Chapter 2

The spirit of survival: cultural responses to resource variability in North Alaska

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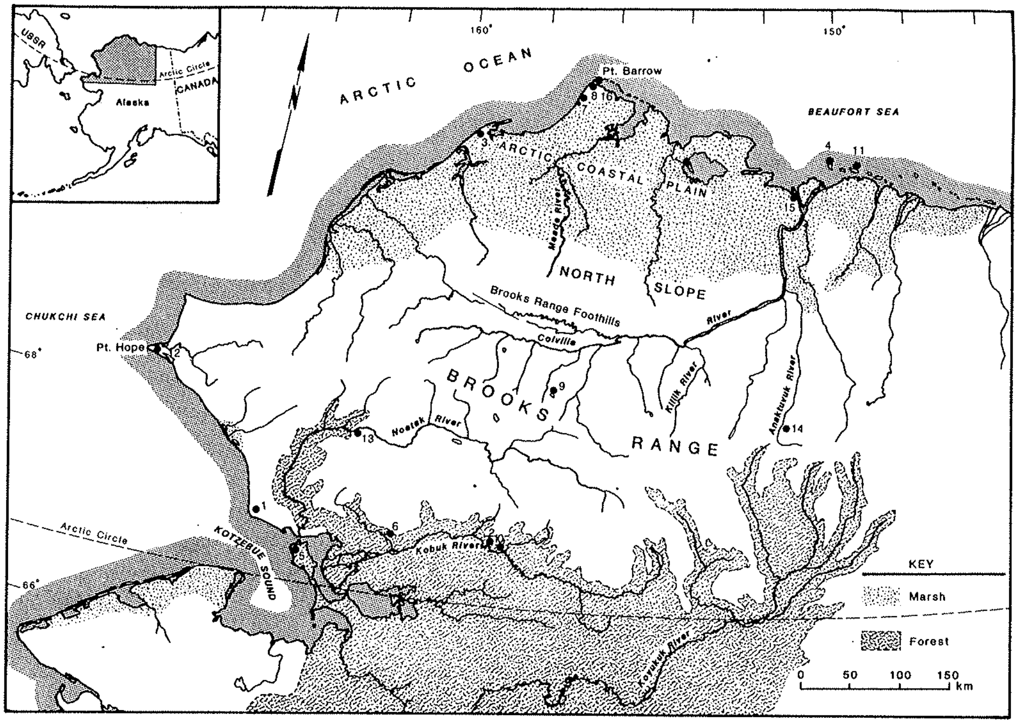
While the basic structure of responses to scarcity is constrained by the nature of those stresses which coping mechanisms must mediate to be effective, the implementation of coping strategies is predicated on the sociocultural context, which defines the range of organisational and technological options for mediating periods of subsistence stress. In this chapter, we reconstruct the spatio-temporal scales of variability in the major faunal resources of interior and coastal Alaska for the late prehistoric and protohistoric periods from variability in relevant climatic and ecological factors. From the structure of resource variability, we predict the basic structure of coping responses, and examine how specific coping strategies were modified over the past 1000 years to adjust to changes in resource structure and sociocultural context.

> While environmental changes of certain magnitudes require adaptive adjustments in subsistence behaviour, the nature of the response is determined in large measure by sociocultural rather than by environmental variables (Euler, Gumerman, Karlstrom, Dean and Hevly 1979: 1089).

At the time of European contact in the early 1800s, Iñupiat Eskimos inhabiting coastal and inland North Alaska pursued ecologically distinct ways of life. The *tareumiut*, or 'people of the sea', practised a subsistence economy based on sea-mammal hunting, with an emphasis on whaling. Tareumiut settlement was accordingly distributed along the coast in relatively permanent villages. The *nunamiut*, or 'inland people', in contrast, focused primarily on hunting the migratory caribou and ranged widely over the interior regions from the Brooks Range north to the Arctic Coastal Plain (Figure 2.1).

For traditional hunting societies, the interior and coast constituted complementary resource zones which experienced similar short-term and long-term patterns of scarcity in their primary subsistence resources, but differed significantly in the timing of those fluctuations, as well as in the density, distribution and variety of alternative resources. By the historic period, cultural responses to subsistence stresses of the coast and interior had given rise to a survival strategy in which the Tareumiut and Nunamiut were economically interdependent societies, linked by inter-regional alliances which converted short-term resource abundance into long-term social insurance.

The particular configuration of responses to scarcity developed by the Nunamiut and Tareumiut represents the end point of an extended history of survival tactics, in which the changing structure of resource variability and the emergence of new institutions and technology continually redefined the constraints on, and options for, survival. In this chapter, we examine the interplay of natural and cultural factors constraining hunter–gatherer responses to risk in North Alaska. We first outline a model linking the basic structure of survival strategies to the basic spatial and temporal structure of subsistence stress for hunter–gatherers. We then evaluate the sociocultural context of survival strategies, including the social, technological and cognitive systems which sup-



1 Cape Krusenstern
2 Onion Portage
3 Nunagiak
4 Thetis Island
5 Kotzebue
6 Ekseavik
7 Walakpa
8 Utkiavik/Utquiagvik
9 Sikoruk/Tukuto Lake
10 Ivisahpat
11 Pingok Island
12 Tigara/Tikeraq
13 Kangiguksuk
14 Kavik
15 Niglik
16 Nuwuk

Fig. 2.1. Major physiographic features of North Alaska and sites specifically discussed within the text

port their maintenance and utilisation. Finally, we examine the operation and development of coping strategies in North Alaska over the past millennium, through consideration of the changing structure of subsistence resources and the changing sociocultural context for mediating subsistence stress.

The structure of resource variability and coping responses

Halstead and O'Shea (introduction to this volume) have identified four basic categories of response to risk which can be considered general *coping strategies*. These are (1) diversification, which attempts to counteract scarcity of one resource through recourse to others; (2) mobility, which attempts to even out spatial discrepancies in resource availability by movement between areas of localised resource abundance; (3) storage, which attempts to even out temporal discrepancies in resource availability, by 'saving it for later'; and (4) exchange, which attempts to play off temporal variability in resource availability against spatial variability in resource abundance (cf. Colson 1979; Minnis 1985: 32–42).

As general coping strategies, diversification, mobility, storage and exchange potentially operate over a broad range of spatial and temporal scales. For example, although a particular form of storage may be limited in its efficacy to mediating crises of relatively short duration (Rowley-Conwy and Zvelebil, this volume), the strategy of storage (that of evening out temporal discrepancies in resource availability by 'saving it for later') is not necessarily so limited. It is the adaptation of these general strategies to the specific structure of subsistence stress which generates the variety of cultural phenomena collectively known as 'buffering mechanisms'.

Responses to subsistence stress are effective only if they transcend, spatially and temporally, the adverse conditions. Accordingly, an analysis of resource variability provides a basis for characterising the basic structure of mediating responses by specifying those contingencies which a given strategy must meet to be effective. Resource variability can be measured along a number of axes, reflecting differences in resource abundance, predictability, and duration and extent of fluctuations, relative to the availability of alternative resources and the coping capabilities of the group under consideration. For example, the *productivity* of a resource determines its potential for *utilisation*, while greater *predictability* or *stability* permits a greater *reliance* on a resource, *ceteris paribus*. However, *productivity* is a function of both physical characteristics, such as body size and abundance, and such cultural factors as the organisational and technological capabilities of a society to be successful in procuring that resource (Jochim 1976, 1981). Similarly, the *reliability* of a resource results both from spatio-temporal fluctuations in its availability and from the success rate of a particular method of procurement. The productive potential and reliability of a resource will therefore vary through time and space in response to differences in resource structure as well as to differences in hunting/storage tactics and technology.

Table 2.1. *Coping strategies vs. spatio-temporal scale of subsistence stress*

General coping strategies	Continuum of stress conditions: Low severity (localised, short-term) ⟷	High severity (regional, long-term)
Diversification	local secondary resources	extra-regional resources
Mobility	increased intra-regional logistic/residential	inter-regional migration
Storage	intra-community (physical storage)	inter-community ('social storage')
Exchange	generalised reciprocity/ informal sharing at intra-societal level	delayed reciprocity/ formalised trade at inter-regional level or negative reciprocity (raiding and theft)

The structure of alternative resources is crucial to the character of environmental uncertainty. Whether the potential alternative resources respond to the same factors as the primary resources, and so vary 'in phase' or 'out of phase' with them, is a critical temporal consideration. Similarly, the spatial organisation of alternative resources, whether aggregated or dispersed, local or distant, used by other groups or not, and the scheduling necessary for their exploitation will constrain the options for buffering scarcity of primary resources.

Because effective responses to risk must match the structure of resource variability, increasing duration and extent of stress lead to a corresponding increase in the spatio-temporal scale of response. In non-stratified societies, this proceeds primarily through an expansion of the social network through which subsistence activities are organised and resources obtained (Wiessner 1977, 1982; Minnis 1985; Spielmann 1986). This network effects an averaging or 'pooling' strategy for risk reduction, in which the impact of localised disaster is diluted by spreading its effects over a wider social arena.

As episodes of stress increase in severity, the capabilities for coping locally are exceeded and the socioeconomic unit or network involved in pooling resources and risk expands. Household and community-level responses are activated first, followed by more extensive social alliances. However, as the scale of subsistence stress expands beyond the bounds of 'normal' social interaction, an increasing degree of formalisation, or ritualisation, is invested in the maintenance of the social relationships which guarantee access to needed resources.

Thus, increasing severity and scale of stress have implications for how diversification, mobility, storage and exchange are implemented among hunter–gatherers (Table 2.1). That is, as the severity and hence the spatio-temporal scale of the perturbation increases, the size of (a) the spatial area over which a given strategy operates and (b) the social unit integrated by that response must correspondingly increase.

For instance, in the event of primary resource failure, procurement may be diversified to include local secondary resources and famine foods. However, if the duration of the failure extends beyond the limited support capacity of local secondary resources, diversification must be expanded to include non-local resources. Similarly, as the size of the area monitored or exploited increases, so does the degree of mobility. More frequent residential moves or longer-distance forays may be adequate responses to reduced local resources, but effective utilisation of non-local resources may involve extra-regional migration.

Exchange networks can also expand to dilute the impact of subsistence stress. Intra-societal exchange or sharing evens out short-term, localised differences in hunting success through the pooling of resources. In a long-term or regional resource failure, however, where survival depends on access to resources and goods outside the normal network of reciprocal obligations, social access will be maintained through increasingly formalised means of exchange, such as trading partnerships, or through delayed obligations inherent in 'social storage'. In the absence of accepted, mutualistic avenues of exchange, necessary resources may be acquired through negative reciprocity, in the form of raiding and theft.

While specific tactical uses of the various coping strategies may be mutually exclusive, at other levels of analysis, and in particular structures of response, they represent nested levels of response within the overarching survival strategy utilised by a society. For example, where high interannual variability makes the amount of a resource which is needed unpredictable (such as when resources are stored for use over the winter, but winter conditions vary greatly), one effective strategy may be physically to store enough of the resource to overcome the 'worse-case' scenario (Rowley-Conwy and Zvelebil, this volume). In good years, unused surpluses from such a tactical response may then be converted into social alliances and debts, through gift giving and the hosting of feasts, thereby creating a form of social storage against long-term variability. Examination of adaptive strategies must therefore concurrently consider solutions to long-term fluctuations and short-term variability in resource abundance and predictability, as these form the matrix upon which both immediate decision-making and long-term processual change are operative.

The sociocultural context of survival strategies

Although the basic structure of response to stress is governed by the nature of resource variability, the realisation of a given survival strategy is embedded in its sociocultural context. The implementation of a given *coping strategy* is predicated on the existence or development of specific *sociocultural mechanisms*, including technological capabilities and social institutions. For storage to mediate a period of scarcity there must be adequate technology for preserving food caches; similarly, exchange rests on predefined social alliances and the social institutions supporting those alliances.

Actions and institutions are in turn motivated by *cognitive structures*, which match cultural perceptions of resource variability with the appropriate alternatives for mediating hardship. These may function at a limited level, such as in the definition of 'famine foods', a form of passive storage identified by Halstead and O'Shea (introduction to this volume), or they may provide a comprehensive 'cognised model' of the environment which identifies relevant aspects of resource variability (Rappaport 1979).

These cultural mechanisms and perceptions define the range of options available for mediating a crisis situation. In the framework of economic decision-making theory, they constitute the body of accumulated reference data against which resource fluctuations are monitored and assessed, and decisions concerning the appropriate response formulated (Minc 1986; Smith 1986).

Finally, any change in the sociocultural context redefines the array of feasible alternatives for buffering subsistence stress. Technological or organisational innovations, for example, may increase the group's ability to cope with resource perturbations, thereby altering the cultural definition of 'severity'. It is this potential for directional change which underlies the historical dimension of survival strategies, such that, through time, survival strategies can be considered the end product of both the specific culture history and the culture-specific redefinition of resource variability.

The general model presented thus far can be summarised as follows:

1 The basic structure of survival strategies must match the structure of resource variability, as defined along the dimensions of resource abundance, predictability and spatio-temporal scales of fluctuations, relative to the availability of alternative resources.
2 Resource abundance and productivity affect decisions concerning the degree of resource utilisation, while predictability determines the degree of reliance placed on a resource. The structure of alternative resources provides the ecological context for decisions regarding responses to variability in the primary components of a society's subsistence strategy.
3 Increasing duration and spatial extent of subsistence stress requires the activation of increasingly expanded socioeconomic networks and the adoption of forms of coping mechanisms which integrate more social units and/or encompass more space.
4 Cognitive models encode information relating to potential responses to variability at different scales. These models form the blueprints for activation and selection of the coping strategies available to a society and reinforce adaptive patterns of behaviour during intervals when the adaptive characteristics are not needed.
5 Technological innovations and societal change alter the matrix upon which decisions about responses to stress are made. The interplay of change and response, which results in the constant restructuring of this matrix, is one of the most important vectors of processual change in egalitarian societies.

We apply this model to resource variability and response strategies of the traditional hunter–gatherer societies of North Alaska in three stages. First, we define the structure of resource variability in this area through an operational model of the ecological factors generating variability in major subsistence resources. With this background we examine the palaeoclimatic record encoded in tree-ring sequences to determine the structure of resource abundance and predictability over the past one thousand years. Secondly, we examine how the basic strategies of diversification, mobility, storage and exchange were modified by Tareumiut and Nunamiut societies of the late nineteenth and early twentieth centuries to match the structure of subsistence resource fluctuations. We then delineate the specific sociocultural mechanisms which facilitated the implementation of those strategies and the cognised model of resource variability which motivated specific cultural responses to resource scarcity. Thirdly, we examine the archaeological record of the late prehistoric and early historic periods (*c*. AD 1000–1920) in order to monitor long-term responses to the changing structure of resource variability.

Faunal resource abundance and predictability in North Alaska

Traditional Tareumiut and Nunamiut hunted a variety of animals (Spencer 1959; Burch 1981), but primarily depended on the major species which could be taken reliably in quantity. In the coastal villages, stored meat and blubber from the bowhead whale (*Balaena mysticetus*) provided at least 50 percent of the winter food supply (Foote and Williamson 1966, Table 7; Marquette and Bockstoce 1980:50; Sheehan 1985:131–6). Seals (primarily the perennially available ringed seal [*Phoca hispida*] and the migratory bearded seal [*Erignathus barbatus*]) were important secondary resources, while walrus, caribou, migratory birds and fish provided the balance of Tareumiut diet.

For historic Nunamiut (*c*. 1850), caribou (*Rangifer tarandus grantii*) supplied 90 percent of winter caloric needs and 70 percent of summer intake (Foote and Williamson 1966; Hughes 1974:588). Secondary resources were more limited than on the coast and consisted largely of fish, ground squirrels and mountain sheep (*Ovis dalli*). These species were not obtained in sufficient quantities to be economically important during most years (Spencer 1959:34; Campbell 1978) and were adequate fall-back resources only over the short term.

For both coastal and interior groups, the degree of dependency on the primary faunal resource was such that its failure could not be entirely mediated with secondary resources (Gubser 1965; Sheehan 1985), although coastal societies, with their greater diversity of alternative resources, were less vulnerable. Accordingly, the availability of these primary species provides a critical measure of the severity of subsistence stress.

The potential of either caribou or the bowhead whale to provide a productive resource base for traditional hunting groups resulted from a high degree of seasonal aggregation and relatively large body size. The Western Arctic caribou herd of northwestern Alaska migrates seasonally between the spruce–lichen woodland south of the Brooks Range and the tundra of the North Slope (Skoog 1968; Hemming 1971). The concentrated nature of the migration as it moves through the high passes of the Brooks Range made it the focus of the communal spring and autumn caribou drives. Nunamiut hunting crews constructed a drive corral (*kangigak*), consisting of poles interset with snares, into which the caribou were driven and killed with arrows or lances. Alternatively, the herd was ambushed while fording a lake or river. Large numbers of animals (200–300) could be taken in a single day and the process repeated over several days or weeks, generating large quantities of meat, which were preserved through drying and caching (Spencer 1959:30).

The spring migration of bowhead whales from the Bering to the Beaufort Sea is similarly constrained by narrow leads of open water created between the shore-fast ice and pack ice by spring wind and thermal conditions (Carrol and Smithhisler 1980). As this lead system becomes narrower and closer to shore with northward movement along the coast of Alaska (Braham, Fraker and Krogman 1980), the whales are funnelled past and in close proximity to the sites of large coastal whaling communities. Whaling crews established camps on the edge of the shore-fast ice and, once a whale was sighted, skin-covered whaling boats (*umiak*s) were launched in pursuit and the animal was attacked with harpoons and lances. As a single average catch weighed 30 tons (Maher and Wilimovsky 1963), a considerable volume of whale meat and blubber could be accumulated and frozen in ice cellars below the permafrost.

The productive potential of these faunal resources, however, contrasts with documented procurement success. Historically, the caribou migration has proved quite variable, both in locus of concentration and abundance (Murie 1935:43; Skoog 1968:116; Burch 1972:352). Similarly, records from the mid-1800s characterise whaling success as inconsistent at best. The following sections briefly outline the structure of variability in these resources and the causal factors generating this variability by which resource availability may be modelled for the prehistoric period.

Temporal and spatial variability in the Arctic caribou

Two scales of variability beyond that of regular seasonal migrations have been identified as affecting the availability of caribou as a subsistence resource (Minc 1986). First, range shifts in response to grazing conditions generated short-term, localised shortages. During migration, caribou generally return to a familiar range until forage quality and abundance are reduced through overgrazing and trampling (Murie 1935; Kelsall 1968; Skoog 1968; Baker 1978:170–1). The herd then relocates to a different range, establishing a new path of migration. Historic records suggest that this pattern of range use and abandonment occurred over a period of 15 to 40 years, depending on herd size and range-use intensity (Murie 1935; Skoog 1968; Minc 1986, Table 1). For traditional hunters, shifts in migration route away from the location anticipated by the drive corral resulted in seasons of scarcity.

Secondly, and of greater severity, were long-term fluctuations in total herd size. Accounts from the 1800s, combined with recent census data, indicate high-amplitude oscillations in the Western Arctic caribou population, with total herd size ranging between several hundred thousand and several thousand (Lent 1966; Skoog 1968; Hemming 1971; Burch 1972; Davis, Valkenburg and Reynolds 1979; Haber and Walters 1979; Aigner 1982). Peak population densities were recorded around 1850–1860 and again in 1960, followed by periods of catastrophic decline. The virtual disappearance of caribou from most of its range during a population minimum created a regional subsistence crisis for traditional hunters of the interior.

Cyclical fluctuations in caribou population size have been linked to long-term trends in the ecological parameters regulating caribou population growth and decline (Minc 1986). The primary exogenous factors potentially limiting caribou populations are: (1) range productivity and (2) winter kill (Skoog 1968; Hemming 1975; Klein and White 1978; Doerr 1979; Haber and Walters 1979; Reimers 1982). Wolf predation, although critical to the recovery of a herd from low population densities (Haber and Walters 1979), does not appear to trigger oscillations in large, productive herds (Klein and White 1978; Doerr 1979; Kelsall and Klein 1979; however cf. Bergerud 1979; Davis *et al.* 1979).

Forage abundance and quality, through nutrition, affect primary parameters of population productivity, including age of sexual maturity, production of young and their survival, average longevity, and resistance to disease, parasites and predators (Klein 1979). Reduced physical condition resulting from severe overgrazing of summer pasture contributes to low winter survival (Klein 1968; Hemming 1975; Haber and Walters 1979; Kelsall and Klein 1979), as well as to greater vulnerability to parasitism and disease (Thing and Clausen 1979), leading to a decline in herd size. Similarly, poor nutrition can delay the age of sexual maturity in female calves (Dauphine 1976) and decrease the percentage of successful pregnancies in adults (Gossow 1979), thereby slowing the rate of herd recovery.

Reduced winter forage and increased winter kill can limit caribou populations without a preceding overgrazing of ranges (Skoog 1968; Klein and White 1978; Doerr 1979; Reimers 1982). Under conditions of high winter precipitation, the formation of ice crust over vegetation leads to starvation and increased mortality. In addition, poor maternal nutrition reduces the birth weight and survival rate for calves (Bergerud 1971, 1979), while wind and precipitation during calving contribute directly to calf mortality (Schytte Blix 1979).

Both range carrying capacity and winter kill are ultimately controlled by climatic factors. Caribou summer pasture, critical for fat build-up and successful over-wintering, consists primarily of perennial tundra species (Murie 1935:36–8; Skoog 1968:136–48; White and Trudell 1980), whose plant biomass increases with warmer temperatures and total solar irradiance (Bliss 1971:417; Tiezen 1973; Miller, Stoner and Tiezen 1976; Brown, Miller, Tiezen and Bunnell 1980; Kummerow, McMaster and Krause 1980). Range productivity therefore increases during periods of warmer and drier years. Conversely, winter kill resulting from the coverage of winter forage by snow and ice becomes greater during years of lower temperatures and greater winter precipitation. The persistence of climatic anomalies affecting range condition and availability would have a corresponding impact on the size and productivity of the caribou population.

Temporal and spatial variability in marine mammal procurement

Two scales of variability are also indicated for marine mammal hunting success in North Alaska: (1) short-term and localised fluctuations in whaling and sealing success relating to hunting conditions, and (2) longer-term cycles in resource availability affecting the entire coastal zone, corresponding to variable weather conditions over a period of several decades to a century. Procurement success of bowhead whales was highly variable over the short term. Records of annual catches since the mid-1800s indicate marked fluctuations from one year to the next and, in the same year, from one community to another (Marquette and Bockstoce 1980). At Barrow, catches fell to extreme lows in 20 percent of the years for which records are available. This corroborates early historic accounts that coastal villages experienced winter food shortages roughly one year out of every five or seven, on account of poor whale or seal harvest (Simpson 1875:264; Spencer 1959:142). However, good and bad years were fairly localised, as the whaling success of one community varied independently of that of others (Minc 1986).

Whaling success along the northern coast of Alaska is largely determined by the impact of weather on local whaling conditions (Minc 1986).[1] For a good catch, the lead must remain open but narrow so that the whales are forced to pass near the whaling crews stationed on the shore-fast ice (Maher and Wilimovsky 1963). The opening of a lead requires a mild off-shore wind to separate the sea-ice from the shore. An on-shore wind, in contrast, drives the pack-ice against the shore and closes the leads (Ray 1885; Saario and Kessel 1966; Marquette 1977). Further, the successful observation and pursuit of whales depends on clear and calm conditions; strong winds, rough water and precipitation in the form of snow or fog limit visibility and increase the risk of being at sea in a small boat (Maher and Wilimovsky 1963; Foote and Williamson 1966). Finally, the length of time whaling can safely continue before the ice breaks up depends on low water and air temperatures (Rogers 1978).

Seal productivity and hunting success are also dependent on ice and weather conditions. Successful reproduction of the ringed seal is contingent on the availability of stable shore-fast ice and adequate snow cover for the construction of pupping lairs. Premature weaning of pups because of early break-up of the shore-fast ice leads to an increased number of starvelings and a stunted growth rate for surviving pups (McLaren 1958a:55–7, 1958b:9; Fay 1974). Early ice break-up also shortened the season during which hunters could safely pursue ringed seals on the ice and hindered the hunting of walrus and bearded seals (Saario and Kessel 1966; Nelson 1969).

The weather conditions adversely affecting whaling and sealing success (i.e. an on-shore wind, high precipitation and wind velocity, and warm water temperatures) represent the early onset of maritime conditions in response to unseasonably warm temperatures in the interior (Minc 1986). As inland temperatures rise, the advection of warmer air seaward creates higher temperatures over water and ice (Moritz 1977; Myer and Pitelka 1979; Haugen and Brown 1980), contributing to the break-up of pack ice (Barnett 1967; Rogers 1978), and generating cloudy, moist and windy conditions along the immediate coast (Allen and Weedfall 1966; Haugen and Brown 1980).

On an annual basis, warmer springs in the interior generate adverse whaling and sealing conditions on the coast. Over the longer term, periods with warm spring temperatures would result in more frequent years of adverse whaling conditions and would increase the probability of a poor year at any one coastal community. Consistently warmer climatic conditions generating unstable shore-ice would further reduce availability of the ringed seal as well as the body weight of individual seals. Thus, the persistence of adverse weather patterns would reduce the productivity and reliability of the coastal resource zone as a whole.

Palaeoclimatic reconstruction

Long-term trends in climatic conditions promoting caribou population increase or facilitating hunting access to marine mammals can be reconstructed for northwestern Alaska using dendroclimatological data from Arctic tree-line spruce stands. Temporally, tree-ring sequences provide a continuous, fine-scale chronology of climatic variability which is directly interpretable from present-day climate–growth analogies. Spatially, the role of synoptic scale pressure systems in generating regional meteorological phenomena in the Arctic (Namias 1970; Cropper 1982; Diaz and Andrews 1982) justifies the extrapolation of tree-growth variability for a considerable distance from the stand site.

Modern climate–growth relationships were examined for seven published tree-ring chronologies (Giddings 1941, 1948) for white and black spruce (*Picea glauca* and *P. mariana*) at latitude tree-line along the Noatak and Kobuk drainages. This region parallels the south slope of the Brooks Range and corresponds spatially to caribou winter range. The spruce stands were sampled according to standard procedures, with each chronology representing the average of a minimum of two confirmatory cores per each of four to 25 trees (Giddings 1941:52).

The effect of climatic variability on radial tree growth was assessed for the period 1907 to 1940 through a comparison of tree-ring widths with monthly climatic indices for the Northern Alaskan Climatological District (Climatological Data 1950).[2] The analysis identified significant correlations between radial growth and monthly temperature, precipitation and snow-depth values during and preceding the actual growing season, using a step-wise multiple regression procedure termed 'response function analysis' (Fritts, Blasing, Hayden and Kutzbach 1971). The percentage of growth variance (multiple R-Square) accounted for by regional monthly temperature and precipitation values ranged from 60 to 83 percent and averaged 68 percent.

These analyses indicate that wider tree-rings reflect years with warm, dry summers and reduced winter snowfall, while narrow rings record low temperatures and greater precipitation during both summer and winter seasons. Growth indices show a positive correlation with current summer temperature, but strong negative response to both summer precipitation and snow depth during the preceding December. The positive response of growth to warm, dry summers suggests that warm temperatures and greater insolation (decreased cloud cover and precipitation) increase rates of net photosynthesis and enhance growth in latitude tree-line environments (Garfinkel and Brubaker 1980:872). Conversely, heavy winter snows may delay the warming of soil temperatures and water uptake required for the commencement of photosynthesis in the spring (Graumlich and Brubaker 1986).

These findings agree with previous studies on the climate–growth relationships of Arctic tree-line species. White and black spruce consistently show a positive correlation with concurrent summer temperature, but a negative response to preceding winter and early spring precipitation (Giddings 1943; Kay 1978; Garfinkel and Brubaker 1980; Cropper and Fritts 1981; Jacoby and Cook 1981). Cropper (1982) has related differential tree growth to the relative persistence of synoptic scale pressure systems generating widespread weather conditions. Above normal tree growth reflects a strengthened Arctic high, generating clear, dry air, and warm temperatures in the Alaskan interior, while below-normal tree growth relates to a weakened Arctic high and the northern displacement of a Pacific maritime high responsible for cold, wet weather.

The availability of both interior and coastal resources can be modelled from the response of Alaskan spruce to known temperature and precipitation regimes (Table 2.2). Wider tree-ring widths reflect mild and dry conditions in the interior, optimal for the growth of caribou summer range and leading to improved physical condition of caribou and an increase in herd size. On the coast, however, warm springs lead to the early development of maritime conditions, with greater coastal precipitation and early break-up of shore-fast ice, resulting in poor whaling and sealing conditions and a reduction of the ringed seal population.

Narrow rings, in contrast, record high precipitation and low temperatures in the interior, indicative of years with reduced caribou range growth, greater snow and ice coverage of available range, and a higher incidence of winter kill in caribou. However, cooler conditions lead to better whaling conditions on the coast, as the leads remain narrow and the shore-fast ice stable.

Reconstructions of climatic variability and resource availability can be extended into the prehistoric period using composite tree-ring sequences from modern spruce stands and archaeological wood (Figure 2.2).[3] These chronologies register long-term cycles of warmer, drier conditions inland alternating with colder and wetter conditions.[4] A direct influence of these alternating climatic conditions on both caribou population size (Figure 2.3) and marine mammal hunting success (Figure 2.4) argues that both interior and coastal resources can be characterised as strongly cyclical in nature, with a variable periodicity and amplitude of fluctuation.

Finally, the ecological and meteorological factors governing the availability of caribou and marine mammals suggest that the

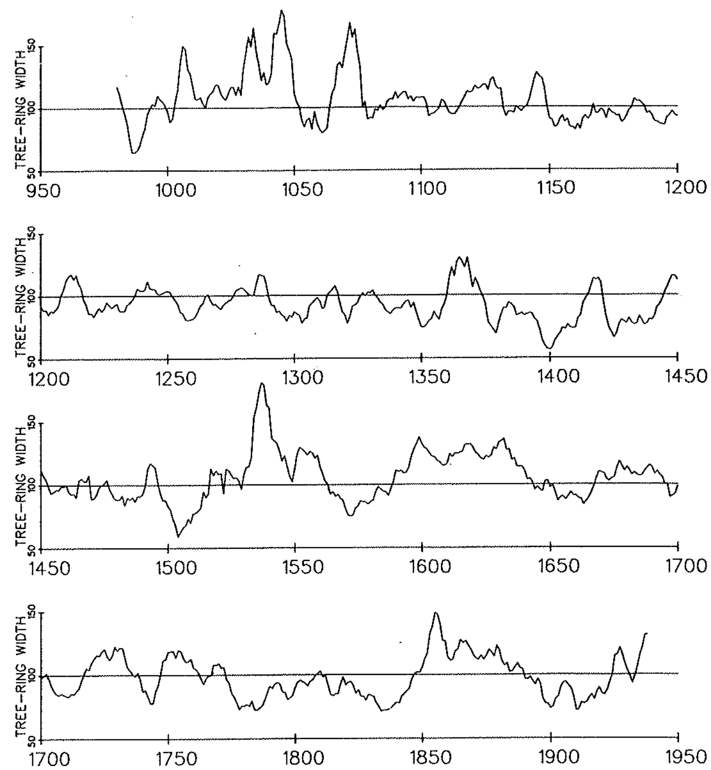


Fig. 2.2. Extended tree-ring chronology of climatic variability expressed as percentage deviation from sequence mean (AD 980–1940)

interior and coast constituted complementary resource zones temporally as well as spatially. Warm, dry conditions favoured caribou abundance but adversely affected marine mammal hunting success, while under conditions of lower temperatures and greater precipitation, the caribou population declined but whaling and sealing conditions improved.

Climatic variability during the late prehistoric period

Utilising the dimensions of amplitude, duration, predictability and periodicity of climatic fluctuations, the extended dendroclimatological sequence (AD 980–1940) was divided into four major periods, each with distinct implications for the structure of resource variability (Table 2.3). The overall abundance of caribou and availability of marine mammals was estimated from the amplitude and duration of oscillations in the growth trend, as well as differences in mean ring-width relative to the overall sequence average (Figure 2.5a). The predictability of climatic conditions on an interannual scale was assessed from the coefficient of variation calculated over five-year intervals (Figure 2.5b). The periodicity of climatic events was examined using spectral analyses of growth variability (Jenkins and Watts 1968), in which the frequency of fluctuations was identified from significant ($p \leqslant 0.05$) peaks in spectral density.

The tree-ring sequence begins in Period I (AD 983–1140) during an episode of relatively warm and dry, but highly unstable, conditions in northwestern Alaska. This period corresponds temporally and climatically to the Neo-Atlantic (AD 900–1200) in cen-

Table 2.2. *Expectations for climatic variability and resource availability reconstructed from tree-ring chronologies*

Growth conditions	Expected local climatic conditions and impact on resource availability: Interior	Coastal
WIDE TREE-RING WIDTHS	*Climate:* Clear, dry air generating warm conditions and decreased precipitation inland.	*Climate:* Early or intensified development of the sea breeze and maritime conditions associated with warm temperatures and greater coastal precipitation; early break-up of sea-ice and shore-fast ice.
Warm dry summers, low winter snowfall, associated with amplified Arctic high.	*Impact on caribou:* (a) Increased summer caribou range growth, leading to better physical condition in caribou, higher resistance to parasitism/disease; better nutrition leading to higher fertility and fecundity and increase in herd size;	*Impact on sea-mammal hunting:* (a) Poor whaling conditions, due to wide lead formation, poor visibility and unsafe ice;
	(b) greater availability of caribou winter range, leading to reduced winter kill in adult and juvenile caribou; less severe springs leading to increased survival rate for calves;	(b) poor seal productivity, due to reduced availability of ice for pupping lairs, leading to increased number of starvelings and reduced seal body size/weight;
	(c) caribou range expands and range shifts become more frequent.	(c) poor seal hunting conditions, due to unsafe ice and low visibility.
NARROW TREE-RING WIDTHS	*Climate:* Cold, wet weather in both winter and summer.	*Climate:* Cold springs and delayed onset of sea breeze.
Cold wet summers and greater winter precipitation associated with northern displacement of Pacific maritime high.	*Impact on caribou:* (a) Cold, wet summers lead to poor range growth and recovery; poor nutrition leads to lower resistance to parasitism/disease/predators and decreased rate of conception and successful pregnancies, sending herd into decline;	*Impact on sea-mammal hunting:* (a) Good whaling conditions, as leads remain narrow, precipitation reduced, and sea-ice solid;
	(b) higher winter precipitation covers available caribou winter range, leading to increased levels of caribou winter kill and greater loss of calves in delayed spring; caribou herd declines;	(b) higher seal productivity, due to greater/longer availability of ice for pupping lairs, such that a greater number of pups are successfully weaned, leading to larger body size and larger population size;
	(c) caribou range contracts to river valleys south of the Brooks Range.	(c) seal hunting conditions favourable due to stability of ice.

tral North America (Bryson and Wendland 1967) and the 'Medieval Warm Epoch' (AD 850–1150) of the eastern Canadian Arctic (Lamb 1965; Barry, Arundale, Andrews, Bradley and Nichols 1977; Williams and Wigley 1983) and Iceland (Ogilvie 1984), episodes marked by significantly warmer summer temperatures in northern Canada (Nichols 1974) and the northern advance of the boreal forest tree-line (Bryson and Wendland 1967). Neoglacial activity was at a minimum within the central Brooks Range (Ellis and Calkin 1984) and south along the North American Cordillera (Porter and Denton 1967:201).

Between AD 1140 and 1510, a long, cool period (Periods IIa and IIb) is indicated, characterised by low-level fluctuations of brief duration (25 to 40 years), with both the amplitude and duration of lows increasing through time. A return to colder conditions is also noted for the Canadian Arctic between AD 1150 and 1550 (Nichols 1974; Barry *et al.* 1977; Andrews and Diaz 1981; Andrews, Davis, Mode, Nichols and Short 1981), and in central North America during the Pacific episode of AD 1200–1550 (Bryson and Wendland 1967). These prolonged colder conditions resulted in the southward retreat of the boreal forest in central Canada (Bryson and Wendland 1967) and neoglacial advances in the Brooks Range (Ellis and Calkin 1984).

The character of the tree-ring sequence changes dramatically after AD 1500. During Period III (AD 1510–1780), the mean

Table 2.3. *Values of ring-width growth indices by period*

Period statistics	Period						Complete sequence
	I	IIa	IIb	IIIa	IIIb	IV	
Date AD	980–1140	1141–1350	1351–1510	1511–1575	1576–1780	1781–1940	980–1940
Years	161	210	160	65	205	160	961
Mean growth(1)	111.16	95.22	89.91	111.96	105.58	97.38	100.73
Minimum growth	35.00	60.00	35.00	42.00	50.56	49.88	35.00
Maximum growth	241.00	141.00	176.00	245.00	155.15	172.65	245.00
Standard deviation	32.43	14.97	22.37	37.99	18.87	22.49	24.98
Coefficient of variation	29.16	15.72	24.88	33.93	17.85	23.10	24.80
Percentage of years with extreme high growth(2)	24.84	3.33	6.25	30.31	18.54	11.88	14.04
Percentage of years with high growth(3)	38.51	28.57	21.25	25.76	41.95	28.75	31.84
Percentage of years with low growth(4)	26.71	59.05	48.13	27.27	35.61	43.75	42.04
Percentage of years with extreme low growth(5)	9.94	9.05	24.37	16.66	3.90	15.62	12.08
Maximum periodicity(6)	40.75	35.00	40.00	...(7)	67.50	80.00	...(8)

(1) All values calculated from standardised growth indices, i.e. percentage deviation from sequence mean
(2) Annual rings exceeding 1 standard deviation above the sequence mean
(3) Annual rings within 1 standard deviation above the sequence mean
(4) Annual rings within 1 standard deviation below the sequence mean
(5) Annual rings exceeding 1 standard deviation below the sequence mean
(6) Frequencies marked by significant ($p \leqslant 0.05$) peaks in spectral density
(7) Insufficient time-depth to assess long-term periodicity
(8) Variable across temporal subdivisions

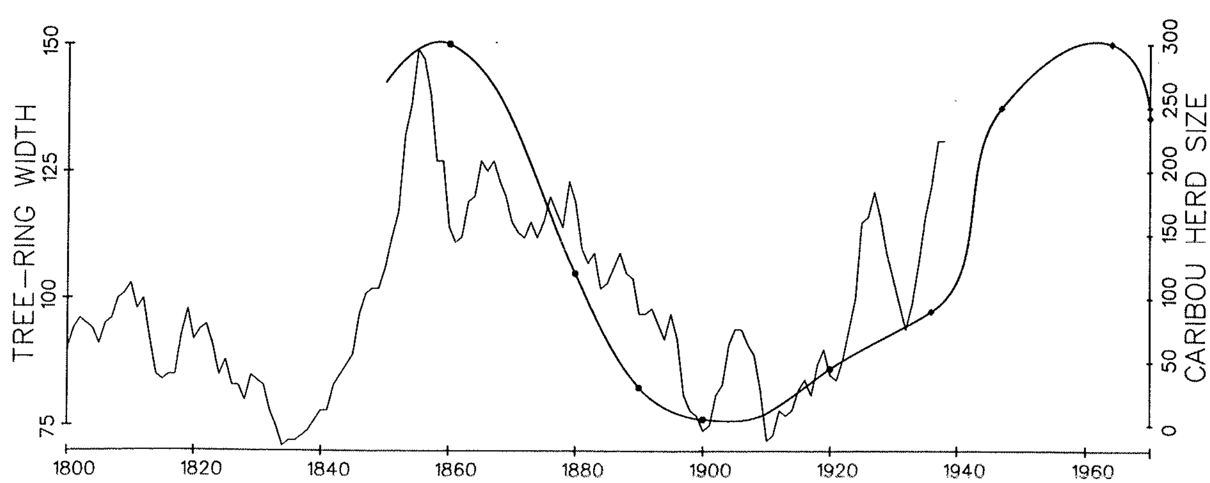


Fig. 2.3. Parallel fluctuations in (1) long-term climatic patterns determined from tree-ring width variability (% deviation from sequence mean), and (2) caribou herd size (in thousands) as reconstructed from historic estimates of herd size (circles) and census data (squares). Data on caribou herd size from Murie (1935), Skoog (1968) and Haber and Walters (1979)

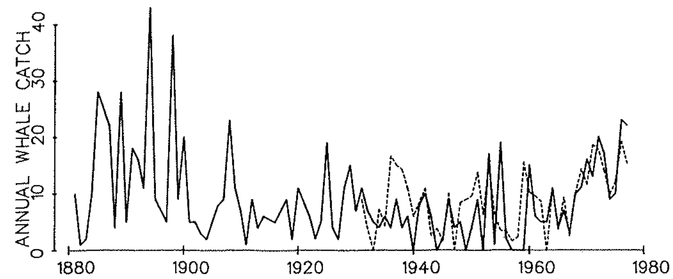


Fig. 2.4. Aboriginal whaling success at Barrow, Alaska, during the historic period (solid line) and that predicted from annual variability in spring weather conditions (dashed line). Whale catch data from Marquette and Bockstoce (1980); predicted catch values from Minc (1986)

percentage growth increases sharply, indicating a return to warmer and drier conditions. This general rise in temperature was accompanied by high-amplitude fluctuations of long-term periodicity (67 years) and a reduction of interannual variability. In contrast, the final phase (Period IV, AD 1780–1940) is marked by a reduction of the growth trend indicating somewhat wetter and/or cooler conditions overall in the context of continued long-term, high-amplitude fluctuations, while increased interannual variability generated less stable conditions over the short term.

Periods III (AD 1510–1780) and IV (AD 1780–1940) overlap the Neo-Boreal episode (AD 1550–1850) in central North America (Bryson and Wendland 1967) and the 'Little Ice Age' of the eastern Arctic (Barry *et al.* 1977), periods characterised as the culmination of cold conditions. In northern and central Canada, however, recent palynological reconstructions indicate a slight warming in summer temperatures after *c.* AD 1450, with a sharp rise to current values in the last century (Andrews and Diaz 1981; Andrews *et al.* 1981). Elsewhere in the northern hemisphere, the Little Ice Age was not a period of uniform cold, but one of extreme variability, in which disastrously cold years alternated with exceptionally warm years (Lamb 1966:465–6, 1977; Ogilvie 1984), a pattern consistent with the high-amplitude fluctuations observed in northern Alaska for this period.

Cultural responses to resource variability in the ethnohistoric period

The structure of resource variability documented above for the late nineteenth and early twentieth centuries created two distinct spatio-temporal scales of subsistence stress for traditional hunters. First, relatively short-term and localised shortages in the primary resource were generated in the interior by caribou range shifts and on the coast by high interannual variability in whaling and sea mammal procurement success. Secondly, long-term fluctuations in climatic conditions with a periodicity of 60 to 100 years alternately favoured the productivity of interior or coastal resources and precipitated regional subsistence crises within these resource zones.

The oral traditions of both the Tareumiut and the Nunamiut similarly recognise two distinct scales of scarcity beyond that imposed by the regular seasonal migrations of the primary faunal species through the hunters' territory: food *shortages*, which result in hunger, and actual *famine*, which results in starvation and death (Minc 1986). These contrasting levels of severity are perceived as

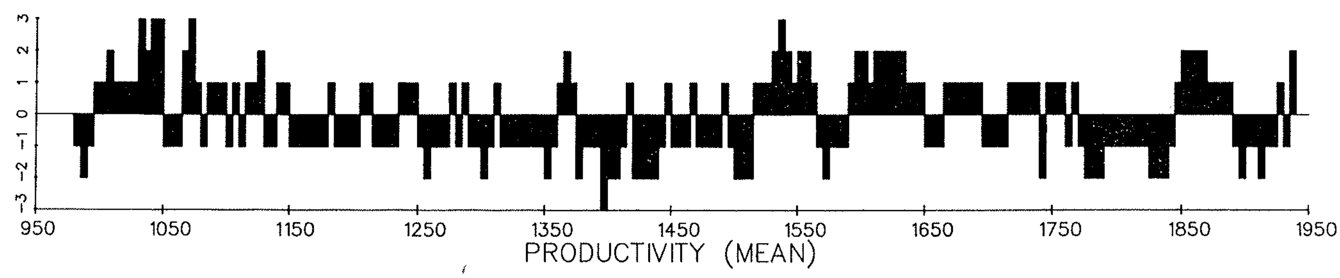


Fig. 2.5a. Measures of resource productivity/scarcity from extended tree-ring chronology (mean by 5-year intervals, expressed in standard deviations from sequence mean)

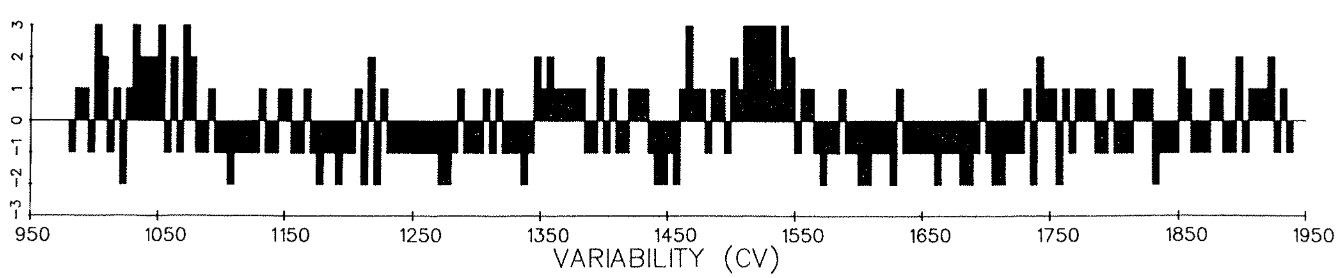


Fig. 2.5b. Measures of resource variability/predictability from extended tree-ring chronology (coefficient of variation by 5-year intervals, expressed in standard deviations from sequence mean)

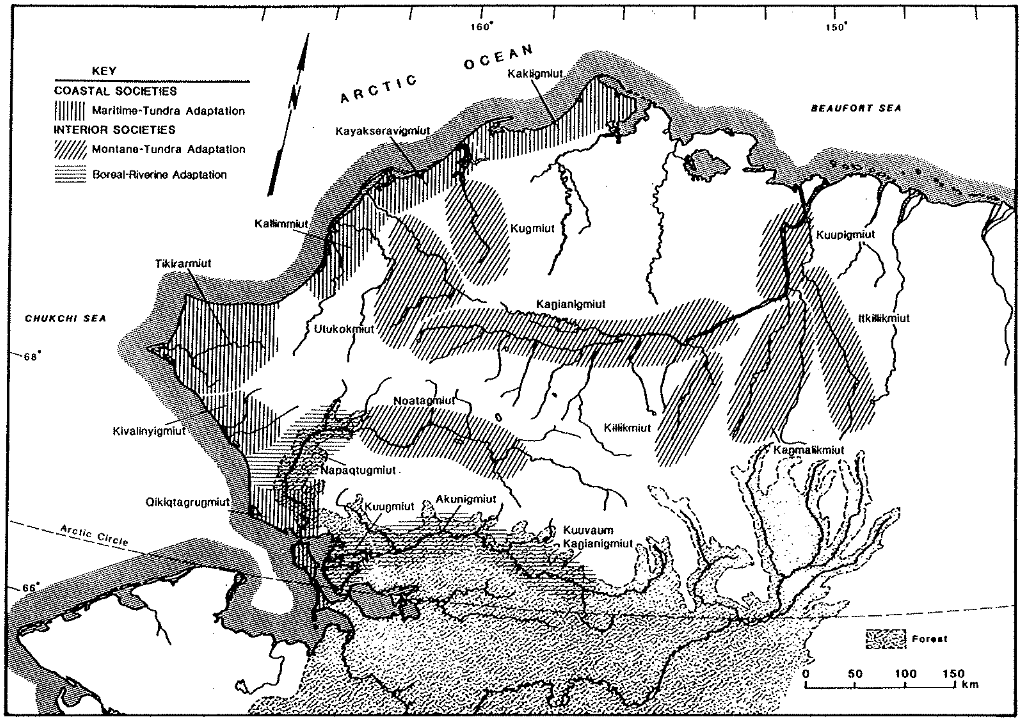


Fig. 2.6. Distribution of aboriginal societies in North Alaska during the early historic period, *c.* 1850–1880 (after Gubser 1965; Burch 1980)

occurring over different spatio-temporal scales and as resulting from different causal factors and so require qualitatively different buffering strategies.

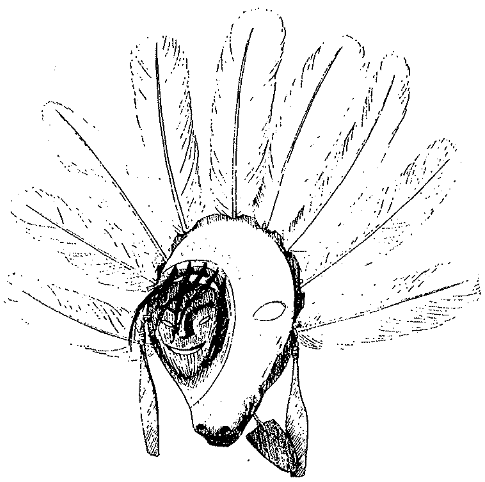
In folktale accounts of hardship, food shortages occur during the naturally lean season of late winter and early spring, when the population is primarily dependent on stored food. The temporary shortage results, however, not from inadequate food supplies, but rather from the unwillingness of certain community members to share their stored surpluses. The alleviation of food shortages therefore depends on an accentuation of those social values and relationships which support the pooling of labour and resources, primarily kinship ties and intra-community voluntary associations.

Kinship rights and responsibilities were held inviolable and centred on the obligation to share food and grant shelter in times of need. Three levels of kinship affiliation provided an expanding network of economic obligations which an individual could utilise in times of need: (1) the nuclear family or local unit of co-residence, production and consumption; (2) the extended family, which established kinship ties and incumbent responsibilities between communities or co-residential groups; and (3) the regional group, or society, whose geographic range was by definition coterminous with the regional 'home' territory (Burch 1981; Figure 2.6).

Cross-cutting local kinship ties were economic bonds formed through association with a hunting crew. The hunting crew, consisting of eight or nine able adult males voluntarily aligned with and directed by an *umealiq* or captain, constituted the minimal work unit necessary for the effective communal spring hunt. The catch was distributed among crew members according to their contribution to the hunt and the needs of their families (Gubser 1965:174–5); however, a larger share belonged to the *umealiq* in consequence of his greater responsibilities to crew and community. The hunting crew gained a year-round economic importance through its association with a *karigi* or men's house. Although primarily a social and ritual association, the *karigi* (pl. *kariyit*) provided the context for shared meals throughout the winter, facilitating the distribution of food from individual stores.

In contrast to the short-term and local impact of food shortages, famine affected the entire community or resource zone. Creation myths suggest the temporal scale of such regional crises by placing accounts of famine in the distant past, and associate the crisis with a period of altered climate. Such a widespread subsistence crisis was not interpreted as resulting from resource failure, however, but rather from the removal of resources from the hunters' territory in response to adverse conditions. The appropriate response to the redistribution of faunal resources involved the relocation of human populations.

Cultural perceptions of resource distribution are encoded in the rituals and taboos surrounding the communal spring hunt. Fundamental to these rituals is the belief that the animal world is animated by sentient spirit-beings, which control the behaviour of corporeal animals. Three classes of spirit-beings were invoked to ensure hunting success: the species spirit or *inua*, the individual breath spirit (*ilitkusiq*), and the spirit double, or *taktok* (Nelson 1899; Marsh 1954; Fitzhugh and Kaplan 1982; Minc 1986). From



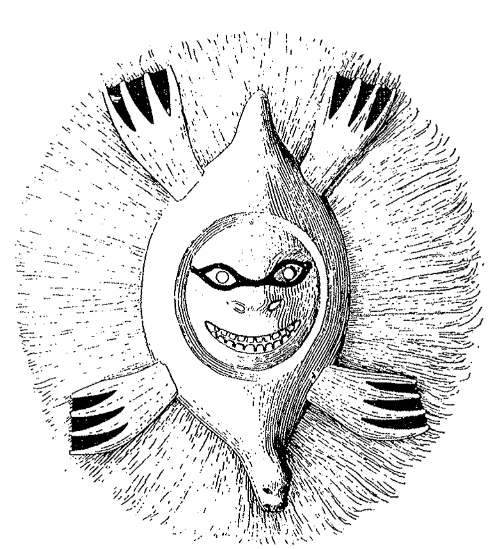


Fig. 2.7. Representations of *inue*: dance masks of bear (left) and seal (right) revealing the inner 'person' of the species-spirit or *inua* (from Nelson 1899, Plates 95,2 and 101,2)

the behaviour of these animal spirit-beings, a cognised model emerges of those factors determining the nature and availability of faunal resources.

The *inua* (pl. *inue*), literally the 'person' or 'owner' of the animal (Figure 2.7) comprises the spiritual projection of an entire species and stands as guide and protector to all members of that species. Since the omniscient *inua* could discern the affairs of man from afar, proper ritual relations had to be established in advance so that this spirit would not warn its species members away from the path of the hunter. Rituals preceding the communal spring hunt attempted to assure the *inua* of the hunters' respect, demonstrated through the complete ritual separation of land and sea. To placate the whale *inua*, all whaling gear had to be cleansed of previous contact with land fauna. Similarly, all weapons used in the caribou hunt had to be washed and scraped clean of contamination from marine fauna, as the association of land and sea elements was offensive to the caribou *inua*. Through the consistent division of land and sea in equipment, hunting activities, food and clothing, the ritual recognition of *inue* stresses the inherent dichotomy between marine and terrestrial resources.

After the kill, hunting ritual was guided by the desires of the individual breath spirit and its spirit double. Animals allowed themselves to be killed by the hunter because they wanted something from man. If these desires were satisfied, the breath spirit would inform its fellow species members of the good treatment it had received. Further, when the breath spirit had been reincarnated, its physical form would return to the same hunter, knowing that it was assured of a proper reception.

Post-kill ritual therefore consisted of two parts. First, the head of the animal was severed from the body, releasing the breath spirit and setting it free to be reincarnated into another body of the same species (Figure 2.8). Secondly, the hunter had to satisfy specific wishes of the departing spirit. The spirits of sea mammals were given fresh water to quench their thirst, because they had none to drink in the sea (Stefansson 1919:351). Caribou, in contrast, were treated to sea oil or whale blubber.

The desires for elements outside the animal's own physical environment reflect its dual spiritual identity. During its lifetime, every animal has a spirit (*taktok*) which is its double in the complementary resource zone (Figure 2.9). Killer whales are the *taktoit* of wolves, bowhead whales are the spirit doubles of musk-oxen, mountain sheep have as their *taktoit* beluga whales, while caribou double as small humpback whales (Nelson 1899:444; Stefansson 1919:357; Jenness 1953:8; Spencer 1959:266–7). These paired animals are said to be *avariksut*, i.e. 'chips off the same block', equivalent, alike, or equal (Stefansson 1919:319), and the pairing of species matches similarities in behaviour or appearance.

The relationship between the paired species, however, is not limited to a static association. When wolves starve on land they go

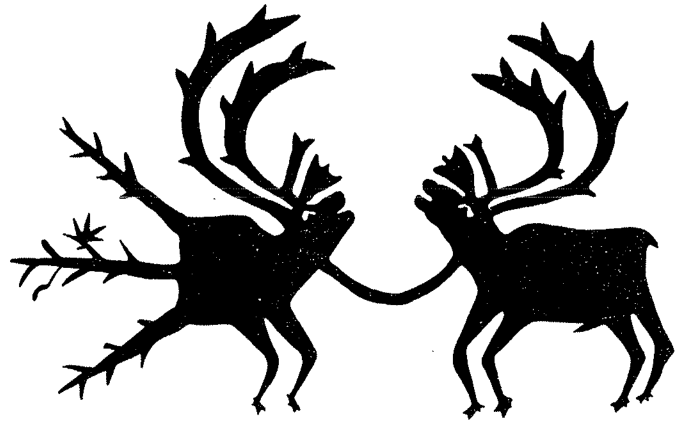


Fig. 2.8. Representation of breath spirit: release of the breath spirit (*ilitkusiq*) from the throat of the caribou at death. Spiked elements on the incomplete figure at left indicate the ethereal nature of the breath spirit (redrawn from Fitzhugh and Kaplan 1982, Fig. 237)

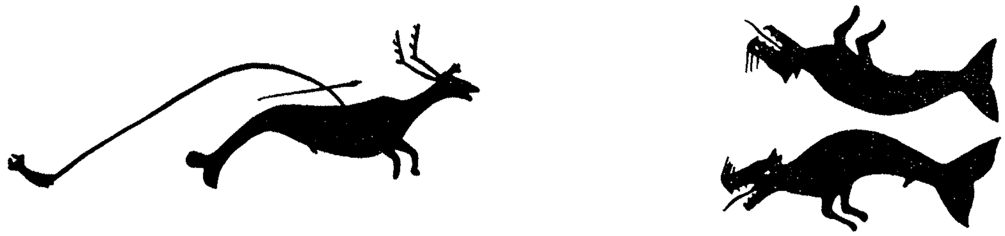


Fig. 2.9. Representations of *taktoit*: spirit doubles (*taktoit*) of caribou-humped back whale (left) and wolf-killer whale (right) (redrawn from Nelson 1899, Fig. 154 and Plate 30,3, respectively)

to their relatives in the sea and turn into killer whales; conversely, killer whales, when unable to find food in the sea, travel inland and become wolves (Stefansson 1919:319). Caribou have been known to leap into the sea and swim away as humpback whales in order to avoid pursuit on land (Spencer 1959:267). Similarly, mountain sheep often wander down to the sea and become beluga. Hence, when there are plenty of beluga off the Arctic coast, mountain sheep will be scarce; when sheep are plentiful in the Brooks Range, beluga are absent in the adjacent coastal regions (Jenness 1953:8).

Both myth and ritual present a model of resource variability which stresses the alternative temporal availability of marine and terrestrial fauna. When land fauna are not found in the interior, they are with their spiritual doubles in the sea, and vice versa. Further, the cognised model encodes an explicit example for appropriate human response to resource failure and famine. Just as fauna may adopt an alternative form and move between resource zones in times of need, human hunters should emigrate and adopt an alternative subsistence orientation when local resources fail.

Access to resources of the complementary resource zone, however, was not guaranteed. The Tareumiut and Nunamiut were highly territorial and relations between regional territories were frequently antagonistic. Strangers were treated with suspicion and hostility, and crossed territorial boundaries either under the sponsorship of a predefined alliance or at considerable risk (Spencer 1959; Burch and Correll 1972). Two forms of alliance sponsored inter-regional travel: trading partnerships and invitational feasts.

Trading partnerships constituted the primary alliance between regional territories and the only formal link between coastal and inland regions. Partners referred to one another as *nyuuviq*, a term which signalled a special relationship conferring both economic advantages and social guarantees. On an annual basis, partners met at a predefined location such as the large trade fairs, to exchange resources considered essential for survival: whale and seal oil were traded inland for food and fuel in exchange for caribou skins for clothing. Of greater importance over the long term, however, an individual gained social access to other territories through the sanction and protection of his partner. In times of need, this social protection could be amplified into actual assistance, in the form of refuge, food and goods (Spencer 1959:170).

The second regular mechanism for relocating people relative to resources was the invitational feast. In a good year, the *karigi* of a successful hunting crew sponsored a series of feasts which distributed surpluses between communities and ecological regions along alliances formed by trading partnerships (Spencer 1959:210–28; Burch and Correll 1972; Okakok 1981:559–67). The major celebration which crossed territorial borders was the midwinter Messenger Feast, a form of competitive feasting and gift giving, so called because it was formally initiated when the host sent a messenger to invite the guests. The Messenger Feast was hosted by a *karigi* only after a particularly successful season and brought together and feasted entire communities from either the coast or the interior for a period of several weeks (Ray 1885; Spencer 1959:210; Burch and Correll 1972). The competitive element of the Messenger Feast further created strong social obligations which functioned as a form of social storage, in that periodic abundance was converted to social debts which could be called in in times of need.

In summary, localised food shortages were interpreted as socially generated and therefore required social mediation, through expansion of the social network to gain access to an increasingly larger resource base. In contrast, long-term, regional famine resulted from locational discrepancies between hunters and their prey, and so necessitated a survival strategy of relocation. Relocation, however, was feasible only with the sanction of predefined social alliances and obligations, maintained between subsistence crises through mechanisms of exchange and social storage. In the ethnohistoric period, these perceptions represented nested responses appropriate to different levels of stress, which were maintained concurrently within the cultural repertoire of survival strategies.

The archaeological record of North Alaska

The archaeological record for the late prehistoric and early historic periods (*c.* AD 1000–1920) in North Alaska monitors long-term responses to changes in the structure of resource variability. As the analysis must rely on archaeological phases two to three centuries in duration (see Figure 2.10), the data reflect aggregated responses to both short-term (seasonal and interannual) and long-term variability. These data are compared with expected responses to the changing structure of resource availability, on the following assumptions:

1 A risk-minimising survival strategy requires that subsistence–settlement systems respond to both the *productivity* and the *reliability* of a resource, relative to the availability of alternative resources. That is, land-use patterns will be structured according to the timing and distribution of *reliable* resources

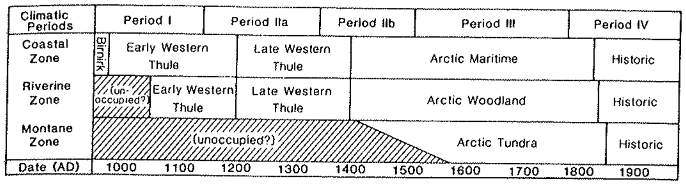


Fig. 2.10. Archaeological phases for North Alaska during the late prehistoric period as used in this study (after Giddings 1967; Davis *et al.* 1981; Anderson 1984)

to ensure that subsistence requirements and biological needs are met, while the particular mix of resources utilised will be proportional to their *productivity*. Further, the broader the range of alternative resources, the higher the tolerance level will be for low productivity and low predictability of any one resource.

2 Over the last millennium, major changes in the productive potential and reliability of caribou and the bowhead whale as subsistence resources were affected both by variable climatic conditions and by observed changes in social organisation and technology, including the development of high payload dog-sled transportation for the efficient movement of resources to people and people to resources, and the emergence of supra-household integrative mechanisms enabling coordinated, communal hunting to maximise seasonal returns and to regulate the distribution of surpluses within the community. These changes in social organisation and technology were directional, in that they redefined the coping capabilities of the prehistoric societies and altered the range of potential responses to subsequent episodes of subsistence stress.

3 The spatial scale of risk-pooling socioeconomic networks parallels the spatio-temporal scale of critical resource fluctuations. Short-term and localised variability in the productivity and predictability of resources was mediated through reliance on intra-regional social networks. As resource fluctuations increased in extent and duration, the spatial scale of social networks increased and inter-regional or inter-resource zone social alliances were activated.

For each period our expectations for subsistence–settlement systems and risk-buffering mechanisms are presented in tabular form (Tables 2.5–2.9), followed by a discussion which focuses on the degree to which the predictions derived from this model are supported archaeologically. In this review *mobility* and *diversification* are monitored through the distribution and type of sites present within different resource zones as well as through available faunal analyses. *Physical storage* is monitored primarily through the presence of facilities and through zooarchaeological evidence, while the potential for *social storage* is held to be inherent in the presence of formalised exchange networks. While the distribution of exotic materials is used to monitor *exchange* generally, the quantity and variety of exotic materials within sites, the pervasiveness of exchanged materials within regions, and specialised production for exchange measure the degree to which exchange networks were formalised.

Other variables monitor the social contexts within which such strategies were implemented. The size of settlements provides a proxy measure of social integration under the assumption that increasing scale will require effective mediation and decision-making institutions (cf. Johnson 1978). Communal structures such as *kariyit* or evidence of communal ritual reinforce such inferences and reflect the formalisation of these integrative mechanisms.

Changes in the distribution of styles provide information on the degree to which populations maintained and reinforced socio-territorial boundaries and the scale of the regions so defined (Wobst 1977), although evidence for active defence of territories is based on the technology and consequences of warfare and raiding. Following Dyson-Hudson and Smith (1978), we expect territoriality to be associated with abundant and predictable ('economically defensible') resources, but we expect active defence only when productive patches are limited in number or extent (cf. Wiens 1976) or when considerable labour or social investment has enhanced their productivity.

It has not been possible to utilise each of these lines of evidence to equal advantage for every period. In compiling this review, we have used data on more than 130 archaeological occupation sites (Table 2.4). Differences in survey and excavation effort are reflected in this data base (Figure 2.11), with knowledge of the coastal region being derived primarily from site-specific excavations and that of the interior montane region primarily from survey. The patterns which emerge from this preliminary analysis are, however, pervasive enough to instil confidence that they reflect real changes in land-use and adaptive strategies rather than the effect of such biases.

Period I (AD 980–1140)

Period I is characterised by warm and dry but unstable conditions, with both high-amplitude climatic fluctuations and high levels of interannual variability (Table 2.5). With decreased availability of marine mammals, this would have been a difficult period for coastal populations, which were organised into small settlements scattered along the coasts (Figure 2.12). The largest settlement excavated to date (Cape Krusenstern) had only five structures and probably represents two discrete occupations (Giddings 1967). Inference that the site was occupied by only 25–30 persons accords well with evidence from contemporary sites in northern Alaska (Stanford 1976:110) and western Canada (Yorga 1980; Morrison 1983) and suggests that intra-community integrative institutions were not effective for coordinating the productive effort of units larger than extended kinship groups, or for mediating conflict between them.

Given the small scale of these settlements and the need for the integration of a number of crews for whaling to be consistently effective, coastal subsistence strategies should have been highly diversified, rather than relying on the capture of large whales to provide a surplus capable of buffering the 'worst case' scenario of a prolonged and stormy winter followed by poor spring hunting conditions. While diversification would not preclude the pursuit of whales, it would not favour reliance on them.

The exploitation of a wide spectrum of coastal and interior resources is evident in this period. Coastal sites have been found

Table 2.4. *Archaeological sites used in regional analyses*

Site	Periods occupied					References
	I	IIa	IIb	III	IV	
Coastal zone and Arctic Coastal Plain						
Cape Krusenstern	+	+	+	+	+	Giddings 1967; Anderson 1984
Jabbertown	+	+				Larsen and Rainey 1948
Tigara			+	+	+	Larsen and Rainey 1948
Nunagiak	+	+	+	+	+	Ford 1959
Walakpa	+	+	+	+	+	Stanford 1976
Shesualik		+				Giddings 1967
XMR 030		+				Davis *et al.* 1981
Utkiavik			?	+	+	Ford 1959; Dekin 1981; Newell 1984; Sheehan 1985
Thetis Island			+			Hall 1981
Nuwuk				+	+	Ford 1959; Stanford 1976
Pingok Island				+		Hall 1981
XMR 004				+	+	Davis *et al.* 1981
XMR 025				+		Davis *et al.* 1981
XMR 026				+		Davis *et al.* 1981
XMR 034				+		Davis *et al.* 1981
XMR 041				+		Davis *et al.* 1981
TES 014				+	+	Davis *et al.* 1981
Niglik				+	+	Hall 1981
Ogotoruk Creek					+	Hadleigh-West 1966
Aqergognat					+	Larsen and Rainey 1948
Killimitavik					+	Ford 1959
Mitliktavik					+	Ford 1959
Siraagrůk					+	Slaughter 1982
Cross Island					+	Libbey 1981
Tigvariak Island					+	Libbey 1981
Flaxman Island					+	Libbey 1981
XMR 038					+	Davis *et al.* 1981
XMR 040					+	Davis *et al.* 1981
XMR 036					+	Davis *et al.* 1981
XMR 033					+	Davis *et al.* 1981
XMR 032					+	Davis *et al.* 1981
XMR 020					+	Davis *et al.* 1981
XMR 006					+	Davis *et al.* 1981
TES 002					+	Davis *et al.* 1981
TES 006					+	Davis *et al.* 1981
TES 017					+	Davis *et al.* 1981
TES 018					+	Davis *et al.* 1981
TES 019					+	Davis *et al.* 1981
TES 020					+	Davis *et al.* 1981
TES 021					+	Davis *et al.* 1981
Interior montane zone						
Croxton	?	?				Gerlach 1982; Gerlach and Hall n.d.
Killiktavik I			+			Hall 1971
MIS 169			+	+		Davis *et al.* 1981
XUR 129			+			Davis *et al.* 1981
Sikoruk			+	+	+	Hall 1976, 1978; Spiess 1979; Gerlach and Hall n.d.
Kinyiksukvik			+	+	+	Irving 1962; Hall 1970; Davis *et al.* 1981
Itivluk Lake			+	+	?	Irving 1962; Campbell 1968a; Hall 1970

Table 2.4. Continued.

Site	Periods occupied I	IIa	IIb	III	IV	References
Kangiguksuk				+		Hall 1971
Kaiyak Lake				+		Campbell 1968a; Hall 1975
Killiktavik II				+		Hall 1971
Siesieaijak Creek				+		Hall 1971
Mitkotayluk				+		Hall 1971
MIS 129				+		Davis *et al.* 1981
MIS 162				+		Davis *et al.* 1981
MIS 164				+		Davis *et al.* 1981
XUR 125				+	+	Davis *et al.* 1981
XUR 127				+	+	Davis *et al.* 1981
Burial Lake				+		Campbell 1968a; Hall 1970, 1975
Desperation Lake				+	+	Irving 1962; Campbell 1968a; Hall 1970
Feniak Lake				+	+	Hall 1975
Liberator Lake				+		Campbell 1968a; Hall 1970, 1975
Swayback Lakes				+	+	Campbell 1968a; Hall 1970, 1975
XHP 158				+		Davis *et al.* 1981
XHP 230				+		Davis *et al.* 1981
XHP 251				+		Davis *et al.* 1981
XHP 255				+		Davis *et al.* 1981
XHP 036				+		Davis *et al.* 1981
XHP 089				+	+	Davis *et al.* 1981
Betty Lake				+		Campbell 1968a; Hall 1970, 1975
Kipmik Lake				+		Irving 1962; Hall 1970
Isihuk				+		Irving 1962; Hall 1970
KIR 044				+		Davis *et al.* 1981
KIR 045				+		Davis *et al.* 1981
KIR 011				+		Davis *et al.* 1981
Killik-Colville				+		Hall 1975; Davis *et al.* 1981
Kavik				+		Campbell 1962; 1968b
Mosquito Lake				+		Wilson 1978
Atigun				+		Wilson 1978
Murphy Lake				+		Wilson 1978
Klo-kut				+	+	Morlan 1975
MIS 218					+	Davis *et al.* 1981
MIS 239					+	Davis *et al.* 1981
MIS 241					+	Davis *et al.* 1981
MIS 248					+	Davis *et al.* 1981
XLR 008					+	Davis *et al.* 1981
XLR 005					+	Davis *et al.* 1981
XLR 014					+	Davis *et al.* 1981
XHP 161					+	Davis *et al.* 1981
XHP 170					+	Davis *et al.* 1981
XHP 179					+	Davis *et al.* 1981
XHP 185					+	Davis *et al.* 1981
XLR 059					+	Davis *et al.* 1981
XHP 074					+	Davis *et al.* 1981
XHP 076					+	Davis *et al.* 1981
XHP 089					+	Davis *et al.* 1981
XHP 078					+	Davis *et al.* 1981
XHP 079					+	Davis *et al.* 1981

Table 2.4. Continued.

Site	Periods occupied					References
	I	IIa	IIb	III	IV	
XHP 085					+	Davis *et al.* 1981
XHP 087					+	Davis *et al.* 1981
XHP 098					+	Davis *et al.* 1981
Etivopar					+	Hall 1975
XHP 102					+	Davis *et al.* 1981
XHP 105					+	Davis *et al.* 1981
XHP 113					+	Davis *et al.* 1981
XHP 117					+	Davis *et al.* 1981
XHP 118					+	Davis *et al.* 1981
XHP 141					+	Davis *et al.* 1981
XHP 290					+	Davis *et al.* 1981
XHP 291					+	Davis *et al.* 1981
XHP 294					+	Davis *et al.* 1981
IKR 037					+	Davis *et al.* 1981
IKR 038					+	Davis *et al.* 1981
IKR 042					+	Davis *et al.* 1981
Ivisak Creek					+	Hall 1975
Nakaktuk Lake					+	Hall 1975
Anaktuvuk Pass					+	Campbell 1962; Binford 1978
Itkillik Lake					+	Hall 1975
Aniganigurak					+	Corbin 1976
Franklin Bluffs					+	Solecki *et al.* 1973
Interior riverine zone						
Onion Portage	+	?	+			Giddings 1967; Anderson 1968, 1984
Kidway's Camp		+				Giddings 1952
Ahteut		+				Giddings 1952
Kavet Creek		+				Giddings 1952
Kotzebue			+	+		Giddings 1952, 1967; Van Stone 1955
Ekseavik			+			Giddings 1952
Canyon Creek			+			Giddings 1952
Ivisahpat			+			Hickey 1976
Kiana				+		Giddings 1952
Ambler Island				+		Giddings 1952
Pick River				+		Giddings 1952
Black River				+		Giddings 1952
Ikpikauruk					+	Giddings 1952
Kayák					+	Hickey 1976
Redstone River					+	Giddings 1952
Tekeahrugaruk					+	Giddings 1952
Shugnak					+	Giddings 1952

both at locations which are well suited to whaling (e.g. Point Hope, Point Barrow) and at others which are less so (Figure 2.12). The presence of one whaling harpoon at Cape Krusenstern and small quantities of whale bone at other sites indicates that bowhead whales were hunted, but the limited use of whale bone for construction or technology suggests that they were not the focus of early Thule economy. Faunal analyses from coastal middens document a predominant reliance on small seals, followed by caribou, with domestic dog, fox, walrus, birds, bearded seals and ground squirrels also present (Giddings 1967:94; Stanford 1976, Table 6).

The inter-regional mobility predicted for this period may be inferred from the presence of caribou in these coastal sites. In addition, each site contained a suite of terrestrial fauna from in-

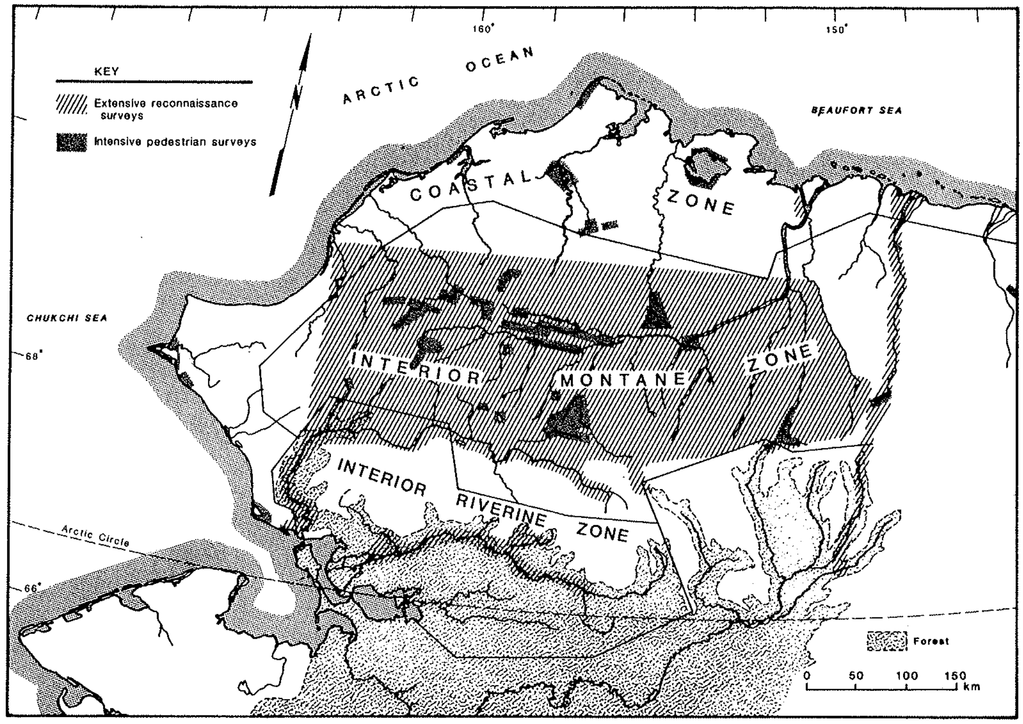


Fig. 2.11. Distribution of published archaeological surveys in North Alaska to 1983. Research conducted by airplane, helicopter or boat and intended to locate the major sites within regions is identified as 'extensive reconnaissance surveys', whereas systematic on-the-ground efforts to locate representative samples of all archaeological remains within a region have been identified as 'intensive pedestrian surveys'

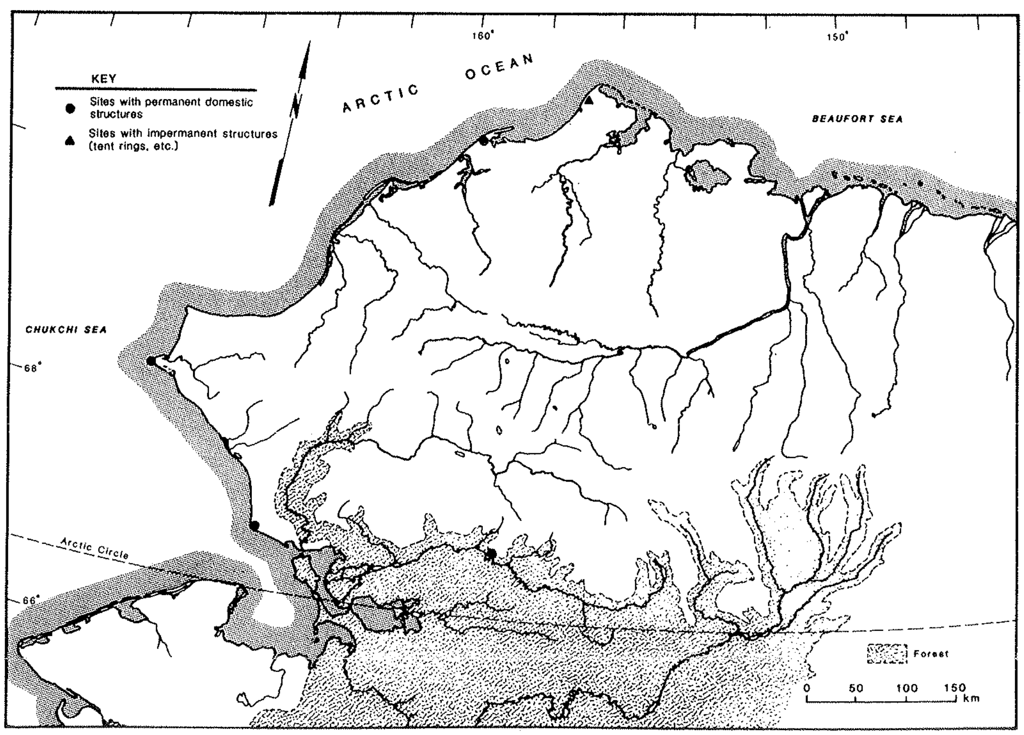


Fig. 2.12. Distribution of reported archaeological sites for Period I (*c.* AD 980–1140) in North Alaska. References for sites in Figures 2.12–2.16 will be found in Table 2.4

Table 2.5. *Expectations for resource availability and subsistence strategies: Period I (AD 983–1140)*

Resource variability & responses to risk	Interior	Coast
Climate:	Warm and dry, but unstable conditions with high amplitude, inter-annual to short-term variability.	Early onset of sea-breeze and maritime conditions bringing high precipitation, warmer air and water temperatures to coast; high inter-annual variability.
Resource variability:	Caribou occasionally abundant; herd size and location unpredictable over the short term; most predictable south of Brooks Range.	Decreased availability of marine mammals due to poor ice-edge hunting conditions and decline of ringed seal population; low interannual predictability.
Settlement:	Settlement in ecotonal wooded river valleys south of Brooks Range near caribou winter range and predictable alternative resources; some use of outlying hunting camps in mountain passes during periods of caribou herd increase.	Low population density; small, widely spaced settlements; some hunting camps in interior. Possible emigration in response to extreme unpredictability and low abundance of coastal resources.
Subsistence:	Heavy utilisation of caribou when available, with reliance on predictable woodland and riverine species including fish.	Broad range exploitation of coastal resources (especially perennially available species); use of inland fauna (caribou) when available.
Responses to risk:		
Diversification:	Focus on caribou with reliance on less abundant, predictable secondary resources of woodland/riverine ecotone.	Utilisation of broad range of coastal and interior resources.
Mobility:	Increased intra-regional mobility to monitor caribou herd distribution.	Intra-regional monitoring of coastal resources; inter-regional logistic forays after caribou in periods of abundance or when near the coast; potential emigration under extreme conditions.
Storage:	Physical storage of seasonal caribou and fish surpluses; recourse to intra-regional social storage.	Physical storage to mediate seasonal shortages; unable to procure regularly and store large surpluses due to low resource abundance and small group size. Inter-community social storage to mediate localised subsistence failure.
Exchange:	High levels of intra-regional interaction within woodland/riverine zone.	High levels of inter-community and inter-regional interaction along coastal fringe.

terior and montane hinterlands (e.g. mountain sheep, musk oxen), which further document seasonal mobility and diversification. Migration is also a likely response to such extreme conditions, and the expansion of the early Thule culture eastwards across the Canadian Arctic Archipelago, as well as into the interior riverine zone of Alaska, does suggest partial abandonment of North Alaska in favour of areas with more predictable hunting conditions (McGhee 1976; Stanford 1976; Yorga 1980).

High levels of interaction among the remaining coastal groups are an expected means of pooling risk, and the presence of artefacts decorated in the Punuk style of the Bering Strait at some sites and small amounts of Asiatic iron and handles for iron blades

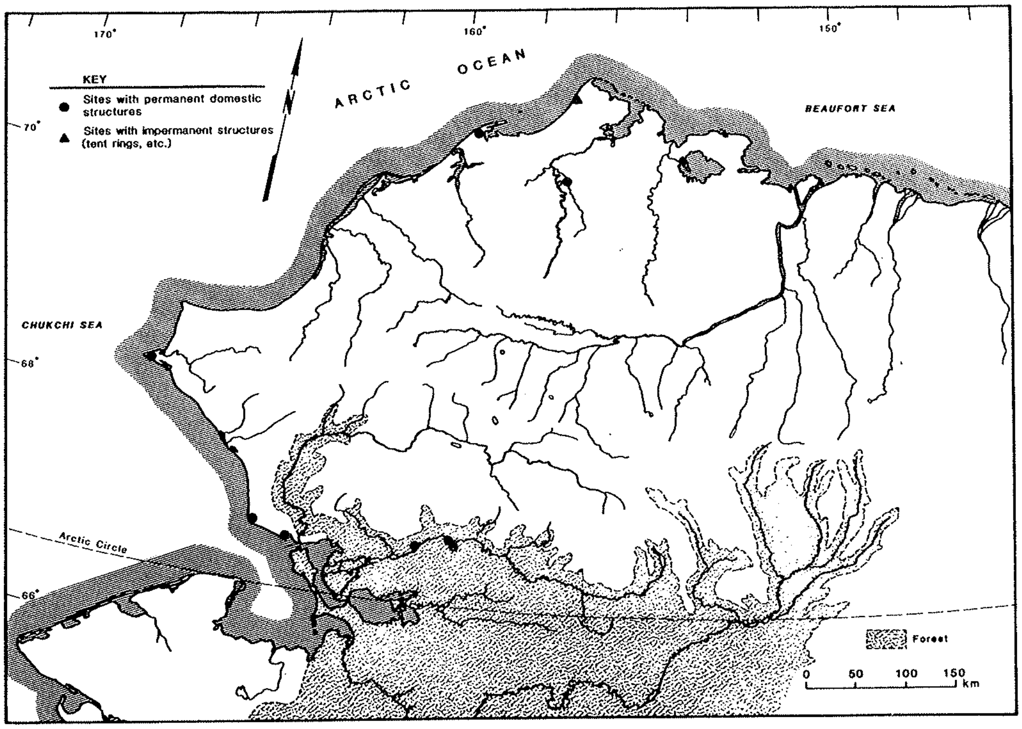


Fig. 2.13. Distribution of reported archaeological sites for Period IIa (*c*. AD 1140–1350) in North Alaska

at most sites (Ford 1959; Yorga 1980; Franklin, Badone, Gotthardt and Yorga 1981:96) documents interaction and at least limited exchange among the coastal populations. In the absence of either large populations or 'economically defensible' resource concentrations, there should be few indications of social boundaries or territoriality, and this conforms with the absence of regional stylistic differences along the coast.

In spite of periodic abundances of caribou, life in the interior mountains would have been precarious because of difficulties in predicting winter storage needs or the yields and location of interior resources, coupled with limited and unreliable fall-back resources on the coast. In the absence of dog sleds capable of bulk transport (which appear much later [below, p. 31]), groups exploiting dispersed herd segments would have had to store meat, fat and hides near spring and autumn kill-sites and to have moved between them throughout the winter – a difficult strategy in sub-zero weather during the dark of the Arctic winter! It comes as little surprise to find that the only evidence for occupation of the interior by Eskimo groups comes from the Kobuk River valley, where reliance could be placed on a diversified economy combining boreal forest, riverine and tundra species. Fishing and terrestrial mammal hunting equipment are well represented in the Early Thule assemblage from Onion Portage and indicate a diversified economic base (Anderson 1984).[5] High levels of interannual and episodic variability would favour considerable interaction with populations within and beyond the interior riverine zone, and the assemblage from Onion Portage, the only Period I site from this zone, is stylistically similar enough to coastal material to suggest intensive interaction along the rivers.

Period IIa (AD 1140–1350)

Period IIa was an episode of low interannual variability, low-amplitude cycles of 25–35 year duration, and somewhat cool and wet climate (Table 2.6). Good hunting conditions, predictable storage goals, increasing availability of ringed seals to augment winter subsistence, and reliable if not abundant interior resources would have made this period generally favourable for exploitation of the coastal zone. Late Western Thule sites are distributed along the coast at both whaling and non-whaling locations (Figure 2.13) and the limited available data suggest village sizes similar to those of Period I (Larsen and Rainey 1948:170; Giddings 1967:29, 95). A small increase in the number of settlements, rather than aggregation of population at previous sites, may therefore be indicated. Thus, although conditions for the procurement of whales improved in Period IIa, small group size continued to limit the effectiveness of whaling.

Given the projected abundance and predictability of coastal resources, the predictable (if limited) abundance of interior resources, and the size of the social units involved, coastal populations should have relied heavily on marine mammals with limited pursuit of whales, perhaps with logistic exploitation of the interior (cf. Binford 1980) for non-food (e.g. hides, antler, etc.) and alternative dietary resources. These expectations fit well with the limited data available. The only coastal faunal assemblage reported for this period is dominated by small seals with lesser amounts of caribou and low frequencies of bird, dog, bearded seal, walrus, polar bear, whale and fox (Stanford 1976). Whaling technology is poorly represented artefactually, although more whale bone was incorporated in the construction of houses at Point Hope and Cape

Table 2.6. *Expectations for resource availability and subsistence strategies: Period IIa (AD 1140–1350)*

Resource variability & responses to risk	Interior	Coast
Climate:	Consistently cool with greater winter snowfall and wetter summers; low-amplitude, short-term fluctuations generate fairly stable but adverse conditions.	Reduced air and water temperatures; more stable ice formation; low-level, short-term oscillations and low interannual variability suggest stable and favourable conditions.
Resource variability:	Decreased caribou population with contracted range to spruce–lichen woodland south of the Brooks Range.	Consistently good conditions for ice-edge sealing and whaling; increase in ringed seal population size and condition.
Settlement:	Decreased population size and density; sites expected along rivers south of Brooks Range and near coastal river mouths.	Increase in population size; many small sites widely distributed along the coast.
Subsistence:	Reliance on broad range of secondary resources, including fish and seals in addition to caribou.	Focus on migratory sea mammals; seasonal forays to the interior for subsistence and non-subsistence resources.
Responses to risk:		
Diversification:	Reliance on broad spectrum of woodland and riverine resources, increased utilisation of marine fauna in years of poor interior procurement success.	Focus on seals complemented by other marine mammals; little reliance on secondary coastal or interior resources. Limited use of whales.
Mobility:	Increased residential mobility, seasonal movement between interior woodlands and coastal river outlets.	Greater permanence of settlement and reduced mobility.
Storage:	Reliance on social storage to resolve both short-term, localised and extended, regional subsistence lows.	Reliance on local, physical storage to mediate seasonal and low-amplitude interannual shortages.
Exchange:	Increased inter-regional interaction and intensified ties to the coast to provide access to critical fall-back resources.	Reduction of inter-community interdependence; concomitant breakdown in coastal exchange networks and emergence of distinct stylistic zones.

Krusenstern than during Period I (Larsen and Rainey 1948; Giddings 1967:95–6), suggesting that whales may have been procured somewhat more consistently. Finally, one small site along the Meade River appears to document seasonal logistic utilisation of the coastal riverine region for fishing and caribou hunting (Davis, Linck, Schoenberg and Shields 1981:231).

Decreased reliance on exchange as a mechanism for buffering stress and the emergence of stylistic zones along the coasts might be expected, given the potential economic defensibility of coastal resources. However, Late Western Thule sites are linked by stylistic uniformity, limited formal and stylistic cross-ties with the Punuk culture, and the utilisation of iron from Siberian sources. Such low-level exchange and interaction documents the maintenance of small-scale, interpersonal patterns of exchange developed in Period I rather than the predicted changes.

With low densities of caribou and limited availability of local secondary resources, reliance on interior resources would have been more precarious than in Period I and conclusive evidence for occupation of the Brooks Range during this period has yet to be documented. In addition, occupation of the interior riverine zone south of the Brooks Range appears to be restricted to the middle Kobuk valley, from which riverine, boreal, coastal and tundra resources were all accessible. However, a decrease in the density of occupation within this zone cannot be documented, suggesting that adaptation to the woodland riverine zone was fairly resilient.

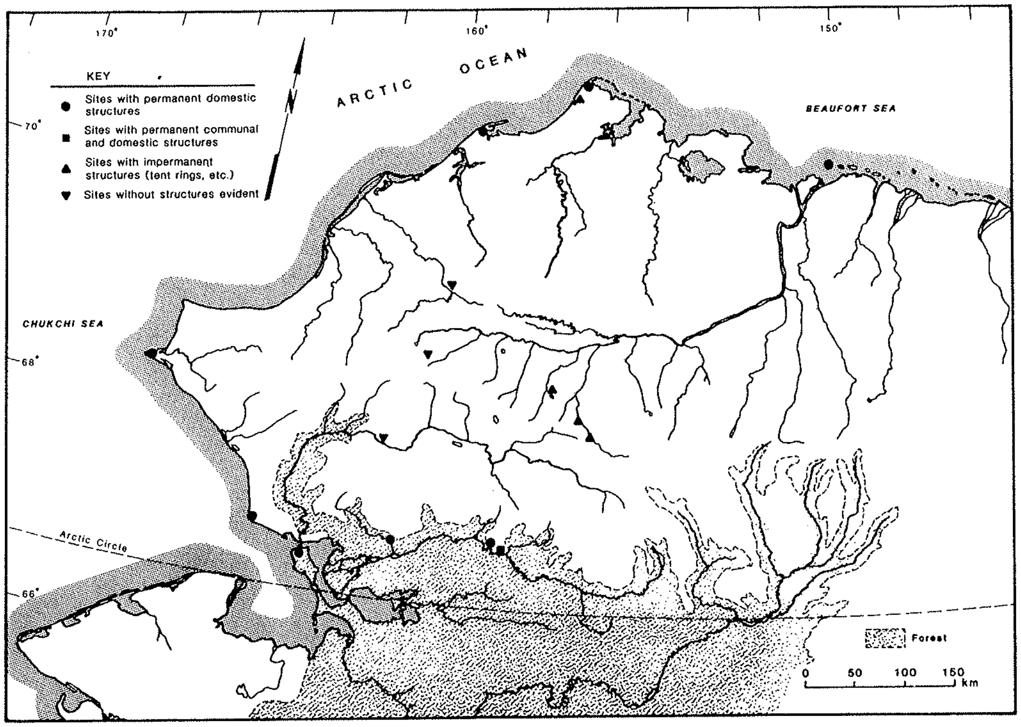


Fig. 2.14. Distribution of reported archaeological sites for Period IIb (*c.* AD 1350–1510) in North Alaska

In the Kobuk sites, caribou dominate the faunal assemblages although artefactual evidence argues for seasonal seal hunting at coastal locations as well as caribou hunting and fishing (Giddings 1952). The incorporation of coastal seal hunting on a seasonal basis indicates an increase in mobility and diversification, as expected in the face of decreased abundances of caribou and other interior resources. Increased exchange within and beyond the riverine zone is also expected, yet current evidence suggests the same low-level patterns of exchange and integration as those observed on the coast. Artefacts from sites in the interior are stylistically similar to those on the coasts and small amounts of Punuk-like material and iron are reported.

Period IIb (AD 1350–1510)

The trend towards increasingly cold and wet conditions which began in Period IIa intensified after AD 1350. On the coast this favoured the pursuit of sea mammals, yet high levels of interannual variability should have made storage needs unpredictable and made locations where currents and coastal morphology ensured early and consistent formation of leads more productive than others over the long run. Intensive utilisation of these locations, and aggregation of population there would be expected in response to such a 'patchy' distribution of risk within this period of relative abundance (Table 2.7).

Aggregated settlement is documented at Point Hope by the appearance of a large village with deep and extensive middens during Period IIb (Larsen and Rainey 1948:175–81), and is reinforced by decreases in the size of sites at less strategic coastal locations south of Point Hope (Figure 2.14) (Giddings 1967; Anderson 1984). However, in the north, small sites remained scattered along the coast (e.g. Nunagiak, Thetis Island), and large villages may not have been established until the end of this period (Dekin 1981; Newell 1984).

The presence of aggregated populations at some locations could have increased the potential for successful whaling through the ability to utilise the monitoring and pursuit capabilities of larger numbers of crews than would have been available in the small villages of earlier periods. The recovery of whale bone and baleen from most coastal sites does suggest that whaling was an important part of the seasonal round for these coastal societies, yet the scarcity of whaling gear and the absence of a specialised whaling 'kit' imply that it did not form *the* major economic focus of coastal societies.

Seals, walrus, birds and small mammals are represented, in addition to whale, in the two reported faunal assemblages for this period (Stanford 1976; Hall 1981:5). In addition, the frequency of caribou at these two sites is relatively high; however, at Walakpa this reflects a shift in site use from a winter sealing camp to a specialised caribou-hunting camp occupied for short periods during the early autumn (Stanford 1976, Table 9). While such specialised, yet impermanent, hunting camps are present on the coast, the hunting and fishing camps established along the rivers of the coastal plain during Period IIa seem to have been abandoned. This supports the reconstruction of an economy focused on the abundant maritime resources of the coast, but utilising interior resources through specialised logistical forays of limited spatial extent in the seasons when hides, pelts and fat reserves were in their prime.

Table 2.7. *Expectations for resource availability and subsistence strategies: Period IIb* (AD *1350–1510*)

Resource variability & responses to risk	Interior	Coast
Climate:	Low temperatures and high winter precipitation; increased amplitude of short-term climatic fluctuations creating more frequent and more extreme adverse conditions.	Cool conditions, increased amplitude of short-term and inter-annual oscillations; less predictable ice conditions over the short term.
Resource variability:	Low caribou population size, herd location less predictable; availability of fall-back coastal resources also less predictable.	Ice-edge hunting conditions generally favourable for whaling and sealing, with less reliable hunting success and predictability of storage needs from year to year at any one locality.
Settlement:	Sites smaller, less permanent; population distributed in fall/winter hunting camps within the riverine zone, ranging to coastal outlets in the spring.	Contraction and concentration of settlement in more reliable (i.e. 'key') locations for marine mammal procurement.
Subsistence:	Reliance on broad range of interior (terrestrial and riverine) and coastal resources in flexible seasonal round focused on periods of peak caribou, fish, and seal abundance.	Focus on ice-edge marine mammal hunting; aggregated populations may lead to greater utilisation of whales and more consistently productive whaling.
Responses to risk:		
Diversification:	Broad range of resources from both interior and coastal zones utilised.	Focus on marine mammals and secondary coastal resources, with use of interior resources when available.
Mobility:	Increased catchment area exploited; residential mobility between fall/winter camps inland and spring sealing camps.	Relatively permanent settlement at key whaling sites; logistic forays along coast and into interior.
Storage:	Limited reliance on physical storage; social storage effected through widespread kinship and social ties between interior groups.	Reliance on physical storage and intra-community distribution of seasonal surpluses; inter-community social ties maintained to buffer localised fluctuations in hunting success.
Exchange:	Increased extent and formalisation of exchange networks; potential specialised production for exchange.	Increased exchange and interaction along the coast in response to uncertainty at the local community level.

On the coast, this period was one of greater abundance and long-range predictability relative to earlier periods, favouring the emergence of territoriality. This expectation is supported archaeologically by the appearance of distinct stylistic zones. Stanford (1976:109) notes a regional diversification of harpoon types, and at least four regional house types are distinguishable in northern Alaska (Barrow, Beaufort Sea/Mackenzie Delta, Kobuk River and Hotham Inlet/Kotzebue Sound) as variants on the Western Thule prototype during Period IIb (Giddings 1952; Van Stone 1955; Yorga 1980; Hall 1981; Slaughter 1982; Newell 1984).

Nevertheless, high levels of uncertainty locally favoured intensification of exchange within the coastal region. As in earlier periods, Asiatic iron and handles for iron blades occur at sites from Thetis Island to Kotzebue. Additionally, copper from Canadian Arctic sources (found at Thetis Island [Hall 1981, Table 2]) indicates that exchange extended eastward at least to the delta of the Mackenzie River, while Kobuk River jade at Kotzebue documents intensified exchange with interior riverine groups. Thus, while coastal networks retained their informal structure during Period IIb, the incorporation of more types of exchanged goods and more distant trading partners at each end of the chain provided the matrix on which later trade networks would develop.

For groups reliant on the resources of the interior, this period was even more precarious than Period IIa, favouring a diversified economic base and greater utilisation of the coastal zone. The few sites known in the Kobuk drainage (Figure 2.14) are smaller than those of Period IIa and a diversified economy combining caribou hunting, fishing and seasonal seal hunting at coastal locations is documented (Giddings 1952). Ephemeral camp sites in a number of passes of the western Brooks Range, together with scattered finds of Kobuk-style projectile points, document late-autumn forays by caribou hunting task groups from the Kobuk/Noatak region (Irving 1962; Campbell 1976; Hall 1976; Spiess 1979:161–2; Davis *et al.* 1981; Gerlach and Hall n.d.).[6] These sites, together with increased utilisation of mountain sheep horn in the Kobuk River (Giddings 1952, Appendix III), imply considerable mobility and the exploitation of larger catchments than at any earlier time in the sequence.

Ownership marks appear for the first time in western Alaska during Period IIb and are especially common in the interior riverine region during Period IIb, suggesting that communal hunting or the division of the products from hunting became of greater concern than previously.[7] A probable *karigi* at Ivisahpat (Hickey 1976) reinforces this inference as ethnographically such structures were the focus for corporate hunting groups and the distribution of products from communal hunts (Spencer 1959).

As expected, broad social networks were maintained within the interior and between coast and interior. Copper in Kobuk River sites may indicate contact with Athabaskan groups of interior Alaska (Giddings 1952; Shinkwin 1979). Stylistic similarities in projectile points from the Kobuk River and suspected proto-Athabaskan sites (Morlan 1975; Campbell 1976) imply communication across ethnic frontiers in the forests south of the Brooks Range. Additionally, Hickey's reanalysis (1976, 1979) of data from the Kobuk River (Giddings 1952) suggests that inter-regional trading networks began to be formalised south of the Brooks Range during the fifteenth century. At that time jade from the Upper Kobuk River appeared at Kotzebue as finished tools, and concurrent reorganisation of seasonal scheduling, to support production for exchange, is noted in the riverine sites.

The establishment of a large village at Kotzebue, near the mouth of the Kobuk River and in a prime location for the exploitation of both marine mammals and anadromous fish, exemplifies the interdependence of the coastal and interior riverine zones (Giddings 1952; Van Stone 1955). Although the scale of this settlement suggests a social context similar to that of the northern coasts, fish, caribou and seals were the primary elements in its economy (Giddings 1952:111; Van Stone 1955:129–31). The society at Kotzebue participated in exchange with both interior and coastal groups, yet the presence of antler slat armour implies that overt hostilities were a component of the network of regionally defined societies which began to take shape during Period IIb (Van Stone 1955:119).

Period III (AD 1510–1780)

The dendroclimatic sequence reveals a major change after AD 1510 with a transition to high-amplitude and low-frequency cycles approximately 65 years in duration, and indicates generally warm and dry conditions in the interior (Tables 2.3, 2.8). The amplitude of these cycles and the degree of interannual variability decrease after AD 1600, suggesting two subphases. Although the structures of climatic and resource variability are relatively similar in Periods I and IIIa, they are also in Periods IIa and IIIb, patterns of settlement, subsistence and responses to variability are quite different because of changes in technology and social organisation.

Artefacts associated with built-up dog sleds capable of hauling large loads overland for long distances (trace buckles, whips, sled shoes, etc.) first appear as a complex after AD 1550 in North Alaska (Giddings 1952; Van Stone 1955; Hall 1978). Such sleds made regular high-volume exchange between the interior and coast viable and also enabled interior populations to maintain a dispersed system of storage in which meat, fat and hides were cached near kill sites well away from winter villages, to be collected in later provisioning forays. Undoubtedly the most important societal change which can be inferred during Period III is the spread of formalised social institutions capable of mediating disputes and coordinating production within aggregated communities. *Kariyit*, community centres in which disputes between kinship groups could be mediated and hunting crews maintained, appear to have been present in the interior during Period IIb (Hickey 1976) but are first documented on the coast during Period III.

In Period III, the distribution of settlements in the coastal zone remained focused on key whaling locations (Figure 2.15). In addition to the large coastal villages of Period IIb, two additional whaling centres emerged near Point Barrow (Okakok 1981; Newell 1984). Smaller villages such as Pingok Island (Hall 1981) and Nunagiak (Ford 1959) were present at less propitious whaling locations, with hunting camps on the coast and a resurgence of seasonal or semi-permanent occupation along the Meade River in the Arctic Coastal Plain.

This focus on key whaling locations suggests that intensive whaling, to produce stores of blubber, skin and meat adequate for years of scarcity, became a central survival strategy for coastal populations during those episodes of Period III when reliance on smaller sea mammals alone would have been insufficient. Artefactual and faunal data confirm the importance of whaling. Specialised whaling equipment was recovered from the later prehistoric levels of the Tigara middens (Larsen and Rainey 1948, Table 3), Pingok Island (Hall 1981, Table 3), and Utkiavik (Sheehan 1985)[8] and whale bones became important architectural components in houses at coastal sites from Tigara northwards. Although bones of marine mammals dominate faunal assemblages at habitation sites (such as Pingok Island [Hall 1981:16]), the wide variety of fauna exploited from these northern coastal sites, together with seasonal exploitation of caribou from autumn hunting camps such as Walakpa (Stanford 1976, Table 6) indicate at least seasonal reliance on interior resources (Davis *et al.* 1981).

Caribou hunting should have become relatively reliable after AD 1600, although during the sixteenth century high interannual variability may have made the Brooks Range viable for only sporadic hunting expeditions. With the beginning of the seventeenth century, the earlier pattern of extremely limited and

Table 2.8. *Expectations for resource availability and subsistence strategies: Period III (AD 1510–1780)*

Resource variability & responses to risk	Interior	Coast
Climate:	Brief transitional period of extremely unstable conditions followed by warmer, drier conditions; high-amplitude, long-term fluctuations generating severe conditions in only 7% of the years.	Generally warmer air and water temperatures, higher spring precipitation; less adverse and variable conditions after AD 1575; long-term fluctuations generate favourably low temperatures 40% of the time.
Resource variability:	Caribou herd size increases and range expands with demographic fluctuations paralleling long-term climatic oscillations; population crash unlikely given overall warm/dry conditions.	Coastal resource availability reduced and less predictable due to unstable ice conditions, but long-term fluctuations create extended periods of favourable conditions as well as adverse episodes.
Settlement:	Settlement expands throughout interior north of Brooks Range to North Slope and onto coastal plain. Increased population; establishment of permanent settlements near major mountain passes with hunting camps throughout caribou range.	Decreased coastal population; abandonment of poorer hunting sites, concentration of population in optimal areas along coast; greater use of seasonal or semi-permanent caribou hunting camps in the interior.
Subsistence:	Emphasis on caribou utilising communal hunting to maximise take during spring and fall migrations.	Emphasis on communal whaling to ensure annual surpluses, with increased reliance on secondary coastal and interior resources.
Responses to risk:		
Diversification:	Intensive reliance on caribou; little diversification.	Intensification of whaling with broad-spectrum utilisation of local resources and increased reliance on interior resources.
Mobility:	Reduced mobility; more permanent settlements near mountain passes, complemented by intra-regional logistic forays.	Increased intra-regional mobility in response to differential local hunting success along the coast; inter-regional logistic and residential mobility for caribou procurement.
Storage:	Intensive utilisation of physical storage to mediate seasonal shortages; long-term fluctuations in caribou mediated through inter-regional connections with coastal and woodland zones.	Intensive utilisation of physical storage to mediate seasonal and short-term interannual fluctuations; long-term fluctuations in productivity of coastal resources mediated through inter-regional social storage.
Exchange:	Intensification of formal inter-regional exchange networks with coastal and woodland zones to buffer long-term caribou population cycles.	Participation in formal inter-regional exchange networks with the interior to ensure access to resources during extended periods of low coastal productivity.

mobile use of this zone ends with a sudden increase in the number, size and degree of permanency of sites in the montane region (Figure 2.15). Deeply excavated houses, large caching facilities and deep middens suggest permanent winter habitation throughout the western Brooks Range (Irving 1962; Campbell 1968a; Hall 1970, 1975; Davis *et al.* 1981). At Sikoruk, 123 housepits and 410 cache pits have been identified, which date to the seventeenth and eighteenth centuries (Hall 1976; Gerlach and Hall n.d.:10). Other

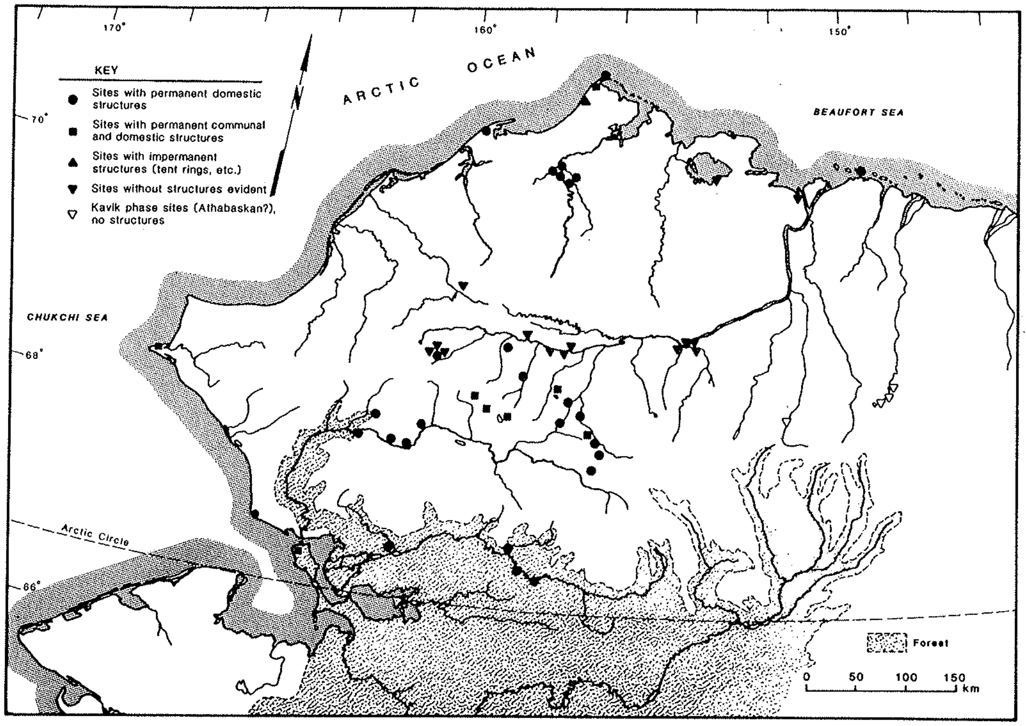


Fig. 2.15. Distribution of reported archaeological sites for Period III (*c.* AD 1510–1780) in North Alaska

sites range in size from eight to more than 50 houses, with *kariyit* at the larger sites in the main mountain passes (Hall 1970). Camps without permanent structures are found throughout the foothills north of the Brooks Range and document high seasonal mobility, dispersed hunting and extensive range-monitoring activities during the summer months (Davis *et al.* 1981).

The expected reliance on caribou is documented by faunal analyses, which also confirm the year-round occupation of the montane region. Faunal remains from Sikoruk indicate autumn caribou herd drives, storage and consumption of the products from these drives throughout the winter, and selective hunting of mature caribou during the late winter months (Spiess 1979). Caribou provided an estimated 95 percent of the diet at Kangiguksuk, a winter encampment on the south slope of the Brooks Range, along with minor quantities of moose, mountain sheep, bear, small mammals, birds and plants (Hall 1971, Table 11).

Although conditions along the interior rivers during Period III were generally favourable, the abundance and predictability of spring and summer caribou migrations in the high montane passes after AD 1600 may have drawn populations out of the valleys south of the Brooks Range. Settlement stability in this region decreased markedly during Period III: although more sites are known along the Kobuk River than in any earlier period, they have fewer structures and appear less permanent (Giddings 1952; Hall 1971). Similarly, at Kotzebue, the village decreased in size and was used only as a seasonal hunting and trading locality by the late sixteenth century (Van Stone 1955). Intensive fishing, together with terrestrial mammal and seal hunting, formed the basic subsistence pattern here, while along the Kobuk River evidence for large-scale fishing increases, augmenting a mixed reliance on large and small mammals, as well as birds. Marine mammal hunting equipment is rarely found in up-river sites (Giddings 1952), suggesting that direct procurement of resources from the coast was limited.

In the eastern Brooks Range, sporadic late-summer occupations of the Kavik phase, a suspected early Athabaskan complex, are documented (Campbell 1962, 1968b; Morlan 1975; Wilson 1978). Although caribou was the main prey at some sites (such as Kavik itself, in Anaktuvuk Pass [Campbell 1968b]), a reliance on small mammals is evident at others (Wilson 1978). Together with the ephemerality of many of these sites, this may imply that caribou were not as abundant in the eastern Brooks Range or that these sites represent only seasonal forays into the mountains from the boreal forests east of the Kobuk drainage, where more permanent proto-Athabaskan occupation is documented (Morlan 1975; Shinkwin 1979).

Period III was one of episodic abundance and scarcity. Locations where adequate provisions could be obtained reliably would have been highly defensible, favouring the maintenance of stylistic boundaries, territorial defence and the formalisation of ritualised institutions supporting intra-societal solidarity. These expectations are confirmed archaeologically. Stylistic differences in artefact types continue to define territorial groupings. *Kariyit* at Old Kotzebue (Van Stone 1955), a number of Brooks Range village sites (Hall 1971) and probably Utkiavik (Dekin 1981; Sheehan 1985), as well as a formal cemetery at Tigara (Larsen and Rainey 1948), provide further indications of intra-societal integration supported by historic and symbolic ties between people, ancestors, spirits and the land (cf. Goldstein 1976; O'Shea 1984). Finally, slat armour from the coastal, riverine and montane zones (Larsen and Rainey 1948, Table 3; Giddings 1952:122; Hall 1978, 1981) indicates that inter-societal aggression spread throughout North Alaska in this period, suggesting that territoriality had more than symbolic expression.

Territorial defence restricts access to resources and represents physical storage in its widest sense, but in the face of localised and regional variability mechanisms of alliance capable of transcending social boundaries are necessary. Given the duration of fluctuations in this period, extensive social networks, maintained and activated through formalised exchange and the storage of social debts, were necessary, and the trade networks which had begun to be formalised along the Kobuk River in Period IIb now spread throughout North Alaska. Soapstone vessel fragments of Canadian origin have been identified at Pingok Island and Kotzebue (Giddings 1952:69; Hall 1981, Table 3), increased proportions of Brooks Range chert were found at Walakpa (Stanford 1976), and finished ivory and whalebone tools as well as blubber-soaked surfaces are present at sites in the Brooks Range (Hall 1976; Davis *et al.* 1981). Jade tools, raw material and manufacturing debris are common along the Kobuk River and at Kotzebue, together with indications of the development of more efficient techniques to produce jade tools for exchange (Giddings 1952:78). Conversely, jade tools, but not manufacturing debris or raw material, have been recovered from sites in the Brooks Range and along the northern and western coasts (Larsen and Rainey 1948, Table 3; Irving 1962; Hall 1976, 1981). These overlapping distributions of exchanged materials, the pervasiveness and variety of exotic materials, the specific production of material for exchange, and indications that at least one of the known trade-fair sites (Niglik) was first utilised during Period III (Hall 1981:4) document the economic underpinnings of a web of alliance and interaction which connected coastal and interior groups.

Period IV (AD 1780–1940)

Archaeological data from Period IV link the prehistoric record with ethnohistoric information discussed earlier in this paper and by Minc (1986). In general, Period IV would have been favourable for the exploitation of coastal resources (Table 2.9) and key whaling points maintained their advantages for settlement. However, prolonged episodes of less productive climatic conditions, high levels of interannual variability, and the likelihood of increasing population following the adoption of high-yield whaling favoured the establishment of seasonal or semi-permanent 'satellite camps' in locations suited to the utilisation of interior, riverine and coastal resources.

At the late prehistoric and protohistoric sites of Utkiavik and Tigara more than 75 house depressions were visible on the surfaces of deeply stratified mounds (Larsen and Rainey 1948:20; Ford 1959; Dekin 1981). Nuwuk, at Point Barrow, was reported to have been of similar size (Simpson 1875; Murdoch 1892; Ford 1959; Spencer 1959). The populations of these villages in the early historic period (*c.* AD 1850) are reckoned at 450–800 persons each (Burch 1980). Between these 'super-sites' were smaller villages of 5–25 houses at locations not as well suited to whaling (Burch 1981). Seasonal hunting camps are known from the coastal region (Hadleigh-West 1966) and along the rivers of the coastal plain, but the semi-permanent villages established along the Meade River during Period III were abandoned by the early nineteenth century (Burch 1980), and may not have been reoccupied until early in this century (Davis *et al.* 1981).

Although intensive whaling remained the focus of coastal economies, heightened interannual and episodic variability and the needs of large, aggregated populations necessitated extensive utilisation of the interior and coast for subsistence and non-subsistence resources (hides for clothing and boat covers, bone and antler for tools, etc.), as well as for seasonally available alternative resources. While on average whales accounted for 50 percent of the diet of the early historic Tareumiut, they were insufficient to fulfil this level of reliance one year in five. As a result, North Alaskan Eskimos relied not only on the stores of the whaling centres, but also on a diversified procurement strategy which made use of small, dispersed settlements, specialised hunting camps and tightly structured seasonal rounds to exploit the range of resources within each regional territory (Foote and Williamson 1966; Hadleigh-West 1966; Burch 1981). The variety of resources incorporated into coastal economies to supplement and ensure the whaling focus are documented both ethnographically (Murdoch 1892; Spencer 1959; Foote and Williamson 1966; Burch 1981) and archaeologically (Hadleigh-West 1966).

Given the uncertainty of storage needs within a period of general abundance, symbolic identification of territories and evidence for defence are anticipated. Stylistic differences, regional dialects, scheduling of seasonal rounds to avoid interaction with neighbouring groups, and preferential endogamy emphasise the territorial boundedness of early historic coastal societies (Burch 1980, 1981). Stylistic differences in harpoon types (Boas 1899) reflect these divisions archaeologically, while the recovery of armour slats from most coastal sites confirms the endemic inter-societal, intra-regional warfare recorded in oral histories (Burch and Correll 1972; Burch 1981).

In the interior, periodic caribou population crashes, relatively frequent shifts in the location of caribou herds, and uncertainty regarding the timing of spring and autumn migrations are documented effects of variability during Period IV. The periodic abandonments of the interior expected from the structure of resource variability are documented historically. However, unlike Period IIb, when similar variability affected the interior resources, a relatively large population maintained itself in the Brooks Range throughout much of Period IV (Hall 1975; Burch 1980). This was made possible by a strategy which combined seasonal aggregation of small, local bands for communal caribou drives with regional dispersion of these bands throughout the Brooks Range, high seasonal mobility, 'dispersed storage' of foodstuffs cached at kill-sites and strengthening of alliances with coastal and woodland riverine societies.

The dispersion of the Nunamiut into the eastern Brooks Range following their expulsion of the Athabaskan Dihai Kutchin (recorded in oral history [Hall 1969]) is evident in the expansion of settlements from a centre west of the Killik River during Period III

Table 2.9. *Expectations for resource availability and subsistence strategies: Period IV (AD 1780–early 1900s)*

Resource variability & responses to risk	Interior	Coast
Climate:	Cooler and wetter conditions; high-amplitude fluctuations of longer duration than in Period III with greater interannual variability.	Lower air and water temperatures, reduced spring precipitation, more stable ice conditions; long-term, high-amplitude fluctuations of greater duration than Period III with increased interannual variability.
Resource variability:	Generally lower caribou productivity, high probability of disastrous caribou declines; alternation of extended periods of low caribou population size with conditions favourable to herd increase.	Generally good whaling and sealing conditions, but long-term, high-amplitude fluctuations generate critical episodes while high interannual variability reduces predictability of yields.
Settlement:	Inland sites smaller and fewer in number, concentrated near key passes where caribou herds are most abundant and predictable. Episodic abandonment of the Brooks Range in response to caribou crashes with emigration to the coast or to river valleys south of Brooks Range.	Increased population size, continued focus of settlement at key whaling sites; establishment of small hunting camps in interior when caribou are more abundant.
Subsistence:	Communal caribou hunting in passes during caribou population peaks, with high mobility on North Slope when migration route or herd size proves unpredictable. Reliance on riverine and coastal zones in event of caribou crash.	Intensive and specialised focus on whaling with continued reliance on secondary coastal and interior resources during episodes of less favourable whaling conditions.
Responses to risk:		
Diversification:	Reliance on caribou hunting with recourse to inter-regional resources in the event of caribou population crashes.	Intensive utilisation of coastal resources; expansion of resource base to include interior resources during extended periods of poor coastal hunting success.
Mobility:	Increased intra-regional mobility to monitor caribou herd movement and location; inter-regional migrations in response to catastrophic decline of caribou population.	Increased inter-community mobility mediating localised, short-term shortages; inter-regional mobility in response to extended episodes of low coastal productivity.
Storage:	Intensive use of physical storage to mediate seasonal shortages combined with the conversion of periodic abundance into social debts both between interior groups to mediate interannual variability, and between interior and coastal groups to mediate long-term fluctuations in caribou abundance.	Intensive use of physical storage to mediate seasonal shortages combined with conversion of periodic abundance into social obligations both between coastal communities to mediate interannual variability, and between coastal and interior groups to mediate long-term fluctuations in coastal resource productivity.
Exchange:	Formalised inter-regional exchange networks between interior, coast and woodlands.	Formalised inter-regional exchange networks between coast and interior.

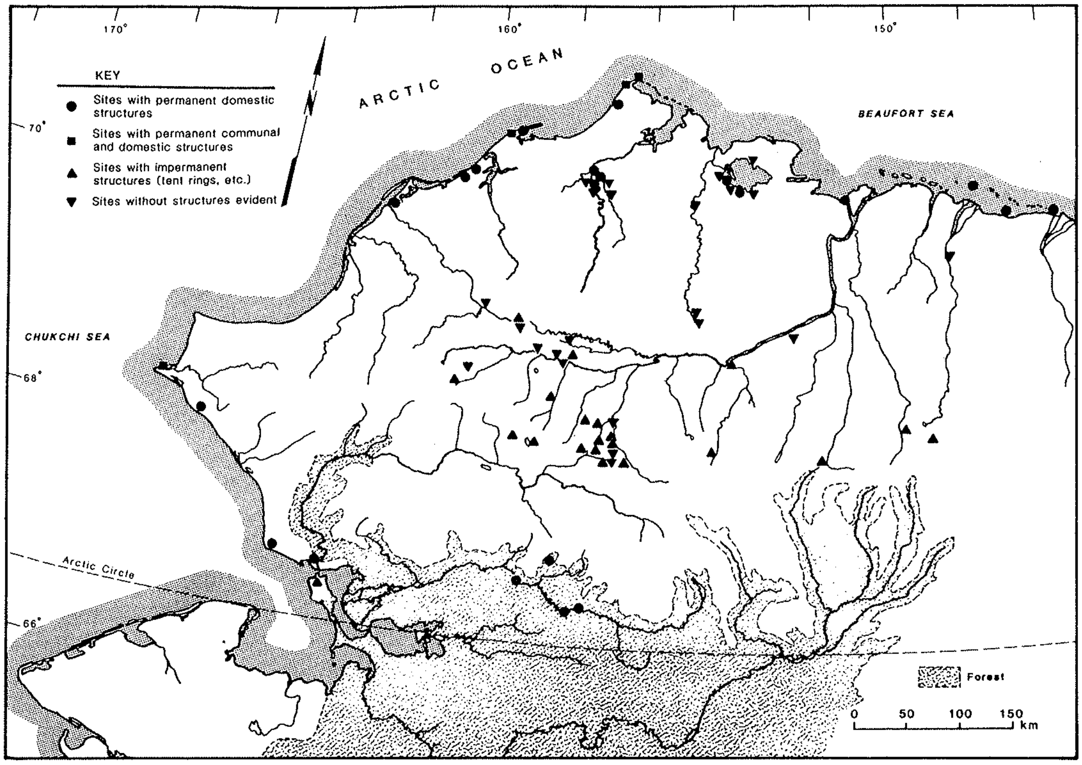


Fig. 2.16. Distribution of reported archaeological sites for Period IV (*c.* AD 1780–1940) in North Alaska

(Figure 2.15) to a strong presence throughout the passes and foothills of the Brooks Range during Period IV (Figure 2.16). The remains of impermanent skin tents and moss-covered houses at these sites (Corbin 1976; Hall 1976) correspond with structures known ethnographically for the Nunamiut (Spencer 1959; Gubser 1965) and reflect high mobility. Although the sites generated by this mobile lifeway are extremely complex (Binford 1978, 1983), available evidence suggests that winter residential groupings were smaller than those in the sod-house villages of Period III.

Within these smaller groups, the *karigi* maintained its primacy for coordinating communal hunts, although its physical form changed from a permanent structure to a large skin tent which could be relocated with movements of the social group (Hall 1970; Corbin 1976). Intra-societal mechanisms for maintaining local group cohesion are thus recorded. As this was a more stressful period than Period III in the interior, mobility and access to a wide range of resources, rather than territoriality, would be expected. In fact, marked social boundaries between Nunamiut groups are not well documented archaeologically, although Nunamiut attacks on coastal and Athabaskan groups are reported ethnographically (Hall 1969; Burch 1981).

A reliance on caribou, procured through large-scale communal drives organised by *karigi* crews, is documented historically and recognised archaeologically from massive caribou processing sites in the passes and along foothill river valleys as well as the extensive stone drive-lanes (*inuksut*) which fill the valleys of the Brooks Range (Binford 1978, 1983; Davis *et al.* 1981). Evidence for the use of large-payload dog sleds increases dramatically during Period IV (Hall 1978; Gerlach and Hall n.d.:28) and, together with widely scattered stone cache pits throughout the North Slope and Brooks Range, documents dispersed storage. Thus, scheduling conflicts between storage and seasonal mobility were circumvented by caching carcasses near kill-sites and retrieving them throughout the winter. Fish bones and marine mammal hunting gear at many sites north of the Brooks Range also indicate that diversified back-up strategies utilising both local and extra-regional resources compensated for uncertainty in caribou yields and storage needs.

Sites in the interior riverine zone remain few and, as in the montane region, exhibit evidence of high mobility, with most houses utilised for one season only (Giddings 1952, 1956). Caribou hunting, seasonal forays for mountain sheep in the Brooks Range, and intensive harvesting of anadromous fish are all components of an extensive land-use pattern in which, unlike earlier periods, sea mammal hunting was apparently not important (Giddings 1952:53).

The expected formalised trade networks are well documented ethnohistorically and archaeologically. These networks had been developing since Period IIb and during Period IV linked coastal, montane and woodland riverine groups into an overlapping web of alliances (Simpson 1875). In the early historic period, if not earlier, these networks were dominated by *umialit*, whaling or caribou-hunting captains and leaders of powerful kinship groups, who utilised their control of exchange to establish relationships of clientage with poorer members of their regional groups and to obtain exotic and needed goods with which to reward their followers (Spencer 1959; Burch 1975; Hennigh 1983; Sheehan 1985). Euroamerican, Asian and Native artefacts in protohistoric and early historic sites throughout North Alaska testify to the extent and intensity of these networks, as well as the cultural significance of inter-regional trade (Hickey 1979; Okakok 1981). The feasting and gift-giving which motivated these patterns of exchange provided avenues along which trading partners and their kin could and did move during episodes of severe subsistence stress in defiance of normal boundaries (Spencer 1959; Burch and Correll 1972). In the light of the high-amplitude fluctuations in caribou populations which are known to have occurred during this period, it is clear that the continued existence of the Nunamiut adaptation during Period IV was predicated upon having friends on the coast.

Discussion: the temporal patterning of coping strategies

From the structure of resource variability, we have been able to predict the basic structure of coping responses and to examine how the coping strategies of diversification, mobility, storage and exchange were modified over the past 1,000 years to adjust to changes in resource structure and sociocultural context. A strong correspondence between observed patterning in the material correlates of cultural responses to stress and our environmentally derived expectations for such responses is apparent in the late prehistoric record of North Alaska.

Diversification through the incorporation of local secondary resources accompanied periods of short-term stress, while longer episodes of stress saw increased reliance on access to the resources of distant communities and resource zones, as had been predicted. In contrast, a restricted focus on caribou or marine mammals characterised periods in which these resources were both predictable and abundant. These relationships held even after North Alaskan societies developed the social and technological means for intensifying harvests of these primary resources, and so could produce massive stores capable of buffering some resource crises. Although intensified harvesting raised the thresholds at which the implementation of coping responses became necessary, they did not eliminate the need for fall-back responses altogether. Thus, diversification is still evident as a back-up to intensive whaling during Period III; and in Period IV, although whaling became the focus of coastal economy and culture, some reliance was placed on secondary resources of the near-coastal and interior zones, particularly for non-subsistence items.

Mobility strategies are not easily monitored because of the coarse temporal resolution of the archaeological record and the unequal emphases on survey and excavation in different zones. However, existing data generally accord with expectations. In the interior, this is particularly evident in the extension of catchments to the coast and high mountain passes in Period IIb under conditions of severe stress, in the sudden establishment of sedentary villages with local storage facilities in these same passes during Period III, when caribou yields would have been abundant and predictable, and in the expansion of highly mobile settlements throughout the Brooks Range in Period IV, when climatic conditions once again made local reliance on this resource risky. Shorter-term patterns of inter-regional mobility and temporary abandonments of the interior, are well reported ethnohistorically and are implied archaeologically by the presence of coastal hunting gear in montane and riverine sites.

Less can be said about mobility within the coastal zone. Emigration from northwestern Alaska during Period I is well documented, although the scale of this migration and the consequent reduction in population density cannot be determined. However, the various changes in the use of the site of Walakpa, the periodic utilisation and abandonment of the Meade River floodplain, and the establishment of satellite villages around major whaling centres during Period IV, all fit well with predictions regarding seasonal scheduling and mobility.

It has also been difficult to monitor *physical storage* strategies. Storage facilities are present in nearly all reported habitation sites from late prehistoric Alaska, as would be predicted in an environment characterised by extreme seasonality (cf. Binford 1978; Rowley-Conwy and Zvelebil, this volume). However, too few facilities have been excavated to track the development of physical storage strategies or changes in the scale of storage facilities and the social groups which utilised them. Nevertheless, *spatially extensive* physical storage strategies, such as territorial defence and dispersed storage (with its implications for increased mobility) appear first during periods when the spatial and temporal scale of stress on resources is high, which is in accordance with expectations.

Changes in *exchange* relationships are among the most marked and intriguing features of late prehistoric North Alaska. In Periods I and IIa very informal patterns of interaction are indicated. From Period IIb, however, formalised networks develop which by Period III provide evidence for the mobilisation of a wide range of materials for pan-regional exchange, overlapping spheres of commodity distribution, specialised production of materials for exchange, reorganisation of settlement–subsistence strategies to accommodate participation in exchange networks, and the establishment of specialised sites for the conduct of inter-regional, ritually embedded exchange.

In our general model we predicted that increases in the scale and duration of subsistence stress would be accompanied by increasingly formalised exchange networks. The informal interaction of Periods I and IIa is associated with climatic cycles of only 35–40 years (Table 2.3). The later regional exchange networks fall primarily within periods when climatic oscillations were nearly twice as long and begin in the riverine zone when climatic episodes favourable for the procurement of interior resources were extremely few and far between.

Not all of the specific responses predicted on the basis of resource variability were met. In Period IIa, decreased evidence for interaction was expected among coastal societies as the relative abundance and predictability of coastal resources enhanced the potential for local self-sufficiency. The stylistic homogeneity and low-level exchange of Period I appear to have continued, however, perhaps reflecting the minimum level of social intercourse needed to obtain mates and monitor resource variability on a regional level, given the prevailing low population densities and small community sizes (cf. Wobst 1974, 1976; Moore 1981, 1983; Root 1983).

Decreased population density and intensified exchange along the inland rivers, expected during Period IIa because of adverse conditions for caribou herds, occurred belatedly during Period IIb, when cold and wet climatic conditions intensified. This discrepancy suggests that the present model may overemphasise the role of caribou for the riverine zone, and that the effects of climatic variability on other boreal forest resources require further attention.

The cultural redefinition of scarcity

In this chapter, we have reconstructed the spatio-temporal scales of variability in the primary subsistence resources of the interior and coastal regions of northern Alaska for the late prehistoric and protohistoric periods from variability in relevant climatic and ecological factors. Two scales of variability beyond that of seasonal migration were identified as creating distinct levels of stress, to which native populations were forced to respond. While the basic structure of responses to risk was constrained by the nature of those stresses, the implementation of coping strategies was clearly predicated on the sociocultural context, which defined the range of organisational and technological options for mediating periods of subsistence stress. Thus, while we were able to predict the *basic structure* of coping strategies from the basic structure of resource variability, the *specific form* of the response implemented was culturally bound and to a great extent the product of historical developments. Further, as the definition of critical fluctuations in resource availability depended on cultural capabilities for coping with scarcity, the relevant aspects of the structure of resource variability varied in response to developments in the specific sociocultural context. As a result, recurrences of similar configurations of resource variability elicited different responses resulting from changes in social capabilities for mediating stress.

In general, the expectations based on the structure of resource variability in northern Alaska accord well with the documented responses of its prehistoric inhabitants. It is also evident that the response categories of diversification, mobility, storage and exchange were systemically interrelated, such that changes in any one component altered the role of other strategies in mediating episodes of stress. The aggregate result of such compounded alterations was directional or evolutionary change, which transformed the social matrix within which decisions were made and through which further responses were affected. As a result, the thresholds at which natural variability created scarcity changed throughout the late prehistoric period in response to social as well as environmental factors.

For example, the aggregation of population at prime coastal hunting locations during Period IIb appears to have been accompanied by the development of mechanisms through which the social stresses inherent in large groups could be mediated, and thus the social preconditions for large-scale communal hunting strategies were established. The productive potential of whaling accordingly increased, with a concomitant increase in the economic defensibility of those points from which communal whaling could be undertaken reliably. During subsequent climatic periods marked by an overall reduction in the availability of marine mammals, the net gain in productivity and predictability of whaling due to corporate hunting permitted a continued reliance on that resource, although with long-term ramifications for other aspects of the subsistence–settlement systems. Increased investment in whaling within periods of overall risk made reliable locations the focus of strongly defended territories at the same time as greater uncertainty required coastal societies to maintain access to the fall-back resources of a wider hinterland. Thus, the overt defence of territories was coupled with greater use of interior resources and increased investment in formalised alliances to maintain access to resources of neighbouring societies.

The end result of these modifications was the evolution of the bounded and specialised societies complemented by interregional alliance networks, which were observed by Europeans in the late eighteenth and early nineteenth centuries. The perspective combining environmental and cultural factors which we have employed in this analysis cannot and does not attempt to explain all aspects of the many processes involved in this evolutionary trajectory, yet it has shed new light on their salient features and timing, and has highlighted problems which stand in need of further investigation. It is apparent that direct historical analogies from the ethnographic record are insufficient to interpret late prehistoric developments in North Alaska. Adequate explanations for the complex processes which characterise this period must begin from a consideration of the nature of environmental uncertainty and an appreciation for the cultural redefinition of critical resource variability through time.

Notes

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1 Statistical analyses of whale catch and spring weather conditions for the period 1907–1940 (Minc 1986) indicate that weather conditions were highly correlated with whaling success and were more critical determinants of interannual variability in procurement than were changes in effort (Marquette and Bockstoce 1980), technology (Mitchell and Reeves 1980) or whale stock size (Breiwick, Mitchell and Chapman 1981).

2 Age-associated growth trends are generally so slight as to be negligible in central Alaskan trees (Giddings 1941:53); significant age trends in stand growth were removed with a negative linear regression model, and annual values presented as standardised indices of growth (deviations from the mean) (Fritts 1976:261–7). Substantial autocorrelations with ring-widths of the preceding two years were evident in the growth indices, indicating a delayed response to prior climatic conditions. In order to elucidate growth responses to annual climatic variability, lagged growth responses were removed with a second-order autoregression model.

3 Two extended series have been compiled for this region: the Kobuk River chronology (AD 978–1948), based on archaeological driftwood and live spruce from sites along the lower Kobuk River (Giddings 1948:30–1), and Driftwood Series A (AD 1500–1850), de-

veloped from driftwood recovered from coastal sites (Giddings 1941:83–5). Both series cross-date well with the Kobuk–Noatak–Norton Bay region, indicating that much of the wood originated from that region and carries an extended climatic record relevant to the study area (Giddings 1941:63). The composite sequence for this study utilised the following series: AD 978–1499: Kobuk; 1500–1799: Kobuk, Driftwood Series A; 1800–1849: Kobuk, Driftwood Series A', Noatak; and 1850–1940: Noatak. Each chronology was first transformed to standardised growth indices and a composite sequence created by averaging individual series. The resultant composite sequence was then filtered through a 10-year weighted moving average to reduce high frequency variability and clarify major trends.

4 There are several difficulties inherent in using such an archaeological tree-ring series for climatic interpretations, notably (1) small sample size due to limited number of cores, (2) regional as opposed to site-specific origin of wood, possibly confounding the effects of climatic and site characteristics on growth, and (3) age-associated trends which are difficult to remove due to partial sequences. Thus, while the chronology offers both sufficient time depth and detail, it requires further corroboration for the earlier time periods.

5 At Croxton, a multi-component site on the shores of Tukuto Lake in the central Brooks Range, dates for occupation by groups using non-Thule, Ipiutak technology (Gerlach and Hall n.d.) range from AD 280 to nearly AD 1400, suggesting that the absence of Thule occupation from the interior mountains could reflect cultural competition rather than ecological uncertainty. However, two radiocarbon laboratories provide quite different ages for the site. The average of dates from one laboratory is approximately 700 years more recent than the average of dates from the other. A split sample from one hearth at Croxton, dated by both laboratories, replicated this discrepancy. One laboratory's dates place the component between AD 600 and 800, the other's between AD 1000 and 1400. The former set conforms to other estimates for the antiquity of the Ipiutak complex. However, until the discrepancy in laboratory dates can be resolved, the true age of the Croxton component remains uncertain. While a number of Ipiutak-like sites are now known from the interior, few can be dated with any precision and at least some clearly pertain to earlier, 'typical' Ipiutak temporal contexts (i.e. *c.* AD 300–750).

6 One sunken-floored tent (Hall's House Type 1) from Sikoruk has been excavated. This structure, EH-1, has been dated dendrochronologically to AD 1410, an assessment in concordance with the artefacts recovered from the structure (Hall 1976; Gerlach and Hall n.d.). Other structures of this type have been reported from Etivluk and Kinyiksukvik Lakes, also in the passes of the central Brooks Range, but have not been excavated.

7 Approximately 41 percent of the arrowpoints from Ekseavik had ownership marks, while at Kotzebue the proportion of arrowpoints with marks rose from 19 percent in Old Kotzebue (AD 1350–1400) to 23 percent in Van Stone's excavated houses (*c.* 1400–1550) (Giddings 1952:45–7; Van Stone 1955:95–6). Ownership marks were also present at Walakpa and from Mound 44 in Utkiavik, but are not found in the collection from Thetis Island (Hall 1981, Table 2).

8 It is widely held that intensive whaling became the focus of North Alaskan subsistence at the beginning of the first millennium AD. Our position clearly differs from that, and argues that intensification on whaling occurred only after 500 years of small-scale whaling by Thule groups. Whaling as an adjunct to a basically seal–walrus–caribou economy must be distinguished from an economic and social system predicated upon successful whaling. Given the difficulty of estimating the contribution of whaling to diet archaeologically, on account of reuse of whalebones and butchery away from the site, identification of the social contexts and specialised technology necessary for pursuing, killing *and* processing whales must be used as indicators for intensive whaling. Harpoon heads large enough for whaling are known from all the periods considered here, but Pingok Island (Period III) is the earliest published site to provide a complex of specialised tools for killing and processing whales, and we use it as a baseline for the beginning of intensive whaling in North Alaska.