the nine foot height accessible to moose means that ideal conditions occur in the first fifteen to twenty years of succession (Miller, 1963:27). Spencer and Hakala, reviewing the reinhabitation of a burn in Alaska found winter browse sufficient to attract moose five years after the burn. Heavy browse growth occurred after seven years, and maximum growth occurred fifteen years after the burn. They concluded that, "After burning in the boreal forest, under suitable conditions, there is a period extending from five to twenty years, occasionally sixty to seventy years or longer, when moose conditions are favorable" (David L. Spencer and John B. Hakala, 1964:30). In the most detailed study to date Scotter has attained comparable results in northern Saskatchewan woodland. He found that shrub production of browse in burned black spruce and white birch forests increased significantly in the eleven to thirty year age class but was steady thereafter (1964:48, Table 4). Counts of droppings were highest for the eleven to thirty year age class (1964:77, Table 20), and indicated that "moose apparently prefer habitats less than fifty years old" (1964:76). Moose populations however were on the whole small in the upland forests Scotter specifically studied (1964:77-8). These authors all agree that moose reinhabit an area in the brush stage and decline significantly in the coniferous forest stage. The latter is confirmed in Alaska in a direct study by Cowan, Hoar and Hatter (quoted in Peterson 1955:158-9). They concluded that, comparing a six-year old stage, an intermediate stage, and a mature forest, a forest approaching climax shows decreases in both the quantity and quality of foods available for moose.

They went on however to suggest that access to older forest stands was requiredby moose when in forests in an early stage of growth. The burned areas covered in the studies by Scotter and Spencer and Hakala are quite limited in size. Peterson stated that moose "rarely venture" into the extensive burned areas in Ontario. He suggested that large burned-over tracts do not normally become heavily populated by moose (1953:39; 1955:159). Apparently one necessity was adequate cover, afforded only in forests. The key factor however was the presence of balsam fir for winter food (1953:39). Peterson claimed that in the eastern part of its range moose concentrations appear to be closely correlated with local distributions of balsam fir (1953:37). Balsam fir "is apparently the most abundant and most important winter food of moose in the eastern part of its range" (1955:131). The implications are that moose will not populate an area permanently until it is in the deciduous forest stage, and then only either in the latter part of that stage, or under other conditions, where the moose can have access to coniferous forest.

This disagreement with the works cited earlier apparently represents a difference in habits of moose in the eastern and western halves of the continent. Peterson thinks so (1955:159-60), and there are sub-species breaks in moose distribution at Lake Superior and in the Yukon territory. (Peterson, 1955:17, Fig. 6). On the basis of this behavioral difference we limit permanent winter residence of the moose to the late deciduous forest stage of succession at Mistassini.

In contrast, the woodland caribou, it is universally agreed, are animals of the mature coniferous forests. During the winter they use woody browse lightly and feed heavily on arboreal and terrestrial lichens (Cringan, 1957:62). Lichens are very slow-growing after destruction by fire (A.W.F. Banfield and J.S. Tener, 1958:569). Scotter studied the situation in northern Saskatchewan, where the average productivity of lichens per acre of birch and black spruce forest increased steadily from forests in the one to ten year age class to those in the over 120 years old age class (1954:48, Table 4). Indeed, in the age classes from 31 to 50 years and up lichens were the only category of forage studied which increased. "More important than the increase in total lichen yield was the increase of high value lichens" which was particularly noticeable in the 76 to 120 year age class and the 120+ age class. (1964:48). Caribou pellet counts increased significantly in the 51 to 75 year age class and above. For the barren-ground caribou he was studying Scotter concluded that they preferred forests over 50 years of age (1964:76). In short, the caribou is primarily an animal of the mature coniferous stage, although it may appear in younger forests or the early coniferous stage.

4- Other Species

In this residual category are the lynx, bear, wolf, wolverine, and fox. These species are characterized in general by the variety of animals they prey upon. Most of them consume small herbivores, primary carnivores, larger herbivores, ungulates, and each other when available. In addition, the majority are omnivorous and consume berries and other vegetation in spring, summer or fall. The larger species of the group in particular appear to find winter survival difficult and tend to have a highly specialized adaptation for that season. This adaptation conditions their presence in various habitats. Under these conditions the species in this group are best treated individually and briefly.

The lynx feeds on hare, small rodents and birds (Shelford and Olson, 1935:387). Ungulates also enter its diet (Trippensee, 1953:89). but whether they are a regular part is uncertain. Seton has written that of "all the northern creatures, none are more dependent on the rabbits than is the Canada lynx" (1928:1, 183). The lynx is particularly adapted to hunting hares in winter, both share the same unique adaptation to snow, natural snowshoes (Pruitt, 1966a:12-13). They have large furry paws which support them on all but the fluffiest of sub-arctic snows. This close relationship between hare and lynx populations has been noted by many authors. P.B. Iurgeson has made a field study in the U.S.S.R. where he found that the scarcer the varying hare the scarcer was the lynx (1955:10, 12). Despite this dependence on the hare the lynx is an animal of the deep coniferous forests, living in the forests and hunting in the stands of brush or deciduous trees. It is thus, a late arrival in the successional phases of regeneration despite its prey relationships.

The bear survives the winter by hibernating. It visits burned areas in very early stages of succession to eat berries, but probably cannot become a resident until a greater quantity and variety of foods are available, as its food requirements are high (Joseph Grinnell, Joseph S. Dixon and Jean H. Linsdale, 1937:128). Bears range over both climax and earlier successional stages but prefer the latter (Shelford and Olson, 1935:387). Hibernation is often in denser climax stands (Shelford and Olson, 1935:387). The bear therefore probably becomes a permanent resident in the late brush stage and is present more or less continuously throughout other phases.

The wolf feeds on hare, moose and caribou (Shelford and Olson, 1935:387). Although its preference for larger game is uncertain, secure subsistence appears to depend on the ungulates. The decline of wolves following the decline of caribou in the last century was noted by Low (1895b:313L), and Banfield and Tenner (1958:570). Their subsequent increase in moose habitat is noted by Banfield and Tenner (1958:570) and in Alaska by R.Y. Edwards (1954:524). The wolf is present both in the deciduous and coniferous stages, primarily as an auxiliary to the moose and caribou, which it will hunt in packs.

The wolverine is a solitary scavenger, eating small herbivores, primary carnivores, or ungulates, fresh or carrion (Grinnel, Dixon and Linsdale, 1937:268). Like the wolf, its numbers are known to decline with declines in ungulates (Banfield and Tenner, 1958:570). It ranges through deciduous and coniferous stages (Shelford and Olson, 1935:387), and probably finds a stable habitat under the same conditions as the wolf.

The wolverine may however be better able to maintain itself in the absence of large ungulates.

Small mammals - hare and mice - constitute the staple foods of the fox during most of the year (Trippensee, 1953:109; Elton, 1942:253). They appear in the early successional stages (Larkin, 1955:156) with the small mammals, and are probably least frequent in the coniferous stage.

In summary then - some of these species are present in all later stages of development; most are closely associated with one particular species, others vary widely; none become permanent residents of the area prior to establishment of substantial small mammal populations in the brushstage.

With this review of the relationships between animal species and the successional stages of forest development complete, it now is appropriate to briefly organize our results.

5 - Composite Model

In summary we propose to outline a composite model of the relationship of animal species to the stages of vegetational succession of a cycle of the boreal forest ecosystem at Mistassini.

Small herbivores and fur-bearing primary carnivores are the first animals to permanently inhabit the burned area, in the middle brush stage. Prior to this the region supports no substantial permanent winter populations, although there are a variety of visitors, mostly in summer. The primary carnivores increase through the deciduous forest stage, but decline in the coniferous forest. The beaver inhabits the area in the late shrub stage and maintains its populations throughout succeeding stages. The moose permanently resides for the first time in the latter deciduous forest stage, to which large populations of moose are limited. The caribou is common in the following coniferous stages, particularly the latter parts. Other species occur intermittently - but not before the brush stage.

It will be noticed that we have continued to talk of stages but have not attempted to assign to them any strict age classification. After a fire, as we have already stated, regeneration is conditioned by a large number of variables, and is highly uneven. Areas where the mineral soil has been exposed take decades longer to reach the shrub stage than other areas. In large burned areas tree regeneration tends to be affected by the distance of seed sources (J.D. MacArthur, 1964:11); so that areas of the burn farthest removed from its edges and from isolated stands that have survived will regenerate more slowly than other areas. Under these conditions no burn will uniformly pass through all stages. Even so, the minimal or ideal times of each stage in a limited area can be outlined, so long as we recognize that there is a factor of error of one-hundred percent or more possible in the figures. Bare, grass, herb and sedge stages probably last from the fire for at least four to five years; the brush stage until seven to ten years after the fire; the deciduous forest stage until thirty-five to fifty years; and coniferous forest stage thereafter.

B - VARIABLE SUBSISTENCE PATTERNS

The particular subsistence pattern that emerges over a given time and in a given place depends not only on the species present but on the relative quantities of these resources available, on the technology which makes some but not others of these resources accessible, and on the cognition of these resources by the population which determines what accessible resources are utilized.

1 - Resources Available

To understand the significance of the model of the cyclical resources for human subsistence some quantitative subsistence values must be placed on the different species available at any one time. The biomass, or living weight, of each species under its optimum conditions provides such a relative scale, especially as biomasses vary considerably between groups of species. No published studies of the relative biomasses of species in a single environment have been made in the boreal forest region to our knowledge. Carl O. Mohr has plotted reports of abundance up until 1940 against average weights of species in order to make a general estimate of biomass (1940:582). These general estimates are based on reports from all over the continent and beyond, and probably reflect most strongly temperate zone distributions rather than sub-arctic conditions. However, we think the relative biomasses of species can be used for our purposes because the proportions of biomass between the major classes of species are of the magnitude of ten to one. Further these proportions are what would be expected in any ecosystem between clusters of species at different trophic levels, i.e. between the total biomass supported at each level[15]. Mohr's data however suggest that these relationships also hold between individual species in their chosen habitats, at least in many cases. Before using his data it is methodologically important to remove from consideration any species for whom there are grounds to suspect that due to conditions in the Mistassini region they never reach populations here, even in favorable stages, that are comparable to those expected elsewhere. The muskrat and mouse are examples that we have previously mentioned, the former being limited by the permanent uncommoness of aquatic vegetation, the latter by snow.

Mohr found that "individuals of most plant-eating species are at least several hundred times as common in their chosen habitats as are individuals of predatory species of equal size in equally favorable habitats" (Mohr, 1940:581). He continued, "Regardless of the average size of individuals composing a species, the population are such that the total weight of each herb-eating species in the habitat from which it sustains itself exceeds one pound per acre, or 646 pounds per square mile, while the total weight of each predatory species rarely exceeds 75 pounds per square mile and often does not exceed two pounds (Mohr, 1940:583). In short, there is an average ratio of at least ten to one between the biomass of herbivores and carnivores. Omnivores maintain weights intermediate between the carnivores and herbivores. The figures for pounds of population per square mile, as we estimate them from Mohr's chart are: (herbivores) moose 640+; caribou 5,000; beaver 640; hare 640 to 40,000; and voles (not <u>Clethrionomys</u> which does not appear on his list, but <u>Peromyscus</u> - a mouse) 640 -; (carnivores) mink 5; fox 50-; lynx 0.5+; wolf 0.5-;

(and omnivores) shrew 50+, skunk 50; porcupine 50+, bear 5 to 50 (Mohr, 1940:582). The extraordinarily high biomass per area of hare and caribou probably do not apply to populations possible in the Mistassini region. The former because of its extreme population cycles sometimes reaches such high numbers in some regions, but does not maintain them for long. The caribou figures probably are for herds on the barren ground and would be lower among more dispersed caribou in the forest zone. In summary however, the figures indicate that the moose, caribou, beaver, hare, and voles maintain biomasses of an order of at least ten times higher than would be expected for mink, fox, lynx, wolf, bear and probably other carnivores. Now we are able to state which of the species that are present in each phase of the cycle are quantitatively most significant: shrub phase - hare and voles; early deciduous phase - beaver, hare and voles; late deciduous phase - moose, beaver and voles; and, coniferous phase - caribou and beaver. Assuming that each of the species mentioned supports a roughly comparable biomass in the phases in which it finds prime habitat to the biomass of the other species in their phases, it is also possible to suggest the general development of total mammal biomass: there is a rapid growth of total biomass which begins in the shrub stage and continues through the early deciduous stage; it levels off in the latter part of that stage and declines slowly in the coniferous stage. This, we would expect, would significantly affect the relative importance of these phases for human subsistence, assuming that a technology is vailable that can utilize all species present.

b - Resources Accessible

It is clear that with the aboriginal technology, particularly the bow and arrow and trap systems, it was possible to kill or capture all the mammal species we have considered. However accessibility for subsistence must include considerations of the energy exchanges, i.e. inputs needed to utilize a technology and the energy outputs in terms of captured animals. Available resources may not be accessible if this energy balance does not favor a net gain for man. Further, available resources may be inaccessible because they are poisonous or otherwise injurious to health, directly or indirectly.

Detailed studies of the energy efficiency of hunting or trapping particular species have not been made. However, there is data on the present day utilization and non-utilization of resources, which we think reveals certain fundamental limits of accessibility. This data does not tell us which species will be utilized at a given time or place, but only which species are never utilized for food, which we think equates with species that are not accessible for food, although available.

Rogers reports that the Mistassini will utilize fifteen of the twenty-eight mammal species available in the area for food, or about 53 percent (1963:33).[16] Those eaten were: caribou, moose bear, beaver, otter, muskrat, hare, squirrel, lynx, woodchuck, fisher, skunk, porcupine, marten and mink. Those not eaten are dogs, wolverines, wolves, all species of foxes, ermine ("weasels"), flying squirrels, chipmunks, mice, shrews and moles.

We will rework Rogers' data to show that reasons of accessibility explain the permanent non-use of the mammal species not utilized for food.

We think that these species are the species which are inaccessible to the Mistassini, with the exception of the dog. The dog is omitted from our discussions because it is a domesticate which offers no subsistence potential to man, being more or less dependent on the catch of the Indians for subsistence itself. Further, there is the suggestion that dogs may not be indigenous to the area, or sled dogs at least (Rogers, 1964:236; Speck, 1925:61).

On Table 5, we have rank ordered the mammals of Lake Mistassini region on the basis of the weight ranges common for each species in eastern Canada as reported by Peterson (1966). It would be expected that some species are not trapped for food because their size does not offer a sufficient return of nutrients for those expended in making, setting, and checking the traps, i.e. they are inaccessible given the technology. This would hold no matter how populous the individuals of the species and no matter what the total species biomass per given area might be. In short, the quanta of this biomass are simply too small to warrant its collection. This is indeed the case, the squirrel represents an absolute break going in one direction - i.e. no animal smaller than the squirrel appears on Rogers' list of species eaten by the Mistassini. The clear break in actual weights comes immediately above the squirrel, between it and the mink, which suggests an intermediate role for the squirrel. This also is the case as the Rogers report that the squirrel when taken by grown men were taken "more for sport than for meat or pelts" (n.d.: 222). Squirrels appear to have been considered particularly suitable for children to snare or to hunt with a sling shot, "They were generally eaten only by the children" (n.d.: 222). Serious subsistence trapping then definitely

TABLE 5 - WEIGHT RANGES OF MAMMALS INDIGENOUS TO THE MISTASSINI REGION

(Collated from Peterson, 1966.)

Species:	Lbs.	Grams
Moose	725-1400	
Caribou	350-550	
Bear	200-600	
Wolf	60-100	
Beaver	30-80	
Wolverine	18-42	
Lynx	11-35	
Otter	10-30	
Porcupine	10-30	
Fox	6-16	
Fisher	5-13	
Woodchuck	4-12	
Skunk	3-14	
Hare	3- 5	
Muskrat		800-1580
Marten		450-1500
Mink		565-1250
Squirrel		140- 250
Flying Squirrel		100- 200
Ermine		80- 182
Chipmunk		75- 115

Mole	34- 77
Vole	30- 48
Mice (5 species in Peterson	10- 40
Bat	6- 13
Shrew	4

stops at the mink. Thus, the permanent non-utilization of species smaller than the mink is explainable in terms of the non-accessibility of these species to efficient utilization for subsistence given the technology.[17]

A number of species larger than the mink are also not eaten by the Mistassini - wolverines, wolves and fox. The reason for non-utilization of these species is not apparent; if size is one limit on subsistence accessibility, then density of population might be a limit on utilization. However, low densities only explain why no major subsistence effort is made to utilize such animals, they do not explain complete non-utilization. If caught in traps set for other animals or if come upon by chance, we would expect these species to be utilized. But, they are not, suggesting that they are unaccessible - not just not utilized - and other reasons must be sought.

One explanation that does present itself is the role of these carnivores in weeding out diseased caribou. Although in competition with man for the caribou, they perform the positive role of destroying caribou with serious internal parasites. These parasites are known to attack man if infected caribou meat is consumed. I have not been able to find out if infection can also come from eating the meat of the caribou's predators.

The evidence for this general ecological pattern is far from certain, as there are but few scientific studies of aspects of the phenomenon. However, a number of well known zoologists and naturalists have written of the existence of such relationships between caribou, wolves, and man, particularly

Pruitt (1960b) and Farley Mowat (1951). There are also some detailed evidence supporting various aspects of the phenomenon. Lois Crisler's observations on wolf predation on caribou indicated that at least half the kills made involved caribou that were obviously crippled or sick, despite the fact that such animals made up only 1.8 percent of stragglers and even less of the main herd (1956:346). Pruitt claimed that the high percentage of success of wolf attacks on caribou was attributable to its attack mechanism only being triggered by diseased or crippled animals. The wolverine and fox are presumably common scavengers at wolf kills as both will eat carrion (Trippensee, 1953: 176, 107). How often they kill caribou themselves, if ever, is uncertain. The wolf, wolverine and fox were all common both in the forested zone and in the barren-grounds (Peterson, 1966: 202, Map 55 and 61, Map 68 and 212, Map 57), and all three species roam widely (Peterson, 1966: 201; Grinnell, Dixon and Linsdale, 1937: 268; Trippensee, 1953: 106). The evidence is somewhat spotty and inconclusive, but highly suggestive. A final piece of most suggestive evidence is provided by the Rogers. Reporting on Mistassini animal lore they state "The meat of caribou killed by wolves was not fit to eat as the latter's teeth were 'bad'" (n.d.: 265). Pending more studies, we propose then that wolves, fox and wolverine may not be eaten because of their role in weeding out sickly caribou from the population, which limits the spread of certain internal parasites. Whether or not the flesh of these carnivores can spread these parasites to man if teir flesh is eaten is uncertain. These species then, are inaccessible for utilization for reasons of health.

In summary, we think that we can state that among the animals accessible to the Mistassini are the larger primary carnivores, the beaver and other medium sized herbivores, the hares, the moose, caribou, bear, and lynx. Unaccessible were all animals smaller than the mink and the wolf, wolverine and fox. The Mistassini apparently utilize all the mammals profitably and safely accessible. We think it reasonable to project this interpretation of accessibility back to aboriginal times. There is internal evidence in Rogers list that suggests that it has not been seriously affected by the post-contact period, particularly the fur trade. The ermine, fox, wolf and wolverine have all been actively sought and trapped for their furs in the post-contact period, but all are non-consumed items. This suggests that these categories of consumable and non-consumable has not been much affected by the fur trade. The ermine is particularly significant in this regard as its consumption does not threaten health. It is also highly unlikely that any species which has been technologically inaccessible in the post-contact period was formerly accessible with the aboriginal technology.

3 - Model of Phases of Human Subsistence

Of the resources accessible in quantity at any time a complex of variables would influence which were actually utilized, and in what order they were sought. Among these variables would be the size of the animal, the ease of locating the animal, the ease of killing the animal, the sociability of the species, the stability of the species population with reference to natural conditions and hunting pressure, and the habitats used in common by various species. Not all these variables are equally important, and we would stress the size of individuals in each species and the stability of the populations of each species.[18]

We propose the following model of the phases of aboriginal Mistassini utilization of mammal resources as the boreal forest ecosystem developed through a cycle from burn to mature coniferous forest. Sporadic forays into the area during the grass, sedge and herb stages might be made but permanent utilization of resources would commence in the middle shrub stage. Subsistence would depend primarily on the hare, but given the dependence on trapping, the small fur-bearing carnivores would provide a quantitatively smaller but important supplement or secondary subsistence, especially when hare population cycles were at their low. Late in the shrub stage primary subsistence would shift to the beaver, with the smaller herbivores playing a secondary role. With the growth to maturity of the deciduous trees the moose would increasingly become quantitatively the primary means of subsistence. Bear would form an important supplement, while beaver, because of their population stability and ease of discovery and capture, would be critical in years of failures of local moose populations. With the increase of caribou populations in the coniferous stage they would become the primary means of subsistence. During this phase, which might account for half the length of the total cycle, the beaver would be an important secondary resource. While all accessible species were almost surely taken whenever they were available, this model of subsistence phases represents the probable relative quantitative extent of dependence on each species when it is available.

4 - Summary

In summary, we have proposed that the cyclical development of the boreal forest ecosystem outlined in chapter III requires that we view the basic aboriginal subsistence pattern as a series of phases, each characterized by utilization of a particular species or group of species. We have proposed a model of these phases for Mistassini, for which we feel there is better evidence than other recent discussions of the aboriginal subsistence patterns in the region, and worthy of consideration and testing in other areas of the sub-arctic boreal forest.

Our model has confirmed both the recent stress on the subsistence importance of big game and the earlier claims for the subsistence importance of beaver, hare and small carnivores. Our contribution to the debate is to combine these species important for subsistence in a model where their relative importance varies regularly and cyclically.

CHAPTER V - CONCLUSIONS - "Feast or Famine"

It is not possible when attempting to reconstruct the outlines of a pre-contact human ecology to fill in all the details or discuss as many socio-cultural variables as would be desirable. This is particularly true of the eastern North American subarctic, where White contact preceeded anthropological study by two and a half centuries and aboriginal socio-cultural elements are difficult to reconstruct. This is one of the reasons we have focussed our analysis so specifically on two points of debate - territoriality and subsistence base. However, our analysis has introduced considerable information on the boreal forest ecosystem which has not been published in anthropological studies before, and which helps us to improve our picture of aboriginal boreal forest human ecology. In consequence it is in order to present an interpretation of how the "feast or famine" life style is a successful strategy of adaptation to the boreal forest ecosystem. This task is appropriate because it was precisely an attempt to define the aboriginal "strategy of adaptation" that Speck was making in his initial formulation of the hunting territory debate. Finally, we think that the "strategy" that was likely in the boreal forest ecosystem is quite different from those now generally proposed for hunting and gathering peoples elsewhere, and is hence instructive of a number of unique features of the human ecology of the boreal forest region.

A - The Hunting Territory Debate and Aboriginal "Strategies of Adaptation

Current work in human ecology starts from the assumption that aboriginal peoples, by their very survival up until contact, must have developed a "strategy of adaptation" which kept them in balance with their environment, and contributed to the equilibrium of the ecosystem of which they were a part. If this were not the case, they could not have survived. Numerous commentators on peoples of the boreal forest region have however denied that such a balance was maintained by sub-arctic Indians. They have claimed that there was a repeated breakdown of the balance between the Indian peoples and the mammal resources of their territories, and that this is shown most clearly in the frequent pattern of starvation and death, reported by the Indians themselves to have existed in and since aboriginal times, and reported over the last 150 years by white traders, missionaries, explorers and scientists. These breakdowns it is claimed, are the product of the "feast-and-famine" life style of the Indian and his basic lack of sense for conserving the resources he depends on.

These views, which probably reached their peak in the latter decades of the 19th Century, continue, relatively unopposed, up to the present. During the latter half of the 19th Century a particularly extensive series of fires, possibly caused by the spread of the introduced larch sawfly or, later, by the starting of forest cutting and the building of roads and railroads, were associated with a general decline of native populations (Hind, 1863:207 quoting Davies in 1840; and 205-6 his own observations; Bell, 1895: 359; William B. Cabot, 1909:191). Low attributed these fires to the Indians themselves who started them through carelessness or intentionally" (1929:21). Many 19th century explorers agreed with Low, as did the popular literature. They attributed the fires, the declines in game populations and the resultant starvation of the Indians to the carelessness, or worse the avarice, of the "children of the forest". Overtrapping went on side by side with other forms of carelessness. These views, in keeping with the general expansion of colonialism abroad and the frontier at home, considered the Indians maladapted to their environment, responsible for their own plight, lacking adequate intelligence and foresight, and generally inneed of supervisory help to establish a reasonable strategy of adaptation. These views have not as yet been superceeded despite the development of a paternal liberalism in government and the public. Nelson, a geologist wrote in 1948 of Mistassini and beyond, "The problems of subsistence are mounting in the north. An increase in the number of Indians and a decrease in the supplies of game in recent years have combined to make an acute situation. The Indian's feast-or-famine way of life has not helped matters. Deaths resulting from starvation are not unknown in the winter in spite of the trader's efforts to mitigate food shortages" (Neilson, 1948:152).

It is striking, given the commoness of these views, that Algonkianists have almost totally failed to comment on this issue, and have even overlooked the fact that the origins of the hunting territory debate lie in Speck's concern over these very matters.

Speck did not argue for the existence of aboriginal conservation of game species in order to strengthen his case for the aboriginal existence of the family hunting territory system, but the reverse, at least originally. He was concerned to rectify what he considered to be an injustice being perpetrated against the Indians of the eastern sub-arctic. In 1913 Speck wrote,"Some writers have accused the Indians of thoughtless slaughter of the game, a few have excused them for the same on grounds of necessity, while practically none have seen the matter in its true light, evidently because they are not acquainted with the customs of the people they are discussing. This is, indeed, only one among a number of fallacies current among historial writers which do injustice to the Indians by putting them on a lower cultural scale than they deserve."(1913a:21). The accusation of slaughter of game, Speck claimed, "is grossly incorrect, the Indians being, on the contrary, the best protectors of the game," (1913a:21). Thus conservation of animals, particularly the beaver, through regulation of the numbers killed, was possible, and aboriginal, because of its close association with the supposidly aboriginal family hunting territory system. Speck attributed the breakdown of conservation to the effects of white contact, particularly the fur trade. "Things which the Indians did not need formerly, or which if wanted could be made by themselves, are now actual necessities and can only be obtained from the trader, who holds them for his own price." (Speck, 1909: 153). "The Indians, although nominally free men, are practically, in a certain sense, the slaves of the great and historic Hudson Bay Company." (Speck, 1909: 148). The implication is that the fur trader continually raised the exchange rates for white goods, and thereby forced the Indian to abandon his basic balance with nature and over-trap his lands.[19]

Speck latter came to use the claim for the aboriginality of the family hunting territory system as an argument against the evolutionary theories of Engles (Hickerson, 1967), although the relevance of these claims for conservation and ecological equilibrium were never entirely lost (Speck and Eiseley, 1939: 273 , Footnote 11). In 1938, Speck wrote an article entitled "Aboriginal Conservators," in which he said of the Indians, "The animal world in their view, enjoyed the right to exist in close cooperation with human beings....Numerous regulations governed the taking and killing of plant and animal life. With these people no act of this sort is profane, hunting is not war upon animals, not a slaughter for food or profit, but a holy occupation" (1938:260; italics in original). The conservation theme however clearly played a lesser role in the later decades of the debate and also in the anthropological journals.

Since Speck's writings there has been almost no mention of the question of Indian abuse of the environment and responsibility for their plight among anthropologists; the only exception is Knight, who pointed out that there was no opportunity for conservation in the sub-arctic (1965:34) because animal populations were so unpredictable. A number of opponents of the claim for the aboriginality of the family hunting territory system have argued that conservation was not aboriginally practiced by the Eastern Algonkians, notably Leacock (1954). They have regularly quoted ethnohistorical documents which directly or indirectly suggest that the native people lacked foresight and planning and that this was a main cause of their suffering. For example, Leacock quotes Le Jeune without comment, "When the Savages find a lodge of them (beavers), they kill all, great and small, male and female. There is a danger that they will finally exterminate the species in this region, as has happened among the Hurons" Leacock 1954:3). While anthropologists must clearly find these claims against native peoples highly distasteful, so long as they remain unproven, the general trend of the debate has been to avoid the issue, and no hypothesis concerning the nature of a possible equilibrium between the aboriginal Indians and their environment has been formulated to our knowledge, since Speck's attempt.[20] This is one reason why we offer a reconstruction of "feast or famine" as a successful aboriginal strategy of adaptation here.

It is not, of course, our contention that aboriginal conservation existed in the form that Speck claimed it did. Rather we wish to start from the assumption that aboriginal Indian utilization was in equilibrium with its environment (Birdsell, 1953:202), i.e. that the ecosystem was balanced, and see if it is possible on the basis of this assumption to postulate the probable mechanisms of adjustment. In short, we want to see if the "feast-or-famine" life style is a successful adaptation to an ecosystem with a dynamic climax of the type we have described in earlier chapters.

B - "Feast or Famine" - As A Strategy of Adaptation

Given that the Mistassini lacked any means to significantly alter the temporal and spatial variations in the productivity of their environment, and assuming that their very survival is testimony that their resource utilization was in adjustment with this productivity, the problem is to describe how their life style made adjustments of their levels of resource utilization to the levels of resources accessible at any point in time and space. Since the Mistassini, as other hunting and gathering peoples, all lived at essentially the same level of affluence (i.e. resource consumption) as a result of their extensive and intensive redistribution system, and if we assume that the technology which they all utilize is not significantly different in its efficiency at different places or at different times in their environment,[21] then the question of mechanisms controlling resource utilization can be reduced to a question of mechanisms controlling population density and distribution. In short, we wish to claim that resource utilization was primarily a function of population density, and that our problem is one of describing the mechanism of what Birsell has called the "density equilibrium system" (1968:230).

Birdsell has convincingly argued, and demonstrated for Australia, that human population densities will be some function of critical environmental variables (1953:177). This does not however explain the mechanisms. These mechanisms are increasingly seen as cultural mechanisms because there is growing evidence that hunting and gathering peoples maintain a population density significantly lower than the carrying capacities of their territories, i.e. they utilize only a small portion of the resources accessible to them (see in Lee and De Vore, 1968: Washburn on page 84; Sahlins, 85 and 95; and Turnbull, 245). These commentators suggest that most populations utilize between 50 and 20 percent of the accessible food. The assumption is that, "It is <u>not</u> adaptive to eat the complete food supply, since - aside from the troubles brought on even by a minor variation in supply - anything like a major seasonal variation will break down the system." (Washburn in Lee and DeVore, 1968:84, italics in original). Under these conditions stress has been placed on elaborating the mechanisms by which hunting and gathering populations are maintained at one-half or less of the carrying capacity of their environments. A number of natural mechanisms,disease and extended lactation,are at work but they do not seem sufficient to explain such a limitation of human productivity which Birdsell estimates could triple the population every thirty year generation (1968:230). Birdsell reports that the range of effective offspring per mating ranges from zero to six among hunters and gatherers, whereas it may be zero to twelve at higher cultural levels. Infanticide, it is now felt, makes up most of the difference. It may account for the killing of 15 to 50 percent of the children born (Birdsell in Lee and DeVore, 1968: 243).

The general picture then is that hunting and gathering populations are maintained at 50 to 20 percent of the carrying capacity of the territory by a significant number of infanticides, and the resultant population curve is slightly undulating (Lorimer, 1954: 103; Bennett, 1966: 425).

While such a model might fit the aboriginal conditions at Mistassini, we think an alternative model fits them better. The human population of the area of a burn would increase rapidly as the vegetational succession progressed and the total biomass of accessible animals increased. This increase would continue for the entire period of a cycle of the boreal forest ecosystem, as areas where mineral soil was burned bare would slowly re-enter the productive cycle. Population growth would be limited to some degree, by the natural mechanisms that operate in all hunting and gathering cultures, and disease - especially respiratory - may have been more common in the north than elsewhere; but, cultural controls would not have been extensive, eg.infanticide. The population would thus be utilizing a high proportion, if not nearly all, the resources accessible to them, until forest fires occurred. When the next fire occurred in this area, part of the population would again migrate while a large, but unknown proportion, would starve to death. This model then is one of local population cycles of great amplitude and long frequency with a population living at near the carrying capacity for much of the cycle of the boreal forest, and being severely reduced after a fire - the region itself being abandoned for a number of years.

The model utilized by Birdsell and others is considered less satisfactory than the one we have proposed because a number of its assumptions seem inapplicable to conditions in the boreal forest. Firstly, the model of slightly undulating populations has been constructed to take account of periods of decline in resources that are assumed to occur every few years and are usually assumed to occur at least one in a generation (Bartholomew and Birdsell, 1953:27). In short, an impetus for limitation of births is provided within each generation. While this is not essential to the model, it is less likely that infanticide would be practiced by a population which experienced severe declines in resources only every seventh to eleventh generation and an increasingly productive environment in the rest. Secondly, the maintenance of populations at density levels below carrying capacity of the boreal forest cannot prevent the deaths that occur after a forest fire. The period of short resources in most environments appears to be caused either by a general but limited decline in all productivity, caused for example by drought or other climatic conditions, or the decline is a failure of a single resource, eg. the barren-ground caribou failing to cross a given mountain pass in one year, in which case other, more limited resources, would be sought. In both these cases it is, at least, theoretically possible to avoid loss of population if the population is sufficiently below carrying capacity before resources become short. In a section of the boreal forest which has just burned, all resources are quickly consumed and no survival is possible at any population density. Actual survival of the population of the area is thus very much dependent on mobility - on ability to get out of the burned region - rather than being only dependent on initial population density. In percentage terms a similar percentage of people will probably die after a forest fire at any initial population density. In short, there is no theoretical density above zero at which a reduction in population by starvation could be avoided.

We think the population model we have suggested, with population growth and declines of great amplitude and long frequency, with minimum control by cultural mechanisms is a reasonable model in an environment in which periodic destruction of local regions is a cyclical occurrence every ten generations, on average, inevitably killing a percentage of the population through starvation, requiring migration of the survivors, naturally re-establishing habitability in five to ten years, and then increasing its productivity thereafter until the next cycle. While this model is reasonable, we do not know if it actually existed. However, our main reason for elaborating it is to show how a "feast or famine" life style is, in fact, a reasonable adaptation to the environment at Mistassini and in similar areas of the sub-arctic boreal forest. The mechanism of control for maintaining an equilibrium of the resources utilized with the resources accessible in the ecosystem is the fluctuation of local population densities through starvation and migration, and culturally uncontrolled growth. "Feast or famine" is not the absence of a "strategy of adaptation", it _is_ the strategy, and it is a reasonable strategy.

CHAPTER VI - SUMMARY

We have made an ecosystem analysis of some of the main features of the aboriginal human ecology of the Mistassini Indians of the sub-arctic boreal forest of Quebec. Sub-arctic human ecology had been the subject of a number of previous studies using the method of cultural ecology proposed by Julian Steward. These analyses had reached conflicting conclusions concerning the aboriginality of the family hunting territory system among the Eastern Algonkians, and concerning the related question of whether small or large mammals were the basis of aboriginal subsistence. Ecosystem analysis has been shown to be capable of resolving these debates, and indeed capable of allowing us to make a reconstruction of the basic strategy of adaptation for maintaining a balance, both temporal and spatial, between environmental resources and human population densities. The ability of ecosystem analysis to clarify the aboriginal human ecology of the Mistassini, when Stewardian cultural ecology had not, lay in the value of two of its analytical assumptions. Ecosystem analysis assumes that we are dealing with an environmental and human system and that the environment can and needs to be analysed in terms of its composition, structure, and dynamics in order to comprehend the human components and their functions in the system, whereas Stewardian cultural ecology seeks the causes of core socio-cultural variables in more or less isolated features of the environment which themselves do not need to be studied further. Ecosystem analysis also assumes that an ecosystem is dynamic, rather than static, and has an equilibrium, or movement towards an equilibrium, which is controlled by a number of mechanisms which allow us to understand both its dynamics and its steady state, whereas Stewardian cultural ecology starts with a static environment and a static adaptation and explains change as an outside event, as a consequence of unique historical events. The greater value of the assumptions of ecosystem analysis became clear in our study.

The development of the boreal forest is characterized by a period of over-maturation wherein tree form and stand density decline and an increasing percentage of the nutrients are tied up in undecomposed matter. This bottleneck is broken by the occurrence of forest fires which destroy the overmature stands, release the nutrients and leave favorable conditions for the regeneration of the forst. Spruce budworm epidemics play an important role in these events by attacking the overmature forest and producing considerable litter, thereby making the forest highly susceptible to lightening caused forest fires over an extensive geographical area. The areas involved were several thousand square miles, and even tens of thousands of square miles. A complete cycle of fire, regeneration and mature forest would, we estimate, last between 200 and 340 years in the Mistassini region. Thus, the entire territory of the Mistassini people, or a significant proportion thereof, would be burned by forest fires and have to be abandoned every seven to eleven generations.

The regeneration of the forest would begin almost immediately and go through a number of stages: grass, herb and sedge, brush, deciduous forest, and coniferous forest. Each of these stages is associated with the reinhabitation of the area by certain species which depend on the vegetation of that stage for food, or protection - protection either directly or indirectly through the effect of vegetation on the snow cover, as in the case of the small herbivores - so that the resources available for human consumption also go through a series of stages. Some of the available resources are not accessible given technological limitations and health considerations, but all those that are accessible are utilized, with the herbivores, who support a relative biomasses approximately ten times higher than that of the carnivores, predominating in subsistence importance. Permanent human habitation of the area would begin between five and ten years after the fire and would depend on hare and small carnivores until the beavers become abundant. Beaver populations, with their great stability, would be important secondary sources of food during the deciduous and coniferous forest stages in which the moose and caribou predominated respectively.

We made an extensive review of the hunting territory debate itself showing how the previous failure of critics to deal with the ecological claims of Speck, Eiseley, Cooper and Hallowell had left a manifest contradiction between the ecological evidence and the ethnohistorical evidence which was the basis of the continued influence of the claim for aboriginality of the hunting territory system. This contradiction also helped explain the pressures to believe that the aboriginal subsistence base was primarily moose and caribou. The data we present on the burning of the forests and their regular abandonment helps to resolve the debate, because a family hunting territory system based on permanent residence and inheritance of clearly demarkated territories could not have existed in this environment. Further the data indicates that there would have been no permanent dependence on large game but rather a regular cycle of differening resources and subsistence patterns in aboriginal times.

Finally we reviewed the origins of the family hunting territory debate, and Speck's attempts to describe the aboriginal strategy of adaptation of the Indian people of the boreal forest - i.e. the way in which they maintained balance with their environment. This strategy he thought he had found in the practice of conservation. We pick up the question again, and assuming that an equilibrium was maintained between man and nature, show that the 'feast or famine' life style - manifest in a population density curve of great amplitude and long frequency - is a successful strategy of adaptation to the boreal forest environment.

We see this study as a further confirmation of the great flexibility, and variability now being uncovered in hunting and gathering cultures, a flexibility which is manifest among the Mistassini in an infrequently studied form - long-term temporal variation. In addition this study further expands and explores the possibilities of ecosystem analysis. Finally, we have suggested that a useful working hypothesis for future studies of human ecology of hunters and gatherers would be that socio-cultural subsystem variability is a function of spatial and temporal variation in the environmental subsystem.

FOOTNOTES:

#1 - Systems analysis is a distinct analytical model from ecosystem analysis, although the former is utilized in some of the techniques of ecosystem analysis, particularly energy flow.

#2 - In the remainder of this paper we will be primarily concerned with winter subsistence - and when speaking of resources, resource utilization, subsistence patterns, will be referring to winter patterns unless we specifically state otherwise.

#3 - It should be noted that the problem of providing a forest classification for the forests of the Quebec-Labrador peninsula has been tackled in a number of locals (Hustich, 1949b; Wilton, 1964; and Linteau, 1955). Linteau's classification was based on studies of the north shore of the St. Lawrence in Rowe's (1959) B1b forest section. Linteau feels his classification is good for the entire section, and reports that he visited the more westerly portions. Mistassini is in the far western end of the section; but without more detailed descriptions of Mistassini forests, which can be used comparatively, or an explicit statement from Linteau, we are reluctant to introduce his classiification here.

#4 - As is clear from our summary, terminology is one of the issues these various authors disagree on. What we have called the main boreal forest - taken from Halliday (1937), Hare calls "Forest sub-zone" (1959), Hustich "Southern Spruce Region" (1949b), and Rousseau "Temperate" (1961). What we have called woodland, after Hare (1959), Hustich calls "Taiga" (1949b) and Rousseau "Sub-arctic" (1961). These various zonal classifications are of course made on different grounds by each author.

We have been influenced not to accept Rousseau's terminology, despite an attraction to it, because of the confusion it would cause to anthropologists. "Sub-arctic peoples" includes peoples of the temperate zone north of the line of agriculture. We still need a terminology that can do justice to the climatological, biological and ethnological variables.

#5 - In this descriptive section we give both common and scientific names on first occurrence or in the faunal lists, but use only common names thereafter, as is usual in anthropological literature.

#6 - The terminology used here is taken, in part, from the analysis of trophic levels in ecosystems and is used and is used as a short-hand. It is not intended as a strict classification of species as many consume at more than one trophic level.

#7 - By the word 'cycle' we shall mean "a phenomenon that recurs at intervals. These intervals are variable in length, but it is implied that their variability is less than one would expect by chance and that reasonably accurate predictions can be made" (Davis, 1957).

#8 - Elliot uses a verbal scale of intensity of defoliation or mortality: light - 1 to 20% of host trees in the area affected by defoliation and/or mortality; medium - 21 to 50%; heavy - 51 to 80%; and severe - 81 to 100% (1960:66). Host trees of the spruce budworm are balsam fir, white spruce and black spruce.

#9 - Ahlgren proposed the following terminological scale of intensities of burns: "1) a light burn is one in which surface fire consumed only loose litter , with slight scorching of crown foliage; 2) a hard burn is one in which surface fire consumed all litter and some duff, and tree crowns were killed by scorching;

3) severe burn is one in which surface fire consumed all litter, duff, and some humus. Occasionally all humus was consumed, revealing mineral soil" (1960:432).

#10 - It is fascinating to note that the 1770's and 1807-1818 were apparently years of intensive spruce budworm epidemics in eastern Canada (Bakuzis and Hansen, 1965:153).

#11 - This interpretation is subject to the same limitations as were outlined when we used Hare and Taylor's estimates of burned land area at Mistassini.

#12 - Shostakovich, 1925, "Forest Conflagrations in Siberia, with Special Reference to the Fires of 1915," <u>Journal of Forestry</u> 23:365-371; cited in Leopold, 1933:348.

#13 - We return to the relationship of resources to population density in Chapter 5.

#14 - The terms 'qamaniq' and 'qali' refer to snow in particular configurations for which the English language has no distinctive word. Pruitt has introduced these Athabascan terms in his numerous publications on the ecology of snow in order to facilitate discussion.

#15 - C.F. Odum (1963) for a brief introduction to trophic structures.

#16 - The fact that all species classified as 'big game' by the Indians - i.e. bear, caribou, moose, and beaver, - are eaten, and the fact that only 53 percent of all species are utilized may have been a reason for some authors claiming that small game was of minor importance, and/or fish were of major importance. The assumption is that this 47 percent not utilized represents a choice on the part of the Indians in favor of other resources. We think it represents the limits of accessibility.

#17 - Since originally writing this analysis the author has seen sub-arctic ermines skinned and can now summarize this section by reporting that these animals are all bone, ligament and pelt.

#18 - This stress is supported by the often quoted preference of the Indians themselves, in ritual and food, for 'big game' - i.e. moose, caribou, bear and beaver.

#19 - A second reason Speck pressed his claims for the aboriginality of the family hunting territories was to strengthen the Indian claims to the land. He quotes at length Teddy Roosevelt's claim that, "To recognize Indian ownership of the limitless prairies and forests of this continent (that is, to consider the dozen squalid savages who hunted at long intervals over a territory of a thousand square miles, as owning it outright) necessarily implies a similar recognition of the claims of every white hunter, squatler, horse thief, or wandering cattleman." (in Speck, 1914): The relevance of claims for aboriginal territoriality is apparent.

#20 - Speck was what today would be called a "radical conservative" whereas his critics, notably Leacock and Hickerson, are materialists who associate themselves more or less with the "revolutionary" tradition. Interestingly, the historical root of both positions, in an active attempt at understanding and improving the human condition, was rapidly swamped by the polemics.

#21 - We make this assumption because Birdsell found in Australia the Aborigines, with a uniform material culture, maintain the same level of extractive efficiency in all regions, despite drastic changes in the flora and fauna (1953:203). Within a given culture this is a valuable assumption, in need of more detailed study.

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