FROM HUTCHINSONIAN NICHE
TO ECOTOPE

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TO ECOTOPE:
AN EXAMINATION OF DONALD L. HARDESTY'S
APPLICATION OF
THE HUTCHINSONIAN NICHE CONCEPT

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ABSTRACT

This study is concerned with critically evaluating and applying recent developments in theoretical ecology to the definition and measurement of the human ecological (Hutchinsonian) niche. An examination of Donald L. Hardesty's attempt to operationalize the concept as a multidimensional hypervolume indicates that, as a result of the failure to adequately divorce the concept from its biological evolutionary context in theory, and the uninformed use of a mathematical formula which does not allow comparative statements to be drawn, this approach is only of limited utility in ecological anthropology. Certainly, such an approach does not provide a sufficiently ecological framework for the analysis of Inuit lifeways. While a refined version of Hardesty's approach is presented and tested in the context of particular harvest data, the outcome suggests that, while the concept of 'ecotope' is more applicable to representing the 'total' ecological reality of human aggregates, the application of the multidimensional niche, in conjunction with the multidimensional habitat, is thus far to be considered as impractical.

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INTRODUCTION

The explicit purpose of this paper is to critically examine Donald L. Hardesty's theoretical and methodological application (1972; 1975;1977) of the Hutchinsonian multidimensional niche concept. The intent is to determine whether or not Hardesty's approach is useful in (1) developing the theoretical framework of ecological anthropology, and (2) in understanding the ecological circumstance of specific Northern Quebec Inuit communities in particular, and other human aggregates in general.

Since the resurgence of interest in ecological studies in the 1950s within anthropology, focus has been placed predominantly on the 'reticulation' of technology and the natural environment. This reticulation has been referred to as 'the exploitative pattern' (Helm 1962: 633). Recognition of the significance of non-cultural data, as well as cultural data (Hallowell 1949; Steward 1955), led to renewed interest in, and the borrowing of, several bioecological concepts and principles (Helm 1962; Sahlins 1964; Anderson 1973; Bennett 1976). Among these is the concept of 'ecological niche'.

Apparently, the first anthropological usage of the term may be attributed to Fredrik Barth (1956:1079), who used it to refer to 'the place of a group in the total environment, its relations to resources and competitors'. Since then, the ecological niche concept has been employed variously (Sears 1956; Geertz 1963; Flannery 1965; Meggars 1971;

Hardesty 1972, 1975,1977; Love 1977), dependent it seems upon which bioecological definition of ecological niche was emphasized. The important point to note is that, for the most part, man and environment are conceptually separated and placed in opposition. However, ignoring the earlier formulations of 'environmental determinism' and 'environmental possibilism', the subject for study became the interactive nature of the relationship between culture and external, environmental factors (Sahlins 1964:132-33). Going beyond the definition of environment as including only natural resources and non-human competitors, Helm suggested (1962:633) that social groups outside of the society under examination ought to be considered also as part of the environmental circumstance (the 'oecumene' of the society). This development may be seen to be of some significance, since it essentially questions the nature of the distinction between man and environment.

It may be suggested that Marston Bates had already approached this subject (1953,1960), and had offered some insight into the problem. The question of the nature of the concept of environment as it applies to the human condition is basic to the theoretical development of ecological anthropology. This paper may be seen to diverge somewhat from the tradition of labelling only those factors external to the social group as being environmental in nature. As will be considered later, while focussing on the Inuit subsistence practice of animal harvesting, all factors that pertain to this activity, whether phenomenal (e.g., social variables, morphology, physiology, or such external natural variables as geography, harvestable resources, and climate) or ideological (cultural variables) in nature, will be discussed as providing the content within which that activity occurs--therefore being essentially 'environmental' in nature (Anderson 1973: 209). This usage is consistent with, and logically necessary to, the approach taken here, whereby the ecological circumstance of human populations does not merely pertain to the 'exploitative pattern' referred to earlier; rather, the ecological circumstance is posited as encompassing the entire 'living arrangement' of human aggregates. The perspective may be termed 'man in his <u>total</u> environment'; it is not rhetorical in intent.

Since ecological studies in anthropology have traditionally relied on the natural sciences for theoretical and methodological direction, the tendency has been to borrow such concepts, principles and techniques of measurement as were deemed informative of man's relation to his 'external' environment. Unfortunately, many such anthropological applications have been rather uncritical of the bio-ecological context of these studies--that is, the purposive evolutionary framework which emphasizes the processes of natural selection and genetic accountability (Richerson 1977). Hence the usage of such concepts and principles as species, adaptation, stability and positive fitness in reference to human populations. While biological evolution has significance in terms of certain human characteristics (i.e., morphological and physiological), it clearly conflicts with anthropological notions of the natures of cultural behaviour and human choice (in terms of the lifespans of human populations and individuals). It is suggested then, when applying bioecological concepts or principles in a socio-cultural anthropological analysis, that critical consideration be given the bioecological context of these materials, in order that inapplicable or inappropriate concepts or principles may not be borrowed as well (either explicitly or implicitly). In terms of the ecological niche concept, such a critical examination constitutes one major objective of this present thesis.

Since Barth's (1956) usage of the ecological niche concept, to refer to the subsistence relations of specific human aggregates to 'resources and competitors', the trend has been to quantitatively measure subsistence relations (Carneiro 1956; Vayda and Rappaport 1968; Lee and Devore 1968; Lee 1969; Kemp 1971). Particularly, focus has been placed on trophic or energy relations. While Kemp (1971) attempted to provide comprehensive energy flow diagrams which represented varying energy networks of particular human aggregates, focus in other studies has been placed primarily on food source. Hardesty's utilization of the ecological niche concept followed this latter trend.

While Hardesty (1975) introduced to anthropology a mathematical formula for measuring ecological niche, this is not seen as a particularly new approach. The orginality of Hardesty's approach is observed to lie in his employment of the concept of the Hutchinsonian 'multidimensional ecological niche'. While the multidimensional form is considered to be instructive, Hardesty's approach is observed to fall short of being a satisfactory format for the development of ecological anthropology. This failure is attributed most particularly to the theoretical premises of Hardesty's argument, whereby improper use of the Hutchinsonian formulation of niche is made. As well, failure is attributed to the emphasis placed on a particular technique of quantification which, without some modification, produces values of no comparability (there is one rare conditional exception). Refinements to Hardesty's theoretical framework and operational technique are proposed and tested in this thesis, utilizing resource harvest data for four Inuit communities on Ungava Bay (raw data obtained from the Northern Quebec Inuit Association, Montreal, Quebec).

However, it is observed that Hardesty's operational approach, either in its original form or in the amended version presented in this thesis, fails to consider wholely the numerous ecological dimensions that affect resource harvesting. In turn, this approach to operationalizing the Hutchinsonian multidimensional niche concept does not approximate, even minutely, the 'total ecological reality' of human aggregates. Any mathematical calculations derived from the above approach must be seen, therefore, as being of very limited descriptive utility, and, concomitantly, of extremely little analytic and explanatory rigour. The Hutchinsonian multidimensional niche concept, while being a brilliant, abstract conceptualization of the total ecological reality of biotic aggregates, remains largely an impractical operational tool.

CHAPTER I

THE NICHE CONCEPT IN BIOECOLOGY

THE HISTORICAL DEVELOPMENT OF THE NICHE CONCEPT

The formative roots of the niche concept may be traced to Charles Darwin's The Origin of Species , first published in 1859. Recognizing that biotic forms exist in 'a web of complex relations' (Darwin 1958:82) under the influence of biogeophysical factors and competition for food and space (Darwin 1958:79-80), Darwin gives illustration

> ...of diversified and of changed habits
> in the individuals of the same species...
> (1958:166).

It is suggested how this is a reflection of each individual's 'struggle for life' (Darwin 1958:163) and adaptation to its 'place in the economy of nature' (Darwin 1958:14). While the ecologic framework for the conceptual definition of niche was thus provided as early as the mid-nineteenth century, one may note that it is generally agreed that 'niche' was not defined and employed as an ecological concept until 1917, when Joseph Grinnell used it to refer to the adaptive relationships of species' phenotypic and behavioural qualities to specific habitat characteristics (1917:433).[1] Niche was later redefined by Grinnell (1924,1928) to represent the

> ...ultimate distributional unit, within which
> each species is held by its structural and
> functional limitations (1928:435).

Grinnell's formulation of niche was primarily autecological,[2] being concerned with individual species, and their distinctive adaptations to their particular environments. This formulation has since been termed the 'habitat or place niche' concept. In contrast, Charles Elton (1927) formulated the 'niche' synecologically, as representing the internal, structural relationships binding species together within a single unit or community (Whittaker and Levin 1975:11). It was thus employed

> ...to describe the status of an animal in its community, to indicate what it is doing and not merely what it looks like... (Elton 1927:63).

This has been termed by many as the 'functional niche' concept. Alternatively, some authors (MacArthur 1968:160; Odum 1971:234) have considered this formulation to be the 'trophic niche' concept due to Elton's emphasis on the food relations of animals. However, Whittaker, Levin and Root (1973:323-324) suggest that, since Elton was an animal ecologist, he no doubt used trophic relations out of familiarity to illustrate his point, while, at the same time, fully understanding the significance of other environmental factors, such that the niche concept so formulated would apply as well to plants and saprobes. Be that as it may, this formulation was later refined by Gause (1934) to refer to all biotic life, rather than to animals alone (Whittaker, Levin and Root 1973:322; MacArthur 1968:160).

Vandermeer notes (1972:108-109) that in the period 1930-1950 many biological theorists had concluded that the definition of the 'ecological niche' as 'an organism's place within an ecological community' (paraphrased from Elton 1927) was unsatisfactory due to its lack of clarity. During this time G. Evelyn Hutchinson introduced his formulation (1957) of the ecological niche as an 'n-dimensional hypervolume', in which

> ...every point corresponds to a state of the environment which would permit the species S_1 to exist indefinitely (Hutchinson 1958:416).[1]

Thus, Hutchinson's conceptualization sought to identify and integrate x number of environmental variables, whose varying natures in combination, produce certain viable conditions for a particular species. Within this context, a species not only interacts with its habitat, but with the community of organisms within which it exists. The ultimate result of such interaction would be, for a particular species or species' population, the acquisition and maintenance of a viable ecological circumstance (MacArthur 1968:160; Whittaker and Levin 1975: 4-5). At the community level, this would lead to species diversity. Some theorists (notably Whittaker, Levin and Root 1973) have labelled this formulation as the 'habitat plus niche' concept. As to the further development of this conceptualization,

> ...it was not until Levins (1968) and Colwell (1969) tried to make niche measurements in nature that the current vigorous activity in the theory of ecological niches came about (Vandermeer 1972:109).

THE BASIC CONTEXT OF NICHE IN BIOECOLOGICAL THEORY

It is necessary at this point to discuss the theoretical context of the niche concepts in bioecology, in order that we may more fully comprehend the essential interrelationships of these concepts, and the complexity of the problem at hand.

The various concepts of niche in bioecology are considered in an evolutionary context, in that a species' adoption of a particular ecological niche is a reflection of its adaptation to changing environmental circumstances. Particularly, evolution is suggested to occur at the species or population level through the process of 'natural selection', whereby maladaptive characters are selectively eliminated genetically, leaving the species or species' population 'positively fit' (able to survive and reproduce) for its immediate set of environmental circumstances. Such population regulation manifests itself within the context of what may be termed 'limiting factors' (limiting in the sense that they determine the nature of a species' niche), which may or may not be density dependent (Whittaker and Levin 1975:32). These variables include geophysical factors (including climate), and such 'biotic'[3] factors as diseases and nutritional requirements, population structure (e.g., genetic structure, age structure, spatial distribution, social structure), as well as intra-specific and inter-specific interactions (Whittaker and Levin 1975:31).

While there are recognized (Odum 1971:211) 'positive', or non-deleterious, interactions in either inter-specific spheres (namely commensalism, protocooperation, and mutualism[4]), or intra-specific spheres (some forms of aggregate behaviour), emphasis is placed on 'negative', or deleteriously discriminating, interactions termed 'relations of competition'. Such emphasis appears to be based on the either explicit or implicit premise that adaptation is generally stress-induced. Inter-specific competition is characterized by direct interference, competition for resources, predation, parasitism, and antibiosis[5] (Odum 1971:211,220; Whittaker and Levin 1975:280), while intra-specific competition may be exhibited in territoriality, as well as some other forms of group behaviour (Odum 1971:197). Such negative interactions may be subsumed under the general principle of

> ...competitive exclusion, the dynamic process of natural selection at the species level (Whittaker and Levin 1975:30).

This principle[6], first formulated by G. F. Gause (1934), considers the competitive process, whereby 'nearly related species' come to occupy distinctive niches. Competitive intensity is suggested to be determined "...by the similarity of the demands of the competitors upon the environment" (Gause 1934:110).

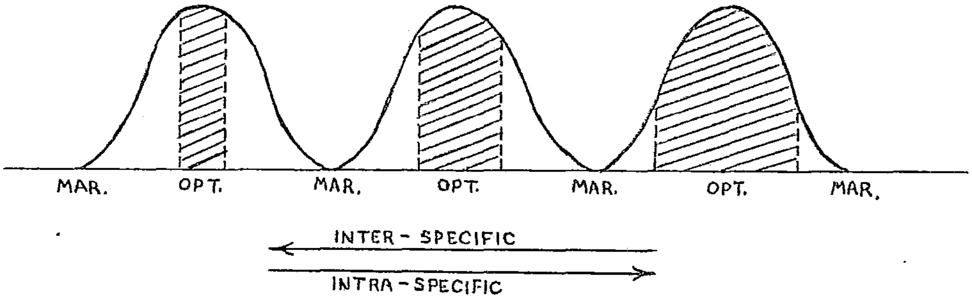
The Competitive Exclusion Principle basically offers two possible outcomes of any competitive interaction, namely either (1) the complete elimination of one species from the community, or (2) some form of 'character displacement', whereby the competing species come to occupy unique operative spheres, by differing

> ...the kind of resource they use, or in place or time of activity in the community, or in their way of relating to other species, or in the manner in which their populations are controlled...(Whittaker and Levin 1975:3).

Hence, niche difference, which arises primarily as a result of competitive interaction, is the basis for the evolution of species diversity.

Character displacement, which includes habitat displacement and niche displacement, may be, according to Odum (1971:240), "...morphological, ecological, behavioural, or physiological..." in nature. The effect of inter-specific competition and intra-specific competition on community relations is illustrated in Figure I, where habitat displacement is graphically demonstrated.

Figure I : The Effect of Competition on Habitat Displacement



Caption: Given in the natural condition that both inter-specific competition and intra-specific competition are manifest, when intra-specific competition dominates, the species in question "...spreads out and occupies less favourable (marginal)..." habitats; whereas, when inter-specific competition dominates, the species "...tends to be restricted..." to those habitats exhibiting optimal conditions (Odum 1971:218; see Figure 7-31).

To briefly summarize then, the major point to be drawn is that the niche concept, and the process of niche diversity (under the influence of such factors as competitive interaction), are in the natural sciences cast in an evolutionary framework which emphasizes the role of the process of natural selection. Competition produces niche diversity through the process of natural selection, due to the assumption of genetic accountability (Odum 1971:240). With regard to transposing the niche concept to the sphere of ecological anthropology, it may be suggested that it is necessary to divorce the concept from, or at least explicitly define whatever relationship still exists with the above-mentioned framework, due to its incompatibility with the anthropological focus on culturally derived behaviour and human choice within an individual's (or population's) life-span. As we shall shortly indicate, Hardesty's application of the Hutchinsonian niche appears to have partially failed to successfully negotiate this particular problem.

THE CONCEPTUAL FRAMEWORK OF NICHE IN BIOECOLOGY

To add clarity and definition to the 'niche' of a species or species' population, it is necessary to consider the species in relation to a specific: (1) environment, (2) community, (3) habitat, and (4) area. While in the preceding section the niche concept was viewed in an evolutionary context, this section suggests that the niche concept might also be considered in relation to the following.

1. The Concept of Environment

Perhaps the most problematic concept in ecological anthropology is that of 'environment'. This specifically suggests itself within the context of distinguishing between organism and its milieu. As Marston Bates speculates (1960:179),

> The...external world is the environment in which organisms live--or is it?
>
> The distinction seems simple and clear enough at first glance, but it breaks down in many ways--until sometimes I wonder whether it isn't a mistake even to try to make the distinction, whether the whole idea isn't basically misleading (Bates 1960:35).

Bates offers (1960:179) three possible ways of defining the concept of environment, namely (1) by specifying those elements perceived by the organism, (2) by specifying those elements which in some way affect the organism, whether perceived or not, or (3) by specifying, through detection or inference, all elements, whether they are influential to the organism or not. He refers to these respectively as (1) the 'perceptual environment', (2) the 'effective environment', and (3) the 'total reality'. The third alternative appears to proceed beyond the scope of this paper, due in part to its deeper philosophical nature, but, more particularly, due to the nature of theoretical science which, at the present, can only refer to such a reality in the most general of terms, namely ecosystem and biosphere.

One is left with the remaining two alternatives which are, in effect, species-oriented, and therefore more appropriate to the present level of investigation. In the ecological context of this investigation, one is concerned with the 'effective environment', that part of the total reality which directly influences the organism(s) under study. In the strictly anthropological sphere of investigation, one as well must turn to the 'perceptual environment' for direction in understanding the relationship between man and the natural world. While some might suggest at this point a discussion of the emic/etic problem, the procedure adopted in this paper, whereby all aspects of the human circumstance are considered as environmental factors, in my view, obviates the immediate need for such a consideration.

The human organism is thus considered as a manifestation of the interaction of all environmental variables, whether in nature phenomenal or ideological. These environmental variables are considered to be combined in some dynamically complex structure of relations, which defines the organism in 'living context'. This conceptualization is not, however, extraordinary for the method of scientific investigation is implicitly based on just such a claim. How else might one logically consider a variable (such as culture) constant, and proceed to examine or measure other variables (such as human behaviour) in its light, without first basing one's procedure on such a claim?

> The problem of man's place in nature, then, is the problem of the relations between man's developing cultures and other aspects of the biosphere. The understanding of these...has been... greatly handicapped by the way in which we have come to organize knowledge (Bates 1960:250).

The ecological-anthropological approach adopted here, which considers all aspects of human existence as environmental variables, is offered as a means of understanding diverse "...interacting systems--which sometimes act as single systems"(Bates 1960:249).

2. The Concept of Community

In bioecology the analysis of species or species' populations is generally considered within the context of the 'natural community', or, in other words, within the context of other species or species' populations occurring in a given geographical area (Odum 1971:5). The major focus of analysis at the community level of organization is that of inter-specific interaction.

More particularly, inter-specific competition is suggested to provide the dynamic input into community relations. This stress-inducing factor, among others, is suggested to be instrumental in determining the nature of the relationship between the species of a community and the community's abiotic substrate,[7] by influencing the rate of the process of natural selection (Odum 1971:213); however, it must be emphasized that this substrate is assumed to set limits on this process (Odum 1971:251), as does the previously mentioned evolutionary process, which it is assumed tends to minimize, through ecological adjustment or adaptation, the effects of negative interactions in favour of positive symbiosis (Odum 1971:212). Again, the major point to be drawn is that community relations are, for the most part, determined by the process of natural selection operating (through competition) at the population level and, more importantly, at the level of the individual organism (Richerson 1977:10). This formulation may be observed to be somewhat less than adequate in the light of cultural factors. It may be seen as a clash of teleological formulation.

In bioecological theory, competitive interaction, as well as other kinds of interaction exhibited by organisms, is assumed to be reactive in nature; that is, reactive to external stimuli. In the latter case, social and cultural change is postulated as arising from interactions in both inter-population and intra-population spheres. However, not only are such interactions suggested to be in part 'reactive to external stimuli', they are also suggested to be in part 'original' or non-reactive in nature; that is, some actions are suggested to occur on the basis of some organism's 'individual originality'. In much of the literature in biological science, such originality is, either explicitly or implicitly, assumed to be either non-existent or insignificant. Thus, while on the surface the mechanics of competition in the fields of bioecology and ecological anthropology may appear similar, they are in fact fundamentally different. Since the human animal is recognized as being critically different from other species, it presents a rather special case for both biological and anthropological theorists.

Another problem suggests that the natural community concept, in its present form, is of little analytical utility with regard to the analysis of the human ecological circumstance. It must be recognized that human populations continuously are a part of, and exploit, more than one biotope at any one time, within which many natural communities are identified. As a result of this transsectional quality of human relations to the natural environment, it would appear that natural community analysis is inappropriate, for other species' populations are considered, in the natural sciences, to occur more or less within a given community (albeit determined by artificial boundaries; see Vandermeer 1972:110). There is a basic incompatibility of analysis indicated. The significance of this position in terms of the niche concept is that immediately, when one begins to consider the human ecological circumstance, the niche concept is necessarily divorced to a certain degree from its 'traditional' role, of representing a species or species' population's ecological relations in the natural world, at least as far as those relations are definitionally considered in the 'natural community' sphere of interacting species. Perhaps a consideration of the human ecological niche in the context of 'ecotope' is more appropriate to the ecological anthropological approach adopted here. This will be discussed further in the following section, as formulated by Whittaker, Levin and Root (1973:334; see also Whittaker and Levin 1975:176).

3. The Concept of Habitat

The species or species' population may also be considered in the context of 'habitat'. As Whittaker and Levin state (1975:2), the habitat(s) of a species or species' population is (are) defined

> ...by intercommunity variables...such as topographic position, elevation, soil moisture and fertility,...and differences in kinds of communities.

These variables are termed 'extensive', in contrast to the 'intensive' niche variables which, in traditional ecological usage, vary within the context of a given community in a given environmental setting

(Whittaker and Levin 1975:2).

Habitat, then, is a definitive representation of the relationship between the species' population and its particular physical substrate. This relationship is interactive in nature, such that organism and substrate are active on and reactive to each other. Generally, though, the relationship is conceived such that the species' population exists in a framework of habitat variables that are bounded by the species' population's biological 'levels of tolerance';[8] within these boundaries, the population has an 'optimum' habitat, surrounded by decreasingly favourable habitat conditions as one approaches the limits (Whittaker and Levin 1975:4-5). One should note Odum's cautionary statement (1971:107) that:

> All physical requirements may be well within the limits of tolerance for an organism and the organism may still fail as a result of biological interrelations.

As Bates further indicates (1960:248), the human habitat, even at the level of a (discrete, it is assumed) human population, is rather difficult to define due to the diverse effects 'culture' has on the population's 'ecological distribution'. Obviously, the habitat concept, as generally defined above, is inadequate by itself in describing the human ecological circumstance. Further discussion follows in the next section in terms of the relationship between niche and habitat.

4. The Concept of Area

The 'area' concept is introduced in this section for two reasons. Firstly, it may be found useful in the methodological part of this paper to use 'area' (meaning distribution in space and time) as an expression of a human population's territory for exploiting harvestable resources. Therefore, definition of the concept within the theoretical section appears valid. Secondly, it will be noted shortly that the 'area' concept is in many ways closely associated with the concept of 'habitat'. Therefore, it may be useful to consider the 'area' concept before introducing the following section.

While the 'habitat' concept refers to the 'kind' of environmental conditions associated with a particular species or species' population, the 'area' concept is concerned with the 'range of distribution' of those relevant habitat conditions (Whittaker and Levin 1975:2-3). While the 'niche' is a representation of inter-specific and intra-specific interaction, 'habitat' is a representation of the substrate upon which such interaction takes place. The physical extent of such interaction is represented by 'area'. While these are the three basic aspects of a species' population's environmental circumstance, we are particularly concerned with 'niche', and therefore, the relationship between 'niche' and 'habitat' must be more closely examined.

The Nature of the Niche/Habitat Relation

It must be noted that each species' or species' population's status in the natural environment varies according to the nature of its particular genetic and physiological features, population characteristics, and way of relating to all environmental factors, including those derived from interaction with other species (Whittaker and Levin 1975:167). In this paper the 'habitat' concept is used to refer to 'extensive' (inter-community) environmental variables that constitute the natural substrate, upon which both inter-specific and intra-specific interactions take place (Whittaker, Levin and Root 1973:328). These interactions, which are usually considered as 'intensive' (intra-community) factors, are represented by the 'niche' concept. Together these various factors are considered to represent the totality of a species or species' population's 'external circumstance' (Whittaker, Levin and Root 1973:333-334).

Both habitat and niche variables may be characterized within their respective 'dimensional hyperspaces', an m-dimensional hyperspace for habitat (first formulated by Ramenski 1924; Whittaker and Levin 1975:166), and an n-dimensional hyperspace for niche (Hutchinson 1958:416). The habitat hypervolume, then, being bounded by the species limitations, is a manifest effect of those extensive environmental variables considered significant.[9] This habitat hypervolume is not merely defined by the species' physiological tolerances, but also by inter-specific and intra-specific competition (Whittaker, Levin and Root 1973:328). Niche variables, considered as axes,

> ...define a multidimensional niche hyperspace interrelating the species of the community. Each species in the community utilizes, or occurs in, or is affected by, some range of these axes, the limits of which outline its niche hypervolume, or realized niche...(1973:332).

To complete this representation it is necessary to include population responses to these axes in order to highlight the 'functional' relationships in the community. Due to the functional perspective, Whittaker, Levin and Root suggest (1973:332) that Hutchinson's formulation more rightly characterizes the 'niche', rather than the 'habitat plus niche' formulation often attributed to it. However, Whittaker and Levin note (1975:166):

> It will be apparent that species are relating to many different axes at once, some habitat, some niche, some a little of each. We shall arbitrarily include the latter among the niche axes.

This suggested overlap of axes basically arises due to the distinction made between intensive (intra-community) and extensive (inter-community) variables. As indicated, habitat axes are, for the most part, 'spatial' in nature, and are usually referred to in terms of gradients which transect community boundaries. However, in some circumstances, rather than considering 'macro-dimensions', it may be worthwhile at times to consider 'micro-dimensions', or spatial variations occurring within the limits of a community. In this sense, because the focus is 'intensive', these variables may be conceptually considered as 'niche dimensions'--hence the overlap of habitat and niche (Whittaker and Levin 1975:173-174; Whittaker, Levin and Root 1973:324-325).

Within this framework, the 'habitat plus niche' concept may be referred to as 'm plus n' ' combination of variables (n' is used to indicate that the n niche axes formulated to represent a community have been extended to represent the full range of communities in a given geographical area; Whittaker, Levin and Root 1973:333). Alternatively, Whittaker, Levin and Root suggest (1973:334) use of the term 'ecotope hyperspace', to represent

> ...the full range of external circumstances to which species in the landscape are adapted... The ecotope...is the ultimate evolutionary context of a species, even if the niche is a proximate one.

Since the 'niche' in this framework is restricted to the representation of a particular community, it is perhaps worthwhile to consider the possibility of using the concept 'ecotope' to refer to the 'total' human ecological circumstance.

However, such usage would, in order to make it compatible with the ecological anthropological approach adopted here, require a somewhat lessened emphasis on natural selection. The question of whether or not such a conceptualization would be useful must remain unanswered until further consideration of both Hutchinson's and Hardesty's formulations has been effected.

THE HUTCHINSONIAN NICHE: A CRITICAL EXAMINATION

It has been noted (Vandermeer 1972:109; Whittaker and Levin 1975:ix) that Hutchinson's redefinition of the ecological niche was revolutionary in the biological sciences, leading to an exponential growth in niche studies. However, several authors (Hutchinson 1958; MacArthur 1968; Vandermeer 1972; Whittaker, Levin and Root 1973) have indicated a number of theoretical and methodological problems associated with this formulation. Thus far, this paper has considered a few of these difficulties. The remainder will be discussed in this section.

Hutchinson's reformulation of the niche concept was constructed in response to the questioned "nature of the ecological niche and the validity of the principle of niche specificity" (Hutchinson 1958:415). In an evolutionary framework, species are active within the context of a large number of environmental factors.[10] Consequently, Hutchinson proposed that these variables could be regarded abstractly as 'a set of n coordinates' (Whittaker, Levin and Root 1973:322), or dimensions of a species' ecological niche. Assuming 'variable' independence, Hutchinson suggested (1958:416) that, for each variable x, there must be limiting values within whose range the species in question could 'survive and reproduce'. If one were to consider any two variables, x_1 and x_2, the area defined would be rectangular in shape, within which any point would correspond to a possible environmental state permitting the species to exist indefinitely. The addition of another variable, x_3, produces a three-dimensional space. With the incorporation of all ecological variables, x_n, an n-dimensional hyperspace is created, representative of the species' 'fundamental niche'.[11] If the relevant environmental factors were observed not to be, in whole or in part, independent, the hyperspace would not be hemispherical, but would form a shape corresponding with those observed dependent relations (Hutchinson 1958:416).

Thus, Hutchinson equates the 'fundamental niche' with the species' 'ecological niche' (Whittaker, Levin and Root 1973:322).

This fundamental niche represents the 'biotope space' biologically acceptable to the species. Given competition (and other discriminating interactions in the environment), the actual hypervolume occupied by the species will be somewhat less than that of the fundamental niche. This is termed the species' 'realized niche' (Hutchinson 1958:418). One should note that it is not physical and physiological factors alone that are postulated as the key determinants of niche specificity, but biological factors (including the competitive circumstance of species) as well.

This emphasis on the 'competitive exclusion principle' illustrates the 'intensive' (Whittaker, Levin and Root 1973:322) nature of Hutchinson's formulation, in that it emphasizes intra-community variables in a 'post-interactive' (Vandermeer 1972:109) framework. While Hutchinson allows (1958:418) some objection to the heavy reliance on this principle, since the identification of competition in nature is difficult, he begs the question (1958:419) by suggesting that competition may either be operating intermittently, or operating in so subtle a fashion as to be presently unobservable. We shall return to this problem later. For the moment, there are a number of other difficulties associated with this conceptualization.

Hutchinson notes (1958:417) the following limitations:

(1) all points in each fundamental niche are assumed to imply equal persistence of the species (zero probability of persistence is postulated for all points outside of the fundamental niche boundaries); however, Hutchinson points out that in reality some part of the niche will be optimal with suboptimal conditions prevailing towards the boundaries;

(2) all environmental variables are considered to be amenable to linear ordering; however, many variables have only been qualitatively described;

(3) the model refers to a single instant of time; however, due to the fact that competition is processual (as are all interactions), the model must somehow represent dynamic situations; and

(4) only a few species of the community can be considered at any one time due to the inherent complexity of the model; interaction of any of the specified species is considered competitive in nature, with all the other remaining species being considered as 'part of the coordinate system'.

With regard to the first limitation suggested by Hutchinson, one may approach the question of optimal/suboptimal regions of niche hyperspace more appropriately in terms of a species' population's 'realized niche'. This is suggested on the assertion that the fundamental niche, for our purposes, represents essentially the Hutchinsonian niche as a 'pre-interactive' framework--that is, before the introduction of particular, empirically-based, dynamic relations. In this context, equal probability of persistence at all points within the hyperspace is meaningful. Given empirical data, one may consider the realized niche. However, is it appropriate to consider this realized niche in terms of optimal/suboptimal regions? What criteria are employed to differentiate these areas of hyperspace? Employment in bioecology requires that optimal/suboptimal regions be differentiated on the basis of a species' relative ability to survive and reproduce, or 'persist' biologically. While one would not wish to exclude this from analysis of human ecological states, one must emphasize, at the same time, the influential character of human culture on human persistence. However, in so doing, the distinction between optimal and suboptimal regions of ecological hyperspece becomes a rather unclear differentiation--and hence, perhaps a distinction impossible to precisely identify. In this context probabilities are spurious.

Due to the controversy of what constitutes relevant criteria, it is perhaps advisable to disregard this distinction, at least until a clearer idea of the ecological relation between the cultural and biological natures of man is formulated. In other words, we may assume that any particular ecological circumstance (the total reality or ecotope) of a species' population at a particular time t, is the singular, natural outcome of the temporally preceding, relevant factors. That is, at time t, the question of whether the circumstance is optimal or suboptimal is inappropriate--the outcome of preceding interactions is assumed to be a necessary product. However, over an extended time period, it may be suggested, upon consideration of all empirical data, that a particular realized niche hypervolume (at time

t_x), relative to other realized niche hypervolumes (at times t_0 to t_n, excluding t_x), may be considered to be superior on the basis of one or more characters. Perhaps niche width is such a character--as a function of resource diversity, and hence, as an indicator of the species' ability to respond adaptively to environmental variability.

Hutchinson (1958) notes, as indicated, the difficulty of integrating quantitative and qualitative descriptions within his multidimensional framework in such a way as to provide significant relationary statements. To resolve this difficulty it is necessary to make these forms of presentation compatible. To do so, one must translate one form into the other. Translating qualitative data into numerical symbols may be accomplished. However, it is basically a translation of a variable from a nominal scale to an ordinal scale (Raktoe and Hubert 1975:6). Ordinal scales vary according to orders of ranking, which may or may not be comparable to that used to describe the original quantitative datum or data. That is, it is possible that the qualitative data may only be translated into integer scores, while the quantitative data may be referred to as real value intervals (Raktoe and Hubert 1975:5). In such cases the alternative is to translate the quantitative data into word sentences composed of relationary qualifiers. While such translation results in some loss of rigour, it allows the possibility of drawing significant inferences from the data as an integrated whole. As well, it reduces the opportunities for implying unwarranted precision of particular quantitative figures (the degree of sophistication of the data is of substantial concern). Either alternative may prove germane to considerations that follow in the analytical sections of this paper.

As to the noted difficulty of attempting to explain dynamic or processual interactions by means of a static model, little can be said. The logical inconsistency cannot be denied--nor can it be ignored, however. One of the connecting relations between habitat and niche, which allows consideration of a species' ecotope, is the dimension of time. Conceptually, all variables are considered in light of it. The essential difference between a static model and a processual model is that, respectively, focus is placed on one and many continuous time frames. Therefore, it appears logically valid that, by constructing a number of static frames of reference while, at the same time, reducing the temporal interval separating them, one may be able to closely approximate the dynamic circumstance. This paper shall endeavour to accomplish this, within the descriptive confines of the data available.

The final limitation presented by Hutchinson has two aspects to be considered. In the first place, competitive interactions are highlighted at the expense of all other interrelationships between species. This is a profound simplification of the ecologic circumstances of species. Secondly, employing competition as the primary criterion for isolating relations, and for selecting species for analysis, Hutchinson proposes that only a few species can be considered at any one time due to the dimensional complexity of the model. Out of necessity, other species are relegated to the position of niche coordinates or 'niche context'. One may recall that this 'complexity' has been somewhat simplified by the assumption of variable independence. While this simplification necessarily reduces the explanatory power of the model, the relative immaturity of the questions posed make such an assumption necessary at this developmental stage. Even so, this problem will later have significance in connection with the application of the concept of 'niche shape'.

Again, the result is a profound oversimplification of a species' 'realized niche'. In fact, as Vandermeer (1972:109) points out, this method of analysis does not expose the 'realized niche' of a species to scrutiny; rather, such an exercise is an analysis of what may be termed a species' 'partial niche'. Further, Vandermeer suggests (1972:111-12) that one may consider m partial niches, ranging from the first partial niche (where species i is examined under the influence of another species j), to the second partial niche (where species i is examined under the combined influence of two species, j and k), up to the mth partial niche (where species i is examined under the combined influence of all, m, species in the community, including species i itself). Thus far, all ecological anthropological investigations have been essentially the examination of partial niches. Hardesty's application of the Hutchinsonian niche is no exception.

CHAPTER II

TOWARDS AN ECOLOGICAL ANTHROPOLOGICAL APPROACH

REFINING HARDESTY'S TREATMENT OF THE HUTCHINSONIAN NICHE

For Donald L. Hardesty (1977:109), the ecological niche of an organism is essentially its 'share' of the energy components of its ecological system. The Hutchinsonian concept of ecological niche as a multidimensional hyperspace is introduced (Hardesty 1972; 1975; 1977) within the context of Charles Elton's earlier conceptualization (1927:64), which stresses the 'function' or 'role' of an animal population in its 'natural community'. Further, Hardesty seeks to describe this function in energetic terms, apparently taking this narrow course of action on the basis of Odum's (1971:234) mistaken characterization of Elton's formulation as the 'trophic niche'. As a result, each dimension of the Hutchinsonian niche represents a separate 'resource variable', and the degree to which it is 'utilized' by the human population. While such an emphasis on energy relations has precedence in anthropological literature (Carneiro 1956; Rappaport 1967; Lee and Devore 1968; Kemp 1971), its introduction within the framework of the Hutchinsonian niche may be considered to originate with Hardesty.

The dimensions of the Hutchinsonian niche are restricted to those 'environmental variables' that are actually 'utilized' as energy resources (Hardesty 1975:71-72). The ranges of 'positive' values associated with each dimension define the 'size' of the niche. This is employed as an expression of the organism's 'fitness' to its ecological circumstance. As well, it is an expression of the organism's 'distinctive' space, occupied in order to reduce competition with other organisms (Hardesty 1975:71-72). Thus, according to Hardesty (1975:73), organisms occupy realized niches under varying influence from competitors and population pressure. Although not stated clearly, it appears that the realized niche concept refers to the amalgamation of all dimensions and their respective realized values. Vandermeer's conceptualization of 'partial niches' is used to refer to the niche space resulting from resource-oriented competition with particular competitors. However, it is apparent that Hardesty considers his application of the Hutchinsonian niche to be, both in theory and practice, directly concerned with realized niches (Hardesty 1975:73). Vandermeer's argument seems to have been insufficiently considered by Hardesty, in that Vandermeer clearly pointed out (as did Hutchinson 1958:417) that it was not possible, at this point in theoretical development, to consider directly the realized niche, in part due to the complexity of the relations. Further limitations of the model at this stage include its inability to cope with more than a few variables at any one time, and the assumption of dimension independency. While one can conceptually consider 'nicheshape' as a function of dependent relations, it is not the shape of the 'realized niche' that is first formulated; rather, it is the shape of the 'partial niche', which gradually becomes more complicated as more dimensions are added (up to the point where all dimensions are included; at this point the realized niche is formulated). Considering the fact that Hardesty's application examines only energy relations, at the expense of all other existing interrelationships, it is untenable to suggest that the 'realized niche' would be directly under review. There are a number of other problems which reduce the level of sophistication of Hardesty's application of the Hutchinsonian niche.

As indicated in the preceding sections, bioecologists have identified certain significant problems associated both with the formulation and application of Hutchinson's multidimensional niche model. To do justice, both to the model and bioecology, it is necessary to consider these difficulties when attempting to transpose the model from one field of endeavour to another. Hardesty recognizes (1975:72) the difficulties of applying the Hutchinsonian niche concept to the human circumstance of 'culture and biological generality'. However, Hardesty fails to: (1) make explicit the differentiation between 'man' and 'environment', (2) explain the nature of 'positive fitness' as it supposedly applies to the human condition, (3) give sufficient reason why all forms of interaction or interrelationships are not to be considered, as the Hutchinsonian niche was originally intended to do, (4) recognize any significant difference between niche and habitat, and (5) indicate the overall conceptual scheme in which the reformulated niche exists, while implicitly eliminating the natural community as an appropriate focus. In fact, Hardesty's treatment of the Hutchinsonian niche varies little from the original formulation; the model is still implicitly based on and rooted in the biological processes of natural evolution. This is most explicitly indicated in Hardesty's (1) reliance on the principle of positive fitness, which appears to mean the ability to survive and reproduce as used in biological science (1975:71), (2) apparent laxity in specifying the natures of such concepts as environment, community, or competition (1975:72), which leads one to assume that there is no difference from those concepts' applications in bioecology. Cultural components are recognized as being important but are not, for the most part, integrated in any formal manner.

ESSENTIAL REFINEMENTS OF HARDESTY'S APPROACH

Whittaker, Levin and Root (1973:325) have suggested the use of the term 'ecotope' to refer to a species' population's total ecological reality. This ecotope may be differentiated conceptually into two multidimensional hyperspaces, representative of both the 'niche hypervolume' and the 'habitat hypervolume'. Following their lead, I would propose that any common dimensions will be arbitrarily assigned to the niche hyperspace. The habitat hyperspace is considered to be relatively simple (Whittaker, Levin and Root 1973: 328), in that it involves a finite number of spatial dimensions. In contrast, the niche hyperspace will involve an infinite number of dimensions, which in turn may be subdivided into three classes, namely cultural dimensions, social dimensions and biotic dimensions (morphological and physiological characters). Cultural dimensions constitute an appropriate ideological order of reality, while the remaining dimensions constitute a phenomenal order. The relations linking the niche and habitat hyperspaces may, I suggest, occur in either order.

The ecological anthropological approach may be elucidated as the study of the structural and functional interrelationships among human organisms or aggregates thereof and their respective biotic, abiotic, social and cultural environments, with special emphasis on those additional interactions, and the conditions, products or outcomes thereof, that provide the dynamic quality of human existence. The dynamic, processual nature of the ecotope, and concomitantly of the niche and habitat, is suggested to arise from the following. The dimensions noted above, in conjunction with those geophysical characters that constitute the nature of the habitat, compose the organism's 'environment'. In essence, the organism and its environment are abstractly combined. This is then the 'total reality' or 'ecotope' of the organism. Within this context, it can be suggested that man not only influences and is influenced by the biotic and abiotic characters constituting the physical reality, but is, as well, active with and reactive to both social and cultural realities. This structure of relationary terms, then, connotes connecting relations which are 'interactive' in nature. The dynamic processes of an ecological circumstance may thus theoretically be integrated with a 'static' model comprised of particular, yet variously identified realities.

Hardesty's attempt to operationalize the Hutchinsonian niche within an anthropological (and therefore autecological) framework gains significance. A consideration of energetic relations, while constituting only a partial element in the total reality or ecotope of man, is thus perceived as a valid and potentially informative endeavour. While a number of problem areas of theoretical interest have thus far been identified, isolated and considered, there remain other problem areas of operational significance. The following section concerns itself with these difficulties.

OPERATIONALIZING THE ECOLOGICAL ANTHROPOLOGICAL APPROACH

As indicated in the preceding section, the total ecological reality of a species' population is called the 'ecotope', which may be represented as consisting of a niche hyperspace and a habitat hyperspace. Further, it was clearly noted that Hardesty's emphasis on trophic relations, while being an important part of this ecotope, does not constitute the entire ecotopic reality. Therefore, it must be kept in mind that the following employment of subsistence data, and the analysis of the same, must not be presumed to constitute the only significant focus through which an ecological reality may be understood. It is nonetheless suggested that Hardesty's operational method, while restrictive, may also be instructive.

Hardesty notes (1975:73) the necessity of ascertaining the most appropriate unit of analysis--whether at the individual, population or species levels of organization. In bioecology, the individual is generally considered as being comprised of genetic and phenotypic characteristics, which in turn are considered as statistical entities indicative of the nature of a given biological population. While it is possible to consider the niche of an entire species, generally empirical studies in bioecology are at the level of the population.

While the concept 'ecological population' has been suggested and employed in ecological anthropology by Vayda and Rappaport (1968), some difficulty might arise over how this relates to the concept of 'biological population', which presumes a statistically random, interbreeding network of individuals. In other words, the term ecological population might possibly, in an associative manner, be equated with the biological population when considering small, local groups of people, and thus generate confusion when considering larger, non-local groups. Employing the term 'species' creates similar problems, in that the species is taken to mean a group of individuals who cannot produce viable offspring by mating with non-species individuals. If one wishes to consider the ecological reality of Homo sapiens, no difficulty arises. However, if one considers only segments of Homo sapiens, and terms each segment a separate species (specifically 'cultural species'; Hardesty 1975:74), the inconsistency is obvious.

To avoid these difficulties, I suggest that the unit of analysis be termed simply the 'human ecological aggregate'. The term aggregate allows, without definitional restriction, the consideration of levels of organization that range from small, localized groups to large, non-local conglomerations. The 'ecological' focus represents, at the same time, the existence of integrative relationary frameworks within aggregates and between aggregates. This heuristic term will be employed in this paper henceforth.

Hardesty refers (1975:74) to the 'ecological distinctiveness' of human aggregates, meaning here the occupation of unique niches, and suggests that these occupations can be expressed quantitatively. Specifically, it is suggested that a modified version of Levins (1968) reformulated application of the Shannon-Wiener[12] formula for measuring 'niche width' is a useful device (Hardesty 1975:75-77; 1977:115). The modified formula suggests that niche width is a function of the variety of animal (and, implicitly, plant) resources harvested by a given human aggregate for subsistence purposes (Hardesty 1975:74-75). Further, it is suggested (1975:75) that such variety may be expressed as: (1) total resource variety (the enumeration of all utilized resources),, (2) spatial variety (distribution within the habitat[13]), and (3) temporal or seasonal variability of harvested resources. It must be emphasized that, while Hardesty suggests that such measurements are an expression of the human ecological aggregate's 'realized niche', this paper proposes that we are in fact only considering what Vandermeer refers to (1972:111) as a 'partial niche'. That is, we are at this point conceptually isolating only one aspect or segment of the realized niche, and, further, we are essentially measuring this niche segment in terms of only one parameter, namely resource variety.

While niche width measurement along the dimension of resource utilization may be informative of a human aggregate's 'ecotope', Whittaker and Levin (1975) suggest some complementary parameters. These parameters may respectively be termed: (1) 'niche overlap', as a measure of the degree of relative similarity (1975:168) of the niche hyperspaces of a number of human ecological aggregates, (2) 'niche' arrangement', as an ordination or arrangement or these human aggregates in relation to one or more niche axes or dimensions (1975: 175), and (3) 'niche space', as an expression of the restrictive interrelation of one niche dimension on another ecotope dimension (i.e., niche or habitat dimension). Such parameters may prove useful in comparing two or more ecological aggregates in terms of the variable expression of particular niche dimensions (meaning that aggregates may exhibit various substantial expressions along one dimension in response to the varying effects of another dimension). One may note that the complementary measures are not restricted to considering only resource utilization; rather, they are conceptually able to measure any niche dimension. Thus, the analysis of particular niche width values may be tempered by other considerations (Whittaker and Levin 1975:175). As well, these various parameters may be suggested to be relevant to a discussion of the habitat hyperspace. In any case, these complementary measures will be discussed later in connection with the analysis of the empirical data employed in this paper.

Ecological distinctiveness, then, essentially means the occupation of particular human ecological aggregates of unique ecotopes, comprised of niche and habitat hypervolumes. It is then an expression of a human ecological aggregate's 'total reality', and not merely, as Hardesty has maintained (1972:461), an expression of a particular network of trophic relations. Neither is it an expression of an aggregate's 'positive fitness'--as a means of separating species within a natural community context. The definition of environment adopted, here, because it refers to the human environment, demands a different context than the natural community, since it is defined autecologically (in terms of distinctively human, social and cultural, as well as biological realities). Such parameters as niche width, niche overlap, niche arrangement and niche shape are employed as comparative devices, serving to isolate those niche characteristics upon which unique ecotopes are formed.

EXAMINING HARDESTY'S NICHE WIDTH MEASURE

Weaver (per Hardesty 1975)

In bioecology, the Shannon-Wiener formula has been reformulated by Levins (1968), and refined by Colwell and Futuyma (1971), to measure the niche width of a species, as a function of the species' distribution over a number of identifiable environments or habitats. Levins proposed (1968:43) a simpler form of the Shannon-Wiener formula, and it is this form that Hardesty has adopted (1975:77;1977:115). The formula is as follows:

$$\text{Niche Width} = 1/\sum_{i}^{n}(p_i)^2,$$

where p_i, for Hardesty, refers to the proportional contribution of resource i to the total harvest, and N refers to the total number of resources. This is consistent with Levins' use of the formula, in that, whereas Levins' classes were identifiable environments, Hardesty's classes are identifiable, utilized resources. However, there are complications and unreported facts that question Hardesty's operational approach.

Subsistence variety is understood to involve two basic components, namely (1) 'resource richness', or the total number of resources utilized, and (2) 'resource evenness', or the 'degree of dependence' placed on each utilized resource. Hardesty refers to the latter (1975:75) as an indicator of the 'effective' subsistence variety, but fails to explain how these components combine, in the context of the formula, to produce a single value indicative of niche width. Without such explanation, the examples of subsistence data he cites (see below) and their respectively calculated niche width values are meaningless. These points are discussed further immediately below.

Using Rogers' (1972) subsistence data of the Mistassini Cree (see Table 1; Hardesty:1975:76), Hardesty employs the Levins' modified formula discussed above to arrive at a niche width value of 3.436. This value, by definition, is the product of the combined influences of the number of resources utilized, and the proportional contribution of each resource to the total harvest. From the information provided by Hardesty, it is impossible to gauge or otherwise consider the independent relationship of these factors to the calculated value. It is not indicated explicitly what numerical scale is appropriate to this value. Is the appropriate range of values 0 to 5, 0 to 10, 0 to 25, or 0 to 100? Levins most clearly states (1968:43) that, given equal utilization of all utilized resources, the niche width value will equal the total number of resources utilized. This would be the maximum possible value--the Optimal Niche Width value. A niche width value of 0 would obtain if none of the recognized subsistence resources were utilized. Therefore, the Cree niche width value of 3.436 is to be considered (it is assumed from the information provided by Hardesty) within the scale 0 to 18, representative of the 18 utilized resources. The functional effect of resource contribution to the total harvest on the niche width value is therefore as follows: as the proportional contributions of the resources varies (i.e., as the proportions contributed by each resource are respectively diverging from parity), the niche width value decreases. Conversely, as the proportional contributions of the utilized resources approaches parity the niche width value increases. Thus, the Cree niche width value is indicative of a pronounced reliance on a few subsistence resources for food supply.

With this in mind, we may note that Hardesty's Table II (1975: 76), which gives niche width values for a number of diverse subsistence-oriented human aggregates, is extremely misleading. Such a presentation improperly suggests that these values are somehow comparable. However, since one is not told the total number of resources utilized in each case, such a comparison is invalid. By dividing each niche width value by the respective total number of resources utilized, one obtains Relative Niche Width values, ranging from 0 to 1. Given the variable number of resources used in each case, relative values which would be mathematically comparable would obtain through the following formula:

$$\text{Relative Niche Width} = \frac{1/\sum_{i}^{n} (p_i)^2}{N},$$

where p_i represents the proportional contribution to the total harvest made by resource i, and N equals the total number of resources harvested. Such a procedure is suggested by Whittaker and Levin (1975:169).

It is interesting to note that Hardesty states explicitly (1977:117) that niches, and consequently niche width values, are comparable only when the noted niches "...are part of the same ecological system". Since no two ecological systems are identical, the niche width measurement is suggested (Hardesty 1977:118) to be only applicable with regard to a specific human population and its biotic environment. However, as we have indicated, if there is a change in the number of utilized resources over a given period of time (for example, over a number of seasons or years), then the calculated niche width values for those time periods are not comparable unless converted to values of relative niche width. At this point, it would seem that the Niche Width formula is useless as a comparative device, and that the Relative Niche Width formula is of limited utility. However, this paper has not adopted Hardesty's position that niche width (or, for that matter, relative niche width) is a measurement of a human aggregate's 'realized niche' or total reality. Rather, it is suggested that niche width is a measure of one of a human aggregate's 'partial niches'--specifically, the natural resource 'harvest relationship' between the human aggregate and its biotic environment (hereafter referred to as 'harvest niche'). Since this relationship is autecological in nature, and since niche width measurement has thus far been discussed in terms of this relationship, limiting niche measurement to the context of a specific, natural ecological system, which is itself defined by synecological relations, is logically unnecessary and inappropriate. If such were not the case, any ecological anthropological approach would be, by definition, logically invalid.

Obtained niche width values, or obtained relative niche width values, only 'indicate' possible differences, either between the partial niches ('harvest niches') of two human ecological aggregates, or between temporal variations of a particular partial niche ('harvest niche') of one human ecological aggregate. Such values do not in themselves specify the nature of any difference. To obtain that information it is necessary to examine the empirical data directly, and the resulting proportional harvest contribution tables. In the context of the partial niche 'subsistence on natural resources', whether one is measuring niche width in terms of biomass, calories, protein or some other character, in order that niche comparisons may be meaningful, (1) relative values, and (2) continuous referral to the empirical data and derived tables (Appendices) are necessary.

One other refinement suggested for Hardesty's operational approach concerns itself with the problem of what constitutes a 'significant' resource. Within Hardesty's framework, one is attempting to identify and quantify those factors considered to be important in separating human populations in terms of the occupation of 'distinctive' ecological spaces (Hardesty 1977:116). These factors, depending on their particular characteristics, may be considered to be 'critical' factors, either in terms of 'quantity' contribution (proportional contribution to the total biomass harvest) or in terms of 'quality' contribution to the total harvest (proportional contribution of calories, protein or minerals). Since Hardesty describes 'quality' quantitatively, there is no essential difference between quantity and quality in terms of the niche width formula. Therefore, the following bears equally well to those measures mentioned above, as well as to measures of spatial and temporal variety.

Although Hardesty fails to indicate this clearly, the 'significance' of a given resource in terms of the niche width formula, is determined by its proportional contribution to the total harvest, whether in terms of biomass, calories, protein or any other character that is quantitatively described. In terms of biomass, any resource that contributes more than 2.1% of the total harvest is considered to be a significant contributor in the Niche Width formula. That is, for $p > .021$ for a given resource, one obtains a p^2 value greater than zero. Combining the positive p^2 values obtained through the formula for all utilized resources produces the inverse of the Niche Width value. Thus, any resource whose proportional contribution to the total harvest is less than or equal to 2.1% does not numerically contribute to the Niche Width value. In other words, the formula itself defines 'significance'. This can be very misleading. An examination of Appendix III, which includes a presentation of the proportional contribution of species to the total monthly harvests for the community of Payne Bay, indicates the following. For Payne Bay, in July, one polar bear was captured. In terms of the total food harvested that month (aside from consideration of the year as a whole), the biomass of that bear was not a numerically significant contribution. However, for the hunter who captured that bear, 350 pounds of dressed meat (average edible weight; see Native Harvest Report:1975: 45) represents a substantial meat supply. As well, the skin could be of considerable economic value if not kept for domestic purposes. Further, the social prestige awarded the hunter for being the only one to capture a polar bear in 1976 in Payne Bay is of great social value. These considerations are overlooked by the formulae considered in this paper. Consequently, it must be emphasized that significance of a resource is not merely determined by its proportional contribution to the harvest. This reaffirms the necessity of critically considering the empirical data in ways not addressed by the formulae under discussion.

Measuring Spatial Variety

With regard to the suggestion (Hardesty 1975:77;1977:115) that niche width may be calculated for the spatial distribution of utilized resources, a change in conceptual focus must be noted. This approach categorizes harvested species in different classes of environments, from each of which resources are respectively obtained. The biomass of these harvested species is then taken to be a direct expression of the human aggregate's dependency on these environments. In contrast to the preceding section in which the niche relationship under examination was 'the harvest of identifiable food resources', in this section the relationship is 'the utilization of specified habitats' (these habitats being specified only as sources of food resources). Within the broader framework of the approach adopted in this paper (in contrast to Hardesty's approach), this latter relationship may be considered as an important dimension in linking the niche hyperspace to the habitat hyperspace. This approach, then, is not as concerned with measuring resource variety *per se*, as it is concerned with measuring the variable degree of dependence placed on identified biotopes by a given human ecological aggregate.

The Niche Width formula will provide a value which will represent a human aggregate's variable dependence on specified biotopes for food supply. However, as Hardesty points out (1975:79), such a value is influenced by the 'joint effects' of habitat characteristics and cultural preferences for certain food sources. As habitat characteristics are variable and complex, so too are the motivational factors affecting food preference. In some circumstances, particular habitat characteristics (such as the degree of difficulty in reaching a certain geographical location) may influence the decision to seek out and capture a particular food source. It is suggested then, that some effort must be made to isolate the differential effects of habitat and culture, as well as other factors, in order that some understanding of the complexity of a human aggregate's ecological reality may be achieved. Hardesty's contention (1975:80-81) that it is unnecessary to separate the effects of habitat characteristics and cultural realities is unacceptable.

This refinement in measuring spatial variety will be employed later in connection with the empirical data to be introduced. Consideration of the problem of identifying appropriate habitat units will be necessary at that time. Suffice it to say that the specification of the nature of the habitat units must not go beyond the capabilities of the empirical data. Since human aggregate dependency on particular habitat units as sources of food is only one 'partial niche' relationship, it would be unwise to suggest that this partial niche describes entirely the relationships between a human aggregate and its external habitat. Most certainly, there are other relationships involved, such as providing satisfactory places of residence (whether temporary or permanent). This further suggests the necessity of directly consulting not only the empirically derived subsistence data available, but any other data available, whether ethnographic/ethnohistoric, or biogeophysical in content. Such an approach will be undertaken with regard to the Inuit harvest data.

Measuring Temporal Variety

The same disregard, for isolating the effects of habitat and culture on the ecotopic reality of a particular human aggregate, is observed in Hardesty's (1975) treatment of the temporal variety of subsistence resources. Specifically, a very serious methodological error in the application of the Niche Width formula is committed.

The formula may either (1) measure the proportional contribution of a resource to the total harvest obtained during one specific time period (in other words time is constant), or (2) measure, over a segmented period of time, the proportion of the harvest of a 'particular' and 'singular' resource allotted to each temporal segment (resource is held constant). Hardesty, however, attempts (Table 5; 1975:81) to measure temporal niche width by measuring, at time segment t (month), the proportional contribution made by each resource to the total harvest of the overall time interval T (year). However, as the time segment varies, often so too does the number of resources (N) utilized. As a result, the mathematical procedure suggested by Hardesty is invalid for reasons listed earlier (see Appendix VII). Consequently, use of Hardesty's Niche Width formula to measure the utilization of a given resource or resources is restricted to application 2 of the formula as noted above. Alternate strategies will be suggested later to achieve application 1.

CHAPTER III

TESTING THE THEORETICAL AND METHODOLOGICAL APPROACH

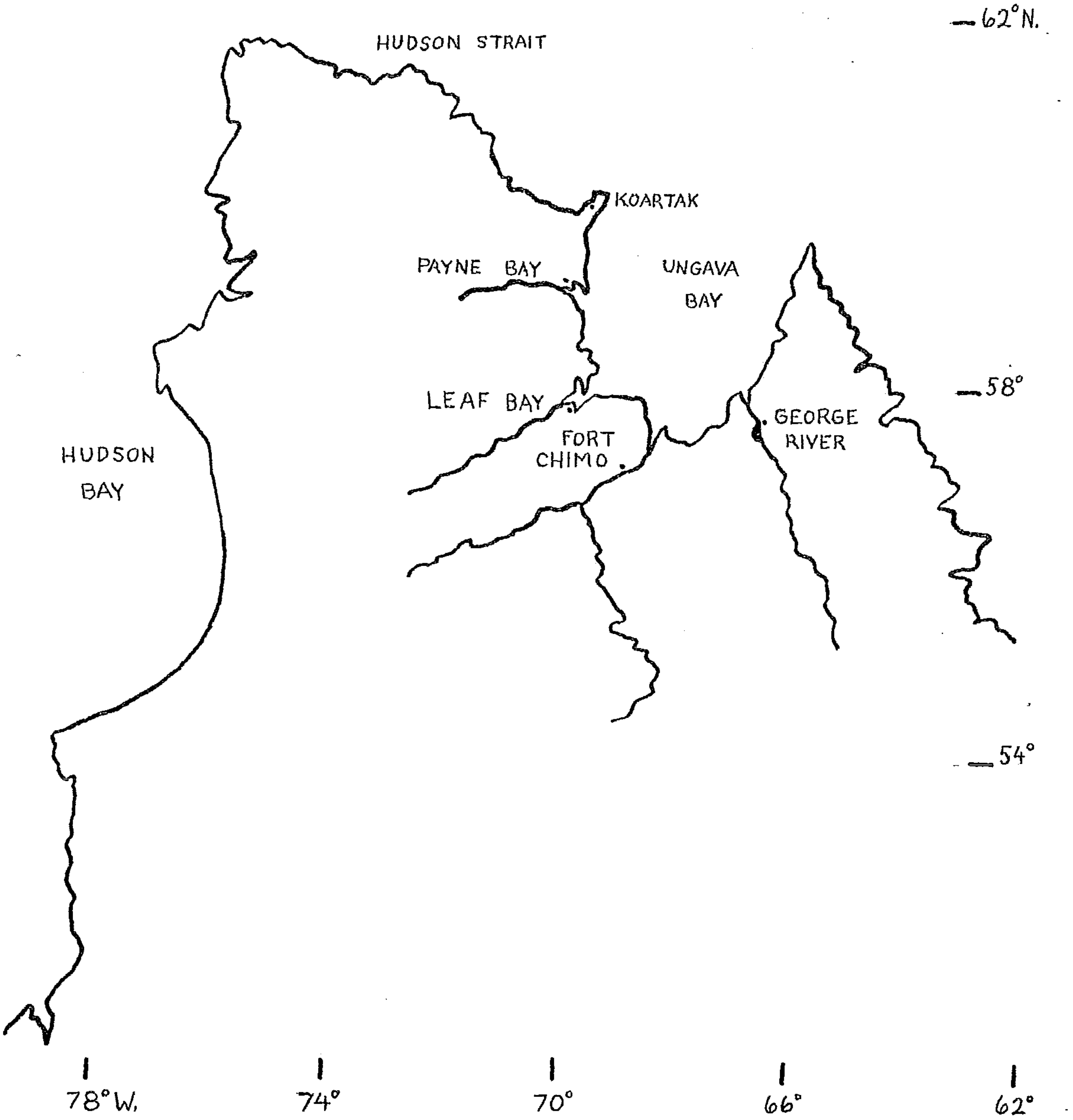
Certain refinements based on theoretical requirements have been suggested with regard to improving Hardesty's approach to ecological anthropology. The 'ecotope' concept has been introduced as a conceptual representation of the ecological circumstance of a human aggregate. Rather than purporting to directly consider a human aggregate's 'realized ecotope' (including its 'realized niche' and 'realized habitat' situations), the approach adopted here suggests that it is necessary to examine increasingly complex 'partial niches' (and, concomitantly, 'partial habitats') in order to ultimately arrive at a consideration of the ecotope of specified human aggregates. The operational method introduced by Hardesty has been refined somewhat to remedy its essentially non-comparative stance, but is also suggested to be, even in the refined stage, of limited scope and utility. To test the theoretical and methodological approach in order to determine its ability to provide significant insight into the ecological circumstance of human aggregates, particular ethnographic and bioecological data have been introduced.

The partial niche directly under consideration may be briefly stated as constituting the 'harvest relationship' existing between given human ecological aggregates and their respective, natural, environmental resources. From earlier discussions it would appear informative to consider this basic relationship as being influenced by at least the following factors, namely (a) those factors affecting harvested species' abundance, distribution and behaviour, (b) those natural factors directly influencing the harvest ability of specified human ecological aggregates, and (c) those socio-cultural factors affecting the harvest ability of those same aggregates. While there are doubtless an almost infinite number of natural and socio-cultural factors influencing the harvest relationship, the attempt to isolate and define the natures of certain recognized factors, and to integrate these into a common system must be made.

THE NATURE OF THE EMPIRICAL DATA

Specifically, the data to be employed pertains to Inuit harvesting in the Ungava region of Northern Quebec. The geographical area under investigation ranges from the territory surrounding the community of Koartak, located on Hudson Strait at the northwest corner of Ungava Bay, south along the west coast of Ungava Bay to the Inuit communities of Payne Bay and Leaf Bay, to the community of George River, located in the southeast quadrant of Ungava Bay. This area may be considered to be approximately bounded within 57° to 60° 30' North Latitude, and 66° to 72° West Longitude (see Map). The empirical harvest data pertaining to the Inuit communities noted above is obtained from the Native Harvest Study presently being conducted

MAP : Northern Quebec and Relevant Inuit Communities (based on NHR 1975:63).



in Northern Quebec by members of the Northern Quebec Inuit Association.

This native harvest study was initiated to determine present levels of native harvesting, in order to negotiate, as part of the James Bay Agreement, guaranteed levels of future harvesting for the Inuit and Cree in northern Quebec (Native Harvest Report 1975:1-2). To collect Inuit harvest data, the Northern Quebec Inuit Association (NQIA) began an extensive investigation of Inuit harvesting, employing native personnel to interview all available hunters to determine household harvests. With the exception of the communities of Povungnituk, Ivujivik and Sugluk, all Inuit communities in northern Quebec (non-native harvests excepted) have participated in this study (NHR 1975:20-21). While the published data (1975) for the harvest periods 1973-1974 and 1974-1975 will be employed to a certain extent, the primary empirical data concerns the 1976 harvests of the communities of Koartak, Payne Bay, Leaf Bay and George River (NHR unpublished; see Appendix One).

To gain greater insight into the nature and significance of the empirical data, this author spent one month in the field (in the communities of Fort Chimo and Payne Bay, Northern Quebec), working under the auspices of the Northern Quebec Inuit Association. Certain problems concerning the collected data pertaining to the two years' harvests preceding 1976 were discussed with some employees of the NQIA. Such problems included: (1) maintaining consistency in interview technique and thoroughness between interviewers, (2) delays incurred by the uncertainty of travel during the interview period, (3) unavailability of some hunters during the interview period, and (4) overestimates of harvests due to improper or misinformed questions, which ignored the natures of group hunting and food sharing (NHR 1975: 19-20,29). These problems were apparently overcome subsequently and therefore do not influence the 1976 harvest data. In fact, interview coverage of hunters rose from approximately 71% of the potential hunters in the 1975 interview period (NHR 1975:24) to over 90% in the 1976 interview period (Lorraine Brooke, pers. comm., June, 1977). While the pre-1976 harvest data were based on informant recall and thus may not be exact, it is believed that the data are accurate considered in respect to orders of magnitude. Since the 1976 is primarily based on calendric diaries, which individual hunters regularly maintain as a record of harvest, it is believed that this harvest data is accurate. As a check, informants were interviewed when the calendars were collected. This author considers the harvest data employed in this text to be accurate, at least in terms of orders of magnitude. This is not intended to be a judgmental reflection on the native harvest data. In terms of this paper, and the methodological approach contained within it, accuracy to within correct orders of magnitude is considered to be the essential significant point.

In the analysis of Inuit harvesting, a number of dimensions of the harvest relationships will be discussed. Among these are: (1) the proportional contribution of species to the harvests of specified time periods (months, seasons, and the year as a whole), as an indicator of the degree and extent of harvest specialization from one community to the next (measured as Niche Width and Relative Niche Width); (2) productivity of harvest, measured primarily as biomass capture per specified time period; (3) percent contribution of species groups to the harvest of specified time periods, as a reflection of the nature and extent of the orientation of Inuit harvesting populations to particular biotopes; and (4) Harvest Niche Overlap, comparing the proportional contributions of species from one community to the next.

Following a presentation of some general features of the landscape, a number of factors influencing the harvest relationship will be discussed. These factors obtain from both the natural and socio-cultural environments. Following the analysis of the data, any significant information derived from the operational approach will be discussed.

General Features: Terrestrial Sub-Arctic

In a most general sense, the climate of the Ungava region is characterized by relatively long, cold winters, and short, cool summers. From the end of spring to the beginning of fall, there are roughly fifty frost-free days (Freuchen and Salomonsen 1958:8-9). Generally, mean daily temperatures range from -20°C. to -30°C. in January to below 10°C. in July (Riches 1973:526). Light intensity fluctuates seasonally, as well as during any given 24-hour period.

This has been suggested to be significant in terms of the cyclical rhythms of living organisms. Due to the low heat budget and short growing season, plants and poikilothermous animals exhibit low growth rates (Dunbar 1968:52). Precipitation, mainly in the form of snowfall, is light, generally not exceeding 20 inches. Lack of water vapour is attributed to the low air temperature, and slight evaporation from frozen seas in winter (Freuchen and Salomonsen 1958:9). Ice break-up in the rivers, under the combined influences of temperature, currents and tides, begins in the southern part of Ungava Bay around the beginning of June. As one moves to the northern part of the bay, break-up occurs roughly two to three weeks later. While expanses of sea ice form during the winter months, the summer sees partial melting and partial break-up of the sea ice along the shore, with large, expansive ice floes the result. At the same time, sheltered bays and fiords usually remain ice-covered into the beginning of summer, while open coastlines, such as those of Hudson Strait, may remain ice-free throughout the greater part of the winter, as a result of the action of winds, currents and tides (Freuchen and Salomonsen 1958:14). Tides in the Hudson Strait-Ungava Bay region have a mean rise of forty feet, with some spring tides reaching sixty feet (Buisson 1952:60).

Due to the influence of prevailing continental westerly winds, which are somewhat moderated by the influence of Hudson Bay, the area enjoys a tundra environment.[14] As a result, the northern extent of discontinuous forest lies to the south of Ungava Bay.

The treeline in the area of present investigation lies near the community of George River, continuing westward about 15 to 20 miles from the coastline, passing approximately 10 miles north of Fort Chimo, and then moving westward and slightly northward roughly as far as the Leaf Bay basin.[15] This discontinuous forest is composed predominantly of cedar and spruce. This discontinuity and irregular extent of the tundra bush is the result of the variable quality of environmental conditions, such that these northern trees are restricted in the main to river valleys, sheltered depressions, and south-facing, well-drained slopes. This transitional zone exhibits an ever-increasing dwarfing influence on trees as one proceeds north, with an evident increase in shrub and heath growth. Freuchen and Salomonsen refer to this (1958:5-6) as a 'subarctic zone'. While the transition from forest to barren-ground (tree-less) regions is not abrupt, a relatively smooth transition from one zone to the other is readily noticeable to the extent of decreasing tree height. This small plant size has been suggested to be an adaptive response to temperature, whereby Arctic plants remain low to utilize 'warmer microclimates that exist near the soil in summer' (Dunbar 1968:52).

The variability of soil quality and distribution (both laterally and in depth) results in overall discontinuous vegetative cover. The result is that, as one moves north away from the treeline, the dominating feature of the landscape is 'bare underground'. As soil character decreases, there is a concomitant increase in the predominance of lichen cover; where the landscape consists solely of solid rock or large boulders, lichen constitutes the only vegetative cover (Freuchen and Salomonsen 1958:9). Lichen mats, ranging throughout the entire area, often cover large areas in a continuous fashion. While overall arctic productivity is low (Dunbar 1968:53), very high lichen production has been noted, particularly in the sub-arctic woodland areas (Banfield and Tener 1958:567-568). Although temperature has been suggested (Freuchen and Salomonsen 1958; Bliss 1962) to be the foremost factor limiting plant production, the variability in soil character (its amount, distribution, and ability to hold nutrients via capillary action), and the amounts of nutrient elements available must also be considered important (Dunbar 1968:53).

The region is an area of Cambrian rock, consisting of slates and limestones, sandstones and igneous rock, with outcrops of granite. Large iron ore beds, as well as deposits of pyrite, mica, graphite and soapstone, are evident (Buisson 1952:63-64). While the interior plateau is relatively flat, varying in elevation from 500 feet to 2000 feet, it is often covered by a series of ridges rising 400 feet to 600 feet above the level surface. Throughout the region are found numerous streams, rivers and lakes, as well as rapids and waterfalls (Buisson 1952:59). The coastline is extremely irregular, with many shore faces of rock being steep and very rugged. Akpatok Island (lying east of Payne Bay), with its 500 square mile area, bordered by horizontal limestone shelves, 600 feet above sea level on 800-foot sheer cliffs, offers nesting facilities for over one million murres. Other animal species are present also (Tuck 1954:66).

Another widespread feature of the Arctic and Sub-Arctic regions is the occurrence of permafrost, or frozen ground (Dunbar 1968:52). With a southern limit roughly corresponding with an annual mean temperature of 23^{0} F., both soil and rock will, to varying depths, be frozen. However, the surface horizon, known as the 'active zone', experiences seasonal thawing and freezing, its depth or thickness being dependent on vegetation or snow cover, direction of slope, or on other factors which prevent heat absorption. The permafrost zone may vary in depth from a few inches to several feet. The primary effect on the landscape is such that neither water nor plant roots may penetrate this zone (Freuchen and Salomonsen 1958:11-12). Some effect on soil formation by permafrost has been suggested (Dunbar 1968:52). Drainage is confined to the active zone, the movement being in a lateral direction. Low-lying and level-surface areas tend to become water-logged and covered by bogs, swamps and lakes (Freuchen and Salomonsen 1958:9,12). Only the more efficiently drained areas experience dryness. A related, thaw-period process, termed solifluction (Freuchen and Salomonsen 1958:12), operates in such a way that the water-soaked active layer of soil tends to move over the permafrost layer in the general direction of slope or water movement. This, in conjunction with rock falls and slides, results in a general leveling of the arctic contour.

General Features: Marine Sub-Arctic

The Ungava Bay-Hudson Strait marine region constitutes part of what may be termed the 'Marine Subarctic' zone (Dunbar 1968: 44; see Figure 10). It is definitionally distinguishable as that area composed of mixed Arctic and non-Arctic (Atlantic Drift) waters (Dunbar 1968:42). Arctic waters are stratified into stabilized layers which do not mix, due to marked density differences; as a result, nutrient supply to surface layers is both small and slow in delivery. Hence, planktonic production is generally low throughout the year, although such productivity oscillates with temperature and light fluctuations at particular times of the year (summer), and at particular places where mixing of the water column takes place (Dunbar 1968:39-41).

In contrast, the Marine Subarctic enjoys the benefit of a phenomenon known as 'Arctic Convergence'(Dunbar 1968:42-43), whereby northward moving Atlantic water is slowly cooled to the point where its density has sufficiently increased (allowing for varying salinities) to allow ready mixing with arctic waters. As a result, the entire mixed zone becomes quite unstable, allowing significant vertical exchange to occur. This vertical exchange draws nutrients up to the surface layers, thus increasing planktonic production dramatically. This nutrient supply is further supplemented in those particular areas where rivers, hastened by the joint action of spring melt waters and tidal forces, enter the Ungava Bay-Hudson Strait area (Bursa 1955:5). As well as summer plankton production, Dunbar notes (1968:49-50) that some algal growth occurs on the underside of the floating ice during the late winter/early spring period, apparently in response to low intensity blue light.

To conclude, an overall comparison of the Marine Arctic and Marine Subarctic waters yields the following descriptive characteristics of the waters of the Ungava Bay-Hudson Strait Marine Subarctic system. They are: (1) the area waters enjoy warmer temperatures than those of the Arctic; (2) there is less vertical stability both in summer and winter, thus making possible a second planktonic bloom in autumn; (3) there is less ice cover; (4) greater variety of fauna and flora is evident; (5) greater organic production (standing crop/unit area) is evident; (6) less seasonal oscillation in both standing crop and most environmental factors, with the exception of temperature, has been noted; and (7) a greater sensitivity to marine climatic change is generally observed (Dunbar 1968:43-48).

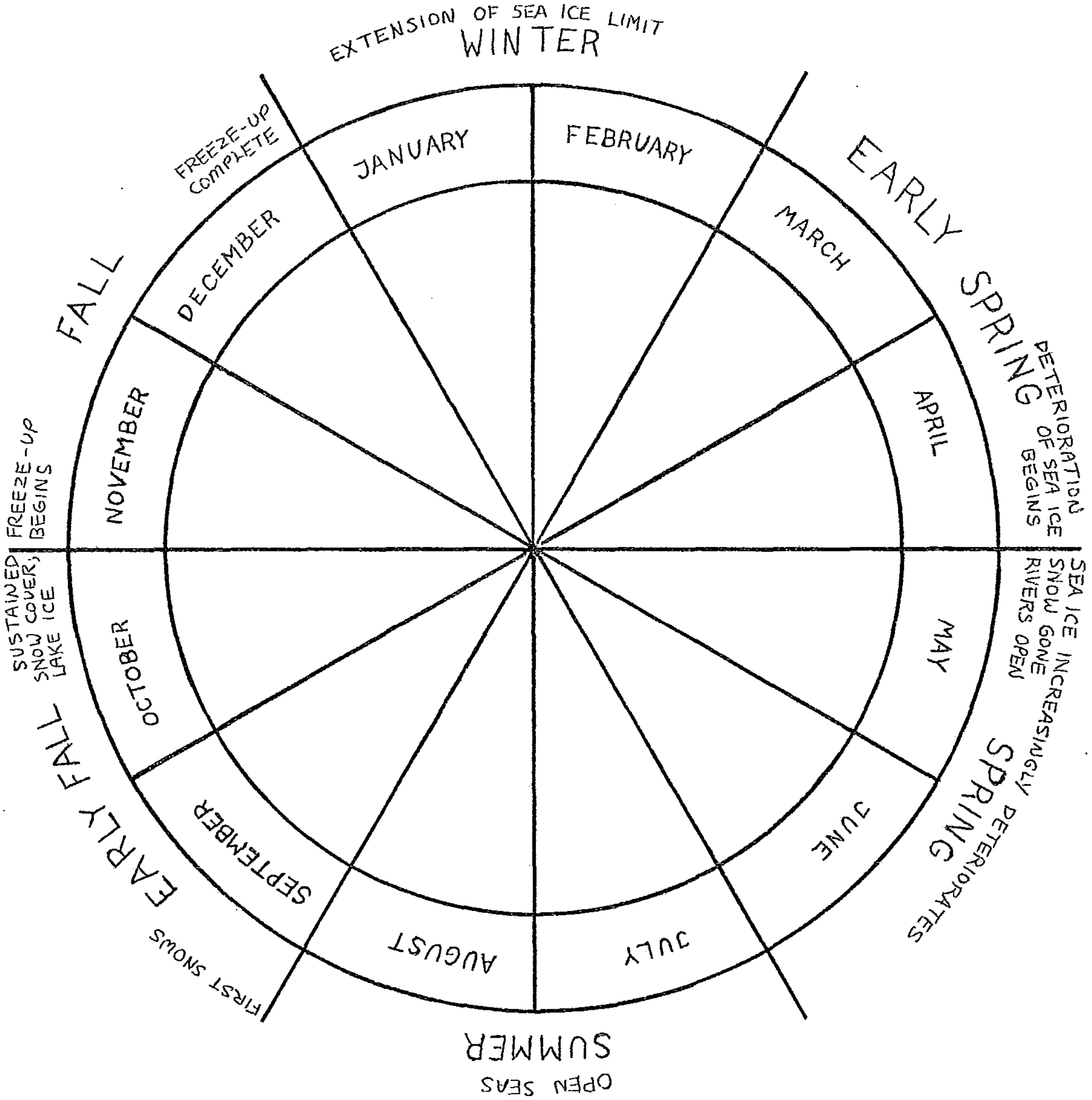
General Features: Freshwater Lakes and Rivers

Lake and river productivity apparently is influenced by depth, climate, nutrient supply, age and the geological and botanical nature of the land comprising the respective watersheds. Shallow lakes tend to be more productive than deeper lakes due to a greater ease of mixing and, hence, nutrient return to the surface. Similarly, the action of rapids, falls and swift currents, in conjunction with tidal behaviour, aid in supplying the surface layers with necessary nutrient elements. As in the subarctic terrestrial setting, nutrient supply is suggested to be the critical limiting factor in the productive process (Dunbar 1968:54-55). While arctic lakes are considered to be 'extremely oligotrophic'(low food producers), certain of these lakes have exhibited substantial crops of insect larvae and small crustacea (Dunbar 1968:54).

A Capsule of the Seasonal Round

Given that the arctic year is sub-divided by the Inuit into six seasons as noted by Brody (1976:204), the duration of any particular season is observed (NHR 1975:57-58,75) to vary by one or two weeks from year to year, and from location to location (depending on relative northerly position). As a guide to the seasons of the Ungava Bay region, the summer season is recognized to generally include the months of July and August (see Figure II). The summer season is graced with open waters and mild temperatures. In early fall the first snow appears, with continuous cover by mid-October. Concomitantly, the freshwater courses are frozen. Freeze-up of the sea begins in November with extensive freeze-up complete by the end of December. Through the winter months of January and February and into March the sea ice areas expand. By April the recession of winter begins with the seaward extension of the sea ice becoming progressively less and melting also occurring, until from the end of May to the middle of June, the ice becomes very unstable and dangerous. At the same time, the snow has all but disappeared on land, and the major rivers are now open, causing further deterioration of the sea ice near the

Figure II: Representation of Seasonal Round*



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*Based on Brody 1975:204; NHR 1975:57-60.

river mouths (NHR 1975:58-60).

General History of Ungava: Demography and Development

Due in part to a social pattern based on nomadic, local bands, early nineteenth century Inuit contacts with white visitors (from whalers or exploratory parties) were sporadic. Following the establishment of Hudson's Bay Company trading posts in Payne Bay, Fort Chimo and George River, contact with traders, missionaries and surveyors became more frequent. Willmott notes (1968:153) that developing Inuit dependence on the fur trader led to (1) the establishment of individual, permanent traplines, which in turn (2) stabilized band camps in terms of membership and location (in relation to the trading posts).

Before the whaling industry declined, the Hudson's Bay Company, in consideration of the fact that the fur trade industry in the Ungava Bay area was rather disappointing in returns, decided to expand the nature of the exploitative relationship, instituting in the 1880s commercial harvest operations for beluga whale, and for salmon and arctic char. The Koksoak, George and Whale rivers were the focus for these operations (Jenness 1968:137-138). By the turn of the century the beluga fishery had ceased, with fishing operations following suit, ending by 1930. In both cases, the decline of the harvest was almost immediate, the cause being attributed to insufficiently large, species' populations. As the commercial fisheries declined and stopped, and as the fur harvest lessened, many Inuit found it necessary to move to the settlements in search of relief. By sharing the food of relatives who were employed in the settlements, many Inuit families were able to manage through poor harvest periods (Willmott 1968:153). Within the limitations imposed by permanent traplines, camp nomadism became a common practice, the camps becoming established at distances from five to fifty miles from the settlements. Living in snow houses in winter and tents in the summer, the Inuit would make occasional trips to the settlements to trade furs, replenish supplies and possibly attend church ceremonies. This lifestyle, varying from times of plenty to times of severe deprivation, was common up until the late 1950s (Riches 1973:526).

In response to the general 'material and psychological depression' of the Ungava Bay region, the federal government instituted in the early 1960s a regional development scheme based on the recommendations of earlier Area Economic Surveys. Somewhat reminiscent of the Hudson's Bay Company's earlier scheme, the government based its programme on the diversification of the trading economy. This programme, however, involved not only expanding commercial harvesting to include a number of harvest resources, but also involved developing an exchange network between northern communities, rather than basing such an economy entirely on the southern market (Riches 1973:526).

For a variety of reasons many of these development projects failed to succeed. Overall, such failure seems to have obtained through government policy inconsistency. The programme suggested that particular villages might start commercial operations specialized on those resources, of which they had a harvestable quantity greater than local needs, which could supply the needs of other Ungava Bay communities. A lumber operation was, for instance, started in George River, the demand for such products being generated by those communities above the tree-line. Specifically, Port Burwell was named as a particular market for this product, with that community exchanging seal meat to be used for sled dog food. However, the government decided shortly afterward to subsidize the construction of homes prefabricated in southern Canada. This relieved the need for northern lumber and effectively destroyed the George River industry. As well, with the widespread acquisition of snowmobiles as a replacement for sled dogs, the market for seal meat was eliminated. Such situations, combined with frequent overestimates of resource commercial quality and the occasional lack of interest in particular enterprises expressed by some Inuit (e.g., Payne Bay eider down industry; see Jenness 1968:139), resulted in little economic development (Riches 1973:526).

Riches perceives (1973:526) three types of economy manifested in the Ungava Bay region, namely (1) wage labour economy, (2) rural welfare, and (3) rural industrial. While communities may not be characterized completely as manifesting one particular type, due to the employment variations within and between families, it may be possible to at least indicate some variation in economic self-sufficiency (in the sense of freedom from reliance on welfare relief). While the communities of Koartak, Payne Bay, Leaf Bay and George River all live in oil-heated prefabricated houses, are serviced with airstrips (or other form of air service), water, sewage and refuse removal, have teaching and nursing services, and one or more government administrative buildings (the latter all with southern Canadian personnel), the opportunities for wage employment are for the most part restricted to maintenance functions, which require only limited personnel. Employment with the Hudson's Bay Company is offered a few in the communities of Payne Bay and George River. Diamond Jenness notes (1968:146-47) that present Hudson's Bay Company establishments are more like 'general stores', presently deriving greater profit in general merchandise than from fur pelts. For a few others employment is available in Co-operative management, and in those few commercial enterprises (crafts, fishing, and the operation of sports hunting and fishing lodges where existent) operating to one degree or another in selected communities (Arbess 1967; Prattis 1973). Generally, as the opportunities for wage employment vary, so inversely does the demand for some form of welfare assistance.

Specifically, Koartak has a permanent government employee and one nurse, Payne Bay a Hudson's Bay Company store, two government employees, and one nurse, Leaf Bay one government employee, and George River a Hudson's Bay Company store, two government employees, two nurses, and a permanent church (Brody 1976: see Appendix). Facilities, and the maintenance staff requirements, vary with these conditioning factors. In terms of population figures, the communities of Koartak, Payne Bay, Leaf Bay and George River, respectively, have Inuit populations of 124, 218, 89 and 286, with, respectively, 31, 41, 17 and 53 hunters (1976 Native Harvest Data:unpublished).

FACTORS AFFECTING THE HARVEST RELATIONSHIP

It is posited that the manifestation of the Inuit harvest relationship, in terms of diversity and quantity of harvest, is a product of the influences of (a) natural factors affecting species' abundance and behaviour, (b) natural factors affecting the harvest ability of the Inuit populations, and (c) socio-cultural factors affecting the harvesting performance of those same Inuit populations. Natural factors affecting species' abundance and behaviour, and catchability shall be considered in the context of particular animal species. Subsequently, socio-cultural factors will be reviewed.

Natural Factors: A Review by Species

Caribou--One of the major animal resources of the Ungava Inuit is the Ungava Caribou (Rangifer caboti). Earliest observations of caribou by southern researchers dates to Low's survey travels of 1897, when it was noted that there were three identifiable caribou herds. A western herd was noted to frequent the Richmond Gulf-Clearwater Lake area in winter, migrating in summer to the highlands of the northeast coast of Hudson Bay. A central herd, from the Larch River area, crossing the lower Koksoak River on its spring trek northward, was observed to spend the summer in the Hudson Strait-west Ungava Bay area. An eastern herd, known to winter south and east of Lake Michikamau around the Canairitok River in Labrador, was observed on the summer plateau ranges east of George River between the Slanting and Ford Rivers (Banfield and Tener 1958:561, 565). Elton's investigations in 1942 apparently corroborate these earlier reports, even though frequent exchanges of individuals between herds were noted (Banfield and Tener 1958:561).

Research from the late 1940s onwards (Rousseau 1947-48;Dunbar 1950; Banfield 1954; Banfield and Tener 1958) indicates the following conditions prevailing during that period. Very few caribou were sighted (through overland and aerial surveys) for the entire area during the summer months, with small herds being reported in the winter months south in the taiga zone (Banfield and Tener 1958:563,565-566). Caribou were noted to have been particularly absent for a number of years north of Payne Bay (1958:565). Information obtained from interviews with the George River Inuit indicated "excessive utilization and continued caribou decline" (1958:562). The eastern herd was noted as being numerically the strongest population. For all three herds, it was noted that long migrations were no longer practiced, indicating that the herds were not large enough to cause over-utilization of tundra-taiga ranges (1958:565-566), and therefore, as scattered groups, practiced local wandering (Banfield 1954:18). The total population of the Ungava caribou was estimated to be at that time around 6000 (Banfield and Tener 1958:564). Banfield suggests

(1954:31) that the introduction of firearms and the fur industry are the primary causes of the diminution of the Ungava caribou herds. These factors, it is suggested, may act in conjunction with the natural, cyclical fluctuations of species' population size.

Nevertheless, present investigations (see NHR 1975:115) seem to suggest much larger herds (the total population approaching 100,000), and the reestablishment of migratory patterns of behaviour. Furthermore, rather than three main herds as noted for earlier periods, it appears now (NHR 1975:115) there are four sub-populations: the North Shore (or Western) herd, the George River herd, and the Leaf River and Caniapiscau-Bienville herds (which are possibly from the original Central herd). As the Native Harvest Report notes (1975:115), the George River herd (approximately 45,000 in number) and the Leaf River herd (approximate population 20,000 to 25,000) are the most important herds of the Inuit, with most hunting occurring during the winter when travel is easier and the cold preserves the meat. While the wintering grounds extend over the southern areas from central Labrador to the region south of Fort Chimo, concentrations of wintering caribou have been observed near most communities on Ungava Bay (NHR 1975:115). The Leaf Bay herd is thought to winter west of Fort Chimo towards Hudson Bay (1975:116).

Banfield's research (1954) on the Barren-ground Caribou (Rangifer arcticus) of the N.W.T. provides the basic features of caribou migratory behaviour and resource requirements. The time and duration of the spring migration from taiga to tundra is dependent on (1) the severity of the preceding winter, and, concomitantly, on (2) the distance penetrated into the taiga during the winter months. Generally, though, spring migrations begin during April and May, with the cows and bulls segregated into separate herds. By July this migration has ended, and the herds have reached the northern limit of their tundra travels. Mid-summer migration, following calving, involves a general retracing of earlier routes back towards the treeline. By the end of August, the herds are to be found on the tundra bordering the treeline. Though the populations are scattered, they are not segregated at this time. In September, the herds regroup, turn north and retrace the spring migration routes on the tundra, but do not penetrate as far north as during the spring migration. Rutting occurs after the impetus of this movement in October or early November, and, following the first snows, migration south to the winter feeding ranges begins (NHR 1975:21-25).

The routes taken are necessarily dependent on the location of the summer and winter feeding ranges. However, such other factors as local topography, burnt areas, overgrazed or unproductive areas, and excessive hunting have an equally significant effect on routes taken and ranges grazed (NHR 1975:20). As a result, the routes taken may vary somewhat from year to year, although all herd members, whether in a compact mass or scattered, follow the same general movement patterns (NHR 1975:18). Between large herds may be found small groups or bands or caribou, which fluctuate in number and size as they disengage from and re-enter nearby herds. The greater part of the ranges are occupied by such bands which, due to their small size and relatively low food requirements (in contrast to large herds which must constantly move in order to guarantee themselves sufficient forage), practice a more localized foraging movement (NHR 1975:18).

Range studies indicate several more detailed environmental factors which influence caribou choice of ranges and routes. Throughout the Ungava tundra zone, large expanses exhibit a continuous lichen carpet. Investigations show that those lichens preferred by caribou "...are common in occurrence and dense in coverage" (Banfield and Tener 1958:567-568). In fact, according to Banfield and Tener (1958: 567), some researchers have concluded that, primarily as a result of earlier low caribou population figures, the lichen production in the areas within the treeline are unsurpassed throughout North America and Europe. Apparently then, forage in Ungava is not a critical limiting factor. However, such factors as (1) hardpacked snow-cover in the tundra areas, which inhibits foraging, (2) man-made or natural tundra fires, which are so destructive as to require 30 years to restore the lichen carpet (1958:568-569), (3) the occurrence and distribution of predator species (1958:570), (4) native utilization patterns (1958:572), and (5) the effects of previous overgrazing of preferred plants, and general trampling, both of which influence the rate of lichen recovery (Wielgolaski 1975:197,204), all affect caribou behaviour and distribution. All must be considered by the successful hunting strategist.

Seals - There are a number of seal species common to the Ungava Bay region: specifically Ringed Seal (Pusa hispida), Bearded Seal (Erignathus barbatus), Harbour Seal (Phoca vitulina), and the Harp Seal (Pagophilus groenlandicus). The first three of these pinnipeds are year-round residents, while the fourth is a migrant (Mansfield, Sergeant and Smith 1975:1-8). The Hooded Seal, another migrant, is relatively rare in this area (Freuchen and Salomonsen 1958:167).

The Ringed Seal, the most abundant and widely distributed of the pinnipeds (Mansfield, Sergeant and Smith 1975:1), spends the winter months along ice-covered coastal regions, preferring open pools in thick pack ice (Freuchen and Salomonsen 1958:36) or tidal cracks along the coast (1958:368). The pack ice, with its rough, uneven surface, affords blow-holes almost complete protection from bears and hunters, forcing both to hunt at the floe-edge where numbers of ringed seal are less abundant (Freuchen and Salomonsen 1958:36-37).

Generally, the ringed seal moves towards and away from the land according to the behaviour of the ice (Dunbar 1949:11). The amount of land-fast ice and its stability are of particular importance to the ringed seal. The amount and stability are both apparently governed by the coastal configuration (McLaren 1955:34). Remaining near shore, seal dispersal apparently directs itself from the more complex coast of high seal productivity to those of less potential productivity (McLaren 1955:35).

The ringed seal is not a gregarious animal (Dunbar 1949:11), breeding solitarily on land-fast ice which has a heavy snow cover in which to build birth lairs (McLaren 1958:170-71; Freuchen and Salomonsen 1958:370). Since the ringed seal has poor eyesight but excellent hearing (Freuchen and Salomonsen 1958:165), one may suppose that the females prefer snow cover in order to hear any approach of danger. There is a decline in feeding activity during this spring breeding period, followed by a period of solitary basking through May, June and July as moulting progresses (McLaren 1958:8). If the wind picks up, they become nervous and return to the water (Freuchen and Salomonsen 1958:165). Prior to the summer plankton blooms, on which they fatten, all seal species, feeding through the winter on fish (Freuchen and Salomonsen 1958:368), become quite lean and, when shot, sink rapidly (1958:273); such losses in hunting are sometimes high. Preferred summer foods for ringed seal are the larger planktonic crustaceans, molluscs, and squids (1958:275).

The Bearded Seal, although widely distributed as well, is much less abundant than the ringed seal, the ratio of bearded seal to ringed seal being slightly higher than 1:3 according to Dunbar (1949:18), although the Native Harvest Report (1975:86) suggests the ratio to be in the order of 1:5. While being common throughout Ungava Bay (Dunbar 1949:18), it seems restricted to feeding areas of high benthic productivity (Mansfield, Sergeant and Smith 1975:5).

Its occasional absence from certain of these areas suggests some summer movement of moderate distance, whether or not it is casual and unorganized as Dunbar (1949:18) suggests. The winter months are generally spent in open water near the coasts (Freuchen and Salomonsen 1958: 368), sharing blow-holes with ringed seal (1958:274), but breeding in herds on pack ice near such open water (McLaren 1958:170). Some association with moving pack ice is noted (NHR 1975:89). It is an extremely nervous animal (Freuchen and Salomonsen 1958:276), with excellent eyesight compensating for its poor hearing (1958:165). While exhibiting the same decline in feeding in spring as does the ringed seal, bearded seal do not bask as frequently, and, when doing so, prefer snow-free ice (McLaren 1958:8). Bearded seals are often observed where thereare walrus, indicative of similar food preferences (Freuchen and Salomonsen 1958:274-275).

The Harbour Seal, the remaining resident to be discussed, occurs only in small numbers and in restricted localities in the Ungava Bay region (Dunbar 1949:9; Mansfield 1967:249). While remaining essentially an animal of open water (Freuchen and Salmonsen 1958: 38), it is known to spend winters in localized coastal areas exhibiting fast currents, rip-tides, zones of upwelling and river estuaries that remain ice-free (Mansfield 1967:249). As well, extensive populations are found during the summer months in freshwater, invading estuaries, rivers and lakes (Freuchen and Salomonsen 1958:402; Mansfield 1967:249; Mansfiekd, Sergeant and Smith 1975:7). This species does not apparently maintain or frequent blow-holes in fast ice, and breeds on land (Mansfield 1967:249). This, and the fact that this species commonly restricts itself to localized areas and bounded freshwater, makes it an easy target for the Inuit. Consequently, it has been eliminated from some local territories (Mansfield 1967:252).

The Harp Seal attends the Newfoundland ice-fields in spring, bearing pups in February and March (Mansfield, Sergeant and Smith 1975:8), rutting and moulting in April; no feeding is undertaken during this period. The migration north begins in April, those entering Ungava Bay arriving in May (Freuchen and Salomonsen 1958: 165-66). Even more so than the harbour seal, harp seals keep to open water, maintaining a distance from continuous ice-fields (1958:38). Hunting must often be accomplished by boat, and losses in the early part of the year are high due to the lack of blubber (1958:273). Although primarily a fish-eater (1958:166), the diet of the harp seal is much like that of all other marine mammals in the area. Certain food preferences, variously exhibited by each, minimize potential competition (1958:275).

It is noted (NHR 1975:69) that marine mammal hunting is carried on at the floe edge in winter and on open water in summer and early fall. In this context, McLaren notes (1961:1-4) that weather is one of the most important variables determining the availability of seals for harvest. Particularly, McLaren suggests that winds greater than 5 m.p.h. hamper seal hunting because, as mentioned earlier, certain seals are annoyed and frightened by strong winds and return to the water for safety. These waters are, to one degree or another, turbulent from wind action, thereby reducing the hunter's visibility, and thus hampering his aim. McLaren further indicates that, by correlating wind velocity with the number of daylight hours, one may get a relatively accurate picture of the number of days of suitable hunting weather per time period (McLaren used the open water season; the following refers to this period). While considerable year to year variation is noted, the figures suggest that fewer than 20% of the time (measured as hunting days) in summer, and less than 10% of the time in the early fall, is suitable for hunting due to the weather.

Walrus - Walrus (Odobenus rosmarus) are neither migratory nor sedentary mammals (Dunbar 1949:5); rather, they are observed to carry out seasonal movements in response to feeding site quality, and sea, ice and wind conditions (Kleinenberg 1959:2; Loughrey 1959: 10). With their principal food being molluscs (Freuchen and Salomonsen 1958:274), walrus are observed in scattered groups in Ungava Bay, carrying out casual movement. It is noted (Nikulin 1957:3-4; Mansfield 1973:71) that, between feeding excursions, walrus are often in herds on drifting ice, provided that such ice is not dispersed by wind and current, at which point they 'haul out' on prominent headlands and small islands. During strong onshore winds and in heavy seas, they frequent more sheltered areas. Unlike many other pinnipeds, walrus cannot maintain themselves for long periods in water, requiring frequent resting periods either on land or on ice (Nikulin 1957:3). As in seal hunting, there is a decline in walrus hunting in winter, due to the shortness of the days, with a revival of such activity beginning as early as late January (Grainger 1955:1).

Whale - The Beluga or White Whale (Delphinapterus leucas) is reportedly a shallow water, coastal animal, enjoying estuarine environments where it feeds on shoals of fish (Sergeant 1955:16; 1962:3; Mansfield, Sergeant and Smith 1975:14). In the Ungava Bay-Hudson Strait region, belugas are not numerous, with irregular variation in population size from year to year (Sergeant 1962:3). Due to insufficiency of food supply during the winter, belugas migrate into this sub-arctic region beginning April, leaving around the end of November. They are not usually sighted near rivers until after break-up (Sergeant 1962:16). Some belugas are known to congregate in July and August in quiet coastal waters and river estuaries of southern Ungava Bay (NHR 1975:98). It has been suggested that some beluga herds winter in Hudson Strait and elsewhere, where tide currents and wind action maintain open water (Sergeant 1962:6). However, as Sergeant cautions (1955:16), while autumnal migration seems to be a constant feature, the time and nature of spring movements is rather unclear.

Polar Bear - Polar Bears (Ursus maritimus) are solitary hunters, being active for most of the year. In the winter months, they are relatively inactive, fasting and exhibiting sleeping patterns similar to hibernation. By February, the males become more active when the light improves, while the females, still in their lairs, give birth to cubs. From March to November, polar bear are more common, engaging for the most part in seal hunting (Freuchen and Salomonsen 1958:36,82,91-92,95).

Land Mammals - With the exception of the caribou, all other land mammals are considered as being permanent residents in the Ungava Bay district. Wolf, arctic fox, red fox, arctic hare, lemming, weasels, otter, black bear and porcupine are common to somewhat localized areas within the Ungava Bay-Hudson Strait region considered here. Some of these animals may exhibit some degree of wandering, while others are essentially sedentary. The population size for many species varies in a cyclical fashion, with many such cycles being interdependent.

Birds - Of the over twenty species of birds common to this sub-arctic region, only murres, guillemots, ravens, ptarmigan and snowy owls are permanent residents (Freuchen and Salomonsen 1958:61). All others, ranging from geese (Snow Geese and Canada Geese), to ducks (Eider, Black,Pintail and Canvasback), to Loons, Terns, and Gulls, to Grouse and Partridge, as well as the odd songbird, migrate to this region in spring. Egg laying primarily occurs during the period from the last week of May to the first week of June (Freuchen and Salomonsen 1958:208). Some nest within the treeline, some in the willows found frequently on the tundra, some on isolated islands, and others on secluded and generally inaccessible breeding grounds--

all selected as a defense against particular predators (Hanson and Currie 1957:228).

Murres seek nesting sites on cliff areas, the major nesting areas in Ungava being on Akpatok Island, where colonies totalling over one million birds are found. Egg loss by falls, slides, gull and fox predation amounts to at least 50% (Tuck 1954:153-54). While the murres winter in Hudson Strait, where open water may be found, they do not leave the sub-arctic zone (Tuck 1954:92,95). Guillemots, since they do not require open water to the same extent that murres require it (murres cannot take flight from ice; Freuchen and Salomonsen 1958:42), remain in the sub-arctic where open water is available locally. While many birds are hunted by the Inuit, many hunters take time to commonly gather eggs from various species, particularly geese, ducks and gulls. Tuck notes (1954:225) that murre eggs, for instance, are very high in caloric content (apparently greater than beef, poultry meat and whole cow's milk), and in addition contain carotene (apparently not found in poultry eggs).

Fish - For the Ungava Bay region, the most important fish is Arctic Char (Salvelinus alpinus), which migrates to the sea in May, spending its time usually in the river estuaries where phytoplankton production is high and capelin are numerous (Freuchen and Salomonsen 1958:170). July and August are the months noted for the char's return to the lakes (1958:294). Salmon follow the same basic pattern (1958:319). Significant numbers of the arctic char do not engage in this migratory pattern, electing to remain in the lakes (1958:170).

Other species captured include cod, whitefish, brook trout and sculpin.

Summation - Natural Factors Affecting Harvesting

Obviously the hunter-gatherer must be knowledgeable of the behaviour of the harvested species. To understand those behaviours, the hunter-gatherer must understand what natural forces exert influence on those species and what preferences (for food or natural features of the landscape) they exhibit. As well, the hunter must have knowledge of how particular species sense danger and react to it, in order that he may hunt the species without arousing any fear in the animal. In other words, the hunter-gatherer needs not only to know the particular 'life-styles' of the animals he stalks, but also their particular 'strategies for survival'. Without such knowledge, the hunter's chances of success are small.

It is therefore necessary for the Inuit hunter to understand and know species' preferences for food (for instance, the caribou's preference for certain lichen species leads the caribou to those areas where that lichen is abundant, both on a macro- and micro-environmental scale), certain types of ice and certain degrees of snow cover, as well as the effect on behaviour of temperature above snow cover, the form and distribution of certain kinds of snow, the location of breeding grounds, the number of daylight hours (for instance, the polar bear has difficulty seeing during the dark winter months, and therefore sleeps until there is sufficient light to see clearly), and wind or weather conditions (if the weather is unfavourable for seal hunting, the hunter may alternatively choose to hunt land mammals). To maximize success, the hunter must search for his prey where natural conditions (1) encourage the species' occurrence, and (2) facilitate harvesting the species.

Socio-cultural Factors Affecting Harvesting

As well as natural factors affecting the harvest relationship of Inuit populations, there are socio-cultural factors. In order to identify these factors, one may ask: what are the motivations inducing the Inuit to hunt, trap and gather? Following, how do these factors affect the Inuit harvest relationship?

In the first instance, it must be noted that hunting and gathering is not merely a means of subsistence, but a way of life in the broadest sense of the term, permeating and giving significance to the Inuit world of today. As Brody indicates (1976:223,226), while the Inuit perceive the passing of the traditional way of life (i.e., primarily subsistence) in the face of increasing involvement in a wage-labour economy, the hunting and gathering experience is no less respected and valued. While wage employment may vary from temporary or seasonal to full-time activity, it is mainly perceived by the Inuit as a means of supporting their activities on the land (NHR 1975: 56-57).

At the same time, wage employment may be seen to influence the harvest relationship in a number of ways. Some wage employment requires the individual to work steady hours, while others allow variable degrees of freedom in work schedules. While certain employment opportunities effectively restrict individuals to the settlement proper (and a few square miles immediately surrounding the settlement), other activities such as commercial fishing allow more frequent harvest alternatives over a somewhat greater geographical area. The variability in time available for harvesting thus varies greatly from one individual to another. This, combined with the effects of variable earnings used to purchase harvest equipment (which will in turn vary with price), widely affects the harvest relationships and harvest effectiveness of individuals. In terms of exported products (e.g., fish, furs), Foote notes (1967:268) the affect of market pressures and demand fluctuations on harvest earnings.

The increasing acquisition, maintenance and eventual dependence on products of southern technology (e.g., nylon nets, rifles and shotguns, hand-fishing equipment, canoes with outboard motors, and snowmobiles) incur high capital expenditures, which increasingly cannot be supported solely on the basis of subsistence-generated income. (Foote 1967:267; Usher 1971:95-102). Thus, while hunting remains an important facet of Inuit life, the complexity of this relationship has increased with growing involvement in the southern economy (NHR 1975:56-57). As a result, there exists an increasing inequality in the ownership of equipment, as one considers the variable cash incomes of individuals, ranging from those primarily supported by welfare to those wage-employed on a full-time basis. Alternatively, as people are less involved in a wage-based economy, they enjoy a greater possible time allotment in which to engage in subsistence activities. Hence, subsistence productivity, in the sense of animal capture(or biomass acquisition), varies from one individual to the next, and, therefore, from one community to the next, depending not only on the allotment of time for subsistence activity, but as well on the quantity and quality of subsistence-oriented equipment owned. These factors must be recognized as being significant when considering the variable harvests of the different Inuit communities.

In point of fact, Usher notes (1972:173-80) that the introduction of the snowmobile has had a profound influence on the Banks Island Inuit subsistence practices and home life patterns. The following appears to hold for the Ungava Inuit as well. While early models of snowmobiles were found to be unreliable and necessitated, as a result, the continued maintenance of dog teams (which greatly increased hunting costs), more modern models were found to be more reliable, lasting two seasons before the need for replacement arose. As a result, dog teams were gradually replaced by the snowmobile. In terms of trapping, it was observed that the snowmobile's increased speed (over dogs) allowed for a greater number of trips and trap checks, thus allowing potentially increased productivity and reduced losses. In poor harvest years, the snowmobile allowed the hunter to operate longer traplines, particularly in spring, and exploit greater territories of land if necessary. Thus, while the costs of trapping are increased, the higher productivity is usually found to compensate adequately. However, it is observed that the change to mechanization is not effected to increase productivity per se; rather, it appears to have been implemented as a means of increasing the amount of available time spent in home-life or community-oriented activities (such as inter-community travel to visit friends and relatives). As Usher notes (1972:178), the Inuit appear

> ...willing to forgo economic returns, or even engage in unprofitable activities, for the sake of convenience, leisure, or recreational enjoyment, to a limited degree at least.

It would appear that motorized freighter canoes play a similar role in Inuit life.

Considering actual harvest tools, the following may be informative. Balikci notes (1964:89-92) that the increased hunting emphasis on guns and rifles by the Povungnituk Inuit has led to the following adaptive responses. In terms of caribou hunting, the trend has been the rejection of co-operative hunting and the adoption of individualized hunting techniques. In turn, with increased productivity and greater mobility, an inland adaptation for winter caribou hunting developed. Traditionally, the winter focus has been on the marine environment. As well, one may note that the necessity for following caribou drives on selected migratory routes has been removed, as a result of the high degree of accuracy and killing potential of the high-powered rifle. The necessity for seasonal selection of harvestable resources on the basis of particular natural factors was thus somewhat obviated, such that the opportunity for carrying out year-round caribou hunting is now available. Similarly, the acquisition of shotguns and small calibre rifles has stimulated considerable wildfowl hunting (Balikci 1964:90). Thus, the potential for harvesting a number of varied resources has materialized. Individualized hunting techniques are similarly reinforced. In both caribou hunting and wildfowl harvesting, the trend to individualized hunting techniques is suggested to arise principally as a result of the simplification of hunting activities (firearms, by increasing the ease of animal capture, has obviated the need for complicated hunting practices and comprehensive hunting knowledge). The use of fishing nets and tackle-line have also led to individualized hunting effort (in terms of single family activity).

In terms of marine mammal hunting (with the possible exception of polar bear hunting), the trend of hunting technique development has been towards collective activity (Balikci 1964:89). The difficult practice of blow-hole hunting has been, for the most part, abandoned for the easier ice-edge hunting technique. While spring ice hunting remains largely individualized in effort, summer seal hunting has become an increasingly collective effort, due to the particular requirements of hunting from motorized canoes.

While both individual and joint ownership of traplines are evident, preference to working traplines in pairs is noted (Balikci 1964:96-97), apparently due to the fact that trapping is often carried out in conjunction with seal hunting, which is a potentially dangerous occupation.

In brief, the acquisition of southern-manufactured tools related to subsistence practices provides the harvestor with a considerable number of harvest options. Generally, though, such options appear to arise from the potential of these tools for increasing productivity (either through greater efficiency in capture or reduced losses). As for what factors motivate the selection of any one particular harvest option, greater consideration is necessary.

While knowledge of animals, and hunting experience, vary from one individual to the next, and thus results in variable harvests at the individual level, it is suggested that such variability is a common feature of all communities, and therefore has little effect on 'relative' harvests from one community to the next. However, in terms of total harvest, such a factor is to one degree or another important, and should be recognized as such. Similarly, in terms of land use, Riewe notes (1976:173),

> The change to part-time hunting has resulted in a change in the frequency of land use in individual cases but not in the extent of land actually used by the community.

While traditional resource harvesting activities are culturally preferred by the Inuit, the desire for, and use of, southern-made hunting and fishing equipment demand engagement with the southern-oriented economic demands placed on them. For the most part, however, the focus of Inuit life remains on the land, as it has traditionally been. As a result, the practice of game harvesting connotes the following purposes: (1) the acquisition of either furs (for domestic or commercial purposes), or meat (for personal consumption or commercial sale), and/or (2) to maintain and participate in harvesting traditional resources for their cultural and social value. Certainly in large part the participation in subsistence activities serves to educate the young and reaffirm for the older generations traditional customs and beliefs (Nelson 1976:203). Children are taught, through participation, the knowledge of (1) basic travel (the stowage of equipment, operation and maintenance of transport equipment, preferred routes), (2) subsistence activities (such as scanning, stalking, immobilization, killing and capture of prey, and its preparation for use--see Laughlin 1976.195-196), (3) appropriate behaviour in emergency situations (Nelson 1976:203), (4) cooperativeness in hunting and travelling (including food sharing procedures), (5) alertness and quickness in action, and (6) the acquisition of a sense of humour in time of misfortune (Nelson 1976:203-204). Through such participation, one acquires knowledge, and through it, prestige and respect.

Aside from the economic and temporal factors noted above, which affect the harvest relationship of Inuit populations, when one considers the actual performance of the harvest task, other factors assert themselves to varying degrees and extents in the decision-making process of harvesting. Briefly, given sufficient equipment and supplies, and a specified allotment of time for subsistence activities, they are: (1) personal harvest requirement either in terms of (a) replenishing cash income through the sale of the harvest to maintain and operate harvest equipment (Usher 1971:95), or (b) replenishing personal food supply, which to one degree or another would be affected by (2) one's personal food preference at that particular time; (3) the potential variability of one's knowledge about particular species, and general hunting prowess; (4) the choice of hunting territory will determine what animals are potential prey (in choosing the marine environment, not only may one attempt primarily to capture seals, walrus or whale, but one may also in the interim periods hunt waterfowl or engage in some fishing; one may recall the importance of weather conditions). In other words, while the decision to hunt for a particular animal is made, alternate prey possibilities must be considered as well, keeping in mind the immediate environmental conditions which may temporarily restrict access to certain species. One might also characterize this as the relative degree of difficulty of capture of particular species. These factors, in total, vary from one individual to the next, and from time to time and place to place. Since they influence the final harvest result, they must be considered to some extent in an analysis of harvest levels.

As Usher indicates (1971:89), on the basis of perceived need and opportunity, people make decisions continuously concerning suitable activity, and, in so doing, are continuously perceiving new options while eliminating preceding ones. As a result of this individual or group decision-making activity with regard to the allocation of time and effort, future events or trends are influenced. Immediate necessities sometimes conflict with long-term goals, with the result that the ideal response to particular, immediate economic situations is seldom achieved. While harvest equipment (whether actual hunting and trapping equipment, or transportation devices and camping supplies) must be maintained for effective harvesting, it is also necessary to build or expand the family dwelling, add or replace major household appliances and furniture, replace clothing, and purchase supplies not obtained from the land itself. All of these materials periodically require costly expenditures. Obtaining the necessary capital either from harvesting or wage labour, or both, requires considerable planning and careful allotment of the hunter's time and effort. It is not a simple task, and, in the economic sense, must involve, to one degree or another, profit considerations, although, as Usher points out (1971:116), profit is not the sole or most important motivation for animal harvesting.

To illustrate the importance of these factors as they influence individual harvesting, one may consult Appendix IX, in which is indicated the range of catch sizes obtained by particular (though unidentified) hunters over the 1976 year. While such variation as is indicated illustrates that individual, social and cultural factors, in their own right, may be as significant in influencing the outcome of harvesting as the availability and catchability of the animal species hunted.

CHAPTER IV

ANALYSIS OF INUIT HARVEST DATA

This section is devoted to the analysis of the harvest data collected for the Inuit communities of Koartak, Payne Bay, Leaf Bay and George River. Specifically, these data will be considered in the context of certain niche dimensions. The formulae for Niche Width and Relative Niche Width measure one such dimension, namely the proportional contribution of species to total harvests (on the basis of month, season and year totals) of the above-mentioned communities. The descriptive statements derived from these formulae, concerning the harvest relationship of these Inuit communities, will be compared with those statements derived from the analysis of other dimensions of the harvest relationship. In so doing, it is hoped that the analytic utility of the above-mentioned formulae will be illustrated. A third formula, the Niche Equivalence formula, will be introduced to rigourously compare species' proportional contributions to harvest by community. As a result, other harvest niche dimensions may be explored.

ANALYSIS OF 1976 TOTAL BIOMASS CAPTURE

It may be observed, from Table I, that all four communities have very narrow Relative Niche Width values; for the most part, this condition may be seen to arise from the yearly biomass harvest dependence on approximately 20% of the total number of animal species captured (i.e., 20% of the species harvested respectively provide $>2.1\%$ of the total yearly harvest). For the community of Leaf Bay, the major yearly biomass contributors are ringed seal, bearded seal, caribou, arctic char and lake trout; for Koartak, Payne Bay, and George River, the major contributors include those species noted for Payne Bay and Leaf Bay, with the addition of beluga whale. It might be informative to note that the major contributing species provide, of the total yearly harvests, 91.7% for Koartak, 92.3% for Payne Bay, 89.1% for Leaf Bay and 90.9% for George River. This indicates some general uniformity among the communities regarding dependence on specific resources.

Table I: Summation Figures Regarding 1976 Total Biomass Capture

	Niche Width	Relative Niche Width	Total Number of species	Number of species contributing 2.1% of harvest
Koartak	4.76	.183	26	6
Payne Bay	5.26	.188	28	6
Leaf Bay	4.08	.151	27	5
George River	4.17	.144	29	6

Generally, one may observe that, as one moves northward from George River to Koartak, the Niche Width values increase, however slightly. Recalling that the formula assigns a larger value to that community in which the proportional contribution of species approaches parity, and considering the contributions made by the major resources for each community (see Appendix II), we may observe that the difference in contribution between the major species harvested is least for Koartak, then, in increasing order, Payne Bay, George River, and finally Leaf Bay.

Considering Relative Niche Widths, the same process holds as noted for Niche Width values; that is, the greater the contributory difference of harvested species, the less the Relative Niche Width value. Again, Payne Bay exhibits the widest value, such value decreasing through Koartak, Leaf Bay, and finally George River. The reason George River exhibits a lower value, or narrower Relative Niche Width, than Leaf Bay, is apparently due to the greater number of total resources utilized by George River.

It would thus appear from formula calculation that Payne Bay exhibits a greater Niche Width relationship with harvested resources, with Koartak, Leaf Bay and George River respectively exhibiting an increasingly narrow Relative Niche Width relationship with harvested resources. That is, in the above order, these Inuit communities exhibit progressively greater dependence on a few specific animal resources for harvested biomass.

However, an examination of Table II, which groups species according to general habitat, indicates the following. For Koartak, one may readily observe the great reliance placed on marine mammals for biomass contribution (75.6%), with 7.5% of the yearly biomass take provided by caribou and 13.5% by fish (8.6% by arctic char).

For Payne Bay, marine mammals contribute 47.3% of the total yearly take, caribou 6.9% and fish 41.3% (33.5% from arctic char). This indicates a greater dependence (in terms of biomass) on both marine mammals and migratory char. For Leaf Bay and George River, the dependence for biomass on marine mammals, caribou and fish are respectively 26.5%, 4013% and 28.2% (23.2% from arctic char), and 24.6%, 35.0% and 37.4% (30.7% from arctic char). Thus, for both Leaf Bay and George River, biomass-related dependence is placed predominantly on three environmental sources, rather than on two in the case of Payne Bay, and on one in the case of Koartak. In this situation, it would appear that Leaf Bay and George River enjoy wide harvest niche relationships, with Payne Bay and Koartak exhibiting increasingly narrow harvest niche relationships. This situation effectively contradicts the indications provided by the Niche Width and Relative Niche Width formulae.

Table II: Contribution of Species Groups to Total Harvest for 1976(%)

	Marine Mammals	Caribou	Fish	Other land Mammals	Wildfowl
Koartak	75.6	7.5	13.5	0.7	2.8
Payne Bay	47.3	6.9	41.3	0.3	3.9
Leaf Bay	26.5	40.3	28.2	1.0	4.2
George River	24.6	35.0	37.4	0.4	2.8

The information provided in Table II need not, nor could not, be explained in terms of the restrictions of these formulae. In fact, this information, or, more properly, the noted niche relationships may be correlated with other information already provided. Such correlation follows.

It has been noted that Koartak, due to its location on Hudson Strait, enjoys open water the year round, with ice formation only occurring in selected areas along the coastline. As a result, the potential for harvesting marine mammals is rather high. Further, one may note that the fresh-water sources emptying into the sea in the area surrounding Koartak are not as large as the Payne, Leaf and George rivers, and as a consequence presumably do not supply equivalent numbers of migratory char and salmon. As well, one must note that commercial fishing operations are absent here, due to the lack of sufficient storage facilities. Finally, as already indicated in the review of literature pertaining to the flora and fauna of Ungava, the caribou population frequenting the northern part of the Ungava peninsula is small, occurring in scattered groups practicing some form of wandering. It was suggested that the northern limit of the caribou distribution was in the vicinity of the Payne River drainage system. This is supported to a degree by the Native Harvest Report (1975), which notes that all of the caribou harvested by the Koartak Inuit were obtained at distance from the community (Zone II in the literature--see Appendix V). Zone II is noted (NHR 1775:26) as being that territory outside of the area that one may reach, and return to the community from, within a day's journey. The 75% contribution of marine mammals to the total 1976 harvest for Koartak is, for the most part, an apparent reflection of the realized availability of potential harvest resources.

In the case of Payne Bay, the commercial fishing industry results in fish being the second major contributor to the total yearly harvest, with marine mammal harvests being first in importance. As in Koartak, caribou contribution is rather low. Similarly, most of the harvested caribou were obtained in Zone II, at some distance from the community. Since the range of caribou distribution supposedly ends in this region, such a condition is understandable. Since the Payne River is productive enough to support commercial operations, and since such activity allows marine mammal hunting, the general orientation to the sea and its littoral regions for potential harvests seems appropriate.

For Leaf Bay and George River the emphasis on harvested resources varies somewhat, although both rely on marine mammals, caribou and fish. For Leaf Bay, caribou provides the greatest biomass, while fish are the largest contributors in George River. Both communities are noted for being situated near favoured grazing areas for caribou, while the George River, due to its extensive network of lakes and feeder streams, can potentially produce a greater fish harvest. Coupled with the fact that this industry allows the opportunity for marine mammal harvesting (and thus offsets the fact that the community of George River is located farther from the coast than Leaf Bay, which on its own might have some relative affect on marine mammal harvests), the conclusion that fish, rather than caribou, are the primary contributors in George River follows. At the same time, data from Appendix V suggests that caribou are potentially more available for harvest in Leaf Bay.

In terms of the analysis of yearly harvest, consideration of the empirical data, with reference to other pertinent information, provides a more detailed account of the niche relationships established for the communities under investigation. The formula for Relative Niche Width, while indicating the degree to which the proportional contribution of harvested resources varies from parity, does not specifically indicate which resources contribute in major fashion, and to what exact extent they do so. These are significant features of the harvest relationship, and the formula, in failing to consider them, must therefore be viewed as critically deficient. It would appear that the utility of this formula is restricted to merely 'indicating' the nature of the harvest niche relationship, while in-depth analysis of the empirical data, in terms of other pertinent information, is necessary in order to explicate the nature of that harvest niche relationship. One may question whether the use of the formula achieves anything useful since the variation in resource contribution is readily apparent by simple calculation of proportions. Yet, the employment of a mechanism which provides a comparative ranking scale may be of some benefit. Use of the formula in terms of month-to-month and season-to-season variation in resource contribution to harvest may be informative.

However, before proceeding with this, one must criticize the formula in one other area. By focussing on biomass contribution as the indicator of the harvest niche relationship, the formula fails to consider other harvest features. Specifically, the formula ignores the harvest of animal skins. Such animals as arctic fox, polar bear and black bear are ignored for the most part by the formulae, since they do not provide sufficient biomass to be noticable in terms of the total yearly harvest. As a result, not only is the meat contribution effectively ignored, but a consideration of the relative niche width data would not even indicate the possibility of other harvest relationships beside biomass yield. Because of this failure, and others which will be considered later, one must entertain use of the formula with reservation and critical consideration.

ANALYSIS OF 1976 MONTHLY BIOMASS CAPTURE

An examination of Tables III and IV, and Figure III (derived from Appendix II), indicates very clearly the month-to-month variability of harvest in terms of proportional contribution made by individual, unspecified resources to total monthly harvests, not only within a community but also between communities. Little more can be stated on the basis of this information, for little order can be discerned.

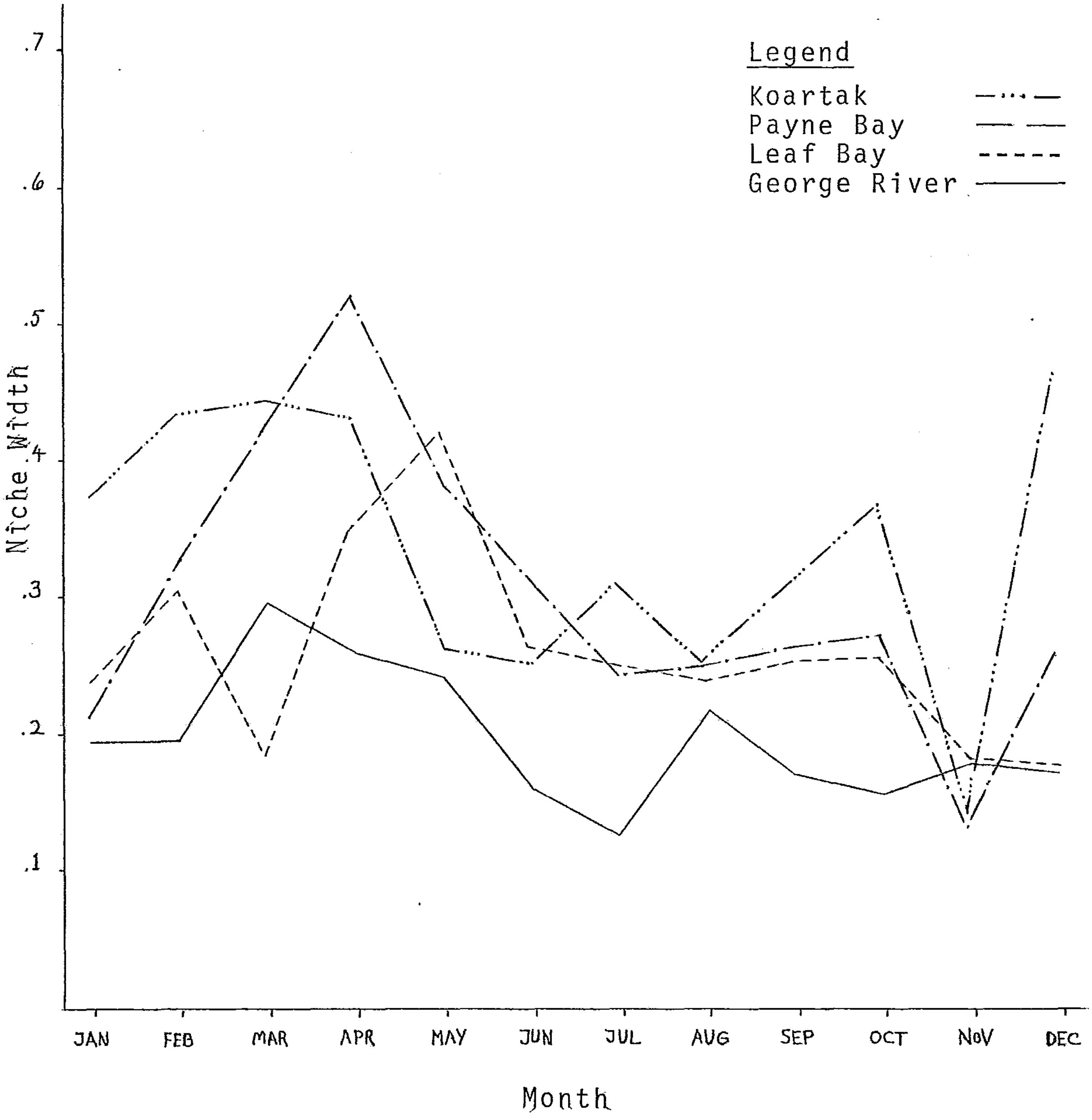
Table III: Niche Width Values/Month/Community (1976)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Koartak	2.60	3.45	4.81	5.16	3.32	3.97	4.05	2.23	2.77	3.57	1.53	2.78
Payne Bay	2.46	3.51	4.22	5.21	6.45	4.93	4.53	4.95	4.43	3.21	1.76	2.29
Leaf Bay	2.06	2.43	2.16	3.16	5.47	4.15	3.45	3.85	3.44	3.00	1.81	1.74
George River	3.29	2.25	3.75	3.55	5.10	3.66	3.06	5.26	3.60	3.53	3.09	2.46

Table IV: Relative Niche Width/Month/Community (1976)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Koartak	.371	.431	.437	.430	.255	.248	.312	.248	.308	.357	.139	.463
Payne Bay	.205	.319	.422	.521	.379	.308	.238	.248	.261	.268	.126	.254
Leaf Bay	.229	.304	.180	.351	.421	.259	.246	.241	.246	.250	.181	.174
George River	.194	.188	.289	.254	.232	.153	.122	.219	.171	.154	.182	.176

Figure III: Graphical Representation of Relative
Niche Width/Month/Community (1976)



Considering relative niche width values, it can generally be discerned that the widest niche values for the communities occurred as following: for Koartak in December, in April for Payne Bay, in May for Leaf Bay, and in March for George River. In all cases many of the resources harvested contribute significantly to the harvests of those particular months (for the appropriate community). Generally, as the total number of resources utilized per time period increases, the relative niche width value decreases, unless a majority of the resources utilized share significantly in the computation of that value (i.e., their harvest contribution must be greater than 2.1% of the total harvest at that time period). An examination of Figure II does not indicate any similarity in relative niche width values between the communities. It does, however illustrate the variability of the harvest relationship from month-to-month.

In the section dealing with the operationalizing of Hardesty's approach, it was clearly noted (p.41) that the formula to calculate Niche Width biased the values obtained, by failing to account for the variation in the total number of resources utilized in a given time period. As a result, it was concluded that the values thus obtained were of no comparative utility, and only of very limited usefulness in indicating whether or not there was a tendency to rely heavily on some of the utilized resources for biomass supply (if the total number of utilized resources was known). No details of the relationship beyond this could be discerned from the obtained values. Consequently, niche width values are introduced here only because relative niche width values are derived from them.

The formula to calculate Relative Niche Width allows some comparative statements to be drawn, since it accounts for and incorporates the variability in the number of resources utilized. In this context, a resource is considered to be significant if it contributes more than 2.1% of the total harvest, thus influencing the computation of relative niche width. However, such a formula and the resultant values, again, can only 'indicate' generally the extent to which resources are being used in contributory proportion to the total harvest of a given time period. For example, examining the Relative Niche Width values for Koartak and Payne Bay for the month of August, indicates that the communities exhibit a rather narrow Relative Niche Width, with both communities having relied on some resources in a proportionally equivalent manner. However, an examination of Appendix III indicates that, for Koartak the major resource contribution comes from ringed seal and bearded seal, while for Payne Bay that feature is shared by beluga whale and arctic char, in conjunction with ringed seal and bearded seal. The share of harvest supply among the four species for Payne Bay is relatively closer to parity than the share manifest between the two species for Koartak. Had not twenty species been hunted and captured in Payne Bay during August (unlike the nine species hunted and captured in Koartak during August), the relative niche width value would have been somewhat higher in August for the community of Payne Bay. While the relative niche width values are the same for these communities for this particular month, the manifest harvest relationships of the communities is not equivalent. Such observation expresses some informative differences. Caution, and constant referral to the empirical data and tabular figures regarding proportional contributions is in order.

ANALYSIS OF 1976 SEASONAL BIOMASS CAPTURE

It was noted that the arctic/sub-arctic year may be considered as being comprised of six seasons. The calculation of Relative Niche Width is a seasonal context (see Appendix IV) may add order to the monthly harvest data. Tables V and VI, and Figure III illustrate the situation.

Table V: Niche Width/Season/Community (1976)

	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Koartak	2.99	5.26	4.07	3.82	3.02	1.81
Payne Bay	2.91	4.98	6.10	4.74	4.10	1.93
Leaf Bay	2.18	2.60	5.56	3.85	4.39	1.80
George River	2.74	3.70	5.26	4.26	3.82	2.82

Table VI: Relative Niche Width/Season/Community(1976)

	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Koartak	.374	.376	.204	.294	.232	.151
Payne Bay	.224	.498	.321	.226	.216	.129
Leaf Bay	.198	.217	.348	.193	.258	.150
George River	.161	.231	.188	.164	.159	.148

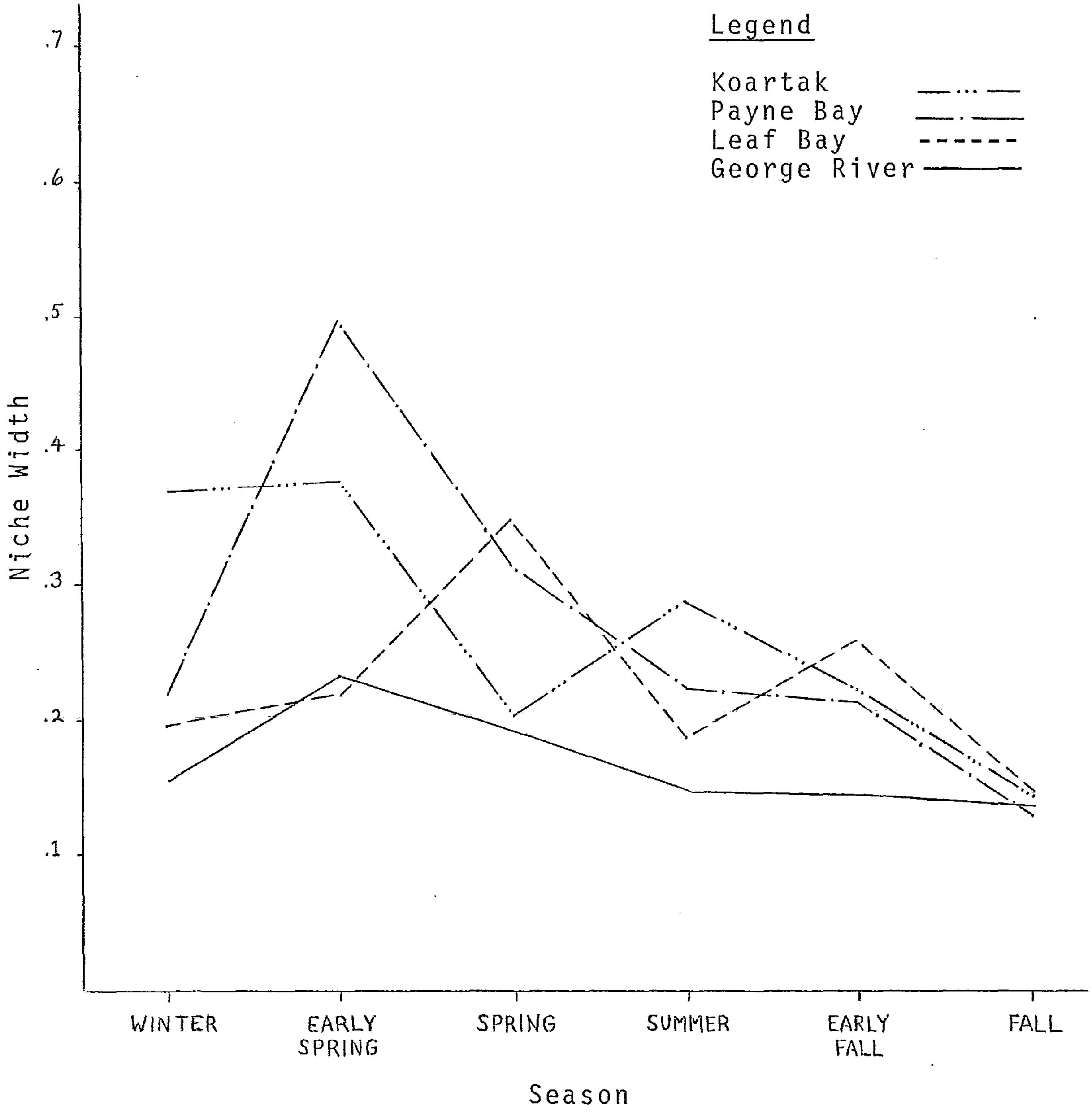
In the first instance, a comparison of Tables V and VI illustrate the bias resulting from calculated Niche Width values. Table V indicates that the widest harvest niche relationships, derived from considerations of biomass capture, occur for the communities of Payne Bay, Leaf Bay and George River during the months of Spring, while for Koartak it occurs in Early Spring. Adjusting for the seasonal variation in the number of resources utilized, Table VI indicates that, while the widest harvest niche relationship derived on the basis of biomass contributions for Leaf Bay remains in the Spring season, the communities of Payne Bay and George River actually enjoy a wider harvest niche relationship in Early Spring. Apparently, Koartak enjoys the widest harvest niche relationship over both the Winter and Early Spring seasons.

Examining Figure III in conjunction with the data presented in Appendix IV yields the following.

The 1976 Winter Season

In the winter season, Koartak enjoys a relatively wide harvest niche relationship, resulting from the fact that 75% of the resources harvested contribute significantly to the total harvest (and therefore influence the formula computation of the relative niche width value). One must recall that the greater the proportion of the total resources harvested contributing more than 2.1% of the total harvest, the greater the resultant Relative Niche Width value. It should be noted that a high relative niche width value is correlated with the utilization of all the available, natural community habitats in the territory.

Figure IV: Graphical Representation of Relative Niche Width/Season/Community (1976)



Specifically, the Koartak Inuit exploit, in order of greatest contribution to least, the terrestrial community (primarily hunting caribou), the marine coastal community (primarily hunting ringed seal and bearded seal, and trapping for arctic fox), the estuarine community (primarily fishing for arctic char), and the terrestrial-aquatic community (fishing for lake trout). In land use terms, this is the widest possible exploitative pattern (given this rather general characterization of natural communities). As well, it is evident from Appendix V that the Koartak Inuit utilized (for the whole 1974-75 season) Zone I land for most harvesting, the principal animal resource obtained in Zone II lands being caribou. In Koartak, the primary food source in this 1976 season was caribou, then seals and finally fish.

The Payne Bay Inuit similarly exploit all natural communities, although in this case fish are the primary food source, then caribou and finally seals. A substantial number of arctic fox are trapped, and a few species of terrestrial small game are captured. The fact that only five (38.5%) of the thirteen species harvested contribute significantly to the harvest results in such a low value for relative niche width. While this is so, it must not be allowed to hide the earlier mentioned land use relationship. Data from Appendix V suggests that this land use relationship is complicated by the fact that, in the 1974-75 season as a whole, Zone II lands were used for harvesting not only caribou, as in the case of

Koartak, but also seals and arctic fox. However, for 1976, Appendix VI indicates that harvest production was down approximately 40% from the previous year's harvest. This may have influenced, or it may be a reflection of, a change in the utilization pattern of the land, whether in terms of (1) restriction of harvesting to local Zone I lands, or (2) reduced harvesting effort (fewer man-hours), or both.

A divergence in natural community exploitation is observed (Appendix IV) for the community of Leaf Bay. Rather than harvesting from all potential areas, the Leaf Bay Inuit apparently concentrate on terrestrial areas for caribou (56% of total seasonal biomass harvest), and on the estuarine areas, including littoral regions, for the harvesting of char (38% of total seasonal biomass harvest), and some arctic fox.

Of the eleven species harvested, only three (27.3%) contribute significantly, those resources being caribou, arctic char and ptarmigan. While ptarmigan, and other small game, only supply minimal amounts of biomass, they are often consumed, presumably (1) either to provide variety to the diet, or (2) to necessarily augment food supply in periods of relative scarcity (M.M.R. Freeman, pers. comm., February, 1978). The rather low value obtained for relative niche width is suggested to arise as a result of the fact that essentially only two of the eleven resources utilized (caribou and arctic char) contribute most (84%) of the biomass harvested in this period.

For George River, only five (29.4%) of the seventeen harvested resources contribute significantly to this season's total biomass harvest, these species, ranked from greatest contribution to least, being caribou, arctic char, ringed seal, bearded seal and ptarmigan. It should be noted that two polar bear were captured. While they do not contribute significantly in terms of the computations involving Niche Width or Relative Niche Width formulae, they must still be recognized as significant resources, if not for their biomass then for the cash value of their furs. As in the cases of Koartak and Payne Bay, the George River Inuit exploit all available natural communities. Approximately 70% of the arctic fox pelts obtained in 1976 in George River were acquired during the winter season (see Appendix VII). Assuming that the general conditions of land use evident in 1974-75 (Appendix V) apply, it would appear that most arctic fox are trapped in Zone I lands, possibly in conjunction with estuarine fishing activity. Over 80% of the total season's harvest is obtained from caribou and arctic char. This fact may account for the low value obtained for relative niche width.

Variation in the biomass harvest from one community to the next during the winter season is evident. The Inuit of the communities of Koartak, Payne Bay and George River harvest from all available natural communities (terrestrial, terrestrial-aquatic, estuarine and marine), while the Leaf Bay Inuit concentrate on the terrestrial (for caribou) and estuarine (for arctic char) natural communities. However, while all natural communities are exploited, Koartak Inuit rely heavily on caribou and seal, while Payne Bay Inuit rely on arctic char and caribou, with the Inuit of George River heavily relying on caribou and arctic char (all species listed in order of greatest biomass contribution). Except for Koartak, all communities rely primarily on caribou and arctic char, although the proportional contribution made by each species to the total seasonal harvest may vary radically.

The 1976 Early Spring Season

Koartak achieves its greatest relative niche width value in this season, arising not only, as in the winter season, due to the fact that a majority (57%) of the resources utilized contribute significantly (greater than 2.1%) to the total harvest, but also because this contribution is more evenly distributed between these resources than was the case during the winter season. Again, utilization of all possible natural communities is achieved, with evidence suggesting broader utilization (more resources) in each, and greater productivity occurring than during the winter season. However, there is a noticeable shift in harvest emphasis to marine mammals and estuarine fish (arctic char), with some increase of capture of such other species as lake trout and land-locked char, and wildfowl. A decrease in the harvest of both caribou and arctic char is indicated; however, the arctic char harvest has decreased dramatically, although the harvest of other fish species is apparently equivalent. As in Koartak, the harvest of arctic fox has decreased substantially. The total harvest is somewhat less than that of the winter season.

For Leaf Bay, little change in the biomass harvest niche relationship is noted, although there is evidence suggesting some expansion of land use, in that some harvest of ringed seal is present. While some fluctuation in the harvest of caribou, arctic char, lake trout and ptarmigan is evident, it is not considered to be significant. As for Payne Bay, the total biomass harvest has decreased somewhat, while it has increased for Koartak. George River, like Payne Bay and Koartak, experiences its greatest relative niche width during this season. This is evidently achieved as a result of (1) greater equality in harvest contribution made by the significant resources, and (2) a higher proportion of the resources (50%) contributing significantly. In this season, the formulae computations include polar bear for their biomass contribution. Some expansion of land use in terms of the utilization of more resources is evident (particularly an increase in the exploitation of wildfowl). A slight increase in the total biomass harvested is noted.

The 1976 Spring Season

The harvest niche relationship in Koartak has changed again, developing in the same direction as noted for the early spring season. Specifically, a greater number of resources are harvested, widely representing all of the natural communities noted earlier. The trend to increased harvesting of marine mammals (now 90% of the total harvest), with a concomitant decrease in caribou exploitation, continues. The harvest of arctic fox has all but ceased. As well, the harvest of fish has decreased somewhat. Although there is generally a slight increase in the harvest of wildfowl (as they continue to migrate to the region), the predominant source of biomass comes increasingly from such marine mammals as ringed seal, bearded seal, beluga whale and walrus. The observed narrowing of the relative niche width arises from the decrease in the proportion of the total number of resources (now 45%) that contribute significantly to this season's harvest. While this is so, the biomass harvested at this season has increased dramatically over that of the preceding seasons.

The spring season's harvest in Payne Bay shares a number of features with that of Koartak, namely (1) greater resource variety, spanning the complete range of identified natural communities, (2) greater harvest emphasis on marine mammals, with noted decreases in the harvest of caribou, arctic fox and fish. Some increase in the harvest of wildfowl is evident. As for Koartak, the number of significant resources has decreased in proportion to the total number of utilized resources. Hence, in conjunction with increased use of such marine mammals as ringed seal, bearded seal and beluga whale, the observed lower value of relative niche width obtains. Again, as for Koartak, overall seasonal productivity (in terms of biomass capture) is increased substantially.

In Leaf Bay, the same basic development takes place, although productivity is only increased slightly. Only two marine mammals (ringed seal and bearded seal) are hunted in the marine community.

This season exhibits the highest relative niche width value, and this may be correlated with the fact that 50% of the total number of resources significantly support the harvest, which is a slight increase from the observed winter and early spring harvests.

For George River, the situation is as follows. Overall, the predominant feature of the biomass harvest relationship is the relatively exaggerated utilization of a large number of resources (27), representative of all recognized natural communities. Marine mammals, including the four species of seal, beluga whale and polar bear, comprise the major biomass source. While the harvest of caribou has decreased, and the trapping of arctic fox declines to a very low level, the fishing harvest appears to have remained relatively constant. Wildfowl harvesting has shown some increase. While overall biomass capture is increasing, the fact that only seven resources are significant contributors (again, polar bear, as well as black bear, are excluded, even though their fur is of some economic or harvestable value) results in a narrow relative niche width.

The 1976 Summer Season

In Koartak, the summer harvest indicates that fewer species are utilized than in the previous season, with three of the four significant species being marine mammals (ringed seal, bearded seal and beluga whale) providing 80% of the total biomass harvest. Arctic char is the fourth significant resource. Caribou hunting, fox trapping and the hunting of many wildfowl has ceased to be productive.

Biomass capture has not decreased substantially, for increased harvesting of the significant resources has apparently compensated for the decrease in the variety of species harvested.

In Payne Bay the harvest situation is much the same as it was in the preceding spring season (in terms of resource variety). However, increased harvesting of marine mammals is evident, as is the case also with arctic char fishing. Canada geese harvest has, on the other hand, dropped substantially. Overall harvests have more than doubled from that of the preceding season. However, due to a lower ratio of significant resources to total number of resources utilized, the relative niche width value has decreased.

With a substantially increased harvest biomass, the summer season in Leaf Bay exhibits greater utilization of marine resources (ringed seal, bearded seal, beluga whale, walrus and polar bear), a relatively constant harvest of caribou, and a substantial decrease in the harvest of fish and wildfowl. The lower relative niche width value reflects this situation.

In George River, the harvest relationship is generally as it was in the spring season, although the realized increase in biomass capture results from increased harvests of caribou and fish. This is unlike the other communities which rely most heavily on marine mammals. Although harvests have increased substantially, and the number of species harvested is large and distributed broadly through the recognized natural community habitats, the relative niche width value is low due to the relatively few significant resources.

The 1976 Early Fall Season

In Koartak, the trend to greater dependence on marine mammals continues, with marine mammals providing 94% of the season's total biomass harvest. The relative niche width value has decreased as a result of fewer significant resources, which it is observed are obtained almost exclusively from the marine habitat. The terrestrial and estuarine regions provide the remaining 6% of the biomass harvest. Harvests have dropped by about 25% since the preceding season.

Harvest productivity in Payne Bay has been reduced dramatically by about 75%. While marine mammals remain substantial biomass suppliers, arctic char has become the primary contributor of biomass. The relative niche width value continues to decline.

For Leaf Bay, the relative niche width value has increased, although productivity has decreased somewhat, with the relative number of significant resources to total utilized resources remaining constant. It would appear then, that the increased value is a reflection of the more equal contributions made by marine mammals, caribou and fish--all primary contributors in this season (fish being the largest biomass source).

The relative niche width value for George River at this season is less than that of the summer season, and results apparently from a lower ratio of significant resources to total utilized resources. Harvests have also dropped, although caribou harvest has increased. Marine mammals and fish (arctic char) are of lesser importance.

The 1976 Fall Season

The lowest relative niche width value for Koartak is obtained in this season, arising apparently from the few significant resources, and the fact that about 90% of the total catch comes from marine mammals. However, overall hunting productivity has increased by over 50% since the early fall season. This is the highest biomass harvest obtained in any season for Koartak.

In Payne Bay, marine mammals are of little importance in this season, fish being the major biomass source (over 80%), with caribou providing about 10% of the total biomass. While hunting productivity has increased by 50% from that of the preceding season, the relative niche width is lower, due to the fact that there are fewer significant resources.

As for Payne Bay, so in Leaf Bay there are far fewer significant resources (caribou and fish), with little biomass contribution derived from marine mammals. While productivity has increased quite substantially, the relative niche width value has fallen. In Leaf Bay, caribou provides the primary source of biomass at this season.

The harvest situation in George River is basically the same as that of the early fall season. Marine mammal harvest is reduced slightly, but fish and caribou harvests are slightly increased, with caribou being the primary biomass source. Hunting productivity is, however, reduced compared to the preceding season. The lower relative niche width value obtained is apparently due to the strong reliance on caribou for biomass, coupled with a decrease in the number of significant resources.

GENERAL HARVEST PATTERNS

Thus far, the analysis has indicated the following general patterns of year-round harvesting in the Inuit communities of Koartak, Payne Bay, Leaf Bay and George River.

From the analysis of monthly harvest figures, and the calculations and values obtained pertaining to Niche Width and Relative Niche Width (the proportional contribution of species to the total harvest at time period t), the most striking feature of the Inuit harvest relationship is its variability, not only from month to month in one community, but also from one community to the next. This monthly harvest variation is such that, if there is a pattern to the year-round harvest relationships, it is clouded by this same variability.

In terms of seasonal harvests for the year 1976, there appears to be a niche width increase in all communities beginning in the winter season, peaking in early spring for the communities of Koartak, Payne Bay and George River, while that of Leaf Bay peaks during the spring season. For the rest of the year, there is a general decrease in the harvest niche width for all communities. At the same time, one may note that, during the seasons leading up to the peak time where the harvest niche width values are greatest, the variation in harvest niche width values increases. Similarly, for the seasons following this peak time, there is an observable decrease in the variability of harvest niche width values from one community to the next. By the fall season this variability between communities is almost negligible, with all communities experiencing their lowest values, or narrowest harvest niche widths.

It is thus evident that the proportional contribution of species to the total seasonal harvests varies with time and community. An examination of the data represented in Figures V to VIII, pertaining to the proportional biomass contributions of certain, major harvested species, by season and by community, indicates the following variations.

For Koartak, the general utilization pattern of seasonal harvesting is as follows: From the winter season, progressing to the spring and summer seasons, there is an evident increase in the exploitation of marine mammals. At the same time, there is a sharp decrease in the harvesting of caribou, such hunting ending in spring. While seal hunting declines in productivity in the early fall and fall seasons, a sharp increase in beluga whale capture is evident. The harvesting of arctic char, and some other species, appears to fluctuate slightly from one season to the next, maintaining a contribution at or below 10% of the total seasonal harvests. From the information provided on animal behaviour and other influential factors, it would appear that this harvest dimension is a reflection of the general availability of game.

Caribou, while never near to the community, appear to spend the winter in the surrounding territory, though possibly moving farther inland into the peninsular interior during the summer months. Thus, they are available in the winter, when the harvesting of marine mammals is poor, due in part to poor weather, dangerous ice conditions and the general inaccessibility of the seals. However, in spring and summer, the relative abundance of marine mammals breeding and basking on the ice makes their capture relatively more productive. Beluga whales return, and more polar bear and walrus are observed. The seasonal orientation to the marine environment thus represents a logical response. Fishing appears to be a secondary harvest practice, attendent on the nature of the primary food source (seals), and the harvest techniques and requirements associated with it, Table VII and Appendix VI indicate that yearly harvest productivity has increased approximately 30% from the year before.

In Payne Bay, the harvesting of arctic char, enhanced by the capture of other fish stocks, is the most important harvest enterprise in terms of biomass. Highest harvest yields are taken during the fall and winter seasons, with lowest takes obtained in spring and summer, when marine mammal hunting is most important. The utilization pattern of caribou follows a similar pattern to that of arctic char. Spring, summer and early fall are the most important seasons for marine mammal hunting, with similar utilization curves for the major species (ringed seal and bearded seal).

Table VII: Percentage of Yearly Catch/Season/Community (1976)

	Winter	Early Spring	Spring	Summer	Early Fall	Fall	1976 Year Total (Biomass)	1974-75 Year Total (Biomass)
Koartak	8.3	10.6	19.7	17.8	13.8	29.8	114,501.3	87,067.9
Payne Bay	10.3	9.6	16.8	38.3	8.3	16.7	183,598.2	312,603.3
Leaf Bay	14.3	9.6	9.9	20.3	16.2	29.7	96,667.4	103,852.3
George River	14.4	15.0	16.7	24.6	16.2	13.1	381,940.7	366,486.8

Figure V: Percentage Contribution to Total Harvest Biomass/Species/Season (Koartak,1976)

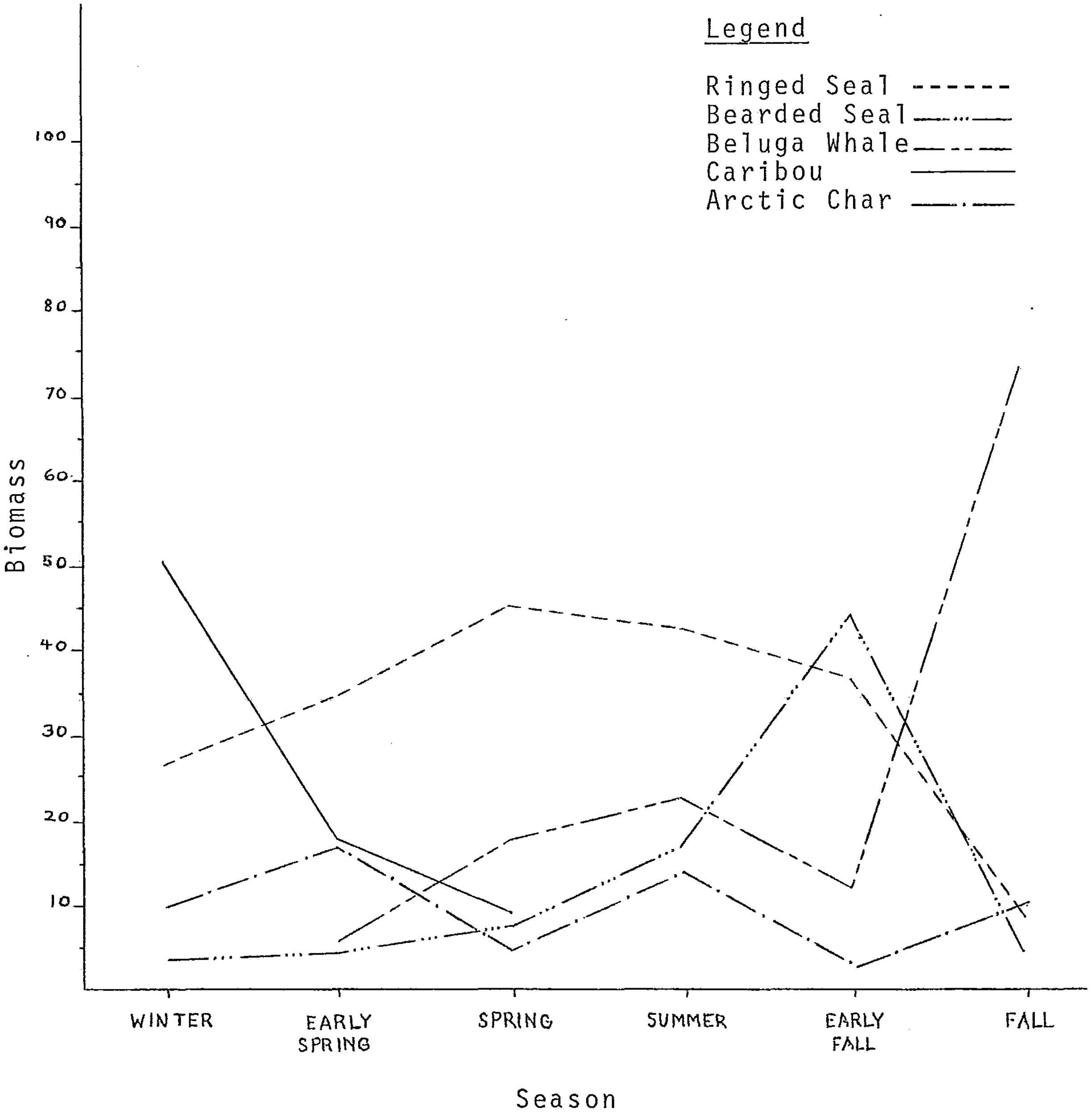


Figure VI: Percentage Contribution to Total Harvest Biomass/Species/Season (Payne Bay, 1976)

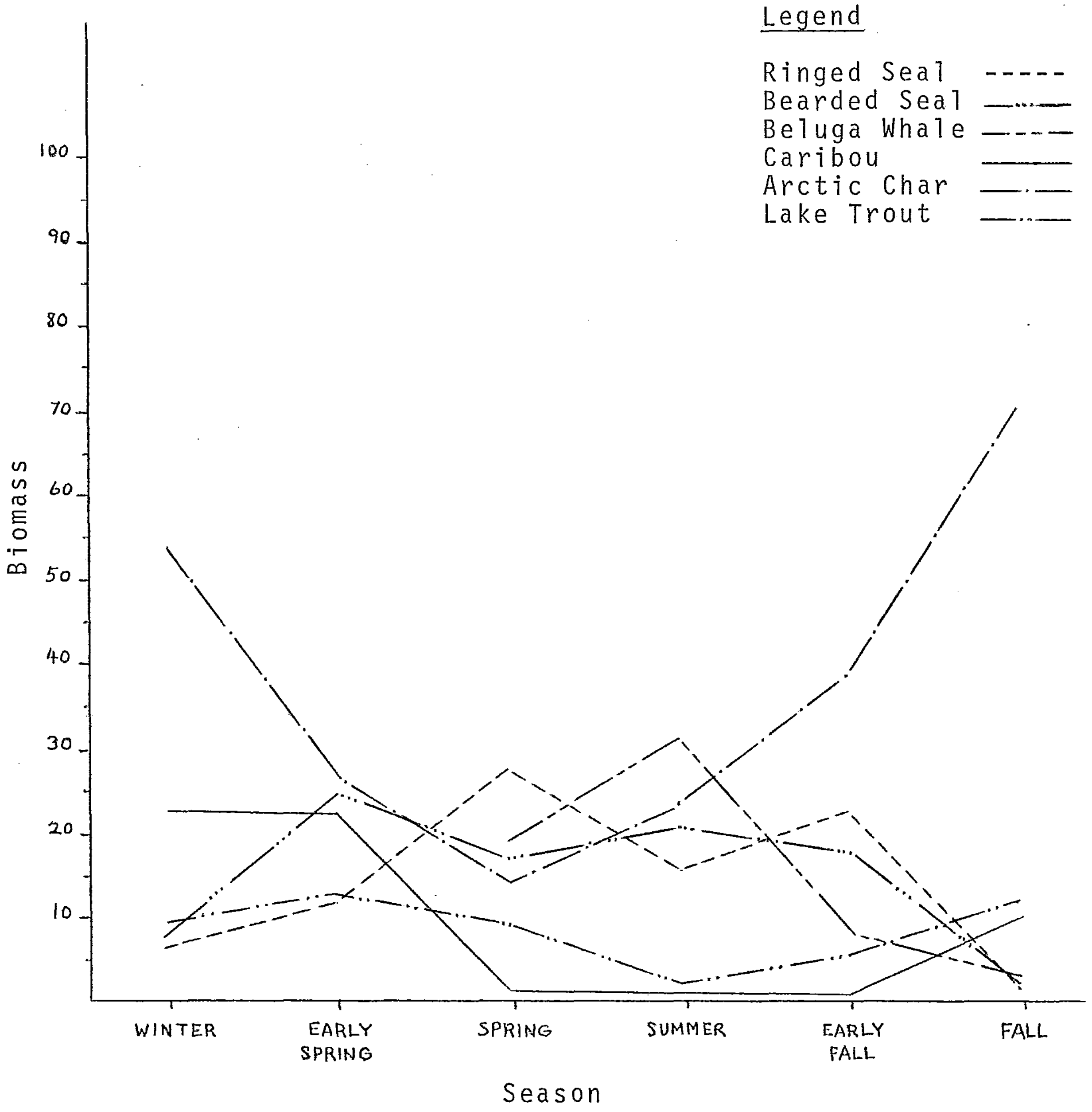


Figure VII: Percentage Contribution to Total Harvest Biomass/Species/Season (Leaf Bay, 1976)

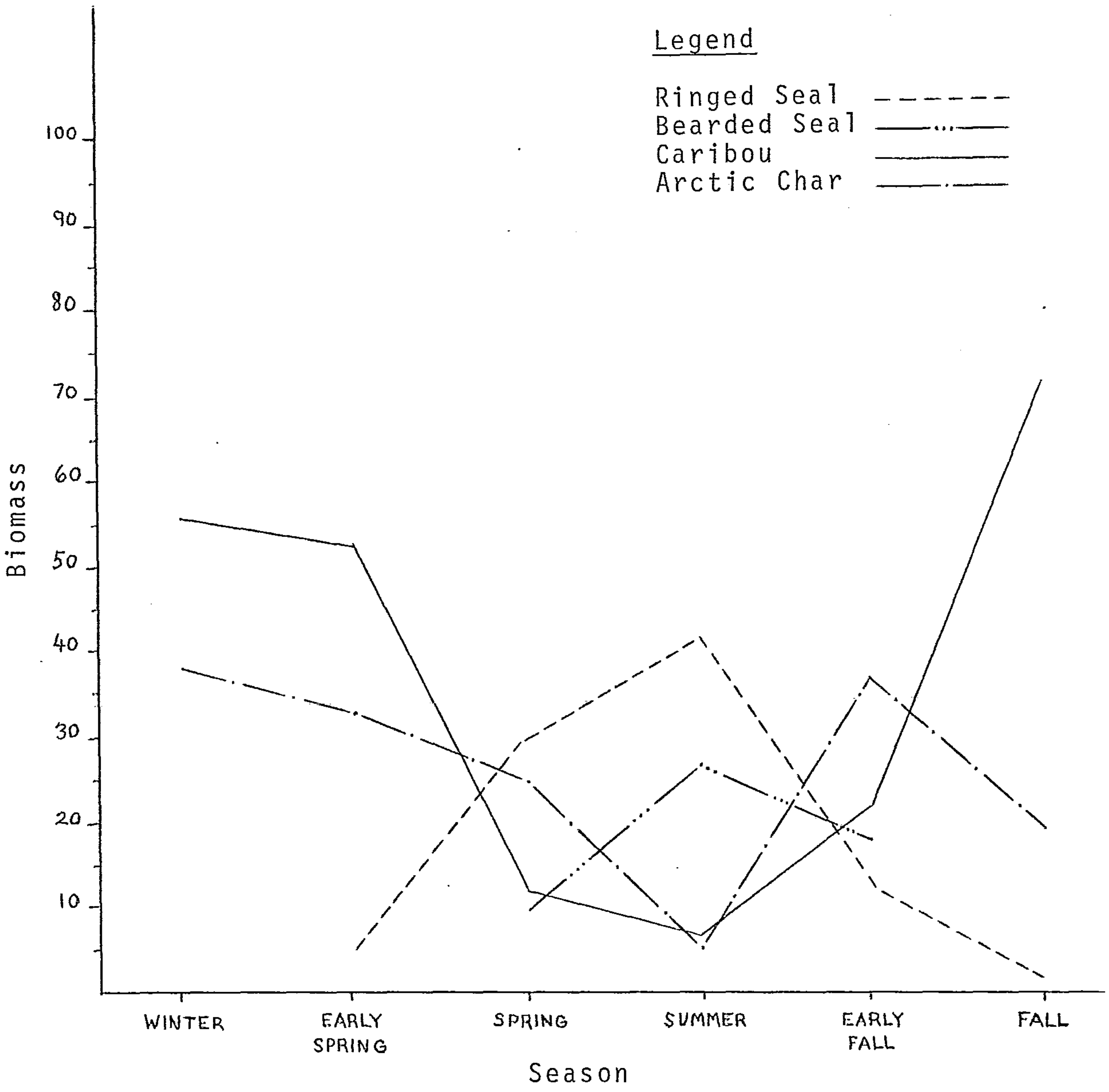
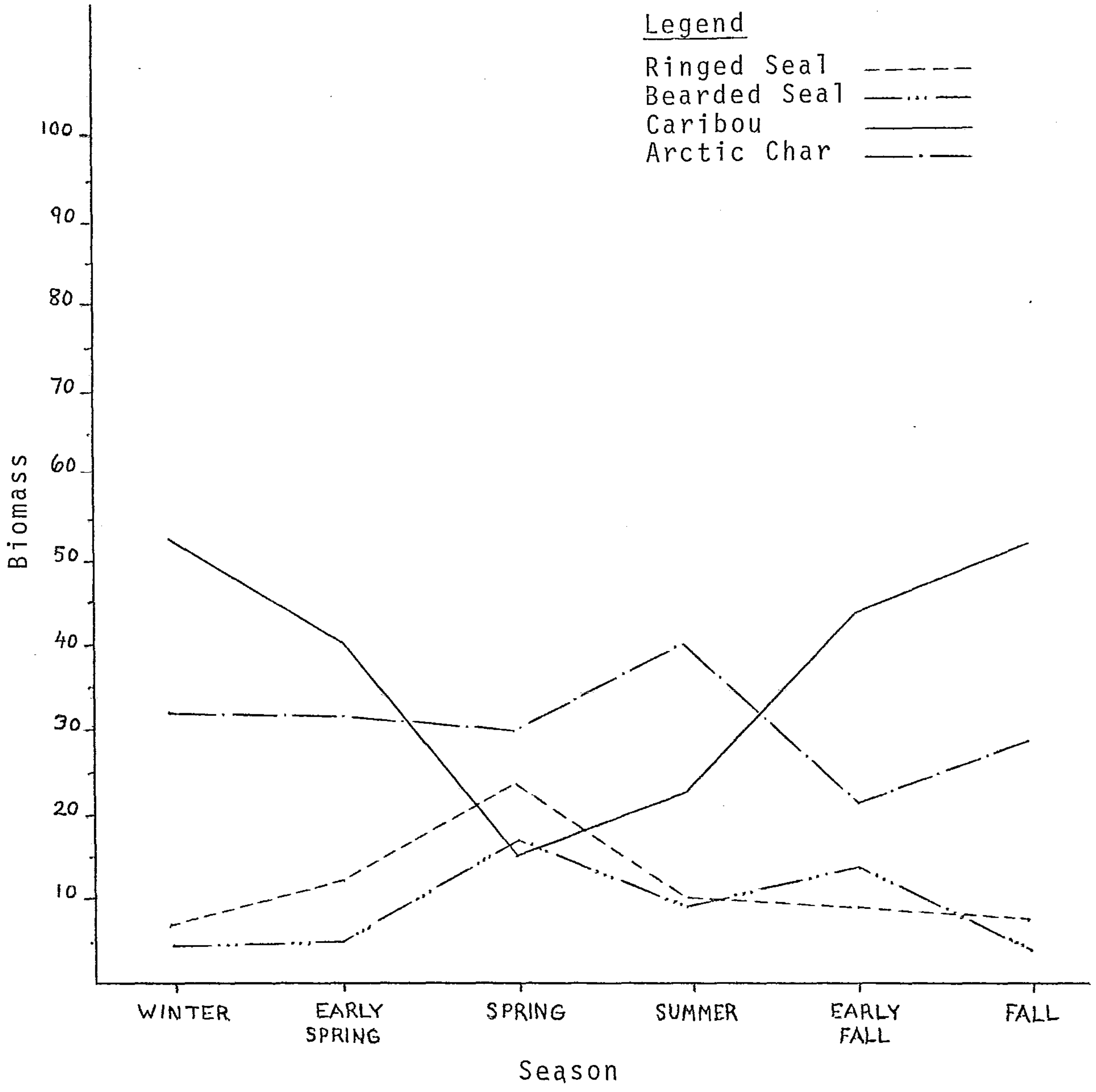


Figure VIII: Percentage Contribution of Total Harvest Biomass/Species/Season (George River, 1976)



Apparently, beluga whale are not plentiful in this area during the early part of the year. However, substantial takes of fall migratory whales indicate the presence of beluga whale in the western part of Ungava Bay. It would appear from the literature that caribou are not over-abundant in this area, and this, in conjunction with the fact that marine mammals head to open water far from shore during the freeze-up period, results apparently in the predominance of fish harvesting. Table VII and Appendix VI indicate a decrease in yearly harvest productivity of approximately 40%.

The relatively large Leaf Bay caribou herd determines apparently to a large extent the overall harvest relationship of the Leaf Bay Inuit. While caribou harvesting is low during the spring, summer and early fall, dramatic harvests of caribou during the fall and winter months indicate that the harvest relationship, while focussed upon a particular species, varies from one season to the next, depending on the availability of alternate food sources. Consequently, marine mammal hunting during the open water period is substantial and a primary focus. Further, fish harvesting follows the utilization curve of caribou. Table VII and Appendix VI indicate a 7% decrease in hunting productivity.

For George River, the caribou utilization curve is quite similar to that of the Leaf Bay Inuit. This is due probably to the fact that an even larger herd inhabits the George River area. However, apparently due to the fact that the community of George River is located farther from the sea than the other communities, marine mammal hunting appears to be of lesser significance than fishing, even though substantial harvests are secured. A 4% increase in hunting productivity over the preceding year is noted in Table VII and Appendix VI.

Thus, the general utilization pattern of harvesting is such that the orientation during the freeze-up or winter period is to the terrestrial environment, while the orientation during break-up is to the marine and estuarine regions. However, as one moves from north to south, caribou hunting alters from being a supplementary activity to being a predominant harvest activity. Inversely, marine mammal hunting activity alters from being the major harvest activity to being supplementary to caribou hunting (in part) and fishing (predominantly). It would appear that fishing, like caribou hunting, generally decreases in importance as one moves further north. Wildfowling and small game hunting appear to follow a similar course. This relationship between species utilization curves may be seen to be a reflection of the increasing variety of species as one approaches the southern part of Ungava Bay. In support, Tables VIII to X indicate clearly increased productivity as one moves in a southern direction. This correlates with the information in Table I, which indicates that the number of species utilized increases as one moves south from Koartak towards George River.

In terms of the distinction made earlier between Zone I and Zone II land utilizaiton, harvest figures tabulated for the

Table VIII: Per Capita Harvest (lbs., edible biomass)/Community (1976)

	Winter	Early Spring	Spring	Summer	Early Fall	Fall	1976 Year Productivity
Koartak	76.5	97.8	181.7	164.6	127.0	275.8	923.4
Payne Bay	85.9	81.1	141.6	322.6	70.2	140.8	842.2
Leaf Bay	154.8	104.1	107.5	220.5	175.8	323.3	1086.2
George River	192.4	200.2	222.4	328.2	216.6	175.7	1335.5

Table IX: Average Harvest (lbs.,edible biomass)/Hunter/Community (1976)

	Winter	Early Spring	Spring	Summer	Early Fall	Fall	1976 Total
Koartak	306.0	391.1	726.7	658.6	507.9	1103.3	3693.6
Payne Bay	456.7	431.1	752.8	1715.2	373.4	748.8	4478.0
Leaf Bay	810.6	545.2	562.9	1154.6	920.5	1692.7	5686.3
George River	1038.2	1080.3	1199.9	1771.2	1168.6	948.1	7206.4

Table X: Total Biomass (lbs.) Capture/Season/Community (1976)

	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Koartak	9486.9	12125.0	22526.2	20313.9	15745.1	34203.2
Payne Bay	18723.2	17675.2	30865.3	70323.1	15310.5	30700.9
Leaf Bay	13779.6	9267.6	9569.0	19627.6	15647.6	28776.0
George River	55024.7	57257.5	63596.6	93875.6	61934.4	50251.6

1974-75 hunting year indicate (see Appendix V) that there is a noticeable difference in land use from one community to the next. The Koartak Inuit exploit Zone I lands much more than Zone II lands for all species except caribou. In Payne Bay, Zone I lands are used for wildfowling and fishing, though most marine mammal hunting, caribou hunting and arctic fox trapping occurs in Zone II. In Leaf Bay, Zone I lands are used as much as or more than Zone II lands for all species, while in George River land use appears to be the same for both areas, although fox trapping looks more prevalent in Zone I lands. These arrangements lend further credence to the statement that resource utilization is related directly to the general spatial and temporal distribution, and numbers of species. The variable harvests of the communities under discussion may be seen in part to be a reflection of these variable ecological circumstances. This does not, however, mean that the socio-cultural factors outlined earlier are not equally important.

NICHE EQUIVALENCE

While a general pattern of resource utilization has been presented, it has been superimposed on a pattern that is variable from month to month, season to season, and year to year, as well as from one community to the next. One may ask: within this context, exactly how measurably (quantitatively) similar or different are the communities under investigation? Thus far, no technique has been proposed to rank quantitatively these communities in terms of the 'similarity' of particular species' proportional contribution to the total harvest (at specified time intervals, from one community to the next). While the formula for Relative Niche Width 'indicates' similarity of resource use from one community to the next, it does not actually compare two specific communities directly by any formal means, and therefore does not compare the communities in terms of specific resources (rather than two communities, one may compare directly the same community at two different time intervals). The following formula can provide such a ranking. The formula is:

$$\text{Niche Equivalence (E)} = 1 - \tfrac{1}{2} \sum_{j}^{n} |p_h - p_k| \ ,$$

where h and k refers to the communities being compared, n refers to the total number of resources utilized, j refers to the particular resource being compared, and p_h and p_k refer respectively to the proportional contribution of resource j to the biomass total of the appropriate time interval. This formula is a modified form of that introduced by Colwell and Futuyma (1971) to measure niche overlap or equivalence between biotic populations inhabiting given habitat areas.

While the focus here is primarily the same as that of the Niche Width and Relative Niche Width formulae, attention on 'particular species' is predominant. That is, it is suggested that differences in relative niche width values from one community to the next, as well as from one time period to the next, are a direct reflection of the variable contributions made by particular species to the harvest. By identifying these differences quantitatively, one may then be able to compare two communities (or the same community at different time periods--this will not be done here) and specify clearly the nature of the difference. An examination of Appendix VIII provides information on the yearly differences of species' contributions between specified communities. These obtained niche equivalence values are summarized in Table XI.

Table XI: Niche Equivalence/Communities (1976)

	Koartak	Payne Bay	Leaf Bay	George River
Koartak	-	.667	.491	.459
Payne Bay	-	-	.630	.669
Leaf Bay	-	-	-	.879
George River	-	-	-	-

NICHE ARRANGEMENT AND NICHE SHAPE

As an expression of the dimension of Niche Arrangement, as outlined in the section concerning operationalizing the niche concept, it was indicated that the harvest patterns of the Inuit communities of Koartak, Payne Bay, Leaf Bay and George River were such that, in the north the harvest pattern was oriented primarily towards marine mammal hunting, whereas, as one moves in a southerly direction, the harvest relationship becomes oriented increasingly towards estuarine fishing and caribou hunting. Niche Equivalence values, as summarized in Table XI, represent indirectly this transition. Examining Appendix VIII, one may note that Koartak differs in its harvest relationship from the other communities due to: (1) primarily its greater dependence on ringed seal, and (2) its lesser dependence on caribou and arctic char. Dependence on other resources varies as well, but these three resources are apparently the principal factors. Consequently, Payne Bay and Leaf Bay are more similar to George River than they are to Koartak, with Leaf Bay being more like George River than (1) Payne Bay is to George River, or (2) it is to Payne Bay, due primarily to the influence of caribou hunting harvests. This may be taken as an expression of the variability of Niche Shape, as defined in the section on operationalizing the niche concept. Unfortunately, the necessary information with which to discern to what degree these conditions are merely a reflection of the natural availability of the harvested resources, or a reflection of any variation in hunting effort from one community to the next, due to such social factors as alternate employment opportunities, is not available at this time. This, however, must not be taken as representing a basic weakness of the theoretical or methodological approach adopted in this paper.

If one wished to analyse the situation further in order to determine which season was most responsible for these differences between these communities, the same procedure would apply (see Appendix VIII). Since the earlier analysis concerning Niche Width and Relative Niche Width values on a monthly basis did not indicate an identifiable utilization pattern, it is suggested that niche equivalence measurements not be done on the basis of monthly data.

Analysis of seasonal niche equivalence, niche arrangement, niche shape, and, of course, relative niche width, indicates the following: (1) the harvest difference between Koartak and George River is based on (a) Koartak's emphasis throughout the year on marine mammals (specifically ringed seal, bearded seal (to a lesser extent) and beluga whale (in the fall), and (b) George River's emphasis on arctic char all year yound, and on caribou for the last six months of 1976; (2) the harvest difference between Koartak and Payne Bay centres on Koartak's emphasis on ringed seal throughout the year and on beluga whale in the fall, while Payne Bay's emphasis in 1976 was predominantly on fish, particularly during freeze-up; (3) the most significant difference between Payne Bay and Leaf Bay centres apparently on Payne Bay's emphasis on fish, particularly in the fall, and on Leaf Bay's emphasis on caribou throughout the freeze-up period; (4) Leaf Bay and George River differ in terms of the seasonal takes of seal, caribou and fish (primarily arctic char); specifically, during freeze-up Leaf Bay exhibits a greater emphasis on fish and caribou than is the case for George River; however, during summer, Leaf Bay exhibits greater emphasis on marine mammals than does George River (George River places more emphasis at this time on fishing and caribou hunting). As a check, one may examine Figures V through VIII and Appendices I and IV. This analysis is consistent with earlier statements concerning the harvest dimensions.

CHAPTER V

CONCLUDING STATEMENTS

Anthropological usage of the niche concept has to date exhibited the following features. A number of anthropologists, interested in the ecological nature of human life, have adopted variously all bioecological usages of the niche concept, ranging from Grinnell's 'habitat or place niche' (see Barth 1956;1959), to Elton's 'functional niche' (see Geertz 1963), to Odum's 'trophic niche' (see Vayda and Rappaport 1968; Lee 1969; Hardesty 1972, 1975,1977; Love 1977). In all cases, the procedure has been to adopt the niche concept, and employ it by considering social and cultural factors as extensions of the niche concept's bioecological context. For the most part, this bioecological context, of such concepts as environment, community and habitat, and such principles as natural selection, adaptation and competitive exclusion, has been borrowed, either explicitly or implicitly, together with the niche concept and without critical consideration.

An attempt has been made to examine with rigourous criticism Hardesty's use in anthropology of the Hutchinsonian niche concept. It was observed that the human ecological approach developed by Hardesty failed to make proper use of this conceptualization as a result of: (1) its failure to divorce this multidimensional niche formulation form the evolutionary framework of biological science, which emphasizes natural selection as the causative mechanism resulting in niche diversity, and to institute it within a framework which incorporates cultural components as significant factors; (2) its failure to differentiate properly between the concepts of habitat niche, functional niche and trophic niche, and between the concepts of fundamental niche, realized niche and partial niche; (3) its failure to consider rigourously the nature of such concepts as environment, community and habitat; (4) its uncritical use of an inappropriate formula to measure niche width; and (5) its overall failure to consider the theoretical and methodological problems surrounding the multidimensional niche concept (as identified by several theorists of biological science). The result is an approach that is, whether intended or not, reductionist in nature; that is, the ecological circumstance of human populations is reduced to, and suggested to be described by, identifiable trophic relations. The ecological anthropological approach adopted in this paper is the result of critical consideration of all of the above.

As a refined alternative, the following heuristic model is suggested. To begin, it is suggested that ecological anthropology concerns the study of the structural and functional interrelations among human organisms or aggregates thereof, and their respective biotic, abiotic, social and cultural environments, with special emphasis on those additional interactions, and the conditions, products or outcomes thereof, that provide the dynamic quality of human existence. The human organism, then, is a manifestation of the interaction of all environmental variables, whether in nature phenomenal (such as morphological, physiological, behavioural or social variables) or ideological (cultural variables). These environmental variables are considered to be combined in some dynamically complex, relationary structure. The Hutchinsonian formulation of a multidimensional niche is combined with a similar multidimensional habitat to represent the 'ecotope', or total reality of human existence, as defined above.

In terms of the Inuit harvest data provided, this alternate approach was operationalized, albeit incompletely (due to lack of the full range of pertinent data). While one may note the various dimensions that constitute the ecotope (morphological; physiological; geophysical environment including climate, natural resources; social structure including political and economic relations, kin networks and group constitution; and ideological systems), it is valid operationally to focus upon a particular circumstance or, in this case, activity, and consider consequently the remaining ecotope dimensions (niche plus habitat) in its light. This is the case with the Inuit harvest data.

Niche Width, and Relative Niche Width, have been employed here to represent the degree of harvest specialization of specified Inuit communities. In this context, Hardesty's formula for Niche Width, and the Relative Niche Width formula developed here, represent merely one 'dimension' of this harvest specialization, namely the degree to which the proportional contributions of biomass (to the total harvest at time t) provided by the harvested resources approaches parity. The calculations involved provide a value which represents this relationship, indicating the extent to which specialization is evident. While it indicates that certain resources provide variable amounts of biomass, one must consult the raw data and tables of calculated proportions to identify specific resource contributions.

While this harvest information is considered to be a representation of actual Inuit land use, the relationship to the land is considered conceptually as being a product of the influences exerted by the various other dimensions, or the parts thereof, that are perceived to be relevant. While the harvest data, and the formula-based analysis of this data, is quantitative in nature, it has been in many cases converted to qualitative statements concerning the noted harvest relationship. In so doing, this analysis becomes meaningful when considering those natural environmental factors, or those social and cultural factors, that can only be qualitatively described.

Considering quantitative analysis of data, it is suggested that Hardesty's use of the Niche Width formula is extremely misleading. Furthermore, it is argued that Hardesty's application of the formula produces no comparative values whatsoever, due to the nature of the formula itself. Such refinement as deemed necessary in order that the Niche Width formula might produce comparative values has been accomplished in the text, the refined formula being termed the Relative Niche Width formula. In order to make consistent quantitative comparisons another formula was introduced, specifically that formulated by Colwell and Futuyma (1971) to measure Niche Equivalence. Other dimensions of the ecotope are Niche Arrangement and Niche Shape. However, it must be concluded that relative niche width and niche equivalence are of only limited used. Specifically, since the base measure of these concepts was the proportional contribution to the total biomass harvest at time t by particular animal resources, these concepts pertain merely to the relative importance of species in terms of biomass capture. This emphasis ignores totally the significance of species arising from other features of the harvest relation. For example, a number of animals are captured sporadically and, when they are captured, accord prestige to the hunter (e.g., polar bear or black bear). As well, while the meat supplied by a bear may not be substantial in terms of the total monthly, seasonal or yearly harvest for a community, it is still a considerable amount for the hunter at that particular time.

The approach adopted in this paper has provided the following analysis of the partial niche 'resource harvesting' for the Inuit communities of Koartak, Payne Bay, Leaf Bay and George River. Overall, the harvest relationship is characterized by variability. Specifically, while in the context of the natural environmental circumstances delimited by the periods of ice break-up and freeze-up, it may be derived from the harvest data that harvesting activity is directed more so to the terrestrial environment during the freeze-up period, and more to the marine environment during the break-up period. Moreover, as one moves from north to south, caribou hunting and fishing alter from being supplementary activity to marine mammal hunting, to being at least as important, or more important than, marine mammal hunting, in terms of biomass capture. In part, this is suggested to be a reflection of the increasing variety, numbers and distributions of species as one moves southerly. However, superimposed on this general pattern of harvest activity is a resource utilization pattern that is characterized by variability in yield from month-to-month, season-to-season and year-to-year, as well as from one individual hunter to another, and from one community to the next.

As a result of the analysis undertaken, the following dimensions are suggested to be significant factors affecting the Inuit harvest relationship. Specifically, those dimensions directly related are: (1) the proportional contribution of species to the harvest of specified time periods (months, seasons, years), as an indicator of the degree and extent of harvest specialization from one community to the next (measured as Niche Width and Relative Niche Width); (2) the productivity of harvest, measured primarily as biomass capture per specified time period per community; (3) percent contribution of species (grouped in terms of biotope association) to the harvest of specified time periods, as a reflection of the nature and extent of the orientation of Inuit populations to particular biotopes; and (4) harvest niche equivalence, as a comparative representation of the proportional contributions of species between communities. Other related dimensions are (1) the relative importance of Zone I and Zone II lands; (2) animal behaviour as a limiting factor of the harvest relationship; (3) availability of cash per hunter or household to finance harvest-related activity; and (4) the availability of time for harvesting as a reflection of (a) combining harvesting with wage employment and other social functions, and (b) suitable weather conditions.

To conclude, it must be said that the formulae considered in this paper fail overall to transmit or represent the cultural and social significance of land use activity. It must be realized that these formulae are very particular in their analysis, as well as in their selective use of subject matter. By considering these in the wider context of the ecotope, which represents the total reality of a given human ecological aggregate, it is suggested that the refined version of Hardesty's application of the Hutchinsonian niche concept, although attempting to illuminate the multidimensional character of the ecotope of particular Inuit aggregates, has failed overall to make the multidimensional niche and habitat concepts practical tools for analysis. The complex nature of ecological realities has been discussed, and from this, the use of the concepts of 'partial niche' and 'partial habitat' in understanding the ecotope of human aggregates has been suggested as a possible means for approaching an understanding of this complex subject.

Appendix I: Numbers of Animals Harvested/Species/Month*/Community

Community: Koartak

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total (∑)
Ringed Seal	42	37	74	56	133	186	183	87	127	55	51	26	1057
Bearded Seal	0	1	1	1	3	3	10	5	21	10	7	0	62
Harp Seal	0	0	0	0	0	0	2	1	2	3	0	0	8
Ranger Seal	0	0	0	0	0	0	0	0	0	0	1	0	1
Beluga Whale	0	0	0	1	0	6	7	0	2	1	40	0	57
Walrus	0	0	0	0	0	2	0	0	0	0	2	1	5
Polar Bear	0	0	3	0	0	0	0	0	0	0	0	0	3
Caribou	22	15	11	5	10	4	0	0	0	0	0	0	67
Arctic Fox	122	61	49	7	2	0	0	0	0	0	0	4	245
Snow Goose	0	0	0	0	2	0	0	0	0	0	0	0	2
Canada Goose	0	0	0	30	87	126	23	45	3	0	0	0	314
Duck	0	0	0	15	0	37	21	13	84	171	40	0	381
Murre	0	0	0	0	0	27	80	33	0	0	0	0	140
Guillemot	0	0	10	5	5	0	0	0	0	0	0	0	20
Loons	0	0	0	0	0	1	1	3	1	0	0	0	6
Arctic Char	58	153	231	212	110	107	542	52	30	38	318	341	2192
Salmon	0	0	0	0	0	0	16	0	0	0	0	0	16
Lake Trout	27	25	57	91	70	131	50	0	0	13	77	25	566
Cod	0	0	0	0	0	1	0	0	0	1	0	0	2
Whitefish	0	0	0	0	0	0	0	0	0	32	34	30	96
Brook Trout	0	0	0	0	2	0	0	0	0	0	0	0	2
Sculpin	0	0	0	0	0	328	306	15	0	0	0	0	649
Ld.-Lkd.Char	27	12	78	36	55	93	65	0	0	10	13	0	389
Hare	4	2	0	0	0	0	0	0	0	0	1	0	7
Ptarmigan	0	0	100	133	745	205	0	0	12	0	0	0	1195
Grouse	0	0	0	0	0	0	0	0	0	0	0	0	0
Partridge	0	0	10	0	12	4	0	0	0	0	0	0	26
Owls	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Bear	0	0	0	0	0	0	0	0	0	0	0	0	0
Porcupine	0	0	0	0	0	0	0	0	0	0	0	0	0

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[*] The heavy vertical lines serve to separate the months into seasons (6), the seasons listed from left to right being Winter, Early Spring, Spring, Summer, Early Fall, and Fall. The summations of the number of animals captured/species/season will be employed in Appendix IV.

Appendix I: Numbers of Animals Harvested/Species/Month*/Community

Community: Payne Bay

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total (Σ)
Ringed Seal	12	26	27	36	99	164	243	91	63	44	7	0	812
Bearded Seal	4	2	9	11	6	16	43	22	9	3	2	0	127
Harp Seal	0	0	0	0	0	0	5	2	0	0	0	0	7
Ranger Seal	0	0	0	0	0	0	0	0	0	0	0	0	0
Beluga Whale	0	0	0	0	6	3	24	11	2	0	1	0	47
Walrus	0	0	0	0	0	0	5	3	0	0	0	0	8
Polar Bear	0	0	0	0	0	0	1	0	0	0	0	0	1
Caribou	15	17	17	13	4	0	3	4	0	1	11	14	99
Arctic Fox	65	31	19	24	6	0	0	10	0	0	25	10	190
Snow Goose	0	0	0	0	0	5	0	0	1	0	0	0	6
Canada Goose	0	0	0	0	313	194	18	15	13	2	0	0	555
Duck	0	0	0	5	26	120	105	133	119	28	8	0	539
Murre	0	0	0	5	10	113	87	63	7	0	0	0	285
Guillemot	0	0	0	0	7	44	40	10	5	0	0	0	106
Loons	0	0	0	0	0	4	4	1	4	0	2	0	15
Arctic Char	1520	682	762	252	290	592	1894	1525	643	697	3510	1282	13649
Salmon	0	0	0	0	0	0	5	1	0	0	17	0	23
Lake Trout	131	99	147	142	247	140	85	169	44	98	289	240	1831
Cod	0	0	0	0	0	0	0	0	4	0	0	0	4
Whitefish	1	0	30	0	0	0	0	2	6	0	0	0	39
Brook Trout	8	1	10	0	0	0	48	103	3	5	31	15	224
Sculpin	0	0	0	0	50	57	254	99	39	4	0	1	504
Ld.-Lkd.Char	27	16	28	19	35	49	16	4	0	8	50	7	259
Hare	7	3	0	0	31	3	0	0	1	5	35	7	92
Ptarmigan	93	42	25	711	1755	346	11	42	239	360	127	154	3905
Grouse	0	0	0	0	10	0	0	0	0	0	0	0	10
Partridge	0	5	0	0	9	4	0	0	0	0	0	0	18
Owls	1	0	0	0	0	0	0	0	0	0	0	0	1
Black Bear	0	0	0	0	0	0	0	0	0	0	0	0	0
Porcupine	0	0	0	0	0	0	0	0	0	0	0	0	0

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[*] The heavy vertical lines serve to separate the months into seasons (6), the seasons listed from left to right being Winter, Early Spring, Spring, Summer, Early Fall, and Fall. The summations of the number of animals captured/species/season will be employed in Appendix IV.

Appendix I: Numbers of Animals Harvested/Species/Month*/Community

Community: Leaf Bay

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total (∑)
Ringed Seal	0	0	5	9	24	63	96	162	28	31	3	0	421
Bearded Seal	0	0	0	0	0	4	13	11	3	10	0	0	41
Harp Seal	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranger Seal	0	0	0	0	0	0	0	0	1	0	0	0	1
Beluga Whale	0	0	0	0	0	0	1	2	0	0	0	0	3
Walrus	0	0	0	0	0	0	1	1	0	0	0	0	2
Polar Bear	0	0	0	0	0	0	0	2	0	0	0	0	2
Caribou	50	10	31	7	7	1	0	9	21	6	104	58	304
Arctic Fox	17	13	10	0	0	0	0	0	0	100	2	23	165
Snow Goose	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada Goose	0	0	0	0	185	19	0	20	12	0	0	0	236
Duck	0	0	0	0	35	138	59	59	41	118	0	0	450
Murre	0	0	0	0	0	5	22	11	0	0	0	0	38
Guillemot	0	0	0	0	5	1	10	29	9	12	0	0	66
Loons	0	0	0	0	0	0	2	0	3	0	0	0	5
Arctic Char	837	336	357	298	135	366	154	62	84	1175	986	202	4992
Salmon	0	0	0	0	0	0	0	11	11	0	0	0	22
Lake Trout	16	0	17	23	40	100	10	0	0	3	95	63	367
Cod	0	0	0	0	0	0	0	0	0	0	0	0	0
Whitefish	8	0	3	2	4	2	0	0	0	0	0	18	37
Brook Trout	5	20	18	14	7	13	64	13	0	23	90	310	577
Sculpin	0	0	0	0	0	30	15	145	329	574	0	0	1093
Ld.-Lkd.Char	3	10	4	3	38	18	1	0	0	0	0	0	77
Hare	1	0	0	0	1	2	1	0	0	0	1	2	8
Ptarmigan	381	244	458	269	248	10	0	2	59	63	108	448	2290
Grouse	0	0	0	0	0	0	0	5	0	0	13	0	18
Partridge	0	10	10	15	10	10	0	0	33	33	86	63	270
Owls	0	1	1	0	0	0	0	0	0	0	0	0	2
Black Bear	0	0	0	0	0	0	0	0	1	0	0	0	1
Porcupine	0	0	1	0	0	0	0	0	0	0	0	1	2

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* The heavy vertical lines serve to separate the months into seasons (6), the seasons listed from left to right being Winter, Early Spring, Spring, Summer, Early Fall, and Fall. The summations of the number of animals captured/species/season will be employed in Appendix IV.

Appendix I: Numbers of Animals Harvested/Species/Month*/Community

Community: George River

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total (Σ)
Ringed Seal	70	29	89	114	289	183	139	167	93	81	68	43	1365
Bearded Seal	5	4	4	7	33	12	21	15	15	22	4	4	146
Harp Seal	5	0	0	0	5	2	0	5	3	1	2	0	23
Ranger Seal	0	0	0	0	2	0	2	0	0	0	0	0	4
Beluga Whale	0	0	0	0	0	4	6	8	0	0	0	0	18
Walrus	0	0	0	0	0	0	0	0	0	0	0	0	0
Polar Bear	2	1	3	1	0	1	4	2	0	0	0	0	14
Caribou	95	127	103	76	38	34	57	101	84	126	112	91	1044
Arctic Fox	136	58	42	14	0	1	1	1	0	3	11	9	276
Snow Goose	0	0	0	0	0	1	0	0	1	6	0	0	8
Canada Goose	0	0	0	17	284	92	55	119	19	16	4	0	606
Duck	0	0	0	0	73	244	260	211	155	93	1	0	1037
Murre	0	0	0	4	10	57	61	68	1	14	0	0	215
Guillemot	0	0	0	0	21	82	75	82	20	4	0	0	284
Loons	0	0	0	0	8	13	39	17	14	4	0	0	95
Arctic Char	2005	1737	2302	1545	622	3510	6319	2030	2124	747	1788	1365	26094
Salmon	1	0	195	0	10	46	117	192	5	6	52	23	647
Lake Trout	22	7	226	53	328	64	60	42	64	230	329	15	1440
Cod	0	0	0	15	9	17	60	60	6	1	1	0	169
Whitefish	0	0	0	0	0	35	157	19	96	502	6	12	827
Brook Trout	220	80	410	153	190	88	81	78	220	1753	307	51	3631
Sculpin	0	0	0	0	10	65	235	256	218	137	0	0	921
Ld.-Lkd.Char	20	0	25	10	86	13	8	225	22	0	32	0	441
Hare	14	4	8	0	7	0	5	3	2	4	22	3	72
Ptarmigan	1003	551	993	776	585	2	6	17	103	143	214	323	4716
Grouse	3	0	0	0	28	0	9	3	0	1	0	11	55
Partridge	126	28	233	149	86	15	3	7	8	41	85	98	879
Owls	3	2	0	0	4	0	4	0	0	0	0	2	15
Black Bear	1	0	0	0	0	1	0	0	0	0	0	0	2
Porcupine	0	0	0	0	0	0	0	0	0	4	0	0	4

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* The heavy vertical lines serve to separate the months into seasons (6), the seasons listed from left to right being Winter, Early Spring, Spring, Summer, Early Fall, and Fall. The summations of the number of animals captures/species/season will be employed in Appendix IV.

Appendix II: Calculation of Niche Width and Relative Niche Width for 1976 Year/Community

Species	Koartak Number	Koartak Biomass	Koartak Pi	Koartak $(Pi)^2$	Payne Bay Number	Payne Bay Biomass	Payne Bay Pi	Payne Bay $(Pi)^2$
Ringed Seal	1057	33295.5	.291	.085	812	25578.0	.139	.019
Bearded Seal	62	13447.8	.118	.014	127	27546.3	.150	.023
Harp Seal	8	760.0	.007	.000	7	665.0	.004	.000
Ranger Seal	1	61.1	.001	.000	0	0	.000	.000
Beluga Whale	57	35739.0	.312	.097	47	29469.0	.161	.026
Walrus	5	2040.0	.017	.000	8	3264.0	.018	.000
Polar Bear	3	1050.0	.009	.000	1	350.0	.002	.000
Caribou	67	8576.0	.075	.006	99	12672.0	.069	.005
Arctic Fox	245	808.5	.007	.000	190	627.0	.003	.000
Snow Goose	2	7.0	.000	.000	6	21.0	.000	.000
Canada Goose	314	1475.8	.013	.000	555	2608.5	.014	.000
Duck	381	647.7	.006	.000	539	916.3	.005	.000
Murre	140	140.0	.001	.000	285	285.0	.002	.000
Guillemot	20	16.0	.000	.000	106	84.8	.001	.000
Loons	6	15.0	.000	.000	15	37.5	.000	.000
Arctic Char	2192	9864.0	.086	.007	13649	61420.5	.335	.112
Salmon	16	136.0	.001	.000	23	195.5	.001	.000
Lake Trout	566	3962.0	.035	.001	1831	12817.0	.070	.005
Cod	2	5.0	.000	.000	4	10.0	.000	.000
Whitefish	96	144.0	.001	.000	39	58.5	.000	.000
Brook Trout	2	4.0	.000	.000	224	448.0	.002	.000
Sculpin	649	324.5	.003	.000	504	252.0	.001	.000
Ld.-Lkd. Char	389	972.5	.009	.000	259	647.5	.004	.000
Hare	7	35.7	.000	.000	92	469.2	.003	.000
Ptarmigan	1195	956.0	.008	.000	3905	3124.0	.016	.000
Grouse	0	0	.000	.000	10	7.0	.000	.000
Partridge	26	18.2	.000	.000	18	12.6	.000	.000
Owls	0	0	.000	.000	1	3.5	.000	.000
Black Bear	0	0	.000	.000	0	0	.000	.000
Porcupine	0	0	.000	.000	0	0	.000	.000
Summation ($\sum$)	--	114501.3	1.000	.210	--	183589.7	1.000	.190
Niche Width	--	--	--	4.760	--	--	--	5.260
Relative Niche Width	--	--	--	.183	--	--	--	.188

Appendix II: Calculation of Niche Width and Relative Niche Width for 1976 Year/Community

Species	Leaf Bay Number	Biomass	Pi	$(Pi)^2$	George River Number	Biomass	Pi	$(Pi)^2$
Ringed Seal	421	13261.5	.137	.019	1365	42997.5	.113	.013
Bearded Seal	41	8892.9	.092	.009	146	31667.4	.083	.007
Harp Seal	0	0	.000	.000	23	2185.0	.006	.000
Ranger Seal	1	61.1	.001	.000	4	244.4	.001	.000
Beluga Whale	3	1881.0	.020	.000	18	11286.0	.030	.001
Walrus	2	816.0	.008	.000	0	0	.000	.000
Polar Bear	2	700.0	.007	.000	14	4900.0	.013	.000
Caribou	304	38912.0	.403	.162	1044	133632.0	.350	.123
Arctic Fox	165	544.5	.006	.000	276	910.8	.002	.000
Snow Goose	0	0	.000	.000	8	28.0	.000	.000
Canada Goose	236	1109.2	.012	.000	606	2848.2	.008	.000
Duck	455	765.0	.008	.000	1037	1762.9	.005	.000
Murre	38	38.0	.000	.000	215	215.0	.001	.000
Guillemot	66	52.8	.001	.000	284	227.2	.001	.000
Loons	5	12.5	.000	.000	95	237.5	.001	.000
Arctic Char	4992	22464.0	.232	.054	26094	117423.0	.307	.095
Salmon	22	187.0	.002	.000	647	5499.5	.014	.000
Lake Trout	367	2569.0	.027	.001	1440	10080.0	.026	.001
Cod	0	0	.000	.000	169	422.5	.001	.000
Whitefish	37	55.5	.001	.000	827	1240.5	.003	.000
Brook Trout	577	1154.0	.012	.000	3631	7262.0	.017	.000
Sculpin	1093	546.5	.006	.000	921	460.5	.001	.000
Ld.-Lkd. Char	77	192.5	.002	.000	441	1102.5	.003	.000
Hare	8	40.8	.000	.000	72	367.2	.001	.000
Ptarmigan	2290	1832.0	.019	.000	4716	3772.8	.010	.000
Grouse	18	12.6	.000	.000	55	38.5	.000	.000
Partridge	270	189.0	.002	.000	879	615.3	.002	.000
Owls	2	7.0	.000	.000	15	52.5	.000	.000
Black Bear	1	210.0	.002	.000	2	420.0	.001	.000
Porcupine	2	21.0	.000	.000	4	42.0	.000	.000
Summation ($\sum$)	--	96527.4	1.000	.245	--	381940.7	--	.240
Niche Width	--	--	--	4.080	--	--	--	4.170
Relative Niche Width	--	--	--	.151	--	--	--	.144

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)
(Proportional Contribution)^2/Species/Month/Community

Community:Koartak

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	.068	.070	.114	.114	.256	.169	.130	.382	.151	.101	.003	.075
Bearded Seal		.002	.001	.002	.006	.002	.018	.060	.195	.159	.002	
Harp Seal							.000	.001	.000	.003		
Ranger Seal											.000	
Beluga Whale				.014		.070	.075		.015	.013	.646	
Walrus						.003					.001	.019
Polar Bear			.023									
Caribou	.307	.190	.042	.015	.024	.001						
Arctic Fox	.006	.002	.001	.000	.000							.000
Snow Goose					.000							
Canada Goose				.001	.002	.002	.000	.002	.000			
Duck				.000		.000	.000	.000	.000	.003	.000	
Murre						.000	.000	.000				
Guillemot			.000	.000	.000							
Loons						.000	.000	.000	.000			
Arctic Char	.003	.024	.023	.033	.004	.001	.023	.003	.000	.001	.002	.263
Salmon							.000					
Lake Trout	.001	.002	.003	.015	.004	.004	.001			.000	.000	.000
Cod						.000				.000		
Whitefish										.000	.000	.000
Brook Trout					.000							
Sculpin						.000	.000	.000				
Ld.-Lkd.Char	.000	.000	.001	.000	.000	.000	.000			.000	.000	
Hare	.000	.000									.000	
Ptarmigan			.000	.000	.005	.000			.000			
Grouse												
Partridge			.000		.000	.000						
Owls												
Black Bear												
Porcupine												
Summation ($\sum(Pi)^2$)	.385	.290	.208	.194	.301	.252	.247	.448	.361	.280	.654	.360
Niche Width	2.600	3.450	4.810	5.160	3.320	3.970	4.050	2.230	2.770	3.570	1.530	2.780
Rel. Niche Width	.371	.431	.437	.430	.255	.248	.312	.248	.308	.357	.139	.463

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

Proportional Contribution (Pi)/Species/Community

Community: Koartak

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	.261	.264	.338	.337	.506	.411	.361	.618	.388	.318	.052	.274
Bearded Seal		.049	.032	.042	.079	.046	.136	.245	.442	.399	.049	
Harp Seal							.012	.021	.018	.052		
Ranger Seal											.002	
Beluga Whale				.120		.264	.275		.122	.115	.804	
Walrus						.057					.026	.136
Polar Bear			.152									
Caribou	.554	.436	.204	.122	.155	.036						
Arctic Fox	.079	.046	.024	.004	.001							
Snow Goose					.001							.004
Canada Goose				.027	.049	.042	.007	.048	.001			
Duck				.005		.004	.002	.005	.014	.053	.002	
Murre						.002	.005	.007				
Guillemot			.001	.001	.001							
Loons						.000	.000	.000	.000			
Arctic Char	.051	.156	.151	.183	.060	.034	.153	.053	.013	.031	.046	.512
Salmon							.009					
Lake Trout	.037	.040	.058	.122	.059	.064	.022			.017	.017	.058
Cod						.000				.001		
Whitefish										.009	.002	.015
Brook Trout					.001							
Sculpin						.012	.010	.002				
Ld.-Lkd.Char	.013	.007	.028	.017	.017	.016	.010			.005	.001	
Hare	.004	.002									.000	
Ptarmigan			.012	.020	.072	.012			.001			
Grouse												
Partridge			.001		.001	.000						
Owls												
Black Bear												
Porcupine												

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

Biomass Capture/Species/Month/Community

Community: Koartak

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	1323.0	1165.5	2331.0	1764.0	4189.5	5859.0	5764.5	2740.5	4000.5	1732.5	1606.6	819.0
Bearded Seal		216.9	216.9	216.9	650.7	650.7	2169.0	1084.5	4554.9	2169.0	1518.3	
Harp Seal							190.0	95.0	190.0	285.0		
Ranger Seal											61.1	
Beluga Whale				627.0		3762.0	4389.0		1254.0	627.0	2508.0	
Walrus						816.0					816.0	408.0
Polar Bear			1050.0									
Caribou	2816.0	1920.0	1408.0	640.0	1280.0	512.0						
Arctic Fox	402.6	201.3	161.7	23.1	6.6							13.2
Snow Goose					7.0							
Canada Goose				141.0	408.9	592.2	108.1	211.5	14.1			
Duck				25.5		62.9	35.7	22.1	142.8	290.7	68.0	
Murre						27.0	80.0	33.0				
Guillemot			8.0	4.0	4.0							
Loons					2.5		2.5	7.5	2.5			
Arctic Char	261.0	688.5	1039.5	954.0	495.0	481.5	2439.0	2340.0	135.0	171.0	1431.0	1534.5
Salmon							136.0					
Lake Trout	189.0	175.0	399.0	637.0	490.0	917.0	350.0			91.0	539.0	175.0
Cod						2.5				2.5		
Whitefish										48.0	51.0	45.0
Brook Trout					4.0							
Sculpin						164.0	153.0	7.5				
Ld.-Lkd.Char	67.5	30.0	195.0	90.0	137.5	232.5	162.5			25.0	32.5	
Hare	20.4	10.2									5.1	
Ptarmigan			80.0	106.4	596.0	164.0			9.6			
Grouse												
Partridge			7.0		8.4	2.8						
Owls												
Black Bear												
Porcupine												
Summation(Σ)	5079.5	4407.4	6896.1	5228.9	8277.6	14248.6	15979.3	4435.6	10303.4	5441.7	31208.5	2994.7

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

(Proportional Contribution)^2/Species/Month/Community

Community: Payne Bay

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	.001	.012	.008	.020	.043	.106	.029	.013	.050	.047	.000	
Bearded Seal	.006	.004	.041	.089	.008	.048	.043	.036	.048	.010	.000	
Harp Seal							.000	.000				
Ranger Seal												
Beluga Whale					.063	.014	.111	.075	.020		.001	
Walrus							.002	.002				
Polar Bear							.000					
Caribou	.029	.087	.051	.043	.001		.000	.000		.000	.004	.036
Arctic Fox	.000	.000	.000	.000	.000			.000			.000	.000
Snow Goose						.000			.000			
Canada Goose					.010	.003	.000	.000	.000	.000		
Duck				.000	.000	.000	.000	.000	.001	.000	.000	
Murre				.000	.000	.000	.000	.000	.000			
Guillemot					.000	.000	.000	.000	.000			
Loons						.000	.000	.000	.000		.000	
Arctic Char	.364	.173	.126	.020	.008	.028	.036	.074	.105	.241	.554	.370
Salmon							.000	.000			.000	
Lake Trout	.007	.009	.011	.015	.013	.004	.000	.002	.001	.012	.009	.031
Cod									.000			
Whitefish	.000		.000					.000	.000			
Brook Trout	.000	.000	.000				.000	.000	.000	.000	.000	.000
Sculpin					.000	.000	.000	.000	.000	.000		.000
Ld.-Lkd. Char	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
Hare	.000	.000			.000	.000			.000	.000	.000	.000
Ptarmigan	.000	.000	.000	.005	.009	.000	.000	.000	.001	.002	.000	.000
Grouse					.000							
Partridge		.000			.000	.000						
Owls	.000											
Black Bear												
Porcupine												
Summation($\Sigma(Pi)^2$)	.407	.285	.237	.192	.155	.203	.221	.202	.226	.312	.568	.437
Niche Width	2.46	3.51	4.22	5.21	6.45	4.93	4.53	4.95	4.43	3.21	1.76	2.29
Rel.Niche Width	.205	.319	.422	.521	.379	.308	.238	.248	.261	.268	.126	.254

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

Proportional Contribution (Pi)/Species/Month/Community

Community: Payne Bay

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	.033	.111	.088	.141	.208	.325	.170	.114	.223	.217	.010	
Bearded Seal	.077	.059	.202	.298	.087	.218	.207	.189	.219	.102	.020	
Harp Seal							.011	.008				
Ranger Seal												
Beluga Whale					.251	.118	.334	.274	.141		.030	
Walrus							.045	.049				
Polar Bear							.008					
Caribou	.169	.295	.225	.208	.034		.009	.020		.020	.066	.036
Arctic Fox	.019	.014	.007	.010	.001			.001			.004	.004
Snow Goose						.001			.000			
Canada Goose					.098	.057	.002	.003	.007	.002		
Duck				.001	.003	.013	.004	.009	.023	.008	.001	
Murre				.001	.001	.007	.002	.003	.001			
Guillemot					.000	.002	.001	.000	.001			
Loons						.001	.000	.000	.001		.000	
Arctic Char	.603	.415	.355	.141	.087	.168	.189	.272	.324	.491	.744	.609
Salmon							.001	.000			.007	
Lake Trout	.081	.094	.107	.124	.116	.062	.013	.047	.035	.107	.095	.177
Cod									.001			
Whitefish	.000		.005					.000	.001			
Brook Trout	.001	.000	.002				.002	.008	.001	.002	.003	.003
Sculpin					.002	.002	.003	.002	.002	.000		.000
Ld.-Lkd.Char	.006	.005	.007	.006	.006	.008	.001	.000		.003	.006	.002
Hare	.003	.002			.011	.001			.001	.004	.008	.004
Ptarmigan	.007	.005	.002	.071	.094	.017	.000	.001	.021	.045	.005	.013
Grouse					.001							
Partridge		.001			.000	.000						
Owls	.000											
Black Bear												
Porcupine												

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

Biomass Capture/Species/Month/Community

Community: Payne Bay

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	378.0	819.0	850.5	1134.0	3118.5	5166.0	7654.5	2866.5	1984.5	1386.0	220.5	
Bearded Seal	867.6	433.8	1952.1	2385.9	1301.4	3470.4	9326.7	4771.8	1952.1	650.7	433.8	
Harp Seal							475.0	190.0				
Ranger Seal												
Beluga Whale					3762.0	1881.0	15048.0	6897.0	1254.0		627.0	
Walrus							2040.0	1224.0				
Polar Bear							350.0					
Caribou	1920.0	2176.0	2176.0	1664.0	512.0		384.0	512.0		128.0	1408.0	1792.0
Arctic Fox	214.5	102.3	62.7	79.2	19.8			33.0			82.5	33.0
Snow Goose						17.5			3.5			
Canada Goose					1471.1	911.8	84.6	70.5	61.1	9.4		
Duck				8.5	44.2	204.0	178.5	226.1	202.3	47.6	13.6	
Murre				5.0	10.0	113.0	87.0	63.0	7.0			
Guillemot					5.6	35.2	32.0	8.0	4.0			
Loons						10.0	10.0	2.5	10.0		5.0	
Arctic Char	6840.0	3069.0	3429.0	1134.0	1305.0	2664.0	8523.0	6862.5	2893.5	3136.5	15795.0	5769.0
Salmon							42.5	8.5			144.5	
Lake Trout	917.0	693.0	1029.0	994.0	1729.0	980.0	595.0	1183.0	308.0	686.0	2023.0	1680.0
Cod									10.0			
Whitefish	1.5		45.0					3.0	9.0			
Brook Trout	16.0	2.0	20.0				96.0	206.0	6.0	10.0	62.0	30.0
Sculpin					25.0	28.5	127.0	49.5	19.5	2.0		0.5
Ld.-Lkd.Char	67.5	40.0	70.0	47.5	87.5	122.5	40.0	10.0		20.0	125.0	17.5
Hare	35.7	15.3			158.1	15.3			5.1	25.5	178.5	35.7
Ptarmigan	74.4	33.6	20.0	568.8	1404.0	276.8	8.8	33.6	191.2	288.0	101.6	123.2
Grouse					7.0							
Partridge		3.5			6.3	2.8						
Owls	3.5											
Black Bear												
Porcupine												
Summation (Σ)	11335.7	7387.5	9654.3	8020.9	14966.5	15898.8	45102.6	25220.5	8920.8	6389.7	21220.0	9480.9

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

(Proportional Contribution)^2/Species/Month/Community

Community:Leaf Bay

Species	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal			.001	.009	.040	.118	.146	.190	.026	.009	.000	
Bearded Seal						.023	.127	.042	.014	.046		
Harp Seal												
Ranger Seal									.000			
Beluga Whale							.006	.012				
Walrus							.003	.001				
Polar Bear								.004				
Caribou	.360	.170	.394	.093	.056	.001		.010	.241	.006	.498	.560
Arctic Fox	.000	.000	.000							.001	.000	.000
Snow Goose												
Canada Goose					.052	.000		.000	.000			
Duck					.000	.002	.000	.000	.000	.000		
Murre						.000	.000	.000	.000			
Guillemot					.000	.000	.000	.000	.000	.000		
Loons							.000					
Arctic Char	.125	.237	.065	.207	.026	.082	.008	.001	.005	.270	.055	.008
Salmon								.000	.000			
Lake Trout	.000		.000	.003	.005	.015	.000			.000	.001	.002
Cod												
Whitefish	.000		.000	.000	.000	.000						.000
Brook Trout	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.004
Sculpin						.000	.000	.000	.001	.001		
Ld.-Lkd.Char	.000	.000	.000	.000	.001	.000	.000					
Hare	.000				.000	.000	.000				.000	.000
Ptarmigan	.001	.004	.003	.005	.003	.000			.000	.000	.000	.000
Grouse								.000			.000	
Partridge		.000	.000	.000	.000	.000			.000	.000	.000	.000
Owls		.000	.000									
Black Bear									.004			
Porcupine			.000									.000
Summation($\sum(Pi)^2$)	.486	.411	.463	.317	.183	.241	.290	.260	.291	.333	.554	.575
Niche Width	2.06	2.43	2.16	3.16	5.47	4.15	3.45	3.85	3.44	3.00	1.81	1.74
Rel.Niche Width	.229	.304	.180	.351	.421	.259	.246	.241	.246	.250	.181	.174

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

Proportional Contribution (Pi)/Species/Month/Community

Community: Leaf Bay

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal			.025	.096	.199	.344	.382	.436	.161	.096	.005	
Bearded Seal						.150	.356	.204	.119	.213		
Harp Seal												
Ranger Seal									.011			
Beluga Whale							.079	.107				
Walrus							.052	.035				
Polar Bear								.060				
Caribou	.600	.412	.628	.304	.236	.022		.098	.491	.076	.706	.748
Arctic Fox	.005	.014	.005							.033	.000	.008
Snow Goose												
Canada Goose					.229	.016		.008	.010			
Duck					.016	.041	.013	.009	.013	.020		
Murre						.001	.003	.001	.001			
Guillemot					.001	.000	.001	.002	.001	.001		
Loons							.001					
Arctic Char	.353	.487	.254	.455	.160	.285	.088	.024	.069	.520	.235	.092
Salmon								.008	.017			
Lake Trout	.011		.019	.055	.074	.121	.009			.002	.035	.045
Cod												
Whitefish	.001		.001	.001	.002	.001						.003
Brook Trout	.001	.013	.006	.010	.004	.005	.016	.002		.005	.010	.063
Sculpin						.003	.001	.006	.030	.028		
Ld.-Lkd.Char	.001	.008	.002	.003	.025	.008	.000					
Hare	.001				.001	.002	.001				.000	.001
Ptarmigan	.029	.063	.058	.073	.052	.001		.000	.009	.005	.005	.036
Grouse								.000			.001	
Partridge		.002	.001	.004	.002	.001			.004	.002	.003	.005
Owls		.001	.001									
Black Bear									.064			
Porcupine			.002									.001

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

Biomass Capture/Species/Month/Community

Community: Leaf Bay

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal			157.5	283.5	756.0	1984.5	3024.0	5103.0	882.0	976.5	94.5	
Bearded Seal						867.6	2819.7	2385.9	650.7	2169.0		
Harp Seal												
Ranger Seal									61.1			
Beluga Whale							627.0	1254.0				
Walrus							408.0	408.0				
Polar Bear								700.0				
Caribou	6400.0	1280.0	3968.0	896.0	896.0	128.0		1152.0	2688.0	768.0	13312.0	7424.0
Arctic Fox	56.1	42.9	33.0							330.0	6.6	75.9
Snow Goose												
Canada Goose					869.5	89.3		94.0	56.4			
Duck					59.5	234.6	100.3	100.3	69.7	200.6		
Murre						5.0	22.0	11.0	7.2			
Guillemot					4.0	0.8	8.0	23.2	7.5	9.6		
Loons							5.0					
Arctic Char	3766.5	1512.0	1606.5	1341.0	607.5	1647.0	693.0	279.0	378.0	5287.5	4437.0	909.0
Salmon								93.5	93.5			
Lake Trout	112.0		119.0	161.0	280.0	700.0	70.0			21.0	665.0	441.0
Cod												
Whitefish	12.0		4.5	3.0	6.0	3.0						27.0
Brook Trout	10.0	40.0	36.0	28.0	14.0	26.0	128.0	26.0		46.0	180.0	620.0
Sculpin						15.0	7.5	72.5	164.5	287.0		
Ld.-Lkd.Char	7.5	25.0	10.0	7.5	95.0	45.0	2.5					
Hare	5.1				5.1	10.2	5.1				5.1	10.2
Ptarmigan	304.8	195.2	366.4	215.2	198.4	8.0		1.6	47.2	50.4	86.4	358.4
Grouse								3.5			9.1	
Partridge		7.0	7.0	10.5	7.0	7.0			23.1	23.1	60.2	44.1
Owls		3.5	3.5									
Black Bear									350.0			
Porcupine			10.5									10.5
Summation ($\sum$)	10674.0	3105.6	6321.9	2945.7	3798.0	5771.0	7920.1	11707.5	5478.9	10168.7	18855.9	9920.1

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)
(Proportional Contribution)^2/Species/Month/Community

Community: George River

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	.006	.001	.007	.023	.094	.029	.007	.017	.011	.006	.005	.004
Bearded Seal	.002	.001	.001	.004	.058	.006	.007	.006	.013	.020	.001	.002
Harp Seal	.000				.000	.000		.000	.000	.000	.000	
Ranger Seal					.000		.000					
Beluga Whale						.006	.005	.015				
Walrus												
Polar Bear	.001	.000	.001	.000		.000	.001	.000				
Caribou	.190	.360	.155	.168	.027	.016	.019	.100	.142	.233	.237	.313
Arctic Fox	.000	.000	.000	.000		.000	.000	.000		.000	.000	.000
Snow Goose						.000			.000	.000		
Canada Goose				.000	.002	.000	.000	.000	.000	.000	.000	
Duck						.000	.000	.000	.000	.000	.000	
Murre				.000	.000	.000	.000	.000	.000	.000		
Guillemot					.000	.000	.000	.000	.000	.000		
Loons					.000	.000	.000	.000	.000	.000		
Arctic Char	.104	.083	.096	.086	.009	.216	.288	.050	.112	.010	.075	.087
Salmon	.000		.003		.000	.000	.000	.002	.000	.000	.000	.000
Lake Trout	.000	.000	.002	.000	.006	.000	.000	.000	.000	.002	.006	.000
Cod				.000	.000	.000	.000	.000	.000	.000	.000	
Whitefish						.000	.000	.000	.000	.001	.000	.000
Brook Trout	.000	.000	.001	.000	.000	.000	.000	.000	.000	.011	.000	.000
Sculpin						.000	.000	.000	.000	.000		
Ld.-Lkd.Char	.000		.000	.000	.000	.000	.000	.000	.000		.000	
Hare	.000	.000	.000		.000		.000	.000	.000	.000	.000	.000
Ptarmigan	.001	.000	.001	.001	.000	.000	.000	.000	.000	.000	.000	.000
Grouse	.000				.000		.000	.000		.000		.000
Partridge	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Owls	.000	.000			.000		.000					.000
Black Bear	.000					.000						
Porcupine										.000		
Summation($\sum(Pi)^2$)	.304	.445	.267	.282	.196	.273	.327	.190	.278	.283	.324	.406
Niche Width	3.29	2.25	3.75	3.55	5.10	3.66	3.06	5.26	3.60	3.53	3.09	2.46
Rel.Niche Width	.194	.188	.289	.254	.232	.153	.122	.219	.171	.154	.182	.176

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

Proportional Contribution (Pi)/Species/Month/Community

Community: George River

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	.079	.034	.084	.151	.307	.170	.083	.129	.103	.076	.073	.065
Bearded Seal	.039	.032	.026	.064	.242	.077	.086	.080	.114	.143	.030	.042
Harp Seal	.017				.016	.006		.012	.010	.003	.007	
Ranger Seal					.004		.002					
Beluga Whale						.074	.071	.123				
Walrus												
Polar Bear	.025	.013	.031	.015		.010	.026	.017				
Caribou	.435	.600	.393	.410	.164	.128	.138	.317	.377	.483	.487	.560
Arctic Fox	.016	.007	.004	.002		.000	.000	.000		.000	.001	.001
Snow Goose						.000			.000	.001		
Canada Goose				.003	.045	.013	.005	.014	.003	.002	.001	
Duck					.004	.012	.008	.009	.009	.005	.000	
Murre				.000	.000	.002	.001	.002	.001	.000		
Guillemot					.001	.001	.001	.002	.000	.000		
Loons					.001	.001	.002	.001	.001	.000		
Arctic Char	.323	.289	.309	.293	.095	.465	.536	.224	.335	.101	.273	.295
Salmon	.000		.049		.003	.012	.019	.041	.002	.002	.015	.009
Lake Trout	.006	.002	.047	.016	.078	.013	.008	.007	.016	.048	.078	.005
Cod				.002	.001	.001	.003	.004	.001	.000	.000	
Whitefish						.002	.004	.001	.001	.023	.000	.001
Brook Trout	.016	.006	.025	.013	.013	.005	.003	.004	.015	.105	.021	.005
Sculpin					.000	.001	.002	.003	.004	.002		
Ld.-Lkd.Char	.002		.002	.001	.007	.001	.000	.014	.002		.003	
Hare	.003	.001	.001		.001		.001	.000	.000	.001	.004	.001
Ptarmigan	.029	.010	.024	.026	.016	.000	.000	.000	.003	.003	.006	.012
Grouse	.000				.001		.000	.000		.000		.000
Partridge	.003	.001	.005	.004	.002	.000	.000	.000	.000	.001	.002	.003
Owls	.000	.000			.001		.000					.000
Black Bear	.008					.006						
Porcupine										.001		

Appendix III: Monthly Niche Width and Relative Niche Width Values (1976)

Biomass Capture/Species/Month/Community

Community: George River

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ringed Seal	2205.0	913.5	2803.5	3591.0	9103.5	5764.5	4378.5	5260.5	2929.5	2551.5	2142.0	1354.5
Bearded Seal	1084.5	867.6	867.6	1518.3	7157.7	2602.8	4554.9	3253.5	3253.5	4771.8	867.6	867.6
Harp Seal	475.0				475.0	190.0		475.0	285.0	95.0	190.0	
Ranger Seal					122.2		122.2					
Beluga Whale						2508.0		3762.0	5016.0			
Walrus												
Polar Bear	700.0	350.0	1050.0	350.0		350.0	1400.0	700.0				
Caribou	12160.0	16256.0	13184.0	9728.0	4864.0	4352.0	7296.0	12928.0	10752.0	16128.0	14336.0	11648.0
Arctic Fox	448.8	191.4	138.0	46.2		3.3	3.3	3.3		9.9	36.3	29.7
Snow Goose						3.5			3.5	21.0		
Canada Goose				79.9	1334.8	432.4	258.5	559.3	89.3	75.2	18.8	
Duck					124.1	414.8	442.0	358.7	263.5	158.1	1.7	
Murre				4.0	10.0	57.8	61.0	68.0	1.0	14.0		
Guillemot					16.8	65.6	60.0	65.6	16.0	3.2		
Loons					20.0	32.5	97.5	42.5	35.0	10.0		
Arctic Char	9022.5	7816.5	10359.0	6952.5	2799.0	15795.0	28434.4	9135.0	9558.0	3361.5	8046.0	6142.5
Salmon	8.5		1657.5		85.0	391.0	994.5	1632.0	42.5	51.0	442.0	195.5
Lake Trout	154.0	49.0	1582.0	371.0	2296.0	448.0	420.0	294.0	448.0	1610.0	2303.0	105.0
Cod				37.5	22.5	42.5	150.0	150.0	15.0	2.5	2.5	
Whitefish						52.5	235.5	28.5	144.0	753.0	9.0	18.0
Brook Trout	440.0	160.0	820.0	306.0	380.0	176.0	162.0	156.0	440.0	3506.0	614.0	102.0
Sculpin					5.0	32.5	117.5	128.0	109.0	68.5		
Ld.-Lkd.Char	50.0		62.5	25.0	215.0	32.5	20.0	562.5	55.0		80.0	
Hare	71.4	20.4	40.8		35.7		25.5	15.3	10.2	20.4	112.2	15.3
Ptarmigan	802.4	440.8	794.4	620.8	468.0	1.6	4.8	13.6	82.4	114.4	171.2	258.4
Grouse	2.1				19.6		6.3	2.1		0.7		7.7
Partridge	88.2	19.6	163.1	104.3	60.2	10.5	2.1	4.9	5.6	28.7	59.5	68.6
Owls	10.5	7.0			14.0		14.0					7.0
Black Bear	210.0					210.0						
Porcupine										42.0		
Summation (Σ)	27932.9	27091.8	33523.0	23734.5	29628.1	33968.5	53023.6	40852.0	28538.0	33396.4	29431.8	20819.8

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

(Proportional Contribution)^2/Species/Season/Community

Community: Koartak

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	.069	.014	.199	.174	.133	.005
Bearded Seal	.001	.001	.003	.025	.182	.002
Harp Seal				.000	.001	
Ranger Seal						.000
Beluga Whale		.003	.028	.046	.014	.537
Walrus			.001			
Polar Bear		.008				
Caribou	.249	.029	.006			
Arctic Fox	.004	.000	.000			.000
Snow Goose			.000			
Canada Goose		.000	.002	.000	.000	
Duck		.000	.000	.000	.000	.000
Murre			.000	.000		
Guillemot		.000	.000			
Loons			.000	.000	.000	
Arctic Char	.010	.027	.002	.017	.000	.008
Salmon				.000		
Lake Trout	.001	.007	.004	.000	.000	.000
Cod			.000		.000	
Whitefish					.000	.000
Brook Trout			.000			
Sculpin			.000	.000		
Ld.-Lkd. Char	.000	.001	.000	.000	.000	.000
Hare	.000					.000
Ptarmigan		.000	.001		.000	
Grouse						
Partridge		.000	.000			
Owls						
Black Bear						
Porcupine						
Summation (Σ)	.334	.190	.246	.262	.331	.553
Niche Width	2.99	5.26	4.07	3.82	3.02	1.81
Rel.Niche Width	.374	.376	.204	.294	.323	.151

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

Proportional Contribution(Pi)/Species/Season/Community

Community: Koartak

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	.262	.338	.446	.417	.364	.071
Bearded Seal	.023	.036	.058	.159	.427	.044
Harp Seal				.014	.030	
Ranger Seal						.002
Beluga Whale		.052	.167	.215	.120	.733
Walrus			.036			.036
Polar Bear		.087				
Caribou	.499	.169	.080			
Arctic Fox	.064	.015	.000			.000
Snow Goose			.000			
Canada Goose		.012	.044	.016	.001	
Duck		.002	.003	.003	.028	.002
Murre			.001	.006		
Guillemot		.001	.000			
Loons			.000	.001	.000	
Arctic Char	.000	.164	.043	.131	.019	.087
Salmon				.007		
Lake Trout	.038	.085	.063	.017	.006	.021
Cod			.000		.000	
Whitefish					.003	.003
Brook Trout			.000			
Sculpin			.000		.008	
Ld.-Lkd.Char	.010	.024	.016	.008	.002	.001
Hare	.003					.000
Ptarmigan		.015	.034		.001	
Grouse						
Partridge		.001	.001			
Owls						
Black Bear						
Porcupine						

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

Biomass Capture/Species/Season/Community

Community: Koartak

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	2488.5	4095.0	10048.5	8505.0	5733.0	2425.5
Bearded Seal	216.9	433.8	1301.4	3253.5	6723.9	1518.3
Harp Seal				285.0	475.0	
Ranger Seal						61.1
Beluga Whale		627.0	3762.0	4389.0	1881.0	25080.0
Walrus			816.0			1224.0
Polar Bear		1050.0				
Caribou	4736.0	2048.0	1792.0			
Arctic Fox	603.9	184.8	6.6			13.2
Snow Goose			7.0			
Canada Goose		141.0	1001.1	319.6	14.1	
Duck		25.5	62.9	57.8	433.5	68.0
Murre			27.0	113.0		
Guillemot		12.0	4.0			
Loons			2.5	10.0	2.5	
Arctic Char	949.5	1993.5	976.5	2673.0	306.0	2965.5
Salmon				136.0		
Lake Trout	364.0	1036.0	1407.0	350.0	91.0	714.0
Cod			2.5		2.5	
Whitefish					48.0	96.0
Brook Trout			4.0			
Sculpin			164.0	160.5		
Ld.-Lkd. Char	97.5	285.0	370.0	162.5	25.0	32.5
Hare	30.6					5.1
Ptarmigan		186.4	760.0		9.6	
Grouse						
Partridge		7.0	11.2			
Owls						
Black Bear						
Porcupine						
Summation ($\sum$)	9486.9	12125.0	22526.2	20414.9	15745.1	34203.2

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)
(Proportional Contribution)^2/Species/Season/Community

Community: Payne Bay

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	.004	.013	.072	.023	.048	.000
Bearded Seal	.005	.060	.024	.040	.029	.000
Harp Seal				.000		
Ranger Seal						
Beluga Whale			.034	.097	.007	.000
Walrus				.002		
Polar Bear				.000		
Caribou	.048	.047	.000	.000	.000	.011
Arctic Fox	.000	.000	.000	.000		.000
Snow Goose			.000		.000	
Canada Goose			.006	.000	.000	
Duck			.000	.000	.000	.000
Murre			.000	.000	.000	
Guillemot			.000	.000	.000	
Loons			.000	.000	.000	.000
Arctic Char	.280	.067	.017	.048	.155	.493
Salmon				.000		.000
Lake Trout	.007	.013	.008	.001	.004	.015
Cod					.000	
Whitefish	.000	.000		.000	.000	
Brook Trout	.000	.000		.000	.000	.000
Sculpin			.000	.000	.000	.000
Ld.-Lkd.Char	.000	.000	.000	.000	.000	.000
Hare	.000		.000		.000	.000
Ptarmigan	.000	.001	.003	.000	.001	.000
Grouse			.000			
Partridge	.000		.000			
Owls	.000					
Black Bear						
Porcupine						
Summation (Σ)	.344	.201	.164	.211	.244	.519
Niche Width	2.91	4.98	6.10	4.74	4.10	1.93
Rel. Niche Width	.224	.498	.321	.226	.216	.129

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

Proportional Contribution (Pi)/Species/Season/Community

Community:Payne Bay

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	.064	.112	.268	.150	.220	.007
Bearded Seal	.070	.245	.115	.201	.170	.014
Harp Seal				.010		
Ranger Seal						
Beluga Whale			.183	.312	.082	.020
Walrus				.046		
Polar Bear				.005		
Caribou	.219	.217	.017	.013	.008	.104
Arctic Fox	.017	.008	.001	.001		.004
Snow Goose			.001			
Canada Goose			.077	.002	.005	
Duck			.008	.006	.016	.000
Murre			.004	.002	.001	
Guillemot			.001	.001	.000	
Loons			.000	.000	.001	.000
Arctic Char	.529	.258	.129	.219	.394	.702
Salmon				.001		
Lake Trout	.086	.115	.088	.025	.065	.121
Cod					.001	
Whitefish	.000	.003		.000	.001	
Brook Trout	.001	.001		.004	.001	.003
Sculpin			.002	.003	.001	.000
Ld.-Lkd.Char	.006	.007	.007	.001	.001	.005
Hare	.003		.006		.002	.007
Ptarmigan	.006	.033	.055	.001	.031	.007
Grouse			.000			
Partridge	.000		.000			
Owls	.000					
Black Bear						
Porcupine						

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

Biomass Capture/Species/Season/Community

Community: Payne Bay

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	1197.0	1984.5	8284.5	10521.0	3370.5	220.5
Bearded Seal	1301.4	4338.0	4771.8	14098.5	2602.8	433.8
Harp Seal				665.0		
Ranger Seal						
Beluga Whale			5643.0	21945.0	1254.0	627.0
Walrus				3624.0		
Polar Bear				350.0		
Caribou	4096.0	3840.0	512.0	896.0	128.0	3200.0
Arctic Fox	316.0	141.9	19.8	33.0		115.5
Snow Goose			17.5		3.5	
Canada Goose			2382.9	155.1	70.5	
Duck			248.2	404.6	249.9	13.6
Murre			123.0	150.0	7.0	
Guillemot			40.8	40.0	4.0	
Loons			10.0	12.5	10.0	
Arctic Char	9909.0	4563.0	3969.0	15385.5	6030.0	21564.0
Salmon				51.0		
Lake Trout	1610.0	2023.0	2709.0	1778.0	994.0	3703.0
Cod					10.0	
Whitefish	1.5	45.0		3.0	9.0	
Brook Trout	18.0	20.0		302.0	16.0	92.0
Sculpin			53.5	176.0	21.5	0.5
Ld.-Lkd.Char	107.5	117.5	210.0	50.0	20.0	142.5
Hare	51.0		173.4		30.6	214.2
Ptarmigan	108.0	588.8	1680.3	42.4	479.2	224.8
Grouse			7.0			
Partridge	3.5		9.1			
Owls	3.5					
Black Bear						
Porcupine						
Summation (Σ)	18723.2	17675.2	30865.3	70323.1	15310.5	30700.9

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

(Proportional Contribution)^2/Species/Season/Community

Community: Leaf Bay

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal		.002	.082	.171	.014	.000
Bearded Seal			.008	.070	.032	
Harp Seal						
Ranger Seal					.004	
Beluga Whale				.009		
Walrus				.002		
Polar Bear				.001		
Caribou	.310	.276	.012	.004	.049	.520
Arctic Fox	.000	.000			.000	.000
Snow Goose						
Canada Goose			.010	.000	.000	
Duck			.001	.000	.000	
Murre			.000	.000	.000	
Guillemot			.000	.000	.000	
Loons				.000		
Arctic Char	.147	.101	.056	.003	.131	.035
Salmon				.000	.000	
Lake Trout	.000	.001	.010	.000	.000	.001
Cod						
Whitefish	.000	.000	.000			.000
Brook Trout	.000	.000	.000	.000	.000	.001
Sculpin			.000	.000	.001	
Ld.-Lkd. Char	.000	.000	.000	.000		
Hare	.000		.000	.000		.000
Ptarmigan	.001	.004	.001	.000	.000	.000
Grouse				.000		.000
Partridge	.000	.000	.000		.000	.000
Owls	.000	.000				
Black Bear					.001	
Porcupine		.000				.000
Summation (Σ)	.458	.384	.180	.260	.228	.557
Niche Width	2.18	2.60	5.56	3.85	4.39	1.80
Rel. Niche Width	.198	.217	.348	.193	.258	.150

Appendix IV. Niche Width and Relative Niche Width by Season and Community (1976)

Proportional Contribution (Pi)/Species/Season/Community

Community: Leaf Bay

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal		.048	.286	.414	.119	.003
Bearded Seal			.091	.265	.180	
Harp Seal						
Ranger Seal					.004	
Beluga Whale				.096		
Walrus				.042		
Polar Bear				.036		
Caribou	.557	.525	.107	.059	.221	.721
Arctic Fox	.007	.004			.021	.003
Snow Goose						
Candaa Goose			.100	.005	.004	
Duck			.031	.010	.017	
Murre			.001	.002	.001	
Guillemot			.001	.002	.001	
Loons				.000		
Arctic Char	.383	.318	.236	.050	.362	.186
Salmon				.006	.006	
Lake Trout	.008	.030	.102	.004	.001	.038
Cod						
Whitefish	.001	.001	.001			.001
Brook Trout	.004	.007	.004	.008	.003	.028
Sculpin			.002	.004	.029	
Ld.-Lkd. Char	.002	.002	.015	.000		
Hare	.000		.002	.000		.001
Ptarmigan	.036	.063	.022	.000	.006	.016
Grouse				.000		
Partridge	.001	.002	.002		.003	.004
Owls	.000	.000				
Black Bear					.022	
Porcupine		.001				

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

Biomass Capture/Species/Season/Community

Community: Leaf Bay

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal		441.0	2740.5	8127.0	1858.5	94.5
Bearded Seal			867.6	5205.6	2819.7	
Harp Seal						
Ranger Seal					61.1	
Beluga Whale				1881.0		
Walrus				816.0		
Polar Bear				700.0		
Caribou	7680.0	4864.0	1024.0	1152.0	3456.0	20736.0
Arctic Fox	99.0	33.0			330.0	82.5
Snow Goose						
Canada Goose			958.8	94.0	56.4	
Duck			294.1	200.6	270.3	
Murre			5.0	33.0	7.2	
Guillemot			4.8	31.2	17.1	
Loons				5.0		
Arctic Char	5278.5	2947.5	2254.5	972.0	5665.5	5345.0
Salmon				93.5	93.5	
Lake Trout	112.0	280.0	980.0	70.0	21.0	1106.0
Cod	12.0	7.5	9.0			27.0
Whitefish						
Brook Trout	50.0	64.0	40.0	154.0	46.0	800.0
Sculpin			15.0	80.0	451.5	
Ld.-Lkd.Char	32.5	17.5	140.0	2.5		
Hare	5.1		15.3	5.1		15.3
Ptarmigan	500.0	581.6	206.4	1.6	97.6	444.8
Grouse				3.5		9.1
Partridge	7.0	17.5	14.0		46.2	104.3
Owls	3.5	3.5				
Black Bear					350.0	
Porcupine		10.5				
Summation ($\sum$)	13779.6	9267.6	9569.0	19627.6	15647.6	28776.0

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

(Proportional Contribution)^2/Species/Season/Community

Community: George River

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	.003	.013	.055	.011	.008	.005
Bearded Seal	.001	.002	.024	.007	.017	.001
Harp Seal	.000		.000	.000	.000	.000
Ranger Seal			.000	.000		
Beluga Whale			.002	.009		
Walrus						
Polar Bear	.000	.001	.000	.001		
Caribou	.266	.160	.021	.046	.188	.267
Arctic Fox	.000	.000	.000	.000	.000	.000
Snow Goose			.000		.000	
Canada Goose		.000	.001	.000	.000	.000
Duck			.000	.000	.000	.000
Murre		.000	.000	.000	.000	
Guillemot			.000	.000	.000	
Loons			.000	.000	.000	
Arctic Char	.094	.091	.085	.160	.044	.080
Salmon	.000	.001	.000	.001	.000	.000
Lake Trout	.000	.001	.002	.000	.001	.002
Cod		.000	.000	.000	.000	.000
Whitefish			.000	.000	.000	.000
Brook Trout	.000	.000	.000	.000	.004	.000
Sculpin			.000	.000	.000	
Ld.-Lkd.Char	.000	.000	.000	.000	.000	.000
Hare	.000	.000	.000	.000	.000	.000
Ptarmigan	.001	.001	.007	.000	.000	.000
Grouse	.000		.000	.000	.000	.000
Partridge	.000	.000	.000	.000	.000	.000
Owls	.000		.000	.000		.000
Black Bear	.000		.000			
Porcupine					.000	
Summation (Σ)	.365	.270	.190	.235	.262	.355
Niche Width	2.74	3.70	5.26	4.26	3.82	2.82
Rel. Niche Width	.161	.231	.188	.164	.159	.148

Appendix IV: Niche Width and Relative Niche Width by Season and Community (1976)

Proportional Contribution (Pi)/Species/Season/Community

Community: George River

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	.057	.112	.234	.103	.089	.070
Bearded Seal	.036	.042	.154	.083	.130	.035
Harp Seal	.009		.011	.005	.006	.004
Ranger Seal			.002	.001		
Beluga Whale			.039	.094		
Polar Bear	.019	.025	.006	.022		
Caribou	.516	.400	.145	.215	.434	.517
Arctic Fox	.012	.003	.000	.000	.000	.001
Snow Goose			.000	.000		
Canada Goose		.001	.028	.009	.003	.000
Duck			.009	.009	.007	.000
Murre		.000	.001	.001	.000	
Guillemot			.001	.001	.000	
Loons			.001	.001	.001	
Arctic Char	.306	.302	.292	.400	.209	.282
Salmon	.000	.001	.008	.028	.002	.013
Lake Trout	.004	.034	.043	.008	.033	.048
Cod		.001	.001	.003	.000	.000
Whitefish			.001	.003	.015	.001
Brook Trout	.011	.020	.009	.003	.064	.014
Sculpin			.001	.003	.003	
Ld.-Lkd.Char	.001	.002	.004	.006	.001	.002
Hare	.002	.001	.001	.000	.001	.003
Ptarmigan	.023	.025	.007	.000	.003	.009
Grouse	.000		.000	.000	.000	.000
Partridge	.002	.005	.001	.000	.001	.003
Owls	.000		.000	.000		.000
Black Bear	.004		.003			
Porcupine					.001	

Appendix IV: Niche Width and Relative Niche Width by Season and Community

Biomass Capture/Species/Season/Community

Community: George River

Species	Winter	Early Spring	Spring	Summer	Early Fall	Fall
Ringed Seal	3118.5	6394.5	14868.0	9639.0	5481.0	3496.5
Bearded Seal	1952.1	2385.9	9760.5	7898.4	8025.3	1735.2
Harp Seal	475.0		665.0	475.0	380.0	190.0
Ranger Seal			122.2	122.2		
Beluga Whale			2508.0	8778.0		
Walrus						
Polar Bear	1050.0	1400.0	350.0	2100.0		
Caribou	28416.0	22912.0	9216.0	20224.0	26880.0	25984.0
Arctic Fox	640.2	184.8	3.3	6.6	9.9	66.0
Snow Goose			3.5		24.5	
Canada Goose		79.9	1767.2	817.8	164.5	18.8
Duck			538.9	800.7	421.6	1.7
Murre		4.0	67.0	129.0	15.0	
Guillemot			82.4	125.6	19.2	
Loons			52.5	140.0	45.0	
Arctic Char	16839.0	17311.0	18594.0	37570.0	12919.5	14188.5
Salmon	8.5	1657.0	476.0	2626.5	93.5	637.5
Lake Trout	203.0	1953.0	2744.0	714.0	2058.0	2408.0
Cod		37.5	65.0	300.0	17.5	2.5
Whitefish			52.5	264.0	897.0	27.0
Brook Trout	600.0	1126.0	556.0	318.0	3946.0	716.0
Sculpin			37.5	245.5	177.5	
Ld.-Lkd.Char	50.0	87.5	247.5	582.5	55.0	80.0H
Hare	91.8	40.8	35.7	40.8	30.6	127.5
Ptarmigan	1243.2	1415.2	469.6	18.4	196.8	429.6
Grouse	2.1		19.6	8.4	0.7	7.7
Partridge	107.8	267.4	70.7	7.0	34.3	128.1
Owls	17.5		14.0	14.0		7.0
Black Bear	210.0		210.0			
Porcupine					42.0	
Summation (Σ)	55024.7	57257.5	63596.6	93875.6	61934.4	50251.6

Appendix V: Zonal Harvesting of Resources by Community
(1974-1975 Season)

Species	Koartak			Payne Bay			Leaf Bay			George River		
	Z1	Z2	H90% Total	Z1	Z2	H90% Total	Z1	Z2	H90% Total	Z1	Z2	H90% Total
Ringed Seal	809	162	971	272	538	1134	128	111	263	167	239	587
Bearded Seal	49	4	53	91	89	222	36	20	61	34	41	107
Harp Seal	10	3	13	1	5	6	0	0	0	3	9	13
Ranger Seal	0	0	0	0	0	0	24	3	27	2	2	4
Beluga Whale	23	13	36	23	18	48	8	2	9	14	7	27
Walrus	9	0	9	5	8	13	0	0	0	1	0	1
Polar Bear	5	0	5	3	18	24	0	0	0	1	4	5
Caribou	0	49	49	66	95	191	219	112	367	409	368	1073
Arctic Fox	517	48	565	232	357	675	95	130	242	306	57	513
Snow Goose	8	0	8	0	3	3	1	0	1	0	6	6
Canada Goose	149	20	169	347	290	795	267	145	449	179	240	570
Duck	584	5	589	413	243	955	165	256	494	221	309	871
Murre			273			807			69			238
Guillemot			56			179			52			312
Loons			13			55			55			117
Hare			2			71			46			99
Ptarmigan			1477			9923			1445			9644
Grouse			0			0			20			91
Partridge			0			584			0			1038
Owls			5			38			4			30
Black Bear			0			0			0			1
Porcupine			0			0			0			1
	FR-Bk	Bk-FR		FR-BK	BK-FR		FR-BK	BK-FR		FR-BK	BK-FR	
Arctic Char	1156	425		11505	14293		3124	1873		18053	10340	
Salmon	0	0		1	7		52	649		44	668	
Lake Trout	374	0		1931	363		682	60		1267	531	
Cod	1	1		0	5		0	0		0	109	
Whitefish	210	0		19	6		398	50		78	291	
Brook Trout	4	0		498	251		367	95		3991	1407	
Sculpin	162	295		83	888		60	256		0	0	
Ld.-Lkd.Char	234	0		0	0		121	14		0	0	

Appendix VII: Mathematical Variations of the Niche Width Formula

Conceivably, one could go so far as to reformulate the niche width formula to read as follows:

$$\text{Temporal Niche Width} \quad \sum_{j}^{t} \left[\frac{\sum_{i}^{n} (p_i)^2}{N} \right], \text{ where}$$

j time segment of total time interval T, i specific resource of total number of resources N, and p_i proportional contribution of resource i to total harvest for time segment j (not for total time interval T).

However, in order to make the obtained niche width value relative to the time interval T, it would be necessary to divide the obtained value by T. The resultant formula would be:

$$\text{Relative Temporal Niche Width} \quad \frac{\sum_{j}^{t} \left[\frac{\sum_{i}^{n} (p_i)^2}{N} \right]}{T} \ ,$$

where T total time interval (e.g.,year), or equals the summation of time segments t (e.g., months).

This procedure does not appear to provide a better value for a harvest niche width, than would otherwise be obtained by simply employing the basic formula for Niche Width, as presented by Hardesty.

Appendix VI: Comparison of Harvests from 1974-1975 Season and 1976 Year

Species	Koartak		Payne Bay		Leaf Bay		George River	
	74-75	1976	74-75	1976	74-75	1976	74-75	1976
Ringed Seal	895	1057	1123	812	213	421	635	1365
Bearded Seal	49	62	277	127	55	41	111	146
Harp Seal	12	8	7	7	0	0	16	23
Ranger Seal	0	1	0	0	24	1	3	4
Beluga Whale	31	57	43	47	7	3	19	18
Walrus	11	5	13	8	0	2	1	0
Polar Bear	7	3	24	1	0	2	4	14
Caribou	40	67	185	99	298	304	1038	1044
Arctic Fox	377	245	800	190	248	165	417	276
Snow Goose	8	2	3	6	1	0	6	8
Canada Goose	170	314	795	555	450	236	570	606
Duck	590	381	955	539	495	450	870	1037
Murre	275	140	810	285	70	38	240	215
Guillemot	55	20	180	106	55	66	315	284
Loons	15	6	55	15	55	5	120	95
Arctic Char	1600	2192	25800	13649	5000	4992	28400	26094
Salmon	0	16	8	23	700	22	715	647
Lake Trout	375	566	2295	1831	745	367	1800	1440
Cod	1	2	5	4	0	0	110	169
Whitefish	210	96	25	39	450	37	370	827
Brook Trout	5	2	750	224	465	577	5400	3631
Sculpin	460	649	970	504	315	1093	0	921
Ld.-Lkd. Char	235	389	0	259	135	77	0	441
Hare	2	7	70	92	45	8	100	72
Ptarmigan		1195		3905		2290		4716
Grouse	1480	0	10510	10	1465	18	10775	55
Partridge		26		18		270		879
Owls	5	0	40	1	5	2	30	15
Black Bear	0	0	0	0	0	1	2	2
Porcupine	0	0	0	0	0	2	1	4
Biomass	87067.9	114501.3	312603.3	183598.7	103852.3	96527.4	366486.8	381940.7

Appendix VIII: Niche Equivalence by Species and By Community Pairs

Species	Koartak/Payne Bay			Koartak/Leaf Bay			Koartak/George River			Payne Bay/Leaf Bay			Payne Bay/George River			Leaf Bay/George River		
	K(Pi)	PB(Pi)		K(Pi)	LB(Pi)		GR(Pi)	K(Pi)		PB(Pi)	LB(Pi)		GR(Pi)	PB(Pi)		GR(Pi)	LB(Pi)	
Ringed seal	.291	.139	.152	.291	.137	.154	.113	.291	.178	.139	.137	.002	.113	.139	.026	.113	.137	.024
Bearded Seal	.118	.150	.032	.118	.092	.026	.083	.118	.035	.150	.092	.058	.083	.170	.067	.083	.092	.009
Harp Seal	.007	.004	.003	.007	.000	.007	.006	.007	.001	.004	.000	.004	.006	.004	.002	.006	.000	.006
Ranger Seal	.001	.000	.001	.001	.001	.000	.001	.001	.000	.000	.001	.001	.001	.000	.001	.001	.001	.000
Beluga Whale	.312	.161	.151	.312	.020	.292	.030	.312	.282	.161	.020	.141	.030	.161	.131	.030	.020	.010
Walrus	.018	.018	.000	.018	.008	.010	.000	.018	.018	.018	.008	.010	.000	.018	.018	.000	.008	.008
Polar Bear	.009	.002	.007	.009	.007	.002	.013	.009	.004	.002	.007	.005	.013	.002	.011	.013	.007	.006
Caribou	.075	.069	.006	.075	.403	.328	.350	.075	.275	.069	.403	.334	.350	.069	.281	.350	.403	.053
Arctic Fox	.007	.003	.004	.007	.006	.001	.002	.007	.005	.003	.006	.003	.002	.003	.001	.002	.006	.004
Snow Goose	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Canada Goose	.013	.014	.001	.013	.012	.001	.008	.013	.005	.014	.012	.002	.008	.014	.006	.008	.012	.004
Duck	.006	.005	.001	.006	.008	.002	.005	.006	.001	.005	.008	.003	.005	.005	.000	.005	.008	.003
Murre	.001	.002	.001	.001	.000	.001	.001	.001	.000	.002	.000	.002	.001	.002	.001	.001	.000	.001
Guillemot	.000	.001	.001	.000	.001	.001	.001	.000	.001	.001	.001	.000	.001	.001	.000	.001	.001	.000
Loons	.000	.000	.000	.000	.000	.000	.001	.000	.001	.000	.000	.000	.001	.000	.001	.001	.000	.001
Arctic Char	.086	.335	.249	.086	.232	.146	.307	.086	.221	.335	.232	.103	.307	.335	.028	.307	.232	.075
Salmon	.001	.001	.000	.001	.002	.001	.014	.001	.013	.001	.002	.001	.014	.001	.013	.014	.002	.012
Lake Trout	.035	.070	.035	.035	.027	.008	.026	.082	.056	.070	.027	.043	.026	.070	.044	.026	.027	.001
Cod	.000	.000	.000	.000	.000	.000	.001	.000	.001	.000	.000	.000	.001	.000	.001	.001	.000	.001
Whitefish	.001	.000	.001	.001	.001	.000	.003	.001	.002	.000	.001	.001	.003	.000	.003	.003	.001	.002
Brook Trout	.000	.002	.002	.000	.012	.012	.017	.000	.017	.002	.012	.010	.017	.002	.015	.017	.012	.005
Sculpin	.003	.001	.002	.003	.006	.003	.001	.003	.002	.001	.006	.005	.001	.001	.000	.001	.006	.005
Ld.-Lkd.Char	.009	.004	.005	.009	.002	.007	.003	.009	.006	.004	.002	.002	.003	.004	.001	.003	.002	.001
Hare	.000	.003	.003	.000	.000	.000	.001	.000	.001	.003	.000	.003	.001	.003	.002	.001	.000	.001
Ptarmigan	.008	.016	.008	.008	.019	.011	.010	.008	.002	.016	.019	.003	.010	.016	.006	.010	.019	.009
Grouse	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Partridge	.000	.000	.000	.000	.002	.002	.002	.000	.002	.000	.002	.002	.002	.000	.002	.002	.002	.000
Owls	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Black Bear	.000	.000	.000	.000	.002	.002	.001	.000	.001	.000	.002	.002	.001	.000	.001	.000	.000	.000
Porcupine	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001	.002	.001
Summation	--	--	.665	--	--	1.017	--	--	1.083	--	--	.740	--	--	.662	--	--	.242
Niche Equivalence	--	--	.667	--	--	.491	--	--	.459	--	--	.630	--	--	.669	--	--	.879

Appendix IX: Variability in Hunter's Catch Size of Ringed Seal/Month/Community

Month	Catch Size 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	25	29	30	35	40	45	49	Number Successful Hunters
Koartak:																														
Jan.	1		1					1		1										1										5
Feb.	1	1		1	2					2																				7
Mar.	1		1	2	2		1			2													1							10
Apr.				2	4			1		2																				9
May	2	2	2	3	1				1	1					1					2					1					16
Jun.	2		1		2	1		2	1	2										2						1		1		15
Jul.	2	3	4				1			2										1		1	1	1			1			17
Aug.	1	3	2	1	3	1		1		1		1							1											15
Sep.	4	1	1	2	2	1	1		1	2	1		1	1						1										19
Oct.	2	3		3	1	1				1				1																12
Nov.	4	2	1		3							1	1																	12
Dec.							1												1											2
Payne Bay:																														
Jan.	2									1																				3
Feb.	2	1								1		1																		5
Mar.	1		1		1			1		1																				5
Apr.	1	2			1	1														1										6
May		5	2		2	2	1	1		1	1												1							16
Jun.	2	2	2	2	4	3	2										1			1			1		1					21
Jul.	2	6		1	3	2		1		2			1		1					1	1	1			1				1	24
Aug.	4	3	2		4	2				2	1	1																		19
Sep.	5	2	4		3	1	1							1																17
Oct.	5	4	2		1															1										13
Nov.		2	1																											3
Dec.																														

FOOTNOTES

1. Patrick M. Gaffney notes (1975:490) that Roswell H. Johnson used the concept of 'niche' in 1910, to represent "a unit of distribution determined primarily by food supply but also by environmental factors."

2. _Autecology_ is the study of the individual organism or an individual species; _synecology_ is the study of groups of organisms which are associated together as a unit (natural community); (Odum 1971:6).

3. All morphological, physiological, ecological and behavioural factors are, for the most part, assumed in the natural sciences to be genetically accountable (Odum 1971:240).

4. Definitions:

   commensalism - an interaction in which one population is benefited with no affect on the other;

   protocooperation - an interaction which benefits both populations but is not 'obligatory' in the sense that such a relation is not necessary for the livelihood of either population;

   mutualism - an interaction which benefits both populations, and is obligatory or necessary for both populations to survive under natural conditions (Odum 1971:211).

5. Antibiosis may be defined as an interaction where one population produces a substance harmful to the other population (Odum 1971:220).
6. The term 'Competitive Exclusion Principle' was coined by G. Hardin (1960).
7. Abiotic substrate is defined as a non-biological, material base.
8. A species' population's 'level of tolerance' denotes that there are minimum and maximum values for each habitat dimension or variable, within which the species' population can continue to viably exist (viability defined by the ability to survive and reproduce). This is based on V.E. Shelford's (1913) Law of Tolerance (see Odum 1971:107-108).
9. It appears that Hutchinson (1958:416) uses the term 'hyperspace' to refer to the potential niche relationship; it merely outlines the dimensions considered to be significant. On the other hand, the term 'hypervolume' is used to refer to the actual niche, after particular characters or features of these dimensions are considered. This differentiation will be employed in this thesis.
10. Apparently, Hutchinson (1958:416; footnote) uses the term 'environment' to represent any 'property' external to the organism under study.
11. Hutchinson (1958:416) credits MacArthur with coining the term 'fundamental niche'.

12. Hardesty mistakenly terms (1975:77) the information content function, from which the Niche Width formula is derived, as the Shannon-Weaver formula. This function was originally derived independently by Shannon and Weiner (Krebs 1972:506; footnote).

13. While spatial distribution of resources is a dimension of the habitat hyperspace, it may be argued also that such a dimension is relevant directly to the form of the niche relationship between the natural environment and the human aggregate (as a resource harvestor).

14. Freuchen and Salomonsen (1958:9) note that the term 'tundra' appears to have originated from the Finnish 'tunturi', meaning 'treeless plain'.

15. The treeline has been generally accepted as the southern terrestrial limit of the Arctic Zone (Freuchen and Salomonsen 1958:3).

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