INUIT HARVESTING STRATEGIES IN THE CANADIAN ARCTIC AND IMPLICATIONS FOR WILDLIFE MANAGEMENT

Marshall Netherwood
Darwin College

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Abstract

The thesis analyses two topics: native harvesting strategies and selected cases of over-exploitation. Its purpose is to assess the credibility of the assumption that hunter-gatherer societies do not have a system of self-regulation.

Theoretical explanations and models are described to elicit underlying principles and coherent systems in hunter-gatherer harvesting strategies and adaptation processes. Two annual cycles of the Netsilik Inuit are discussed and examined in a formal theory model to analyse what changes and effects occurred when the rifle was introduced to their subsistence economy.

The evidence supporting the Pleistocene overkill theory and the claim that hunters over-exploited some of the major barren-ground caribou herds in the Northwest Territories is examined. The evidence is found to be unproven and inconclusive.

The nature of self-regulation in hunter-gatherer societies as supported by ethnographic literature is described and determined to be extant. Hunters practice control in harvesting through the acquired knowledge and institutional means to monitor and avert overhunting. It is also evident that harvesters have a sound basis of knowledge and expertise in animal ecology. In the appendix, four cases are described where the traditional system of harvesting/management has proven successful and superior to state imposed wildlife management.

The thesis concludes that the assumption is erroneous: there exists a socially-constructed system of self-regulation. The implications for wildlife management are discussed and it is concluded that although there is greater recognition of the native system of harvesting/management today, it is not generally accepted that they possess the knowledge and expertise to organize an effective management strategy.

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INTRODUCTION

It is assumed by many that hunter-gatherer societies do not to have any self-regulatory system governing their harvesting strategies. Instead, it is assumed that they operate on a random basis of exploitation without consideration of other implications. Evidence of this, as the argument goes, is found in the numerous cases of over-exploitation of animal resources where hunters have neither the knowledge nor institutional means to monitor or avert over-hunting. Primarily on the basis of this evidence, protective legislation and wildlife management systems have been imposed to prevent animal populations from further decline and to restrict hunters' actions.

This thesis investigates the credibility of this assumption by examining native harvesting strategies and selected cases of over-exploitation in northern Canada. The present study focuses on Inuit harvesting strategies and includes a wider body of ethnographic literature on northern native groups.

Native hunting and over-exploitation

The evidence of over-exploitation can be divided into the time period before the advent of modern technology, refered to as the pre-rifle period, and the period after the general introduction of modern technology, refered to as the post-rifle period.

Pre-rifle period

One of the largest pre-modern events relating to over-exploitation is said to have occurred during the Pleistocene period, i.e. the time when hunters first entered North America. This event was the unprecedented extinction of vertebrate faunas (e.g. mammoths, mastodons, horses, ground sloth, etc.). There had been earlier periods where faunas were rendered extinct and were replaced by similarly adapted genera, but in the Pleistocene period this replacement did not occur. In North America, 46 small mammals and 56 large land mammals became extinct and a number of authors have marshalled arguments to the effect that hunters caused these extinctions through overkill. One of the most articulate spokesmen of this Pleistocene overkill hypothesis is Paul Martin.

Martin developed this theory for the following reasons. First, he became convinced that the other major hypothesis, climate, did not adequately account for these extinctions. Second, he became influenced by evidence regarding the relationship between humans and animals that became extinct (Grayson 1980 p. 390). He argues that when humans first arrived in North America and moved south of glacial ice about 11,500 years ago, these preadapted big-game hunters met with large animals. Because these animals had not previously been subject to human predation, they lacked the defensive behaviours they would otherwise have acquired. These spear and fire-equipped Clovis hunters took complete advantage of these animals and on their southward migration across this continent, left a trail of extinct populations, and, ultimately, extinct genera (Grayson 1980 p. 388). According to Martin (1967):

> The thought that prehistoric hunters ten to fifteen thousand years ago... exterminated far more large animals than has modern man with modern weapons and advanced technology is certainly provocative and perhaps even deeply disturbing. ... The late-Pleistocene extinction pattern leaves little room for any other explanation (Martin 1967 p. 115).

Post-rifle period

The Pleistocene overkill hypothesis is cited as evidence that over-exploitation occurs today for two reasons: first, for its "resemblance to [the] dire effects that recent human cultures are inflicting on many surviving species of large mammals" (Webb 1984 p. 192) and second, as spear-equipped hunters had no self-regulatory system to prevent over-exploitation, such is the case with rifle-equipped hunters who would simply escalate this wanton killing. Klein (1984), in refering to the hypothesis, writes "there is little doubt... that man has continued to play a major role in large mammal extinctions throughout North America up to the present time" and "even before the introduction of firearms in historical times, local extermination of musk ox (*Ovibus moscatus*) populations in Alaska and Canada occurred; these reductions were accelerated with the arrival of firearms..." (p. 173). According to Macpherson (1981):

> The immigrants from Asia, via Beringia, were hunters, and it has been shown (Martin 1967) that their advent extended a process which had long been current in the Old World - the depletion of the varied large mammal faunas of the Pleistocene era. Canada's present game animals are the survivors of the process (Macpherson 1981 p. 103).

Macpherson continues, adding, "there seems no evidence then, that wildlife was purposely managed by Amerindian population in northern Canada at the time of contact" (op. cit. p. 104).

The rifle is viewed by many wildlife biologists (e.g. Banfield 1951; Bergerud 1974; Kelsall 1963; Miller 1983; Parker 1972; Theberge 1981) as the most destructive, single piece of modern technology possessed by native hunters. Kelsall (1968) concluded that "early examples of excessive and unneccessary slaughter of caribou are legion, and modern-day counterparts can be found for most" (quoted in Theberge 1981 p. 281). Bergerud (1974) hypothesized that:

> ... in pristine situations, there was a fine balance between gains and losses in caribou populations. ... With the advent of hunting with rifles, this precarious balance between recruitment and mortality was upset and the populations started to decline. Such a decline would be gradual at first because of the large number of animals, but would accelerate as numbers decreased. The law of diminishing returns may have applied only weakly to caribou hunting (Bergerud 1974 p. 762).

To Miller (1983),"this use of modern technology has tipped the balance greatly in favour of the native hunter... the so-called harmony between primitive native hunters and caribou was imposed by the caribou's continuous movements; the native's relative lack of mobility; and the native's poor weaponry" (p. 173).

In more recent years, direct and indirect evidence of over-exploitation is abundant. In the caribou crisis of the 1950s, where caribou populations had declined drastically from former levels, over-hunting and wastage practices by native hunters were said to be the principal cause of this plight (e.g. Banfield 1951, 1956). In the 1970s and early 1980s, a similar crisis occurred where the Kaminuriak caribou herd declined to barely one quarter of its former population. Many people laid the blame squarely on the users (Pelly 1986 p. 41). At Coppermine, NWT, there have been caribou slaughters far in excess of local need, and thousands of carcasses are reported to have been left to rot (Usher 1982 p. 10). In the eastern Canadian Arctic and Alaska, walruses are reputed to be killed and used only for their ivory. In Alaska, State biologists say that natives have always hunted to the limit of their capacity, only now with modern technology, this means overhunting (Mackenzie 1985 p. 22). It is argued that modern tools, (i.e. high-powered rifles with telescopic sights and mechanized transport) give hunters the means to find and kill large numbers of animals with relative ease (Usher 1982 p. 10). To curb these problems of over-exploitation, protective legislation measures and a wildlife management system were imposed. In northern Canada today, the management of fish and wildlife is based predominantly on this wildlife management system.

Thesis plan

It is assumed that hunter-gatherer societies do not have a self-regulatory system governing their harvesting strategies based on the examples of over-exploitation outlined above. The present study investigates the credibility of this assumption by examining native harvesting strategies and selected cases of over-exploitation.

Chapter 2 describes the theoretical explanations and models of anthropologists and archaeologists which examine the structure of hunter-gatherer activities and provide hypotheses for the existence of underlying principles.

Chapter 3 continues the theoretical approach using the ethnographic examples of the 1918 and 1926 annual cycles of the Netsilik Inuit. The differences between the two cycles are discussed and examined in a theory model. The question of over-exploitation is introduced.

Chapter 4 examines the evidence supporting the Pleistocene overkill hypothesis and the evidence supporting claims that hunters over-exploited the major barren-ground caribou herds in the Northwest Territories. Bergerud's (1974) and Miller's (1983) viewpoints are examined in the chapter's conclusions.

In Chapter 5, the nature of self-regulation as supported by ethnographic literature is investigated and postulated to be extant. Characteristics of the traditional system of harvesting/managment are described.

Chapter 6 presents the conclusions and the implications for wildlife management.

CHAPTER TWO

Theoretical approaches

This chapter describes some of theoretical approaches used by both anthropologists and archaeologists in researching hunter-gatherer harvesting strategies and adaptation processes. One area of their research is construing these varied activities that have observable patterns (e.g. annual cycles) and actions (e.g. procuring methods) as part of a logically consistent or coherent system. To this end, theoretical models and explanations have been developed to (1) permit researchers to predict adaptive actions in given situations, rather than the norm of researchers having first to study and describe these strategies and then offer explanations as to how these actions are accomplished and (2) to cross-culturally test hypotheses.

Some of the earlier theories, such as environmental determinism and environmental possibilism, viewed the environment both as dominating and determining human adaptations. One proponent of the environmental possibilism theory was Kroeber (1939), who suggested that:

> While it is true that cultures are rooted in nature, and can therefore never be completely understood except with reference to that piece of nature in which they occur, [they] are no more produced by that than a plant is produced or caused by the soil in which it is rooted (Kroeber 1939 p. 1).

Major weaknesses in these theories were their lack of any formal theory to explain adaptation processes and variations (Smith 1984 p. 68).

Following these earlier theories came the approach of cultural ecology. Cultural ecology places a strong reliance on the explanatory power of the environment, but not to the extent that man-environment relationships are determined (Bettinger 1980 p. 190). Accordingly, cultural features can change independent of environmental features, and yet remain closely adjusted to the environment so as to provide efficient and effective means for societies to perpepuate themselves (Smith 1984 p. 69).

Cultural ecology continues to be a general approach used in research, but one that still lacks a unified body of theory (e.g. explicit hypotheses)(Bettinger 1980 p. 194). Because of this, the accepted research strategy in cultural ecology has been to first infer and describe behaviour and then to offer explanations as to how this behaviour accomplishes its presumed function (loc. cit.). To achieve the desired opposite effect, that is, (1) to predict adaptive responses to given situations rather than merely describe behaviour and (2) to reduce patterns of human ecology to a set of underlying goals or principles, researchers have developed numerous predictive models of hunter-gatherer behaviour. Several of these models are described.

Models of hunter-gatherer adaptation

Informal models

Informal models in ethnographic studies are used to generalize the adaptive principles underlying a given subsistence system. The models' aim is to reduce what appears to be a complex set of economic decisions into a few rules befitting various situations (Bettinger 1980 p. 198). For example, Rogers and Black (1976) did an analysis of the subsistence strategies of the Weagamow Ojibwa and suggested three rules or principles guiding their choices.

- Principle 1. To seek food resources chiefly at the time when they are most readily and abundantly available.
- Principle 2. To locate and distribute the human population (providers and consumers) in such a manner as to minimize time and energy spent on travel and transport, and regulate group size, in accordance with resource availability (Principle 1) and the existence of appropriate habitat for campsites.
- Principle 3. To be ready with contingency plans that may override or supercede the rules as given when circumstances demanded it for survival (Rogers and Black 1976 p. 20-22).

Other researchers, such as Gould (1977) with the Western Australia Desert culture, suggest that subsistence adaptation is governed by a strategy of "risk minimization" when procuring food (Bettinger 1980 p. 200). Harvesting decisions are then kept flexible, and are made in such a way as to reduce uncertainty (loc. cit.). Like Rogers and Black (1976), Gould presents nine principles guiding their choices of strategies (Gould 1977 p. 169-70).

Other informal models are essentially the same in their stressing the importance of minimizing risk and in their "simplicity and parsimonious summarization" of basic adaptive principles in subsistence economies (Bettinger 1980 p. 202). The weaknesses of these models are, however, that they are qualitatively defined, ambigious and difficult to use as predictive models (loc. cit.).

Formal models

Many of the formal models of subsistence resource use are derived from other disciplines, particularly biology, economics, and geography. Three of these models described are economic theory, game theory, and optimal foraging theory. One common feature of the three models is that they account for subsistence behaviour in terms of principles that weigh the relative costs and payoffs of different economic choices as a basis for adaptive solution (Bettinger 1980 p. 221).

1. Economic model

This model as developed by Earle (1980) shows (1) how a decision-making model may be used to predict an optimal combination of procurement strategies for a subsistence economy, and (2) how changes in environmental, cultural and other factors can result in economic change (p. 2). The model is based on the assumption that producers assess the costs and yields of available procurement (harvesting) strategies and then select the strategy mix that minimizes costs while still fulfilling subsistence requirements.

In determining what the nature of these costs are in this decision-making model, the basic distinction is between the *total cost* of a strategy and its *unit cost*. Total cost is the sum of all expenditures by the producer during a specified time period (e.g. a year) and unit cost is the cost of producing a specified amount (unit) of a resource (e.g. 1 deer). Of particular theoretical importance is the *marginal cost* which allows both an evaluation of the relative efficiencies of available procurement strategies and a choice of an optimal strategy mix to fulfill subsistence requirements (Earle 1980 p. 8). Figure 2.1 depicts an idealized cost curve for a procurement strategy, illustrating how marginal cost increases as output approaches the limit imposed by resource availability (with other factors, e.g. technology, social organization, that determine the particular shape of the curve held constant):

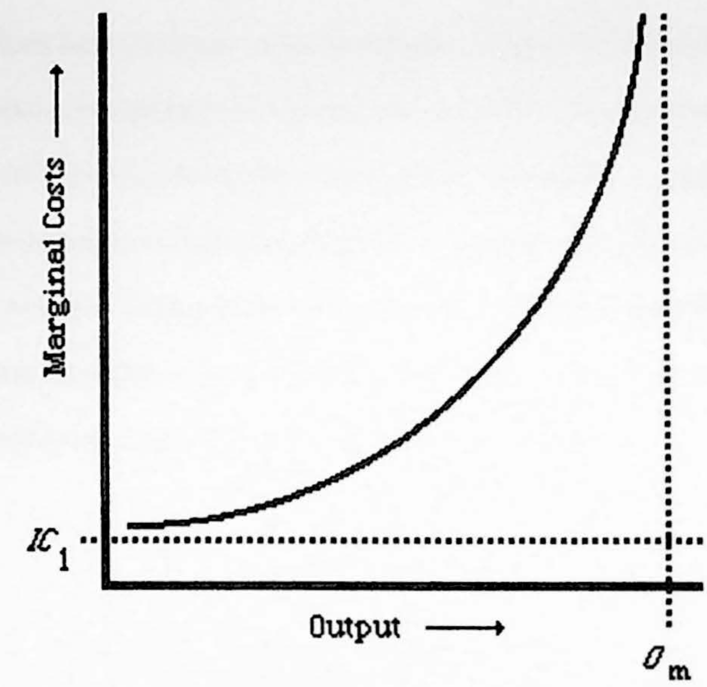

Figure 2.1 Idealized cost curve for a procurement strategy. IC_1 is the initial cost and O_m is the maximum yield of the strategy. After Earle 1980.

To investigate a subsistence economy, a researcher would want to indentify the alternative strategies available to a group and to describe empirically, their separate cost curves. From this, it is possible to suggest how a group selects a strategy mix. The basic assumption of the model is that the group's selection will be made by assessing alternative strategies that minimize costs while filling its output requirements, rather than attempting to maximize profits. This assumption has certain support in ethnographic literature (see e.g. Nietschmann 1973 Table 24), but there are many cases where factors (e.g. risk) result in a strategy mix with different levels of marginal costs (Earle 1980 p. 16).

There are numerous key factors determining this strategy mix; two of these are human activities and changes in technology. Where human activities result in over-exploitation of animal resources, for example, this decreases the prey density and its potential annual yield. On a cost curve, this action causes a decrease in a strategy's maximum potential yield and an increase in its initial cost. The marginal cost is thus increased causing the importance of that strategy to decline. When the prey population is reduced to a critical level, the hunter will switch to an alternate, less costly, resource. Figure 2.2 illustrates this change.

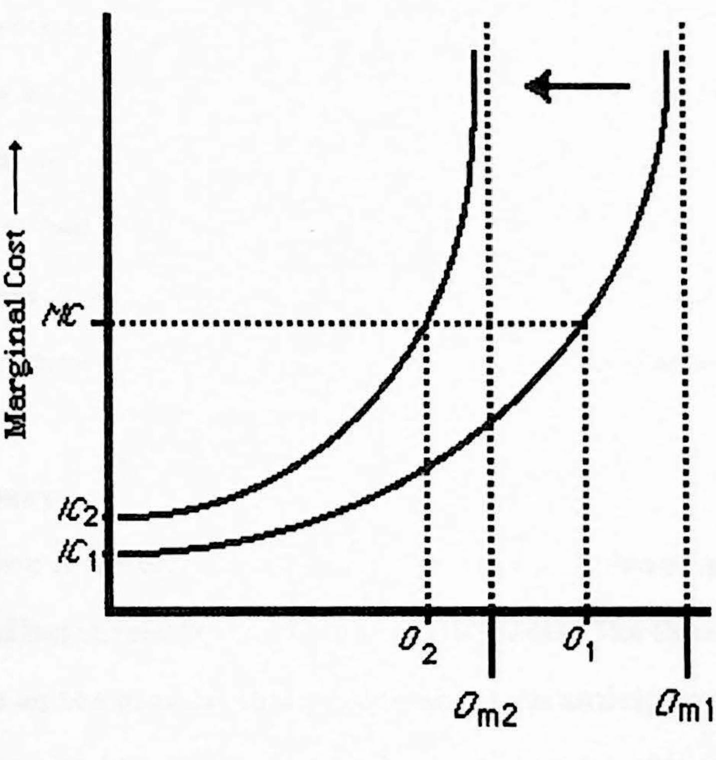

Figure 2.2 Shift in the cost curve of a strategy caused by an human activities (e.g. over-exploitation) resulting in decreased density of the prey species. Specific shifts are in initial cost increasing from IC_1 to IC_2, in maximum potential yield decreasing from O_{m1} to O_{m2}, and in strategy output decreasing from O_1 to O_2. After Earle 1980.

Changes in technology are another key factor in determining strategy mix. A new technological tool is accepted by a group for two basic reasons; first, the introduction of a item that increases the efficiency of procuring a resource would cause a downward shift in the procurement cost curve and as a result, increase that resource's importance in the subsistence economy. Second, a new tool may result in an increase in the maximum yield of a resource and thus permit the means by intensification of increasing production (Earle 1980 p. 23).

In summary, the economic model uses the evaluation of the costs of different strategies as related to output. Strategies will reflect the law of diminishing returns: costs increase more rapidly than returns. As existing strategies are intensified, their marginal costs increase and the economy diversifies into other strategies. With a specific total output for a subsistence economy, the model offers a framework within which subsistence decisions can be evaluated and predicts that individuals will select a mix of alternative strategies with equal marginal costs (Earle 1980 p. 25).

2. Game theory

Game theory is concerned with situations in which two or more persons select actions that affect themselves and other participants. The theory approaches the resource base on the premise that participants first anticipate the predictability of future resources and then choose their harvesting strategies accordingly (Savelle 1986 p. 17). One of this theory's best applications is for understanding the kinds of options that are open to persons under different conditions and how they might go about making the best of uncertain situations (Bettinger 1980 p. 216).

Two important game theory solutions are the minimax and Bayes solution. Where decision makers are concerned with the worst that can happen, that is, with the minimum subsistence levels that mixed harvesting strategies can provide, then the minimax solution is a sensible strategy to adopt (Coombs 1980 p. 192). The principal features of the minimax solution are;

1. It maximizes minimum payoffs.
2. Is based strictly on the payoff matrix.
3. Is always a mixed strategy if:
   a) at least two admissible actions exist (if only one exists, minimax = Bayes = the admissible action);
   b) the minimum payoff function includes payoffs from at least two states of nature (Coombs 1980 p. 193).

The Bayes solution is when the decision maker predicts the environmental states (based on e.g. prior knowledge or experience) and calculates for any harvesting strategy an average (expected) payoff, i.e., the mean average payoff they may expect to receive over a determined time if they employ that strategy (Coombs 1980 p. 192). The principal features of the Bayes solution are;

1. It maximizes average payoffs.
2. Is based on the payoff matrix plus the environmental strategy.
3. One pure strategy is always Bayes; this pure strategy will be the only Bayes strategy, unless one particular environmental strategy prevails, in which case *all* strategies (pure and mixed) will be Bayes (Coombs 1980 p. 193-4).

Both of these solutions are represented in Figure 2.3. The minimax solution occurs at point x . The Bayes solution, in attempting to maximize average payoffs through a pure strategy, has the minimum payoff well below that of a mixed strategy.

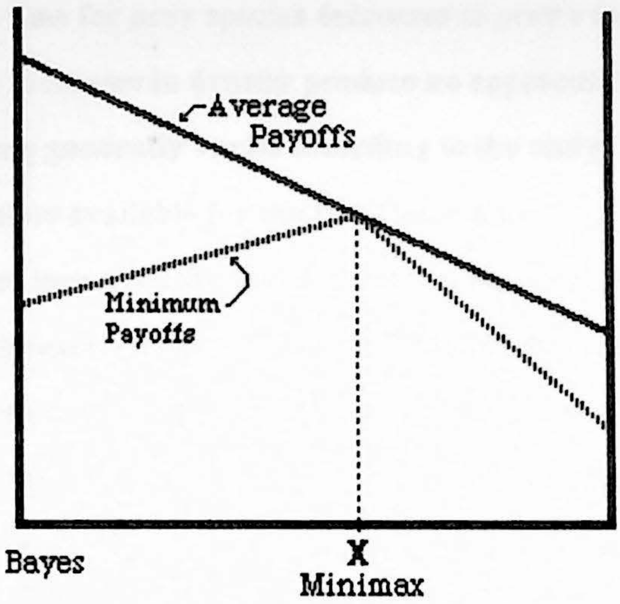

Figure 2.3. Average payoff function. Minimax strategy maximizes the minimum payoff, and Bayes strategy maximizes the average payoff. After Coombs 1980 and Savelle 1986.

3. Optimal foraging theory

The Optimal Foraging Theory provides a cluster of simple models which produce operational hypotheses about foraging behaviours expected in different environmental circumstances (Winterhalder 1981 p. 13). Foraging refers to tactics used to obtain nonproduced foodstuffs or other resources, i.e., those not directly cultivated or husbanded (e.g. hunting, trapping, gathering, etc.) (op. cit. p. 16).

In this theory, harvesting strategies are scheduled so that maximum benefit is obtained for human survival and reproductive success. This scheduling is acheived by enumerating all potential subsistence items and determining for each the amount of time it takes to locate one of the items (search time) and the amount of time it takes to capture and process one unit of the item (handling time) (Bettinger 1980 p. 208). Generally, search time for prey species decreases as prey's density increases, until a point after which increases in density produce no appreciable decrease in search time. Handling time generally varies according to the size of food item relative to the number of harvesters available for the task (loc. cit.).

Reliance on the item with the lowest handling time will maximize efficiency, but may result in high search times. Other items into the diet can be added, thereby lowering the search time but increasing the handling time. The problem, then, is how to determine the 'optimal' foraging strategy between the number of dietary items and the time spent foraging. The optimal foraging theory provides a model to determine this point of equilibrium, which will occur when decreasing search time equals increasing handling time. This process is illustrated in Figure 2.4, the optimal diet indicated where the two search and handling lines intersect (and based on all items of the diet of equal food value).

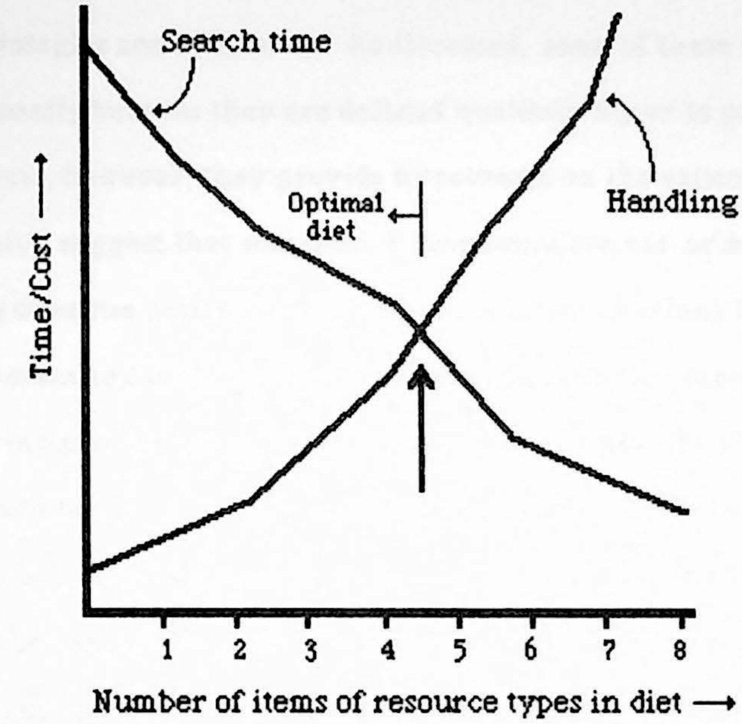

Figure 2.4. Optimal diet breadth model. As an increasing number of resources are added to the diet, the search time decreases as the handling time increases. Time/cost can also expressed in terms of energy. At the intersection of the two curves (where the decrease in search time equals the increase in handling time), the optimal diet breadth is represented. After Bettinger 1980 and Winterhalder 1981.

Two important implications follow from the optimal foraging model; first, whether or not an item is included in the diet is independent of its own abundance and depends only on the abundance of items with lower handling times, and second, as the overall abundance of all items decreases, more items are added to the diet (Bettinger 1980 p. 210).

Discussion

This chapter has described various theoretical approaches to hunter-gatherer harvesting strategies and adaptation. As discussed, some of these models are difficult to use operationally because they are defined qualitatively or as predictions. As heuristic devices, however, they provide hypotheses on the existence of underlying principles which suggest that subsistence economies are not *ad hoc*. The three formal models construe patterns of human actions into coherent frameworks that can be used to generate and test hypotheses and they account for subsistence behaviour in terms of principles that weigh the relative costs and payoffs of different economic choices as a basis for adaptive solution (Bettinger 1980 p. 221). In addition, these models predict adaptive responses to given situations rather than merely describe behaviour as the range of empirically observed responses (Bettinger 1980 p. 195). Both the economic and the optimal foraging theories suggest that on the basis of cost, over-exploitation would not occur because hunters would switch to another resource in the law of diminishing returns.

The next chapter continues this theoretical approach. As the interplay between ethnographic data and the model in theory building is important, two annual cycles of the Netsilik Inuit are outlined and examined in a formal theory model.

CHAPTER THREE

> *An old Eskimo man was asked how he would summarize his life; he thought for a moment and said "Willow smoke and dogs' tails; when we camp it's all willow smoke, and when we move all you see is dogs' tails wagging in front of you. Eskimo life is half of each.* (Binford 1983).

This man was speaking of a time when annual harvesting cycles were a way of life. This chapter describes two similar annual cycles of the Netsilik Inuit of Pelly Bay, Northwest Territories. The first of these cycles in 1918 is considered the last 'traditional' annual cycle as the hunting tools and techniques used were traditional, e.g. hunting caribou from kayaks using spears. In 1919, the opening of the Hudson's Bay Company store in Repulse Bay brought an end to traditional cycles for the Netsilik were now assured of a regular supply of guns and ammunition. By the end of the 1920s, all Pelly Bay hunters had rifles which they used for caribou, musk-ox and bear hunting (Balikci 1964 p. 45). The second of these cycles in 1926 is thus a post-rifle annual cycle.

A discussion and theory model follow to examine the differences between the two annual cycles, and the question of over-exploitation is introduced. Both annual cycles are from Balikci's (1964) monograph *Development of basic socio-economic units in two Eskimo communities*; a fold-out map (on p. 78) charts the movements of the two cycles.

1918 Traditional Annual Cycle

There were four families of approximately 30-35 adults camped on the sea-ice in the middle of Pelly Bay, about twelve miles west of the estuary of Kugardjuk River (long. 90° 10' W., lat. 68° 32' N.: see 1918 migration route on map). The area was very good for sealing with favourable flat ice and near to the Kellet River (Kuuq) from where cached fish were transported. One of the hunters, Audladjut acted as headman for the group and the people spent the winter sealing at the breathing holes with caribou harpoons. Around the end of April, the four kayaks that had been left the preceeding autumn at Tunirtat were brought to this camp and covered with fresh skins; they were used during all their inland travels.

They remained together in the sealing camp until it was time to set up the tents at the end of May. The four families then separated; one family went north to Maniituardjuk (north of Helen Island) to hunt seals; the second family moved to the western side of Pelly Bay and from there to Ariak (Simpson Lake), while the third family did the same, only moved in a direction slightly south of this place. The fourth family, Audladjut's, moved to the spring sealing grounds near the little island Qimikvik, in front of the estuary of Kugardjuk River. Audladjut's group had nine dogs for six hunters, or 1.5 dogs per hunter, and one wooden sled. Spring sealing around Qimikvik Island was successful and nine caches of seal oil were made.

In the first two weeks in July when the time came for the salmon run, the group moved to the stone weir at Aliarusiq, north of Barrow Lake. They arrived there early enough for some good fishing with leisters through the wet lake ice. When the char started moving downstream, they repaired the stone weir in preparation and had a successful a fishing season. The group filled three caches of dried char.

At the beginning of August they started hunting caribou in the vicinity of Barrow Lake. Only one hunter had a rifle for which he prepared his own ammunition; this rifle was not the first firearm among the Pelly Bay people (e.g. one hunter in 1906 obtained a rifle from Amundsen). Around the end of August the group moved to the artificial caribou crossing place at Amaktuq Lake. At this crossing, many caribou were speared from kayaks and enough caribou skins for new clothing were secured for the entire group. They stayed there until the end of September, caching three large portions of caribou meat. The kayak frames were left again at Tunirtat.

At this time, they left for the fishing grounds along Kellet River (Kuuq) with some men having to travel the route twice to bring the caribou skins to this new location. At Kuuq they camped at the place called Inirgjuak (long. 89° 37' W., lat. 68° 15' N.) where the hunters travelled short distances along the river, fishing with leisters through the thin autumn ice and filling two caches. At the end of the fishing season, they brought over some of the cached caribou meat and the women started working on the new winter clothing. Around the middle of November, the four families regrouped and moved to Isurtuk (long. 90° W., lat. 68° 24' N.) where the sewing work was finished. In the beginning of December they returned to winter sealing on the flat sea-ice.

The 1918 annual cycle of Audladjut's group consisted of a circuit of approximately 80 miles. It was conducted with the aid of nine dogs and a single wooden sled. Temporary sleds of seal and bear skin containers for dragging were also used, all pulled by the men, women and dogs. The annual cycle reveals a summer and autumn inland adaptation practicing sporadic or intense caribou hunting and char fishing, and a winter and spring marine adaptation characterized by sealing at the breathing holes on the sea ice. From the wide range of hunting and fishing techniques known, only a selected number were used that year that were suited to the topography of the area and the distribution of the local animals (Balikci 1964 p. 41-3).

1926 Post-rifle annual Cycle

It was early winter of this year that the lake ice was only two feet thick. The group were camped at the point of Tikiranujuk (long. 92° 18' W., lat. 69° 8' N.: see 1926 migration route on map) on the large peninsula on Lady Melville Lake. There were approximately seven hunters including Audladjut (the headman of the 1918 annual cycle) with families and they hunted caribou with rifles and fished with leisters through the lake ice. Caribou hunting was conducted individually. Each hunter would travel on foot without a sled or dogs and would stay out until he made a kill; sometimes this took only a day, sometimes several nights. When a caribou was shot, the skin and a choice piece of meat were brought back to the camp and the rest was cached under stones.

Lady Melville Lake was a good caribou hunting area at that time of the year and the group obtained two years' worth of caribou skins for clothing. The older people said that it was much easier to hunt caribou with rifles than with bows and spears. It was important, however, there was enough ammunition. When the lake ice became too thick for fishing, they decided to stop fishing, and caribou hunting to save ammunition, and rely on cached meat. They stayed at this camp until it was time for the migration to the sea-ice in January. Audladjut had one dog and a small wooden sled; another hunter had five dogs and a longer wooden sled, and a third hunter had four dogs with a wooden sled. Before the camp was moved, they divided among themselves all the cached caribou meat and loaded it on sleds. There was no cached fish left. They went first to the head of Kangirslukdjuak Inlet (long. 91° 26' W., lat. 69° 22' N.) and then went directly towards the sealing region in front of Kangiq (long. 90° 21' W., lat. 69° N.) in Pelly Bay where they set up the winter camp for sealing. At this location, several more people joined the group. One of the hunters

Iluiliq to continue caribou hunting in winter. Sealing was good and several caches of seal blubber were placed in sealskins and buried under the snow.

To trade for the imported supplies, such as rifles and ammunition, at the Hudson's Bay store at Repulse Bay, some trapping for foxes had to be carried on. The group had at least eleven steel traps and these they placed near the sea shore not far from the camp. Trapping journeys took them a day only. In April, four men using sleds and dogs started on the Repulse Bay trading journey. The rest of the people moved camp near the little island of Nakungajuk (long. 90° 28' W., lat. 69° 7' N.) where they continued to hunt seal at breathing holes. They remained there until the end of May, waiting for the return of the trading party. When they returned, the group moved to Sadlurtalik and hunted seals on the large, open breathing holes with the spring sealing techniques. They made five caches of seal blubber. Two of the hunters did not participate in sealing; instead, they returned to the southern shore of Lady Melville Lake to fish. At the end of June, the whole group followed the same trail and left their sleds at Kangirslukdjuaq. Late spring was spent fishing with leisters and fish harpoons at the mouths of the rivers flowing into Lady Melville Lake.

During August the caribou hunting season started. Two hunters moved in a northeasterly direction while the rest of the group travelled in the opposite direction towards Kingardjuaq Mountains (long. 93° 20' W., lat. 68° 24' N.). Caribou hunting was usually conducted individually, except on occasions when large herds were spotted and several hunters would participate in stalking animals with rifles. In the beginning of September, they started travelling towards the Netsilik River (long. 93° 20'W., lat. 69° 24'N.), hunting caribou on their way. Enough skins were secured for new clothing and very little meat was cached. On Netsilik River, the thin autumn ice proved unrewarding for fishing with a leister or a fish lure and they were unable to cache any fish. Some of the hunters joined another group camping at the southern end of Tasirdjuaq Lake (Middle Lake, near Spence Bay settlement) in a caribou hunt northwards to Peregrine Bluff. The trip was a failure and in not killing any caribou, they survived on fish. Empty-handed, they walked back to their camp by the Netsilik River which had little food. Soon after, one of the hunters made a kill of ten caribou, followed by a second which brought in a total of thirteen caribou. That was enough for the camp.

When it became time for the migration towards the sealing camp in late November, the group left Netsilik river and started on the journey to Pelly Bay. They had to stop at a fishing place of Tugakturvik where they fished until the end of December. After the young men did a return trip to Kangirslukjuaq to pick up the sleds, the whole group travelled towards the sealing camp near Kanquq in Pelly Bay. On their way south, they picked up the blubber caches at Sadlurtalik, and it was not until the middle of January that they started sealing again.

Discussion

Part I

The 1926 annual cycle reveals a different pattern than the 1918 traditional cycle. While the basic alternation of summer-autumn caribou hunting and winter sealing at breathing holes remained essentially unchanged, the whole caribou hunting complex was completely transformed. The steady supply of rifles and ammunition greatly simplified, intensified and individualized caribou hunting (Balikci 1964 p. 48). Hunting at caribou crossing places came rapidly to an end and the hunter, no longer restricted by waiting for the migrating herds to move in his direction, was now free to pursue the migrating and resident caribou herds. Where in 1918 collaborative techniques were required for caribou hunting, the rifle-equipped hunter could easily make a kill alone (loc. cit.). With bow and arrow, a hunter could produce fatal results at a distance of 30-50 metres; with a rifle, the same hunter could be highly succesful at 300 metres or more (Keene 1979 p. 393).

Numerous hunting techniques and technological items changed with the wide-spread use of the rifle, e.g., kayaks and spears for caribou hunting were replaced by the rifle. Because caribou were a highly valued resource, efforts were made to extend and intensify the hunting season. In 1926, for example, the caribou hunt ended in December and one hunter continued to hunt caribou that winter. Traditionally, after the fall caribou migration southward, all caribou hunting stopped. In addition, hunting in late fall with the snow creaking underfoot rendered bow hunting impossible; with rifles, this was no longer a problem (Balikci 1964 p. 48). Fishing during the fall became less important, e.g., in 1918 the group fished along the Kellet River, in 1926 the group moved to the best caribou hunting grounds.

While the 1918 annual route consisted of a circuit of 80 miles, the 1926 route was over 170 miles in length (excluding the trading trip to Repulse Bay and the caribou hunt to Peregrine Bluff). This longer annual cycle was made possible by (1) the increase in the number of dogs, made possible after better harvesting returns to provide dog food and (2) the use of imported wooden sleds (Balikci 1964 p. 48-9).

Part II

Balikci's descriptions (above) of the differences in the two annual cycles provide some explanations for the transition from the pre-rifle (1918) to the post-rifle (1926) period. The basis of these explanations is derived mainly on empirically observable changes (e.g. spears were replaced by the rifle, choice of area and resource in travel, etc.). While instructive, this approach resembles the norm of researchers having first to study and describe these strategies and then offer explanations as to how these actions are accomplished. The limitations with this approach are (1) it is limited to general concepts, (2) it lacks a theoretical framework to permit further testing, and (3) it does not predict adaptive responses to given situations.

To move beyond this approach, there are formal theories that provide a theoretical framework and predict adaptive responses. One of these theories is linear programming. Similar to game theory, linear programming differs in that its aim is to find the most economical (least cost) solution to a given economic problem (Bettinger 1980 p. 216). As the problem of obtaining subsistence needs is a problem of resource allocation, any population must decide how it can best allocate available resources. To test this most economical (least cost) solution, a model of optimal subsistence strategies can be generated using linear programming (Reidhead 1980 p. 143). The term *programming* refers to a planning process or program of activities which best satisfies a specific goal among all feasible alternatives (Keene 1979 p. 370).

Keene (1979) in his *Economic optimization models and the study of hunter-gatherer subsistence settlement systems* uses linear programming to construct models of the traditional economy and the changing subsistence patterns among Netsilik Inuit (p. 369-404). His aim is to develope a general model which can deal with the questions of (1) what factors influence the subsistence decisions of hunter-gatherers, and (2) what variations in these decisions are necessary in response to specific perturbations. The models are based on the following assumptions:

- Assumption 1. Economic activities among hunter-gatherers are organized.

- Assumption 2. The primary goal among hunter-gatherers is to provide the basic nutritive and other raw materials necessary for the survival of the population. The needs of the population will be satisfied whether or not they are perceived by the decision makers.

- Assumption 3. When faced with a choice between two resources of equal utility, the one of the lower cost will be chosen. Hunters and gathers attempt to satisfy their basic needs at minimum cost. Therefore, economic behaviour is both satisfying and optimizing.

- Assumption 4. There are limits to the amount of a given resource which can be exploited within a given amount of time.

- Assumption 5. Any alternation to the subsistence settlement system can be modeled in term of changes in costs or limits of resource exploitation (Keene 1979 p. 370).

From these assumptions, two models of linear programming are presented:

1. A model of the annual subsistence cycle of a small Netsilik group (50 persons) using traditional hunting techniques. Input for the model comes from the data describing the wildlife, environment, and human nutritional requirements for the area. Then, to test their accuracy, the predictions are compared to ethnographic accounts of traditional Netsilik economy.

2. A model of a change in the annual subsistence cycle which results from a change in technology, specifically the introduction of the rifle. Again model prediction are compared to the empirical case (Keene 1979 p. 371).

In establishing these two models, 12 column vectors representing resources (e.g. caribou, fish, polar bear) and 12 row vectors representing 10 nutrients (e.g. energy, fat, protein), one nonfood value (e.g. hides) and a cost of acquisition, are presented in tables (p. 380-86). These are calculated in terms of minimum annual required intakes. From these tables, the model of the annual cycle of a small Netsilik group (50 persons) using traditional hunting techniques computationally interpreted and is summarized graphically in Figure 3.1. In comparison, Figure 3.2 is the ethnographically observed annual cycle.

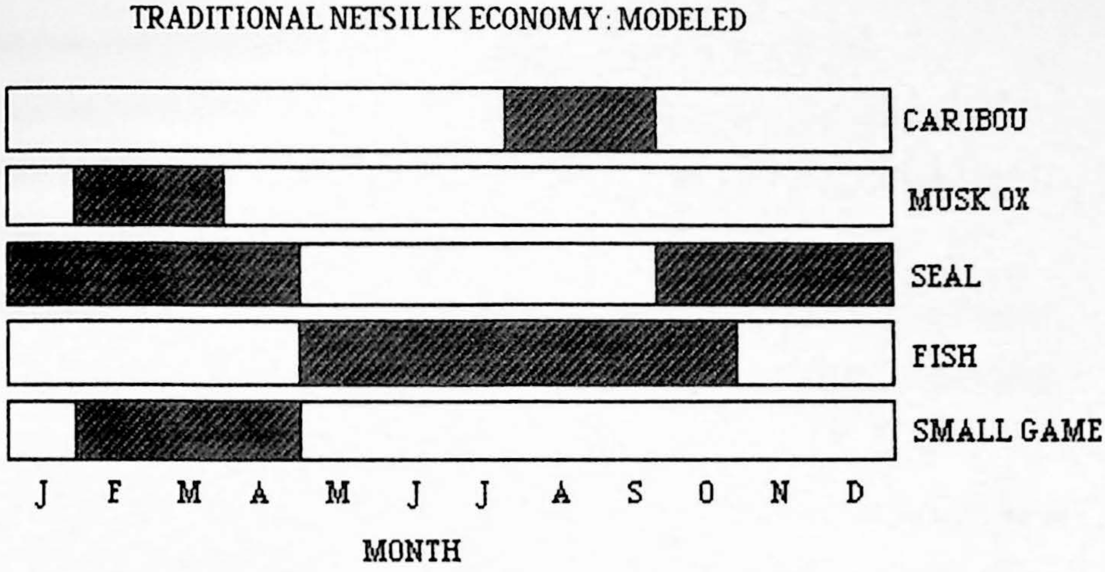

Figure 3.1 Optimal resource schedule for traditional Netsilik economy as modeled. After Keene 1979.

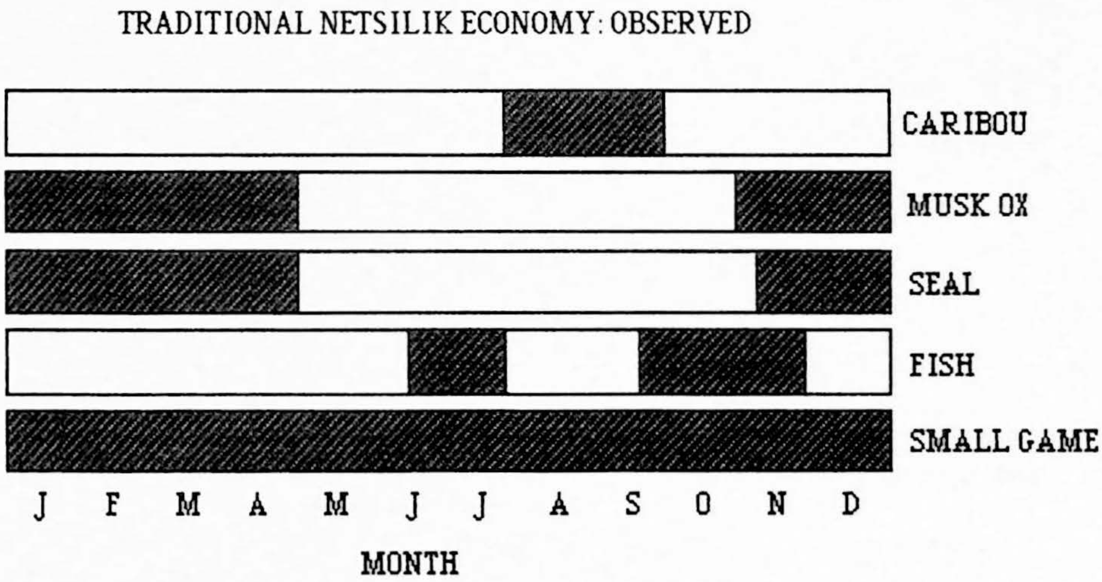

Figure 3.2 Resource schedule for tradtional Netsilik economy as ethnographically observed. After Keene 1979.

The modeled resource schedule (Figure 3.1) appears congruent with the ethnographic resource schedule (Figure 3.2) and with ethnographic accounts of Balikci (1964), Brice-Bennett (1976), Damas (1969). However, as Keene points out, there are discrepancies. In the modeled economy, (1) fish productivity is overestimated both in early spring and fall; and (2) small game, generally procured throughout the year, are scheduled only in the winter (p. 388). Traditionally, small game were a marginal or supplemental resource. Although there are other differences between the two resource schedules, there is little value in attempting to confirm the absolute accuracy of the predictions of the modeled resource schedule unless it is considered along with the postoptimal analyses, i.e., the sensitivity of the model to changes in the input values (e.g. costs, requirements, etc.)(op. cit. p. 390).

According to Keene's calculations (in table 16.3, p. 283-5), most of the 12 resources in the optimal solution have been exploited to their maximum allocated levels. This is attributed to the small Netsilik population inhabiting a large territory stocked with resources of quite diverse cost and minimal differences in utility (p. 391). The necessary resources are available, but the population is restricted from more extensive exploitation because of limited manpower, mobility and technology. The linear programming model predicts that if these restraints were removed, the Netsilik would subsist for almost the entire year on two or three resources, with the majority of the resources coming in May through October. This is summarized graphically in Figure 3.2. Empirically, this is very nearly what happens following the use of the rifle, which removes one of the limitations: this annual cycle is summarized graphically in Figure 3.3.

POST-RIFLE NETSILIK ECONOMY: MODELED

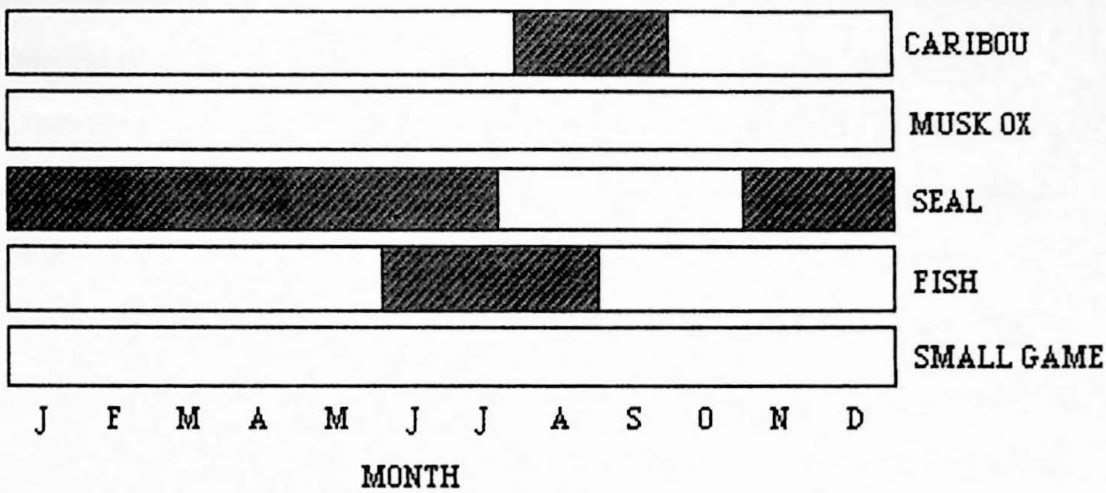

Figure 3.3 Optimal resource schedule for post-rifle Netislik economy as modeled. After Keene 1979.

POST-RIFLE NETSILIK ECONOMY: OBSERVED

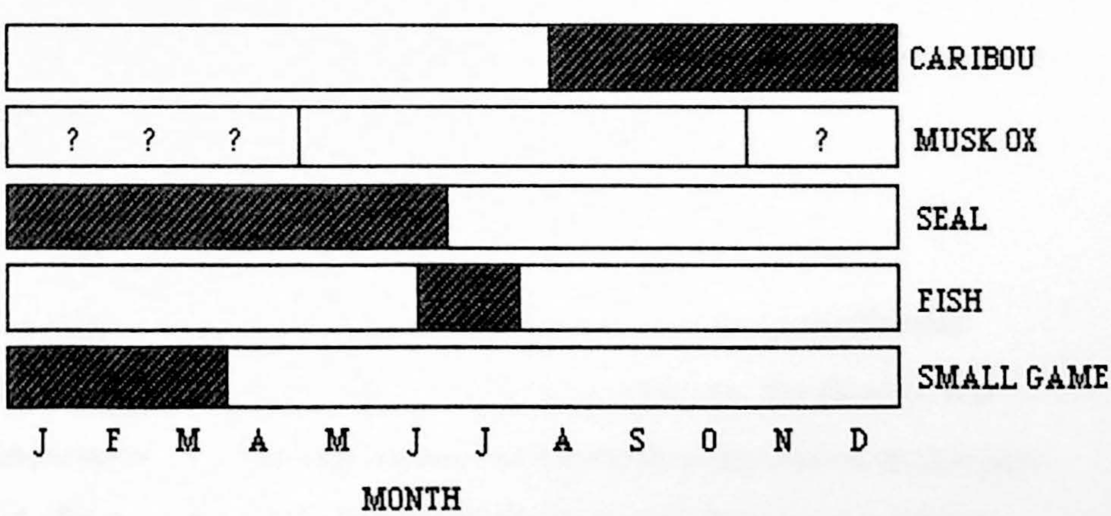

Figure 3.4 Resource schedule for post-rifle Netsilik economy as empirically observed. After Keene 1979.

The model resource schedule (Figure 3.3) is said to be actually more congruent with the empirical case (Figure 3.4) than the two figures appear to indicate (p. 394). The final interpretation must be made in conjunction with the postoptimal analysis.

In caribou hunting, the rifle decreases the pursuit time by allowing the hunter to be more successful at greater distances; hence the cost or bounds (i.e. the limits of exploitation) are lowered. In addition, the hunter with a rifle is able to harvest more animals at one time, thus the maximum catch of the caribou will increase. The rifle will not have the same effects on all resources, e.g., the cost of fish will remain unaltered and the effects on birds will be minimal (unless shotguns are used). The model indicates the harvest of fall caribou and winter and spring seal will increase as exploitation limits increase. In fact, the unbounded model predicts subsistence based entirely on fall caribou and spring seal (Keene 1979 p. 394).

To conclude, the linear programming approach provides a rigorous theoretical framework that can be used to generate and test hypotheses and predict adaptive responses to given situations. Though these models represent only a first approximation, their major value is that they force us to recognize the actual complexities inherent in subsistence economies and to focus on important interrelationships between variables (Keene 1979 p. 399-400).

Part III

According to Balikci (1964), the "generalized use of firearms in the Netsilik country produced extensive changes in the migration patterns, distribution, and numerical importance [i.e. over-exploitation] of the caribou population in this part of the Arctic". (Balikci 1964 p. 51). In both of the annual cycles recounted above, however, there is no suggestion that these hunters over-exploited their resources before the generalized use of rifles in 1918 or after in 1926. Although the whole caribou hunting complex was completely transformed by 1926, the example of two successful hunts resulting in enough caribou for the camp suggests a rational procurement strategy and not over-exploitation. The next chapter will delve into this possibility and other issues of over-exploitation.

CHAPTER FOUR

THE ISSUE OF OVER-EXPLOITATION

The chapter examines the evidence supporting the Pleistocene overkill hypothesis that early man over-hunted and the claims that hunters over-exploited some of the major barren-ground caribou herds in the Northwest Territories. On the basis of this evidence, it is assumed that hunter-gatherer groups do not have a self-regulatory system governing their harvesting strategies. It is most important that this evidence is established as accurate. Bergerud's (1974) and Miller's (1983) viewpoints are examined in the chapter's conclusions.

Pleistocene Overkill theory

When Martin first proposed this hypothesis in detail, the theory made many predictive statements about the nature of archaeological, paleontological and paleoclimatic records (Grayson 1984 p. 820). Since this time, "the overkill issue [has become] one of those scientific controversies fueled by the paucity or ambiguity of relevant data; the amount written on the subject... is in inverse proportion to the hard evidence" (op. cit. p. 808). Skeptics are quick to point out that this theory is almost entirely conjectural given the lack of 'hard' archaeological evidence (C. Martin 1978 p. 169). Butzer (1971) argues that none of the cogent arguments used for prehistoric overkill are conclusive and postulates that though man may well have played a secondary role in some of these extinctions, even this evidence is incomplete (p. 512). On the Pleistocene extinctions in North America, he concludes that "at the present level of understanding, we have no reason to blame prehistoric man" (loc. cit.).

Discussion

The use of this theory as evidence of over-exploitation (e.g. Ellen 1986; Klein 1984; Macpherson 1981) is untenable given the lack of conclusive evidence and understanding. Therefore, the theory that "the late-Pleistocene extinction pattern leaves little room for any other explanation [but over-kill] "(Martin 1967 p. 115) is still unproven.

The rifle and the barren-ground caribou

> *It is to be hoped that there will never be so few caribou that it will possible to count them* (Clarke 1940)

Part I

According to Balikci (1964), the generalized use of rifles by the Netsilik produced "extensive changes in the migration patterns, distribution, and numerical importance of the caribou population in this part of the the Arctic" (p. 51). The main factor behind these drastic changes in caribou distribution is attributed to the regular supply of arms and ammunition to the natives by the trading posts (loc. cit.).

Balikci cites Rasmussen's experience of a 'caribou massacre' by the Netislik with firearms in 1923 as evidence of over-exploitation. From Rasmussen's account, Balikci concludes that "repeated massacres like this one disrupted and finally brought to an end the migrations of the mighty herds" (op. cit. p. 52). Rasmussen witnessed the following event:

...we saw the first great herd of caribou coming trotting down over the hills... At a distance they looked like an enormous force of cavalry advancing in lines of fifty to a hundred animals.... All the men seized their guns and hunting bags, and a moment later they lay concealed here and there.... This was the first real caribou massacre of that autumn, and therefore [the caribou] approached unsuspicously at the same quick trot down towards the shore, until a deafening volley of rifle fire suddenly checked them all. ... Shot after shot cracked, animal after animal tumbled over... until the whole cavalcade split up into a number of small flocks as if prearranged and galloped back to the interior of the island (Rasmussen 1931 p. 78).

Discussion

This event took place in the autumn when many natives rely on caribou for both food and clothing. When conditions are ideal, an entire group can secure within days its autumn supply of meat (Calef 1981 p. 54). In addition, hunters are known to make an "insurance" kill immediately (i.e. make a large kill at one time), especially when preservation conditions are good. They subsequently devote their time to other non-hunting pursuits (Burch 1972 p. 354). As Rasmussen witnessed a large killing when caribou are most needed, Balikci's correlation of this account may not be accurate. It is possible that Rasmussen observed a singular planned strategy, and not a repeated massacre . Unfortunately, Rasmussen does not say how large the "great herd" was, how frequent or infrequent these killings were, what rationale lay behind these actions, whether or not the animals killed were needed, and indeed, how many animals were killed. Given this list of critical unknowns, the argument is essentially this: there are too many unrecorded variables to rely on this event as conclusive evidence that "repeated massacres like this one disrupted and finally brought to an end the migrations of the mighty herds". With this amount of essential data missing, the event is open to more than one interpretation and Balikci's conclusion is not necessarily the correct conclusion.

If Rasmussen witnessed a planned strategy, serious implications are raised. Some authors (e.g. Keene 1979) cite Balikci's account (1964) as evidence of over-exploitation; other authors (e.g. Banfield 1956; C. Martin 1978; Parker 1972*a*;

Theberge 1981) cite additional historical accounts (e.g. Hearne 1795; Pike 1892; Stefansson 1913, 1943; Whitney 1896) for the same reasons. While it is beyond the scope of this present study to examine each of these situations, it can be postulated that conclusions drawn from historical evidence are prone to misinterpretation given the paucity of information.

Part II

There is a legend that the barren-ground caribou population in Canada's north was inexhaustible. Earlier travellers in the north saw "thousands upon thousands", sometimes 20,000 to 30,000 caribou in solid columns and so large in total number that "to estimate their numbers would be impossible" (Steele 1953 p. 1164). Seton estimated the barren-ground caribou population at over 30 million, and "may be double that" (Seton 1920 p. 261), while other naturalists' estimates ran has high as 100 million animals (Banfield 1956 p. 4). Later researchers saw these figures as gross estimates. For example, in calculating the distribution of the caribou and the carrying capacity of the environment, Banfield estimated 1,750,000 animals in 1900 (Banfield 1951 p. 13). Miller (1983) cites four independent estimates that seem probable (sic): one estimate is Banfield's (of 1,750,000); the others are 2,396,000; 2,500,000; and 3,840,000 animals (p. 171). There are other population estimates (e.g. Anderson 1938; Clarke 1940; Mair 1963; Loughrey and Kelsall 1970), but there appears little consensus on which of these estimates is the most probable. Banfield's estimate of 1,750,000 animals in 1900 is cited frequently.

In the early 1920s, the Canadian Government and residents of the north became alarmed at the excessive slaughter of caribou by native and white persons involved in the fur trade (Kelsall 1963 p. 5). The natives, according to Kelsall (1963), "long accustomed through neccesity and primitive hunting methods to take whatever game they could at any time, often slaughtered caribou until their ammunition ran out" (p. 5). Although this concern over declining caribou numbers continued into the 1930s and early 1940s, it wasn't until 1948 that the first intensive caribou investigation was undertaken.

The biologist A.W.F. Banfield was the principal investigator of this barren-ground caribou survey. Aerial surveys (using strip transect technique) were the main methods employed for this investigation, while aerial photographs, ground observations and other techniques were used to supplement and verify the aerial observations. The results of the 1948-49 survey estimated the caribou population at 670,000 animals. When Banfield compared this figure to his 1900 estimate of 1,750,000 animals, it revealed a 62% reduction in caribou numbers in fifty years (Banfield 1951 p. 14). The annual mortality figures were then calculated at 178,000 animals (100,000 by hunters, 34,000 by wolves, and 34,000 by disease, accidents, etc.) and compared with an estimated calf crop of 145,000, which meant a deficit 33,000 animals per year (Banfield 1956 p. 5). "This shrinkage", wrote Banfield, "resulted from the virtual wiping out of certain herds and from lesser reduction of other herds" (loc. cit.).

In 1955, a complete resurvey (using a non-stratified strip transect technique) of the barren-ground caribou was conducted. Most of the total range of caribou between Hudson Bay and Mackenzie River was covered in strips fifteen to twenty miles apart, so "it was unlikely any significantly large herd was missed" (Anon 1957 p. 371). This survey revealed a total of 279,000 caribou, a decrease of 60% from the 1948-49 survey only six years earlier. To Banfield (1956) and others (e.g. Anon 1957; Tener 1960), these results were "alarming" for the actual decline exceeded the expected calculations by about 50% (p. 6). "It provided", wrote Kelsall (1963), "a quantitative demonstration that extradordinary means were necessary if caribou were to be saved and increased, so that they would continue to be a useful renewable resource" (p. 6). Although wolf predation, disease, poor calf crops and other factors were all researched as possible causes, it was concluded that the main cause of the decline of caribou was native hunters (Anon 1957 p. 372; Banfield 1956 p. 7). "Orgies of killing still take place at several [caribou] crossing points" where "each year thousands of caribou carcasses are abandoned" (Banfield 1956 p. 7). At other points, men, women and children pepper passing columns of caribou with small-calibre rifle slugs (loc. cit.). By the winter of 1957-58, the caribou numbers were estimated to have decreased to 200,000 animals (Parker 1971 p. 5).

Given this verdict, measures to curb both over-exploitation and dwindling numbers of caribou were taken as obligatory. As the natives had no apparent system or control over their rate of exploitation, steps were needed to fill this void. To Banfield and others, the system of wildlife management was part of the solution. "Management", wrote Banfield, "of this [caribou] resource must... be directed primarily towards controlling the number of caribou killed annually, ... [for] only with wise management can it be assured that barren-ground caribou will continue to supply food and clothing to residents of northern Canada "(1951 p. 51-2). Two federal-provincial committees were established. The first, the Technical Committee for the Preservation of Caribou, included biologists and technical officers working directly on caribou or related problems (Kelsall 1963 p. 6). The second, the Administration Committee for the Preservation of Caribou, was empowered to act on the recommendations of the Technical Committee and to suggest courses of action, legislative or otherwise, to the federal and provincial Cabinet Ministers (loc. cit.). Some of the protective legislation passed included: the restriction of hunting to persons (e.g. natives) who were obliged by their lifestyle to use caribou for their own consumption; waste and abandonment of caribou meat was prohibited; the protection of female and calf caribou; efforts to get natives to use alternative food sources where the new legislation proved a hardship. Dependency on the caribou diet prevented the initiation of closed seasons on caribou in the north (loc. cit.).

Discussion

More recent studies suggest that only one-fifth or one-tenth as many caribou can be supported in these ecosytems as was previously thought (Calef 1981 p. 56). Accepting the fact that many of the earlier population estimates were grossly exaggerated, how accurate are the 1948-49 and 1955 survey estimates? According to Parker (1975), both the 1948 estimate (670,000 animals) and the strip transect technique used are subject to a large degree of error (p. 631). In theory, all the animals are supposed to be counted within a strip of constant width. In practice, however, the errors are numerous, e.g., animals unobserved due to obstacles such as trees and rock; animals unobserved directly beneath the aircraft; movement of animals on or off transect due to disturbance; animals undetected due to observer fatigue (loc. cit.).

The use of the non-stratified strip technique in the 1955 survey is also subject to considerable error, although the technique is considered more reliable and of sufficient accuracy for monitoring population trends (Parker 1975 p. 635). While the 1955 survey estimate can be taken to be the more accurate estimate of the two, its accuracy can still be questioned. Benson (1963), in reviewing these survey techniques, stressed that "aerial surveys are yet in their infancy, and are far from being precise and sensitive tools for measuring wildlife populations" (p. 8). Parker (1975) concludes in his review of aerial surveys used for estimating the numbers of barren-ground caribou, that although the total population estimates are subject to considerable error (see below), aerial surveys will continue to be a major tool in the management of these animals (p. 636).

If the 1955 survey is the most reliable study of the barren-ground caribou for its time, this raises a matter of importance regarding the reliability of earlier estimates. If the 1948-49 survey estimate and technique is subject to a large degree of error, how large could this degree of error be? Perhaps, as an example, the barren-ground caribou population between 1949 and 1955 declined only 25% and not the calculated 60%. Accordingly, the 1949 estimate of 670,000 was too high, and importantly, it wasn't over-hunting by natives that was at fault, but the survey's estimates. Furthermore, if the accuracy of 1948-49 survey is questionable, how reliable is the earlier 1900 estimate which is based on range capacity? Given the 'guesstimate' nature of this earlier figure, it is equally plausible that the 1900 estimate of 1,750,000 animals is too high. Others have cited this 1900 figure as low, e.g., Miller (1983 p. 171) gives four independent estimates where the 1900 estimate is the lowest (c.f. 2,395,000; 2,500,000; and 3,840,000). In reality, we really do not know what the primitive caribou populations were or to what the quantifiable percentage these herds increased or decreased.

If native hunters are being blamed for major reductions in caribou numbers derived from a set of unknown and disputable population estimates, perhaps the blame is grossly unjust. Over-exploitation could have occurred locally, e.g., where the Netsilik brought "extensive changes in ... the caribou population *in this part of the Arctic*" (Balikci 1964 p. 51, italics added), but it may not have occurred on the scale claimed given the lack of verifiable evidence.

There is a second source which lends support to this argument. Banfield (1951) mentions it only once, and otherwise does not take it into account. Starting in 1934, a caribou questionnaire was distributed to northern residents as a second method of monitoring trends in caribou population. These were plotted on a series of annual maps, and:

> from inspection of these maps it is noted that there is no clear-cut evidence of a major decline in population in the period 1934-49. The majority of the correspondents indicate that there has been a gradual irregular decline in numbers in recent years. The maps do indicate annual local shifts in populations" (Banfield 1951 p. 15).

Banfield provides no explanation why there should be a fifteen year hiatus in the major decline of the caribou from 1900 to 1949, where the caribou populations supposedly dropped by 62% due to over-hunting. Moreover, if the natives were over-hunting caribou throughout this period, why does this not appear in the survey. Although there is no mention of the accuracy of this second source or the possible cause of the gradual irregular decline are stated, this second source does incriminate the survey estimates as the problem and not the hunters.

In returning to Banfield's observations of the apparent mis-use of rifles (e.g. natives "peppering" caribou with small-calibre rifle slugs), this conclusion (like Balikci's) is open to more than one interpretation. To illustrate why the wrong caliber rifle is sometimes knowingly employed by natives, Sonnenfeld's (1960) experiences in Alaska provide some insight:

> ... a small caliber rifle is less efficient but permits the use of cheaper ammunition, which also provides the hunter with more shots. For the highly skilled hunter, either of these economies might prove a true economy; for the less adept it was likely to prove a false one. When I accompanied a group of Eskimo... on a caribou hunt, none was equipped with larger than a .22 caliber rifle. A hunt for a small "humpback" whale... lasted the whole of the twilight, primarily because, for the most of this time, the only weapons available to the Eskimos were rifles, a .30-06 being the most powerful of these. Though considerations other than economy were involved, the inappropriateness of the rifle, and the waste, were obvious (Sonnenfeld 1960 p. p.184-5).

It can be surmised that had Sonnenfeld observed only this hunt, where hunters were mis-using rifles to kill a small whale, his opinion might have coincided with Banfield's: that their use of small-caliber rifle slugs in these situations was without reason. This account demonstrates that appearances alone can be misleading.

Part III

In the absence of other data, the two caribou survey estimates taken in 1955 (279,000) and 1957-58 (200,000) were cited in every published report on barren-ground caribou for over a decade (Parker 1971 p. 5). In the mid-1960s, the belief grew that caribou were no longer as scarce as some had thought. The 1955 estimate was considered to be outdated and one biologist published unsubstantiated reports of an uncontrolled population explosion in barren-ground caribou that would culminate in the starvation of hundreds of thousands of animals (loc. cit.). These unfounded reports brought pressure on the N.W.T. Games Management service to relax its restrictions on caribou hunting by white residents. Lacking facts on the actual status of the caribou populations, the territorial government proceeded to liberalize hunting and finally allowed commercial exploitation of the herds in 1968.

In 1967, the Canadian Wildlife Service conducted a survey of three of the four mainland barren-ground caribou populations (Bluenose, Bathurst and Beverly). With an estimate of the fourth herd (Kaminuriak) included, the total count was 385,500 animals (Parker 1971 p. 5). The 1955 estimate (279,000), minus the results of unsurveyed areas covered in 1967-68, was reassessed at 257,700 animals for these same populations. In a direct comparison of the 1955 and 1967 estimates, this indicated the populations had increased by 127,800 (49.5 %) during the 12 years between surveys. This growth rate was used to justify increased exploitation of the caribou populations (op. cit. p. 5-6).

Parker (1971), however, analysed the data and other factors relating to two survey estimates and arrived at a startlingly different conclusion. In recalculating the 1955 estimate, he arrived at a total of 390,534 caribou - 5,000 more animals than the 1967-68 estimate of 385,500 (op. cit. p. 8). Accordingly, he concluded that (1) the 1967-68 barren-ground survey provided no evidence that the four mainland populations had increased since 1955 and (2) the relaxation of hunting regulations for these populations may have been based on invalid comparisons of data (loc. cit.).

Discussion

The implications of Parker's conclusions are notable. First, his analysis suggests that the 1957-58 estimate of 200,000 is completely inaccurate unless the population declined from 390,534 in 1955 to 200,000 in 1957-58 and increased again to 385,500 in 1967-68. Second, it was the 1955 survey results that were a "quantitative demonstration" (Kelsall 1963 p. 6) that hunters were over-exploiting caribou populations by 60% in a six year period. From Parker's analysis, it is difficult to know which survey estimates to believe and which comparisons of data are valid. Based on this information, the certainty that hunters over-exploited these animals is questionable. If a prerequisite to effective management of a wildlife species is the knowledge of the population dynamics of that species, it appears that "confidence limits are so wide as to render estimates virtually useless for management purposes. ... and makes a mockery of attempts to manage the resource" (Fuller 1979 p. 181).

Part IV

In the 1960s and the late 1970s, a crisis was prompted by biologists' reports that some of the caribou herds were in danger of extinction. One of the four major barren-ground caribou populations, the Kaminuriak, was said to have declined to an all-time low of 39,000 animals, only one-quarter of its population thirty years earlier (Pelly 1986 p. 41). While there is no consensus in the literature on this figure of 39,000 (e.g. 30,000 (Thompson and Fischer 1979); 34,000 (Miller 1983)), there was a general consensus that the Kaminuriak population declined because of over-exploitation. This included the wildlife officers in the Keewatin, who were largely unanimous that the Kaminuriak herd was being over-harvested (Thompson and Fischer 1979 p. 273). In his report on *An estimate of the size and structure of the Kaminuriak caribou herd in 1977*, Heard (1981*a* p. 18) concluded that the combined effects of hunting (>6%/yr.) and wolf predation (>8.5%/yr.) exceeded the average annual recruitment of this herd (10%/yr.).

From evidence of the biologists' reports, many people laid the blame on the hunters. Close regulation of caribou was proposed because snowmobiles made over-hunting too easy (Arima 1984 p. 461). In 1977, the issue was taken to court by the people of Baker Lake over the effects of their exploitation of the Kaminuriak herd. Wray (1983) explains some of the events:

> For two and a half years the officials of the wildlife service ... accused us [at Baker Lake] of mass slaughtering, they sat in the federal court of Canada... and accused us of inhuman practices, they accused us of everything imaginable. All this time the people of Baker Lake and the people of Keewatin in general said, "You are wrong, the caribou are not declining, they have moved." We tried to tell them, we even took them out and showed them where the caribou were, we showed them the tracks of the caribou and they came back to us time and time again and said, "Well, you are not biologists, you are not zoologists, you do not have a university degree, you do not know what you are talking about." (Wray 1983 p. 380).

At one meeting in the early 1980s, hunters were told by "an expert in counting caribou" that he thought the caribou would disappear and that hunters might be allowed only five animals per year in an attempt to preserve their numbers (Mumgark 1982 p. 40). Some of the representatives of Inuit, Indian and Metis user groups who met with government officials stated that their traditional practices were sufficient management for maintaining the caribou populations (Pelly 1986 p. 41).

In 1982, however, all the current biological data showed that the caribou herds were much larger than estimated and that they were expanding their ranges at an optimum rate (Barber 1986 p. B16). A year later, surveys revealed that caribou populations had returned to their former levels and the Kaminuriak herd numbered

180,000 to 230,000 (Pelly 1986 p. 42). This confirmed the long-standing Inuit claim that the herds were not in danger of extinction and biologists' information was incorrect. It also emphasized the need for biologists to gain a fuller understanding of both the population dynamics and migration patterns of caribou (loc. cit.; Curly 1983*a* p. 379). The results of the survey precipitated the passing of a loss of confidence motion in the goverment wildlife biologists by the Legislative Assembly of the Northwest Territories (Northwest Territories 1983*a*, 1983*b* p. 401-2). By 1986, the combined population of the Beverly and Kaminuriak herds was estimated to be over 600,000, nearly six times larger than the minimal estimate of the early 1980s (Barber 1986 p. B16).

Discussion

The above investigation can be summarized. First, regarding the Pleistocene overkill theory, we have no reason at present to blame early man for over-kill. Second, both historical accounts (e.g. Rasmussen) and first-hand observations (e.g. Banfield) are prone to misinterpretation given a lack of information. Third, the management of mainland barren-ground caribou populations by the state system and its practitioners has many shortcomings. Fourth, the evidence used as explanation for the over-exploitation of the barren-ground caribou by hunters is unsupported.

Regarding this last statement and the Kaminuriak event, the problem clearly rests in biologists' incorrect data and not over-exploitation. This raises a matter of concern. Since the data on the Kaminuriak caribou - the most intensely studied herd in the world (Monaghan 1983 p. 383) - was erroneous, what does this say about the accuracy of the earlier, less studied, caribou surveys? It can be postulated that protective legislation and wildlife management deemed essential in the 1950s on the veracity of this data was unnecessary.

To reiterate, Bergerud (1974) wrote, "it is my hypothesis that, in pristine situations, there was a fine balance between gains and losses in caribou populations. ... With the advent of hunting with rifles, this precarious balance between recruitment and mortality was upset and the populations started to decline. Such a decline would be gradual at first because of the large number of animals, but would accelerate as numbers decreased. The law of diminishing returns may have applied only weakly to caribou hunting" (p. 762). Miller (1983) wrote, "this use of modern technology has tipped the balance greatly in favour of the native hunter... the so-called harmony between primitive native hunters and caribou was imposed by the caribou's continuous movements; the native's relative lack of mobility; and the native's poor weaponry" (p. 173).

According to Bergerud's hypothesis, the advent of hunting caribou with rifles started and accelerated the process of over-exploitation. But did the generalized use of firearms in a hunter-gatherer society upset the so-called harmony of man-animal relationships into such a pattern? From the chapter's analysis of barren-ground caribou, the evidence required to support this hypothesis is non-existent. Bergerud writes ""it is my hypothesis that, in pristine situations, there was a fine balance between gains and losses in caribou populations", but what were the numbers of caribou in 'pristine' situations?

According to Miller, the native's poor weaponry (e.g. spear, bow and arrow) was one of three restrictions governing the hunters' rate of exploitation. But was, in fact, the balance between primitive native hunters and caribou population imposed by restrictions beyond the hunter's control (e.g. poor weaponry)? If so, these hunters had neither the knowledge nor the institutional means (e.g. self-regulation) to control their rate of exploitation with or without firearms. From what has been examined in this chapter, evidence does not support this conclusion.

Since the evidence to support both of these viewpoints is inconclusive, this reveals another aspect which begins the next chapter. As the advent of the rifle did not lead to unbounded exploitation, this suggests the existence of some control or regulation of harvesting. In Part IV on the Kaminuriak incident, there is some suggestion of control when native spokesmen stated their traditional practices were sufficient management for the caribou (Pelly 1986 p. 41). The next chapter will examine the existence of self-regulation.

CHAPTER FIVE

> *Man's contact with nature has never been direct; it has always been mediated through knowledge structures via his senses and his intellect. We have no other means of knowing the world around us.* (Moscovici 1976)

ON THE NATURE OF SELF-REGULATION

Every native society has a body of unwritten customary laws governing allocation and use of resources. That few have been committed to writing, as in the case of the Elder's Rules in Labrador, is not a refutation of their existence (Usher 1981 p. 58-9). As one hunter explains it:

> Even the Inuit of way back in history never set down rules. So it is really hard to set down rules. They used to just live and hunt. We didn't have any rules like we have today from the Kabloona [whites]. Those who are living today can't find any rules made by those living before because they didn't make any. It would be just as difficult today (Mautarituaaq 1978, p. 128-9).

Customary law in the indigenous system rests on communal property arrangements in which the local harvesting group is responsible for management by consensus (Usher 1987 p. 6). Management can be defined here as: an information base used by a set of practitioners with a distinctive world view; a system of rules, norms and customs concerning rights and responsibilities that are intended to govern the behaviour of all who partake of wildlife and its benefits (loc. cit.). It is this system of management that is a core feature of all northern native cultures which links their values, ethics and cosmology in an integrated, non-compartmentalized view of the environment (op. cit. p. 7). Amongst the Iñupiat (Inuit) in Alaska, for example, language, world view, ideology, technology, education and epistemology have emerged from the surrounding environment (Nelson 1981 p. 112). One native expressed his view this way:

> To us the land and marine environment are not separated... To Inuit, for most of the year, the ice and land are not different. We live from the resources of both... the land and water are one. Please do not look upon our land (as) in different boxes, ocean resources in one box - wildlife management is yet another box ... We see our environment as a whole and only learn about your boxes with difficulty (quoted in Berkes and Freeman 1986 p. 437).

Harvesting and management are said to be conceptually and practically inseparable (Usher 1987 p. 6). Therefore, when natives speak of their traditional 'management' of wildlife, they are not refering to some separate practice they apply to harvesting. Feit (1973) wrote that because hunting has an effect on animal population dynamics (e.g. yield, sex balance, age structure, etc.), it is therefore possible to anticipate the consequences of harvesting patterns making it possible for hunters to control, or in a sense, manage their resources as well as themselves (p. 116). Paine's (1973) thesis states that hunters will hunt a localized animal population until it is depleted below a critical level at which juncture the principle of least effort prevails and hunter moves on (p. 303). One significant point is that what is "too low" in yield for the hunters is unlikely to be "too low" in population density for the specie's reproductive purposes. By reducing the population somewhere below its own ceiling level, the population will proceed subsequently into a period of fast growth. This explains, in part, the cyclical pattern yields experienced by hunting groups over a period of years in the same hunting territory (loc. cit.).

In Greenland during times where traditional methods were used (e.g. hunting seals from kayaks), the idea of retaining an ecological balance was expressed and manifested in numerous ways. Several settlements, for instance, would be populated for limited lengths of time before being used in rotation to conserve local animal stocks (Kapel and Petersen 1982 p. 67). Hunting ceremonies were used not for the purposes of improving hunting efficiency, but to instill a respect for living creatures and to caution against the wasteful use of animals (loc. cit.). Unnecessary hunting was deprecated (Petersen 1965 p. 117) and even though people normally avoided interferring in matters of other households, hunters who threw away meat were scolded by other men (Kapel and Petersen 1982 p. 67). Hunters also recognized that it was not always the hunting of the animals that disturbed the balance of the stock in the area. It is necessary for game to enjoy a certain peace and if one continually travels over the animal's habitat it has an effect on the stock: it is one of the reasons why some hunting fields are left "fallow" (Petersen 1965 p. 111). In the past, hunting regulations were not necessary. The exploitation pattern, distribution principles and other customary rules allowed a low harvesting rate with maximum utilization of the animals killed. However, when changes in population occurred and new harvesting techniques yielding more profit resulted in greater loss of animal life, new hunting methods and regulations were developed to avoid any unnecessary loss (Kapel and Petersen 1982 p. 68).

The Koyukon in Alaska have a highly developed conservation ethic focussed upon the maintenance of resource species and an avoidance of waste (Nelson 1982 p. 224). In the Koyukon language, the word meaning "to use" has always meant "to kill" or "to catch": the two concepts are inseparable (op. cit. p. 227). For the Cree of northern Quebec, a good hunter is someone who can constantly provide for his needs, and not one who harvests in quantity; they disapprove of killing animals for the purpose of building a reputation or for self-aggrandizement. A self-limiting principle is in operation which acts as a negative feedback loop: increasing levels of harvest decreases the incentive for further harvesting effort (Berkes 1981 p. 169).

In addition to the studies of indigenous self-regulation systems in northern Canada (e.g. Freeman 1985*a*), in Alaska (e.g. Nelson 1983) and in Greenland (e.g. Kapel and Petersen 1982), there is a body of international literature supporting the proposition that hunter-gatherer societies have for a long time regulated their rate of exploitation without depleting the stock population (e.g. Johannes 1978; Nietschmann 1972, 1973), e.g.

> If animals are indiscrimately trapped, poisoned and slaughtered, whole species would be threatened with extinction. In order to avoid such eventuality, hunting populations 'cultivate' game by allowing it to breed. Such an attitude is totally foreign to predacity. It reflects a high measure of foresight and self-control as well as conscious, premeditated relation to the environment which is still current today and probably emerged at a very early date. ... For hunters tend, as a rule, to respect the habits of different species and preserve them from extinction (Moscovci 1976 p. 50)

According to Usher (1987), the indigenous system is far more sophisticated than many credit it to be and it has remained intact to a remarkable degree despite the numerous problems (p. 7). These problems include intervention where the wildlife management system has either ignored or failed to recognize an indigenous system (e.g. Brody 1982; Hackman and Freeman 1975; Gottesman 1983; McCandless 1985; Usher 1987) and where wildlife predictions by biologists have contradicted the local harvesting group's own knowledge (e.g. Anon 1985b; Kallutkak 1982; Leo 1982; Mumgark 1982). As a result, the native system went underground and remained in practice only at local levels, until more recent years when it was reasserted by native harvesters (mainly in the context of Native claims) and revealed by social scientists (Usher 1987 p. 7).

Customary law remains viable as long as it is socially supported by the whole community. There have been occasions where customary law dealing with animal resources has collapsed and over-hunting has resulted. Berkes (1981) cites an example in the 1920s where the Cree in northern Quebec contributed to the depletion of beaver when their customary law and land tenure system collapsed due to non-native trappers ignoring the native land tenure and from competition between the fur trading companies (p. 170). However, once the government prohibited non-native trapping in the area in the 1930s, customary law and land tenure became operative and the beaver populations recovered in the 1940s and 1950s (loc. cit.). Berkes (1981) adds:

> Historical and current experience show that the effects of these perturbations are not necessarily permanent. In some cases, where the root cause of the perturbation is dealt with (as in the case of the beaver in the 1930s) customary law becomes operative once again and the system recovers. In other cases there may be permanent change; the ground rules are redefined and the system adapts to change. The adaptations may not come about smoothly or rapidly; there may may considerable social disruption, which may contribute to poor conservation practices during the period of adjustment (p. 172)

In recent years there has been discussion and concern about changing social values, economics and modern technology (e.g. snowmobiles) resulting in the loss of hunting skills and traditional values concerning the minimum wastage of meat and increased exploitation. What has been viewed as a decline, however, is not always the case. For example, the efficiency of walrus hunting (measured in terms of retrieval rate and use of the animal) by the Southampton Island Inuit remained not only high, but increased significantly between 1961 and 1970 when dogteams, which were fed on walrus, were replaced by snowmobiles (Berkes and Freeman 1985 p. 446; Freeman 1974/75). Much hunting is done for non-material reasons (e.g. Wenzel 1983) and for purposes other than obtaining maximum harvest of wildlife (e.g. Berkes 1982).

Hunters and trappers will forgo maximum economic returns, or even engage in unprofitable activities, for the sake of convenience or leisure (Usher 1972 p. 178). Usher (1982) writes:

> I believe the answer is that although [the use of modern technology] ... facilitates overhunting, it is not the cause of it. So long as people utilize what they are hunting for, either themselves or among their own community, then the introduction of new technology will most likely be used to save time rather than increase production. If a family needs 30 caribou a year to feed itself, there is no intrinsic incentive to get 60, unless some new use can be found for the extra ones (Usher 1982 p. 36).

There are exceptional instances when a frenzy of killing takes place, especially where there are large numbers of animals in one location. But every hunting culture deplores these outbursts and has the social means to ensure that they are not frequent enough to endanger the welfare of the group (loc. cit.). When thoughtless slaughter occurs, it is undoubtedly made more destructive by the use of high-powered weapons. Yet the ancient technique of driving animals off cliffs or through narrow passages afforded similar possibilities for excessive hunting (op. cit. p. 37).

Discussion

From these selected accounts, it is evident that (1) there is a socially constructed system of self-regulation and (2) hunters practice control in harvesting through the acquired knowledge and institutional means to monitor and avert overhunting. This is not to say that natives never over-harvest or that they are natural conservers. Rather, as Burkes (1981) puts it, good resource-use practices develop among people who are dependent on a particular resource (p. 173). Not all agree; Ellen (1986), for example, argues it is less the conscious wisdom, or even some superbly adjusted system which has evolved over the millenia, which leads to the maintenance of an ecological balance between man-animal relationships, but more the consequences of isolation, low population densities and other factors which have the mechanical effect of making regulation easier and more probable (p. 12). He adds, "alter any of these variables and the situation might look very different" (loc. cit.). While his argument is understood, it does not take into account historical and current records where changes in such areas as technology, population and economics have occurred and the ecological balance has remained through readjustment (e.g. Kapel and Petersen 1982) or recovery (e.g. Berkes 1981).

As harvesting and management are considered inseparable, hunting is more than the simple action of procuring animals through various strategies and management is more than the simple action of leaving hunting fields "fallow". The following examines the nature of this traditional system.

The traditional system

Hunting is a way of life, not just a "subsistence technique" (Laughlin 1968 p. 304). Hunters develop their art of hunting methodically and while it is quite true that hunting is made possible by tools, it is far more than a technique or even a variety of techniques (Moscovici 1976 p. 49).

On technology

Ridington (1983) points out that the simplicity of artifacts used by hunters is sometimes mistaken for low technology (p. 56). While we have come to use the word technology to refer to the tools used, the root of the word comes from the Greek word "techne", meaning skill or art. Thus, we have subtly shifted the definition of technology from the knowledge of a technique to one that emphasizes the artifactual product of a technique (loc. cit.).

To be a successful hunter, one needs to possess knowledge rather than a particular tool. Tools might be lost, but knowledge remains with a person throughout life (op. cit. p. 57). Success depends upon being well-informed and free to intelligently act on available information. From this point of view, a technology that is carried in the mind and coded in oral tradition, rather than carried in hand and coded in the form of a tool, is highly cost efficient. Knowledge of the entire environment is held carefully in the mind and carried from place to place (loc. cit.).

On knowledge

The traditional system is based on empirical evidence and systematic accumulation of detailed observations (Freeman 1985*a* p. 275). By assessing deviations from the norm that are qualitatively derived (e.g. health of the animals, more barren cows, behavioural traits such as passivity and nervousness, etc), both numerical and qualitative trends occurring in the status of the population are derived (loc. cit.).

From year to year hunters evaluate the state of the animal population and any trends in population can be compared to prior records (Feit 1973 p. 122). If a hunter lacks understanding of a situation, other hunters in the community are equipped with the resources of their own experiences to provide assistance in interpreting the events (Freeman 1985*a* p. 275). The sum total of communities' empirically-based knowledge is voluminous and often stands in marked contrast to the limited data of science studies on these same species (loc. cit.). Whatever credence the scientist places on the local interpretation of observed events, the objective and detailed observations of hunters provide a considerable stock of basic, empirical knowledge. Much of their anatomical knowledge, life history data and taxonomies are known to be exceedingly accurate by scientific standards, and represent a wealth of baseline data otherwise unobtainable today (Freeman 1975 p. 257). Freeman (1985*b*) provides an example of how some of this knowledge is derived:

> Inuit and northern Indian peoples understand very fully the feeding relationships of the animals they utilise for food, since the examination of stomach contents (among other organ systems) is part of the almost routine biological examination that accompanies the butchering process. Indeed, utilization of some animals and plants as food (e.g. capelin, *Mallotus vilosus*, and bivalves *Cardium* spp. and *Mya truncata*) may only occur where these foods can be obtained from the stomach of marine mammals or birds (Freeman 1985*b* p. 249).

In concluding, it is evident that a viable and adaptable self-regulation system exists with hunters and gatherers. It is also evident that harvesters have a sound basis of knowledge and expertise in animal ecology. In the appendix, four cases are described where the traditional system of harvesting/management has proven successful and superior to state wildlife management.

CHAPTER SIX

CONCLUSIONS

This thesis has investigated native harvesting strategies and selected cases of over-exploitation. The purpose has been to assess the credibility of the assumption that hunter-gatherer societies do not have a system of self-regulation. I conclude that the assumption is erroneous. Hunters do not range randomly through their environment, and hunting and gatherering is not pursued on the simplistic basis of "catch as catch can" or "anything that moves goes into the pot" (Nietschmann 1972 p. 41). This notion of hunters' existence being in "so-called harmony" with man-animal relationships only because of his lack of mobility, lack of good weaponry and other factors, is simply in error.

In the pre-rifle period, we have no evidence to blame early man for extinctions occurring in the Pleistocene period. Man has spent 99 per cent of his 2,000,000 years on earth as a hunter-gatherer and this would seem to argue *a priori* for the existence of effective self-regulation to prevent the extermination of species on which he has depended. In the opinion of one hunter:

> For many centuries we have depended upon our resources for survival. We will continue to do so for many centuries to come. We are the greatest managers of our renewable resources with our Circumpolar homelands. ... and we have never wiped out any species of animals (Ernerk 1986*a* p. A5).

The availability of firearms did not start or accelerate the process of over-exploitation as predicted. With the barren-ground caribou crisis in the 1950s, it is arguably the survey estimates that were the problem and not the decline in caribou populations from over-hunting. With the Kaminuriak crisis in the 1980s, it is assuredly the survey estimates that were the source of the problem and not the hunters. There is a socially constructed system of self-regulation based on customary law and there are occcasions when this law has collapsed and resulted in over-exploitation. However, this does not refute the existence of self-regulation or imply that it is out-moded; rather, in some cases, the ground rules are redefined and the system adapts to change. There is also a traditional system of harvesting/management of animal resources, which means the system of management has been superimposed by the wildlife management system. This leads into the final section on implications for wildlife management.

Implications for wildlife management

Many wildlife professionals now recognize that native hunters routinely amass an enormous set of empirical data that could be of great value to the state management system (Usher 1987 p. 9). Inuit hunters are working in some areas with wildlife biologists. As one biologist noted, without the accompaniment of hunters, he could travel for days without seeing any caribou for the Inuit simply know where to look (Pelly 1986 p. 40). Most management agencies now acknowledge that native people are entirely capable of learning whatever scientific and managerial techniques and approaches non-native institutions can teach them. This was not the case ten or twenty years ago (Usher 1987 p. 9). In addition, almost every program undertaken by the NWT Department of Renewable Resources involves both biologists and Inuit - whether it is on an airborne survey, a prolonged field camp on the calving ground, the placing of radio-collars to trace sample animals, or a mobile ground survey (Pelly 1986 p. 42).

There have been new developments in caribou research more recently. In 1983, the Beverly and Kaminuriak Caribou Management Board was established whereby native groups and government agencies co-manage caribou herds (Monaghan 1986). New developments involve:

- devolving and decentralizing the management system so as to incorporate more direct input at the local level;
- establishing user advisory boards, and
- encouraging native people to become qualified to work as technicians and managers in the state system (Usher 1987 p. 8).

While these developments are an improvement, they may lead to situations in which the native harvesters merely provide the data (e.g."Inuit assistants" (Pelly p. 40)) and the state system continues to do the managing and allocation. There are hunters who feel that wildlife should be left alone altogether. According to one hunter:

> I will never totally accept the methods that biologists use, because I feel that wildlife is meant to be just that - wildlife. Caribou are not domesticated, so I am strongly against treating them as domesticated animals, constantly tampering with them with tagging and radio-collaring" (Pelly p. 42).

These developments do not necessarily serve to incorporate elements of the indigenous system as such, much less result in an indigenous system of self-management. On the contrary, they are much more likely to result in the continuation of the state management system in a decentralized but largely unchanged form. It is not yet generally recognized that knowledge and expertise of native harvesters provides them with the tools to integrate and organize these data into an effective management strategy (Usher 1987 p. 8-9).

To conclude, this is not an argument for what is known as "green primitivism" (e.g. Ellen 1986), where western man, having shorn or lost his ecological balance in the world, should subscribe to this traditional system to cure his environmental miseries or, in the case of wildlife management, abandon one for the other. Rather, as Watt (1972) has said, "...an extremely prudent civilization would try to maintain other civilizations with different ideas .... Over the short term, the ideas of civilization *A* might appear vastly superior to those of civilization *B*. But over the long term it could turn out that the apparently "primitive" practices of civilization *B* were based on milennia of trial and error and incorporated deep wisdom that was unintelligible to civilization *A* "(p. 82). As one native stated:

> Not only has their [traditional] expertise regarding the land proved accurate, reliable and valuable as knowledge, but they have witnessed changes that have come to the North with the wisdom that science in all its complexities seems to miss (Tizya 1975 p. 2).

APPENDIX

These four cases illustrate some of the usefulness and accuracy of native knowledge and expertise in wildlife management.

a) Bowhead whales

The western Arctic bowhead whale (*Balena mysticetus*) has been regularly hunted by Alaskan Iñupiat (Inuit) for over 2,000 years; prior to the commercial whaling period, it was estimated that these hunters were taking as many as sixty whales each year (Bockstoce 1981 p. 163). Between 1848 and 1910, the commercial whaling industry depleted this stock by removing 20,000 to 30,000 whales (loc. cit.). When the industry ended around 1915, the Iñupiat subsequently returned to subsistence hunting. From that period to the 1970s they continued to harvest between 10 and 15 whales per year; most whales struck were also caught (Berger 1986 p. 82).

From 1970 to 1977, hunting efforts expanded due to economic, ecological and cultural factors. Accordingly, there was a significant increase in the number of whales taken, including those that were struck but never captured. Between 1973 and 1977, respectively, a total of 47, 51, 43, 91, and 111 whales were struck or killed (loc. cit.). The Iñupiat were convinced that the bowhead populations had increased over the last 15 years and in their view, the expansion of the whaling effort along with increased catch, indicated a thriving bowhead population (loc. cit.).

In 1977, the International Whaling Commission (IWC) became increasing concerned over this number of high landings. The Scientific Committee of the IWC recommended a zero catch of bowhead in Alaska based on the following premises; 1) the current population of the bowhead was estimated to be somewhere between 600 and 1,800 animals; 2) this was less than 10 percent of the initial population size; 3) the Iñupiat harvest had increased appreciably in the last few years, primarily as a result of an increase on hunting efforts; and 4) the harvest risks for the species were unacceptably high (op. cit. p. 83). In June 1977, the IWC called a moratorium on the hunting of all bowhead whales.

The decision surprised the Iñupiat and those in Point Barrow were convinced there were more whales than estimated (Anon 1985 p. 22). In meetings following the moratorium, the problem developed for the IWC to substantiate the accuracy of their population estimates. Most field studies had been limited to observations on whales as they swam thorough open channels off-shore on their migrations in spring and autumn. The assumption was that all whales migrate past the observation points during these fixed periods, and that all passing whales were seen by the observers (Berger 1986 p. 83-4). The hunters said the whales were migrating offshore (loc. cit.) and swimming under the ice, and that the scientists were missing them. The hunters were not believed (Anon 1985 p. 22).

The native office of the North Slope of Alaska hired their own scientists to conduct research on population numbers. They used hydrophones to record the calls of passing whales and these calls were later sorted out and tallied. They found the whales were swimming under the ice and they estimated that 4,417 whales migrated past Point Barrow in 1985 (loc. cit). According to one scientist, the statistical methods used to analyze this data have become so refined, this census truly reflects the bowhead whale population in the Western Arctic (Berger 1986 p. 84). Based on these findings, a series of further negotiations were held and the IWC eventually agreed to adjust its quota regulations upward.

b) Fish habitat

In 1982, the federal Department of Public Works (in the Northwest Territories) proposed to blast and dredge a shallow section of the Mackenzie River to ease problems in river transportation. The proposed location was at Rampart Rapids, a few miles upstream from the community of Fort Good Hope. The people of that community have fished at Rampart Rapids for many generations and have a vast knowledge of fish habitat, spawning and nursery areas and migration patterns in the region (Delancey 1985 p. 10).

The community was alarmed at the proposal for they knew that the site was a prime spawning area for several species of fish important to the local economy. Their argument was rejected by government officials, however, and the officials in using the Department of Fisheries and Oceans (DFO) information said the spawning areas in the Mackenzie River were not known and there was no evidence in support of the community's claim (loc. cit.).

The proposal was later suspended for political reasons. Within two years, the DFO biologists reported to the community that through aerial studies of fish migration, they had confirmed that the proposed site was a spawning area for two, and probably six, species of fish. In a subsequent study held by the community, over 100 known spawning areas in the Mackenzie River and surrounding streams and lakes were identified (loc. cit.).

c) Peary caribou

On Ellesmere Island in the 1950s, a small community was established in an unoccupied area that was richly supplied with game. The authorities, however, who were concerned for the seemingly abundant Peary caribou, insisted the Inuit camp be located away from the main caribou feeding areas and that they (1) hunt only large male caribou and (2) only take a few animals from each herd. The Inuit, however, were unhappy with both of these regulations and predicted that such a plan would lead to quick extinction of caribou in their hunting region (Freeman 1985*a* p. 271). This is in fact what occurred; by the late 1960s, the caribou were virtually eliminated in this area despite the Inuit harvest of only 26 caribou annually for a total of 140 animals.

The Inuit believe that each small group of Peary caribou is a social group with good reason for their being together; they point out that given the marginality of the environment, the large and older males are important for the group's survival. The older animals' have experience and physical strength for digging through the snow for food and are more passive to the more nervous younger animals or pregnant females: a behavioural trait that has a calming effect on the younger animals of the group (op. cit. p. 271-2). With the critical role that energy balance is known to have in ungulate populations, these behavioural aspects of caribou biology are especially important. It was this behavioural knowledge of the Peary caribou that formed the basis of Inuit knowledge, in contrast to the inaccurate quantitative perspective held by the game managment service (op. cit. p. 272-3).

d) Muskoxen

In this same Inuit community, there was a proposal to institute a tourist sport hunt of the local muskoxen population. The game management service's proposal was based on: (1) only old male muskoxen would be harvested, (2) the best trophy animals were the old solitary and outcast bulls, (3) the meat would be given to the Inuit, (4) a quota of 12 trophy animals would be taken and (5) reducing the muskox population would be beneficial for the Peary caribou, which having more food, would increase in numbers (Freeman 1985*a* p. 272).

The Inuit believed all these propositions to be erroneous. They observed that the best trophy animals are the bulls in their prime and not the old males having damaged or missing horns. They knew that the existence of solitary bulls is a transitory phenomena which occurs only during the rutting period when irritability among males is at a peak. The Inuit were aware, however, that even during the rutting time, any threat to the scattered herd would cause all the animals to come together and the solitary bulls would fill their appropriate role. They also knew that the meat from the senile bulls was unpalatable and the meat from bulls in rut during the trophy season was uneatable (loc. cit.). The proposal for a fixed number of trophy animals taken annually was seen as a threatening proposition for the regional musk-oxen population because of (1) the slow growth of the animals, (2) the importance of the social organization for survival, and (3) the uneven and unpredicable recruitment levels. Finally, the Inuit observed that muskox and caribou eat different foods (loc. cit.). It should be noted that the muskoxen were not hunted by the hunters for food or skins and that their critique of this management proposal was based upon mainly esoteric knowledge. Muskox were an "unknown" species (except for oral tradition for a few hunters) until the people had moved into the region thirteen years earlier (op. cit. p. 273).

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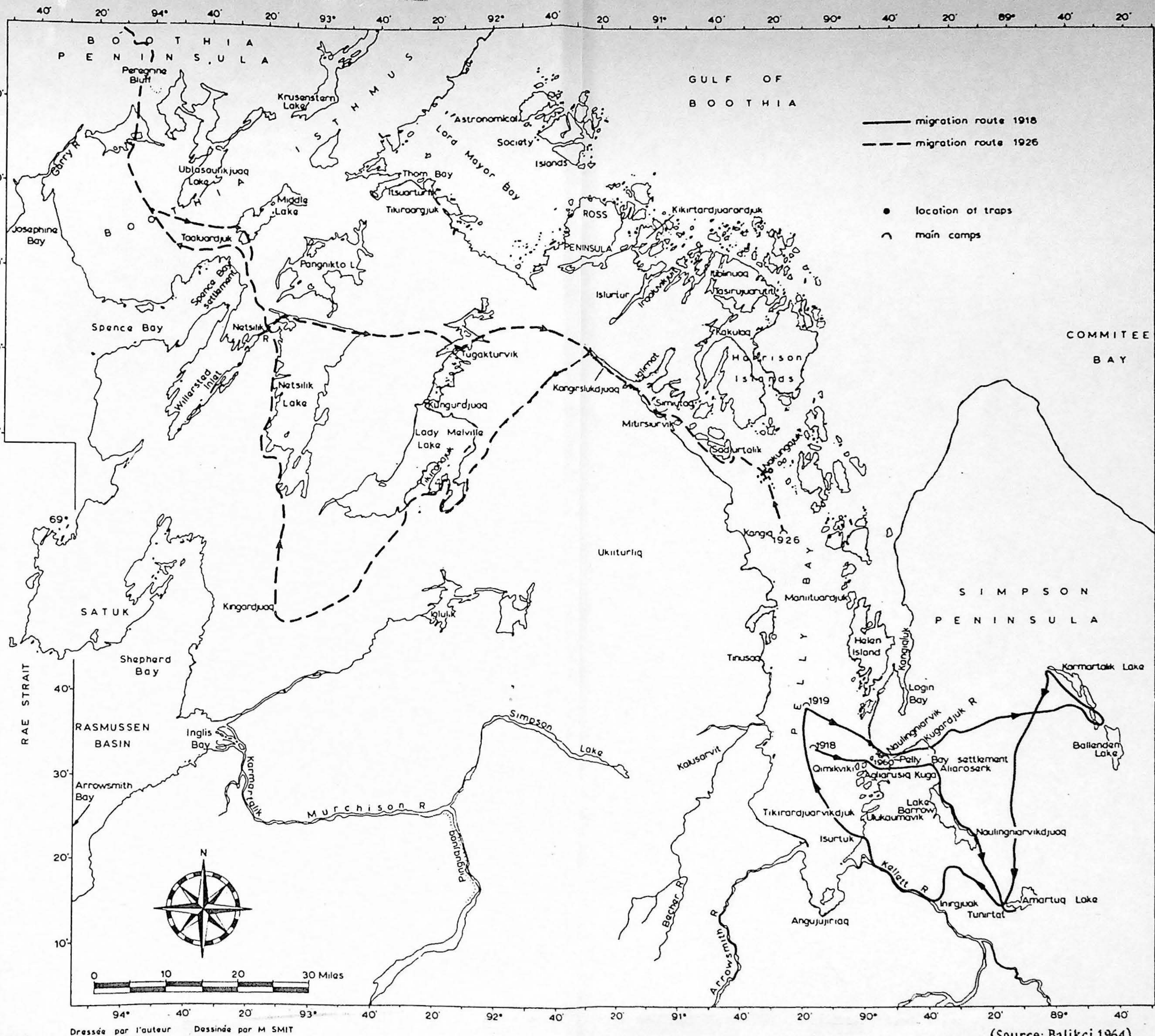

(Source: Balikci 1964)