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CHAPTER SIX

The Implications

ABSTRACT

This chapter considers how to relate the environmental changes outlined in chapter five to possible human adaptations in the Mesolithic. The wider implications of these potential adaptations are also addressed. General principles determining the resources available in different woodland environments, as described in chapter three, form the basis for a discussion of how resource availability would have changed. This thus allows possible adaptations to be outlined, which can be assessed in the light of the patterning in the archaeological record, as described in chapter two. The evidence for adaptations to shifts in the distribution of different environmental zones and changes in the character of environments is suggestive, and the adaptations described present a very different picture of Mesolithic societies than traditional interpretations. In the light of these potential adaptations, and other issues raised in previous chapters, the question of gradual population increase is re-assessed. The advantages and possible applicability of the *geographical perspective* adopted here are discussed in the Conclusions.

INTRODUCTION

Chapter five presented a model of probable dominant woodland types in Mesolithic northern England. The model has a number of limitations - it is only a large scale description, and there are a number of uncertainties in the components. However the general changes described by the model are quite resistant to 'credible' changes in the important components of the model.

The next 'step' is to try to relate these environmental changes to possible human adaptations. It was clear from chapter four that this is not easy. Human societies are not so much affected by changes in woodland types as by the changes in resources which accompany them. Not only changes in abundance but also the distribution of different resources and other characteristics, such as reliability, will be important. Even then, adaptations to changing resources can take a number of different routes - if resources become scarce locally, populations may adapt by either increasing the intensity of exploitation (or including more 'costly' resources in the diet) or by shifting exploitation to another region, for example.

CHANGING RESOURCES

One way of addressing how the nature and distribution of resources may have changed through time is to take a general ecological approach. We cannot hope to define the precise quantities of different resources nor the level at which human societies exploited them, but broad environmental changes affect ecosystems at many levels (or trophic levels) from plants to the small and large game which feed on them. What we might be able to do, albeit cautiously, is to consider what changes in the nature and distribution of different types of woodlands may imply for ecological changes affecting the full range of woodland resources, from plants to small and large game animals. This picture may be very general, but since it is well known that ecological changes (such as the succession from shade intolerant to shade tolerant species) have very similar affects on different woodland around the world (Rieley and Page 1990; Röhrig and Ulrich 1991), it is likely to be a relatively reliable one, and potentially of relevance for understanding changes in Mesolithic lifestyles.

POSSIBLE ADAPTATIONS

Changes in resources do not so much 'dictate' specific adaptations as prompt a number of possibilities. One approach to relating changes in resources to possible human adaptations is to consider the most likely ways in which humans may have adapted to the changes defined (rather than defining one obvious 'path'). It would then be possible to address how well any, or all, of these changes may explain the patterns observed in the archaeological record. Of course the archaeological record against which to compare possible adaptations is a poor one, nonetheless there are consistent patterns in this record as illustrated in chapter two. Existing interpretations (as discussed in chapter one) are not necessarily the best or only explanations for patterns observed in the archaeological record. The approach defined, by addressing spatial changes in environments and in human adaptation, may give us much finer tuned insights and may suggest a better explanation for the changes observed than that of 'gradual population increase'.

One limitation will inevitably be that this is purely a 'terrestrial' approach and thus a biased viewpoint. However, we can reasonably assume that whilst coastal resources are likely to have played a role terrestrial resources formed the major component of annual resources for a majority of the groups in northern England for which evidence remains today, and changes in these resources will have had a significant impact on these populations. For one thing, our record is almost exclusively an inland one. Evidence for any populations which may have depended heavily on coastal resources has largely been submerged by rising sea-levels. For another, in any case for most of northern England raw materials used by Mesolithic groups have been derived almost exclusively from inland sources, even though equally as high quality coastal raw materials exist, and where there is evidence for coastal occupation, coastal raw materials are often used only by populations at or near the coast (C. Conneller pers. comm.). This suggests that for much of northern England (the Pennines being a particularly important example) the exploitation system seems likely to have been largely an inland one.

In adopting the approach defined above, there are clearly two definite problems to be addressed - that of modelling changes in resources on the basis of broad ecological changes, and that of defining possible human adaptations to these changes. These two issues are discussed in turn below.

THE IMPLICATIONS OF CHANGING ENVIRONMENTS FOR CHANGES IN AVAILABLE RESOURCES

THE ECOLOGICAL BASIS

In order to evaluate what environmental changes 'mean' to hunter-gatherer populations we need to understand the ecological structure of woodland resources. The discussion in chapter three demonstrated that two main characteristics of woodland types are particularly influential in determining the *abundance* of plant and animal resources. These two characteristics are the *shade* cast by the woodland canopy, and the type of *seeds* produced. The nature of the soil substrate (which is itself affected by the woodland composition) is also influential. Finally, the *diversity* of plant and animal resources in different environments is also important in reducing the risks posed by poor seasons for key resources (as discussed in chapter four).

THE ABUNDANCE OF RESOURCES

The extent of shade

The shade cast by the woodland canopy is the most influential factor affecting the abundance of understorey plant species. In general terms, the more light that reaches the forest floor, the more abundant the undergrowth layer will be. The shade cast by different types of woodland can be compared by using the 'leaf area index'. The amount of shade cast is the highest for shade tolerant species which are 'late' in the vegetation succession. Thus the leaf area index for lime woodland is very high, for oak somewhat less, while birch has a very low leaf area index having an 'open' canopy (Röhrig and Ulrich 1991: 29). Not surprisingly, lime woodlands support only a very limited amount of undergrowth, and as Rodwell (1991) notes, lime woodlands in the British Isles today have an impoverished field layer.

Differences in the shade cast by different tree types clearly also affect the abundance of large and small game animals, which largely depend on the understorey vegetation for food. Many large game animals are specifically adapted to open conditions (such as aurochs and horse) and are largely species of the early Holocene landscape (as discussed in chapter three). However deer (red and roe deer), alongside boar, are particularly associated with woodland environments and are the large game resource which most typifies ideas about Mesolithic subsistence. Nonetheless, although deer thrive in open woodland, Late Mesolithic forests would have become a less suitable habitat for deer as forest density and shade increased (Jochim 1976: 101-102). Keene (1981: 101) states that *'contrary to popular belief, the climax forest is not good deer habitat'*. Clearly the early stages of woodland succession with light canopies and much undergrowth are the most favourable habitat for large game. As noted by Kitchings and Walton (1991: 362):

'The increased availability and variety of food material during the early and mid-successional stages provide for potentially more mammal species and greater numbers of individuals of a particular species'.

Nevertheless, even late in the woodland succession, where lowlands are dominated by closed canopy woodlands, the upland areas (where shade intolerant species are more competitive) remain as productive environments for game animals. Studies of the densities of large mammals in modern environments (where dense forests have spread throughout the lowlands) show that the highest densities are found at higher elevations (Kitchings and Walton 1991). Not only the more open canopies but also the greater range of habitats available due to altitudinal zonation in the uplands are important (Wilson 1974) in contributing to this abundance.

Although there is a clear contrast between upland and lowland environments in terms of available resources, the character of the lowland forest will affect the *seasonal variation* in resources in this zone. The annual leaf fall of deciduous trees leaves the forest floor unshaded for the winter months, whereas coniferous forests (such as pine) in contrast shade the forest floor all year. Deciduous woodlands thus have a short 'vernal' period in early spring (until the end of March/early April) when some undergrowth species flower rapidly before the full development of the forest canopy (Röhrig and Ulrich 1991). Thus a marked seasonality is one of the major characteristics of temperate deciduous ecosystems. For animal species dependent on woodland resources it is, in effect, a double seasonality as resources are available in early Spring and Autumn (where nut producing trees dominate the canopy) but scarce in mid-Summer and Winter. The short 'vernal' period may be important, however Simmons, Dimbleby and Grigson (1981: 100) note that most species which succeed in this short growing season are inedible for either humans or herbivores. This is probably because the most important food plants for humans (such as tubers) often need a long period of sunlight to develop. What edible plants did thrive in these conditions were nonetheless potentially significant.

The effect of soil types

Even given an open forest canopy, the density of undergrowth vegetation may also be affected by the soil conditions under which it grows. These conditions may limit growth in some situations, either because soil is poorly developed (where soil development is slow, such as on igneous rocks, or where the activities of soil organisms are limited by very low temperatures - such as in the extreme uplands) or because soils have been altered by later processes. These later processes can take a variety of forms. The increasing waterlogging, leaching, and acidification of upland soils under the process of peat formation for example, restricts the range and abundance of plant species. Equally, the leaf litter of coniferous woodlands, especially pine, is very acid and restricts understorey plant growth. Consequently, even aside from their year round canopy, pine woodlands support only extremely meagre undergrowth.

Certain soil characteristics (such as pH, soil texture or water availability) can encourage the growth of specific understorey plant communities. It was clear from chapter three that wet soils at the edges of rivers and in open alder 'carr' can support potentially important resources such as tubers. In fact, particular plant species can be specific to particular soil conditions (Mabey, 1996, notes wild parsnips grow in open areas on chalky soils for example). Adding the specific understorey plant species to any model of changing woodland types would be very difficult. The precise types of plant species which would have been present on any soils is difficult to define. For one thing, little is known about when specific plants spread into the British Isles (with many of our present 'native' plants introduced after the Mesolithic). Additionally, given the potential numbers of different edible plant species available (Clark 1976 suggests 250-450 species), the issue of specific plant resources is too complex to be a component of a 'general ecological' model. In any case, the presence of edible plant species would have largely been determined by the availability of open areas. Since all except the poorest soils would have supported a wide range of edible species, *abundance* (depending on the nature of the woodland canopy) would also be the main criteria affecting plant resources for human populations, and clearly the abundance of plant species is also the main factor governing large mammal concentrations.

The types of seeds produced

Certain tree types produce large edible seeds (nuts) which affect the abundance of game animals. In fact, only two of the important tree types in the model - hazel and oak - produce nuts (hazelnuts and acorns). Of course annual nut production (or 'mast') may be used directly by humans (and as discussed in chapter three there is evidence for exploitation of hazelnuts at several sites in northern England), but more importantly, mast is extremely important for large game animals. As illustrated in chapter three, hazelnuts are a more predictable resource than acorns, but both provide a significant source of protein and fat. Boar, in particular, depend on annual acorn production to allow them to survive over the winter, and poor mast years might have had major effects on boar populations.

THE DIVERSITY OF RESOURCES

'Shortfalls' in resources caused by poor years (severe winters or early frosts for example) would have been as problematic for human as for animal populations. Individual resources may vary in how reliable they are (as noted in chapter three, yields of bush fruit are more reliable than those of tree fruit), but in general ecological terms, the more diverse the range of resources present, the less long term risk there is of catastrophic bad years (in effect 'backup resources are more likely to be available). The issue of risk was discussed in chapter four, and the diversity of resources is clearly a consideration when assessing how the character of resources may have changed throughout the Mesolithic.

Myers (1986; 1989: 89) and other authors (Clarke 1976; Mellars 1975; Jacobi 1976; 1978; Smith 1992) suggest that the spread of deciduous woodland (or oak in particular with previous 'birch-pine' woodland seen as coniferous) would have been associated with an increase in the diversity of understorey vegetation. As discussed in chapter four, these interpretations have been based on using modern woodlands as analogs for the different phases of Mesolithic woodland development. Rather than an increase in the diversity of species, the reverse appears to have been more likely. First, the spread of understorey species is much faster than that of slowly maturing tree species, and diverse understorey vegetation thus likely to have characterised the early stages of woodland development. Secondly, the reduction in *abundance* of undergrowth species as woodland density increased would have been likely to have associated with a reduction in diversity. As Margalef (1958: 45) notes, in general ecological terms *'The general pattern of species diversity through succession in temperate deciduous forest is one of an increase in the early stages with a decline in the late successional stages'*.

High levels of species diversity may have been retained in the late stages of woodland succession in certain zones. In modern temperate forests, in line with the increase in abundance of species at higher elevations, there is also usually an increase in the number of species (Simpson 1964; Kitchings and Walton 1991: 362). The relatively high diversity in this zone compared to the lowlands is related to the overall abundance of plant species and to the narrow spacing of different ecozones (of different woodland types). The actual diversity in any upland region would also be affected by factors such as particularly poor soils, or cold exposed conditions, which could reduce the range of plant species.

COMBINING DIFFERENT INFLUENCES ON RESOURCE ABUNDANCE

In principle, from a broad based ecological standpoint, the abundance and diversity of terrestrial resources (from plants to small and large game) would have been greatest in the open canopy woodlands that characterised the early stages of succession. At a later stage of succession comparable types of environments would still have been present in the uplands. Nevertheless it is not just the increasing shade of the lowland forest canopy but how this related to other factors such as the presence of nut producing trees, the distribution of pine woodlands, or the development of peat, which holds the key to understanding how resources changed during the Mesolithic and what type of effect they may have had on human populations. In practice, the relative pace of these changes and the actual distribution and spatial relationships among different environments with different resource characteristics will have been the major influence on Mesolithic resource exploitation strategies.

The model of changing environments described in chapter five provides the basis for a discussion of these changes, but before making any interpretations of the effects of changing environments, it would be helpful to summarise the environmental changes described by the model.

EARLY MESOLITHIC (10,000bp - 9,000bp)
(11186 (10909) 10461BP- 9912 (9612) 9384BP)

UPLANDS:
treeless scrub or open birch

LOWLANDS:
open birch

changes
with the spread of hazel and rise of the tree line (and with sea-level rise)

INITIAL LATE MESOLITHIC (9,000bp - 7,500bp)
(9912 (9612) 9384BP - 8142 (7908) 7651BP)

UPLANDS:
birch, a narrow band of pine
and increasingly mid-upland oak

LOWLANDS:
oak forest, with some local patches of pine,
hazel on calcareous soils

changes
with the spread of increasingly dense oak and the development of an altitudinal zonation in the uplands

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TERMINAL LATE MESOLITHIC (7,500bp - 5,000bp)
(8142 (7908) 7651BP -5598 (5309) 4972BP)

UPLANDS:
stable altitudinal zonation of birch, pine and mid-upland oak, but with localised peat accumulation

LOWLANDS:
lime in the South and East, with oak in the Northwest, ash on calcareous soils

changes
taking place with the spread of lime in the lowlands and of ash on calcareous soils, and the separation of Britain from the continent

Figure 6.1 Sequence of changes in vegetation patterns in Mesolithic northern England.

THE ENVIRONMENTAL CHANGES

The model of probable dominant woodlands constructed in chapter five showed that the Mesolithic was a period when inland environments were continually changing, as different tree types spread from glacial refugia at different rates. The spread of these tree types altered the character of both upland and lowland environments in a way that was both more complex than a transition from ‘coniferous to deciduous’ woodland (as described by interpretations to date) and which also varied spatially, particularly between lowland and upland areas. This sequence of changes (as described in chapter five) can be described by three general phases (summarised below in **figure 6.1**[1], and illustrated in **figures 5.15-5.17**).

[1] - Calibrated dates taken at 1σ (minimum and maximum of calibrated age ranges), with a standard deviation of 250 years on the uncalibrated date, calibrated using CALIB 3.0, Stuiver and Reamer 1993: 215-230.

THE EFFECT OF ENVIRONMENTAL CHANGES ON THE DISTRIBUTION OF RESOURCES

There seems to be two important processes taking place during the Mesolithic, an increasing density of woodland (especially in the lowlands) with the birch-pine-oak-lime succession, and the arrival and replacement of nut producing trees, with oak being replaced by lime in most of the lowlands and hazel by ash on calcareous soils. The relationship between these two processes, combined with other factors such as the spread of pine, or peat accumulation, are the key to understanding changes in the nature and distribution of resources in the Mesolithic.

A general way in which resource availability in the uplands and lowlands would have changed throughout the Mesolithic is postulated in **figure 6.2**.

Essentially, although variable in time and space, the nature of the changes in upland and lowland forests ought to lead to reduced availability of plant and animal resources in lowland forest through the birch-oak-lime succession, whilst the uplands with upland birch and mid-upland oak would have seen much less of a reduction. The development of altitudinal zonation may also have been important in providing a range of different resources for animal populations.

Reference to the maps of the distribution of different woodland types (**figures 5.15-5.17**) adds a further dimension. With the exception of hazel, tree types spread from the south of the region, and the woodland changes are brought about by a gradual northward shift of woodland types (with birch and oak, for example, surviving for the longest in the north). The effect of changes in sea level in reducing the extent of lowland forest is also evident. In fact, the loss of land to the Irish Sea in the west reduces the lowlands by about a half from the Early to the end of the Initial Late Mesolithic, and to the east, the vast land area of the North Sea Plain is submerged during the same period.

Other more specific elements of woodland distribution are also noteworthy, such as regional differences within northern England created by the interaction of tree types with the particular elevation and substrate characteristics. The distribution of pine in the Northeast has been discussed previously (in chapter five). The two zones of upland oak, created by the flat plateau topography of the Pennines and North York Moors, are potentially important given the relative productivity of this zone compared to neighbouring lowlands.

EARLY MESOLITHIC

UPLANDS

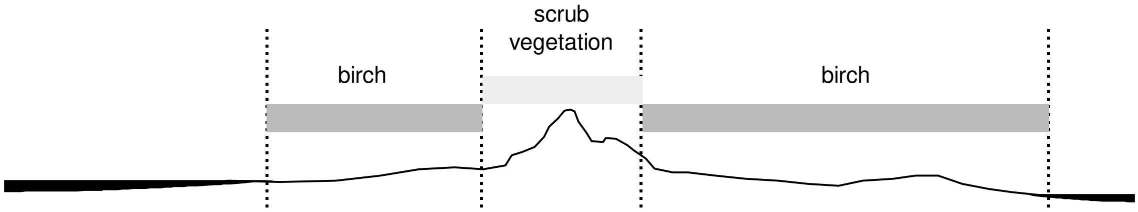
Open birch with hazel, or scrub vegetation leading to open birch

LOWLANDS

Birch with an open canopy and much nut producing hazel

diverse and abundant plant and animal resources

Iversen (1973: 126) refers to these woodlands as the
'*endless nut groves, a garden of Eden where one could reap without having sown*'.



INITIAL LATE MESOLITHIC

UPLANDS

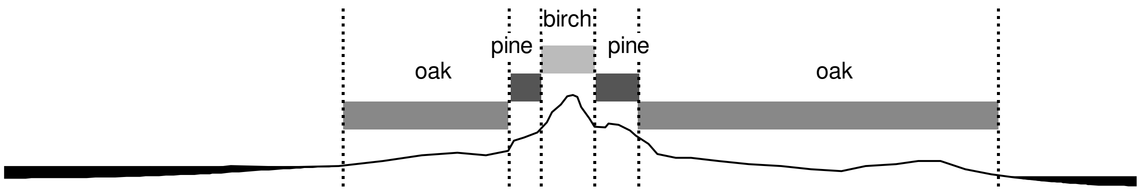
Altitudinal zonation with upland birch and mid-upland oak (less dense at the edge of its range than in the lowlands and with important acorn 'mast') separated by a narrow band of pine

Abundant resources except for
some areas of pine being resource poor

LOWLANDS

Predominantly oak forest, initially open but more closed through time. Pine also in a few areas unsuitable for growth of oak.

Early open oak woods would have supported much plant and animal resources (particularly because of the production of mast). As oak woods became denser the numbers of game animals would have reduced (though dense oak forest is still an important environment for boar because of the availability of mast).



TERMINAL LATE MESOLITHIC

UPLANDS

As the Initial Late Mesolithic but with development of upland peat and replacement of hazel by ash

Abundant resources in the mid-upland oak and birch forests, although increasing waterlogging and the accumulation of peat encroached on these environments in places.

LOWLANDS

The arrival of lime would have brought increasingly dense lowland forests (without annual mast). Ash (without nuts), although a relatively open woodland type also replaced hazel (with hazelnuts)

The lowlands would have become increasingly resource-poor with resources being concentrated at the edges of woodland, at the coast, rivers and in clearings.

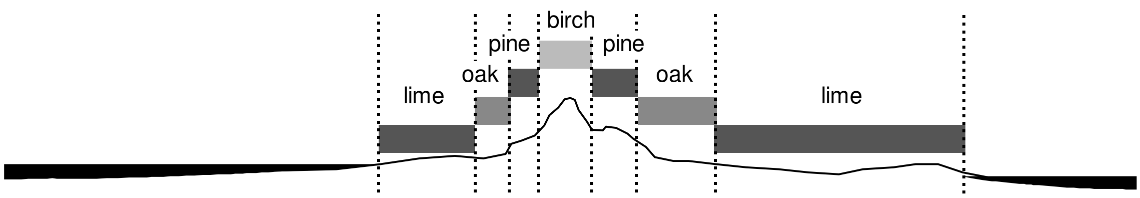


Figure 6.2 Changes in resource availability with vegetational changes in the Mesolithic.

The changes in woodland types described by the model, and the ecological implications of these changes, provide sufficient basis for interpretations of potential human adaptations in the Mesolithic. Before going on to consider these adaptations, however, we need to pause to consider one element which influences resource availability and is not represented in the model. This is the influence of small scale processes on our conclusions about resource changes, a factor which has in the past dogged interpretations of changes in woodland types.

The Character of the Lowland Forest

As noted in chapter five, the environmental model presented is very much a large scale, general picture of changes in forest types and cannot be held to be entirely accurate at the local scale. The ‘population front’ of tree types is likely to have been diffuse and patchy, and moreover the model only describes the ‘most likely’ tree type given the model’s assumptions: that is that which we might expect to be the most frequent. Because the opportunities for establishment and growth of saplings in temperate forests are governed by random processes, single stands of plant species are actually rare (Röhrig and Ulrich 1991). The most important potential effect on the small scale description of forests comes not from the variability in woodland trees but from the fact that even dense woodland stands may have ‘gaps’ (or clearings) in the canopy, which provide the main opportunities for new growth.

The relative abundance of *clearings* is an important point of discussion (Rowley-Conwy 1980; 1987), with most recent authors agreeing that clearings in Mesolithic climax 'wildwood' were probably more frequent than early interpretations based on tree pollen dominated cores suggested (Simmons 1996), particularly if herbivore activity kept areas clear for longer periods (Simmons *et al.* 1982: 42; Simmons 1996: 131). Runkle (1982) showed that clearings form about 9.5% of the total land area of modern American deciduous forests, although in modern European forests with different climate systems large scale clearings caused by major fires or severe storms are much rarer (Röhrig 1991). But, even if clearings made up 9.5% of the Mesolithic forest, clearings need to be quite large (of the order of 1.0 ha.) for grasses to grow successfully (Röhrig 1991). More importantly, in terms of exploitation by hunter-gatherers, clearings are unlikely to be *predictable* in either the extent or the type of vegetation they support (often governed by chance dispersals of certain taxa), or their location, and will rapidly grow over.

This being said, the lowlands in the Late Mesolithic were clearly not a ‘resource desert’ of the type imagined by Clark (1936), and the passage of hunter-gathers exploiting resources in the lowland forests was undoubtedly a common event. The important point, however, is that lowland forests were *relatively* poor in resources in the Late as opposed to the Early Mesolithic. Clearings may have made plants and large game relatively more abundant here than in the surrounding woodland, but only because of the characteristics of this ‘secondary succession’ are similar in many ways to the ‘primary succession’ which characterised Early Mesolithic environments.

Aside from clearings of course, other openings in lowland forests may have been important. The model in chapter five also overlooks a complex network of small rivers, tributaries of the main rivers illustrated, and larger expanses of water at lakes, which would themselves create clearings in the lowland forest. Plant resources at *riversides* might have been abundant, especially as rivers provide a large amount of ecotonal ‘edge’ to the lowland forest, and moreover the clearings at rivers, in contrast to those caused by tree fall, would be stable and predictable. Riverside resources may on the other hand have been difficult to get to, although if water transport was widely used this would make riverside resources easy to harvest and transport. *Lakeside* environments will also undoubtedly have supported varied and abundant resources throughout the Mesolithic. However one point to note is that the gradual in-filling of lowland lakes (such as the Vale of Pickering (Cloutman 1988a; 1988b; Cloutman and Smith 1988), or the Humber estuary (Van de Noort and Ellis 1995) is well attested, and would have reduced the available resources in these environments. Whatever the absolute abundance of resources in Mesolithic lowland forests, these environments clearly presented *more* of a challenge to Mesolithic populations as time progressed. This was a challenge that could be met in a number of different ways, as discussed in detail in a later section.

ADAPTATIONS TO ECOLOGICAL CHANGES

Until now the main emphasis on ecological changes in the Mesolithic has been on determining the effect of changes in the *abundance* of different resources. In contrast, as illustrated in chapter four, there are many other important factors. The *distribution* of different resources (and how different distributions relate to each other) appears to be a major consideration. There are clearly several key changes taking place in the nature and spatial distribution of resources in the Mesolithic (even taking on board the influence of small scale processes discussed above). The environmental model described in chapter five, and ecological interpretations described above, may allow us for the first time to consider the implications of these changes.

Marked changes are evident from the environmental model alone. It is clear, for example, that through time we see a gradual northward shift of environmental zones; there is still a zone of lowland birch to the north in Scotland for example, when oak woodlands dominate lowland northern England. There is also quite clearly an upward shift in environmental zones as birch, pine, and later oak are pushed to higher elevations within northern England. Added to this, the distribution of later woodland types is also clearly more complex, especially with altitudinal zonation in the uplands.

The ecological model described here allows us to consider the effect that these changes may have had on the changing distribution of woodland resources. Shifts in environmental zones imply shifts in zones of resources. As the earlier stages of succession are first replaced by later stages in the south (**figures 5.15-5.17**), northern areas retain the more productive resource zones (birch v. oak, oak v. lime) for longer. The spread of dense lowland forest also causes shifts in the most abundant resource zones towards to the uplands. The structure of later environments adds a further complexity, with altitudinal zonation providing greater diversity and therefore a more stable resource base (with other similar resources available when any resource fails). As a result of resources becoming more concentrated in the uplands, an increasing fragmentation of the most productive resource zones also develops. The two processes - the shift in distribution of the most abundant resource zones, to *the north*, as well as to *the uplands*, and the change in the structure of the environment with an *increasing fragmentation* of upland resources - would have prompted very different adaptations from human populations. These potential adaptations, and the arguments for and against changes on the basis of the archaeological record, are discussed in what follows.

A SHIFT IN THE LOCATION OF THE MOST ABUNDANT RESOURCE ZONES

Figure 6.3 shows the way in which the upland and lowland resource zones change from the Early to the Terminal Late Mesolithic. The shift in the focus of the most abundant resource zones is also clear from the model (**figure 5.15-5.17**). From a rather even distribution of birch (with hazel) in the Early Mesolithic, a contrast gradually develops as lowland forest density increases, between upland resource-rich environments (an altitudinal zonation with birch and upland oak) and lowland resource-poor environments (with dense oak or lime forest). Other factors, such as the distribution of resource-poor upland pine, and mast production in lowland oak woodland in the Initial Late Mesolithic, also influence the distribution of resources, and rising sea levels add a further component to environmental changes, causing large areas of lowland to be inundated. Nevertheless, the process of increasing lowland forest density, reducing resource availability in this zone, is the most important factor restructuring resource availability.

The changing relationship of uplands to lowlands, and subsequent changes in resource availability, would have provided a major challenge for hunter-gatherer populations. Several different types of adaptation are possible. A change in the relative importance of the two zones, with the lowlands playing a less important role in subsistence seems likely. This may have meant that populations spent longer time periods in the uplands, or more particularly, there may have been a wider range of activities carried out in the uplands or shifts in the settlement pattern with base camps more often in upland rather than lowland areas. A further possible adaptation, given the pressure on lowland resources, may have been to intensify the exploitation of resources in the uplands, by including resources with lower return rates into the diet for example, or by using techniques to increase the yields of important resources.

The evidence for or against either type of response may be difficult to assess, since the actual pattern of exploitation of resources is extremely difficult to determine from the available archaeological evidence (as described in chapters two and three). Nevertheless, evidence from sites of both zones, the uplands and the lowlands, does exist and a close consideration of this evidence may help resolve whether the approach explored here finds any support.

The argument against changes in the role and use of the uplands

The main evidence *against* either an increasing relative role for the uplands, or an increase in the intensity of use of the upland areas, in effect, against any *changes* in upland exploitation, comes from interpretations of assemblages from both periods. The upland assemblages of both Early and Late Mesolithic sites (dominated by microliths) are commonly interpreted as transitory upland hunting camps (after Mellars 1976), and a purely hunting based exploitation of the uplands is thus presumed to characterise activities throughout both periods. Additionally, the consistent locations of sites of both periods (apparently in places with a 'good view' for hunting game, Jacobi 1978: 325, as discussed in chapter two) also

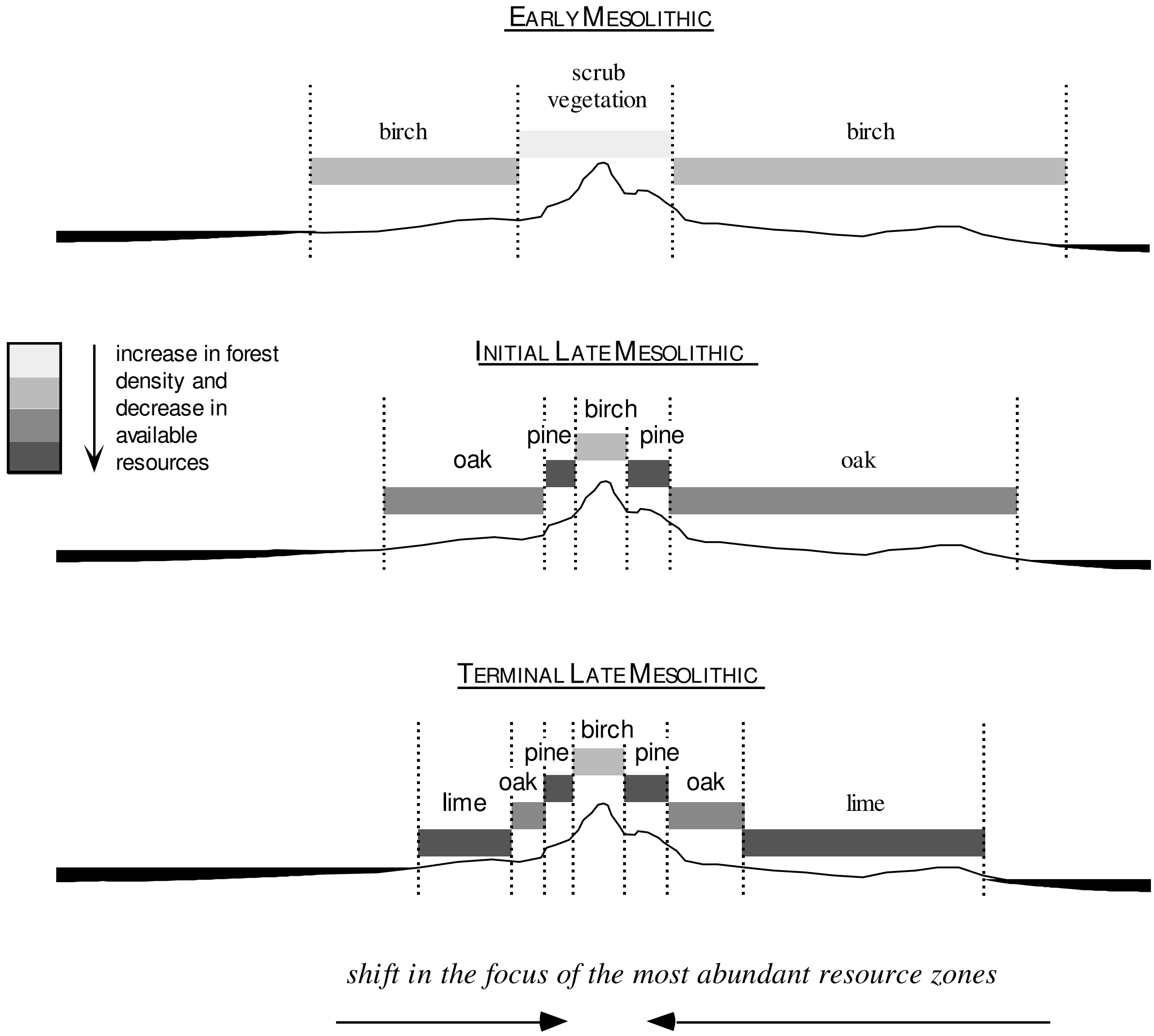


Figure 6.3 Changes in upland and lowland resource zones in the Mesolithic.

contributes to the idea of long term continuity in patterns of upland exploitation. This apparent continuity, particularly in such a restricted range of activities, provided little support for changes in the relative roles of the uplands and the lowlands. However, the problematic nature of the archaeological record means that a closer examination of the biases is warranted.

Various lines of evidence suggest that changes in settlement patterns and in upland adaptations from the Early to the Late Mesolithic may not be detected archaeologically. The material evidence for such changes may be very subtle. If only the length of time spent in the uplands changed through time, with the same activities taking place (from similar, probably lowland, 'base camps'), archaeological sites may not be distinctively different between the two periods. Nonetheless, we might still expect an increase in the number of sites, in the sizes of sites or in the frequency of re-occupation. However, the original extent of sites or frequency of re-occupation are difficult to assess (as discussed in chapter two) and because of this there may not be any recorded changes in these characteristics. Any increase in the numbers of upland sites is also difficult to judge. There *are* more Late than Early Mesolithic sites in the Pennine sample (58 Late compared to 23 Early sites, a clear increase even taking into account the length of the two periods), but this is only a small sample. Sites in all the uplands of northern England cannot be separated into each period without extensive research. Nonetheless, since *most* recorded sites come from the upland zone (as discussed in chapter two), overall increases in site numbers (as discussed in chapter one), what Jacobi terms the '*infilling of the landscape'* (1976), may be largely a record of changes in upland activities. Although difficult to 'pin down', changes simply in the length of exploitation of the uplands could easily have taken place. More marked changes may however be equally difficult to determine.

It is possible that changes were much more fundamental than simply increases in the length of time spent in the uplands. Quite distinct changes in activities may apparently 'slip through the net' of archaeological interpretations. The *locations of upland sites* (discussed in chapter two) and the *character of settlement patterns* (discussed in chapter four) in the Early and Late Mesolithic appear to be remarkably similar, but the evidence for this continuity has been seen to be questionable.

In terms of the *common locations of sites*, as demonstrated in chapter two, the common 'site preferences' were as much a result of modern biasing factors affecting the discovery of sites as any real patterning in the Mesolithic use of the landscape. The distribution of sites could thus change markedly between the two periods without these changes being recorded in the presently documented archaeological record. 'Base camps' (or longer term occupation sites) could even have been present *in the uplands* in the Late Mesolithic, but not situated within the 'window of visibility' determined by peat erosion.

In terms of *activities*, the often simplistic means of interpreting upland sites may be obscuring differences in exploitation patterns between the Early and Late Mesolithic. Most upland sites, with a high proportion of microliths compared to scrapers, are interpreted as 'hunting sites'. Several lines of evidence have been drawn together here to suggest that this may be a biased and misleading way in which to view Mesolithic activities. The idea of a dominance of hunting appears to have been biased by early interpretations of subsistence practices (discussed in chapter three). The distributions of upland and lowland sites have been biased by different effects on the recovery of sites in the two zones, (discussed in chapter two), as have the different sizes of upland and lowland sites. The ethnographic support for two distinct seasons of upland and lowland exploitation has also been found to be misplaced (chapter four). In simple terms, the use of the uplands may have been more diverse (and more long term) than the 'hunting site' interpretation suggests. For one thing, microliths are not necessarily a reflection of hunting activities, as microliths are known to have been used for other purposes than just hunting (as discussed in chapter four). Equally, differences in activities at different sites may be better described by other tool types, or by ways in which artefacts are produced and discarded. Myers (1986; 1987) illustrates that there are a number of different types of upland sites, defined by the proportions of other tools as well as by microliths and scrapers.

Not only the assignment of microlith dominated sites as 'hunting sites' but also comparisons between the Early and Late Mesolithic may be misleading. A similar proportion of microliths in Early and Late Mesolithic assemblages is not necessarily an indication of similar activities as it appears that the use of different tool types changed between the Early and Late Mesolithic. As discussed in chapter four, the greater usage of microliths in the Late Mesolithic (with many more in each projectile point than in the Early Mesolithic) is well documented (Myers 1986; 1987), as is the lower incidence of scrapers in *any* assemblage. In fact, whilst Early Mesolithic 'base camps', with high frequencies of 'domestic artefacts' such as scrapers and burins (and even evidence for shelters, Spikins 1995d) are known, comparable sites have yet to be found for the Late Mesolithic. These sites may not yet have been recovered or alternatively they may not exist. In effect, *all* Late Mesolithic sites may be dominated by microliths, and Finlayson and Edwards (1997) note that this is indeed the case for assemblages analysed from both upland and lowland contexts in Scotland. However, all Late Mesolithic sites are clearly not 'hunting sites', and, as noted in chapter four a primary concentration on the proportion of microliths in assemblages may be obscuring important differences between Early and Late Mesolithic upland sites.

The arguments for changes in the role of the uplands and for upland exploitation patterns at least warrant further consideration.

The argument for changes in the role of the uplands

Given that changes in the period of exploitation of the uplands, or of the activities taking place in this zone, may not be identified archaeologically, it is possible that the role of the uplands may have changed markedly with the suggested changes in the distribution of different resource zones. The distribution of sites, and archaeological and environmental evidence for upland activities may provide further clues.

After the arrival of dense woodland in the Late Mesolithic, there appears to be a paucity of lowland sites compared to those in the uplands. The changing distribution of sites can be considered at two scales. Evidence for the relative proportions of sites in each period is available at the regional scale from the Pennine dataset (with typologically dated sites) and at the national scale from radio-carbon dated sites. The sites in the Pennines have largely been recovered from the upland zone, nonetheless there are some sites in the lowlands. It is noticeable that although three Early Mesolithic sites come from this zone there are no Late Mesolithic sites (**figure 6.4**). We would expect to find several Mesolithic sites within the lowlands, especially as Late Mesolithic sites are much more common generally (with 58 Late rather than 23 Early sites in the Pennines). Evidence for the large-scale distribution of sites in each period comes from radio-carbon dated sites. However, these sites are limited in number and many of the sites have multiple dates making it difficult to judge how to 'weight' different dates (as they may represent the same phase of activity). **Figures 6.5** and **6.6** show the distributions of Early Mesolithic and Late Mesolithic sites (data from Smith 1990, with additions from March Hill, Spikins 1994; 1995b, 1996a) and the 200m OD contour. Some separate sites are too close to each other to be easily distinguished and the numbers of these are marked. However, the only Late Mesolithic sites which are clearly inland lowland occupation are found on calcareous soils, that is, they would have been situated within more open ash/hazel woodland rather than the dense oak or lime forest[2].

[2] Of 11 *separate* sites dated to the Early Mesolithic, 6 are in the lowlands and 5 in the uplands, whereas of the 11 separate sites dated to the Late Mesolithic only 2 are in the lowlands (and these are in the main open lowland 'ash or hazel' zone) while 5 are in the uplands, although strictly speaking 4 coastal sites in the Lake District are also 'lowland' occupation.

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Autor:
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Figure 6.4 Early and Late Mesolithic sites in the Central Pennines, with vegetation model for the Initial Late Mesolithic.

Obviously a more detailed analysis of assemblage types (or more dated sites), and detailed surveys, would be needed to *confirm* the paucity of Late Mesolithic sites within the dense lowland forests, especially considering that sites appear to be more visible on theses calcareous soils. Nonetheless, the distribution of dated Early and Late Mesolithic sites at least suggests that a change in the relative importance of the uplands through time warrants consideration. Although also limited by a small sample, a very similar pattern exists in southwest Germany, where Jochim notes a shift in settlement towards higher areas of the Danube valley and lakeshores to the southeast (Jochim 1990).

It is possible that the use of upland 'base camps' (or longer term occupation sites) may have followed the suggested shift in the use of the uplands. As noted previously, these types of sites may be below the narrow window of visibility provided by upland peat. Alternatively, many of the Late Mesolithic sites recorded in the archaeological record may *be* 'base camps' (although perhaps only occupied for a limited period, a few days for example). This latter interpretation at first seems nonsensical, as upland Late Mesolithic sites are consistently dominated by microliths. However, as discussed above, both the character of settlement and the nature of tool use in both uplands and lowlands may have changed significantly between the two periods. The paucity of scrapers at Late Mesolithic upland sites need not necessarily indicate a lack of 'domestic' activities (such as hide working for example). Late Mesolithic technologies are much more constrained than are Early Mesolithic technologies by the size of the raw material nodules used and this affects the artefacts produced. Small microliths characteristic of the Late Mesolithic are easily produced using small nodules, but larger tool types are much more difficult, and 'costly' in terms of available material, to produce. Analysis of assemblages from recent excavations at March Hill (Spikins 1994; 1995b; 1996a; 1999; in prep) have revealed that other artefact types, such as cores, are often used as scrapers, (Conneller 1996) and that, as well as microliths, other artefact types, such as retouched blades, are commonly produced and used on upland sites, although when analysed they are not classified as 'tools'. Furthermore, as well as a diverse set of lithic artefacts, high densities of artefacts and of features (a hearth every $5m^2$ excavated) which in other contexts would be interpreted as evidence of longer term or more varied occupation have been recovered (Spikins 1994; 1995b; 1996a). Whether upland Late Mesolithic sites were what we might call 'base camps' or 'residential camps' or not, there is clearly more to upland occupation than simply hunting activities.

One way to assess this possibility of a more diverse range of activities on upland sites than present interpretations suggest may be to re-analyse many of the lithic assemblages from both zones using a different emphasis than that of 'traditional' tool types. The use of microwear or residue analysis for example may be appropriate. However, one further source of evidence already suggests that the way the

Figure 6.5 Distribution of Early Mesolithic radio-carbon dated sites in northern England (showing 10,000bp coastline and 200m OD contour).

Figure 6.6 Distribution of Late Mesolithic radio-carbon dated sites in northern England (showing calcareous soils and 200m OD contour).

uplands were exploited, and not just the emphasis on this zone, *was* changing throughout the Mesolithic.

The intensity of upland exploitation

There is abundant evidence for human induced clearances in the Mesolithic (recently detailed by Simmons 1996). The evidence for the presence of human induced clearances of vegetation in the uplands (through the use of fire or branch lopping) suggests a link between these activities and the spread of dense lowland forest. Clearances effectively increase both the plant and animal *productivity* and *concentration* of woodland areas by returning forest floor vegetation to the early stages of succession. Cleared areas are notably most long lived in the uplands where tree growth to fill canopy gaps is slower. Thus it may be significant that most of the evidence for clearances comes from the upland zone (although the pollen record is also biased towards this zone). Whilst evidence for clearances has been found from the Early Mesolithic, the vast majority of the evidence for clearances actually dates to the Late Mesolithic period, with a particularly high number of clearances recorded at the end of this period (Simmons 1996; Zvelebil 1994). An increase in upland clearance equates with an increase in intensity of exploitation of the uplands, since clearances would evidently increase upland productivity. Clearances may thus have been one of a possible range of more intensive patterns of exploitation prompted by changes in local resource availability.

As well as prompting short term increases in abundance and predictability, clearances may have affected the *long term* availability of resources. Although the exact timing and nature of peat formation would depend on local conditions (Simmons 1996), the removal of vegetation and a change in the run off patterns would have acted to encourage increased waterlogging and peat formation. Peat areas support only a limited range of plant resources and peat formation may have placed a constraint on upland exploitation. Peat formation was particularly widespread and early in date in some regions such as the Central and Southern Pennines where the densest concentration of Mesolithic sites have been found (Tallis 1991). In fact, there are hints in the archaeological record of the long term effects of peat formation on upland exploitation. In comparison to other sites within the 'window' of recovery, mentioned in chapter two, sites dated to the very end of the Late Mesolithic do appear to be situated on plateau promontories (Jacobi 1976, Spikins 1995b) away from early forming peat areas. The recently excavated 'rod microlith dominated' site at March Hill in the Central Pennines (Spikins 1995b; 1996a; 1999) being a particularly good example. The development of peat may have added a subtle 'twist' to the shifts in environmental zones and an added pressure on upland environments. Quite how activities changed in response to this ecological change is difficult to define.

Although the archaeological evidence for the *exact* nature of upland activities is limited (with only lithic artefacts and some burnt features surviving in acid upland peat), there are some indications of *changes* in these activities, particularly associated with the intensity of upland exploitation, these changes appear to correspond to changes in the character of lowland forest. Another change which is apparent from the model, the northward spread of vegetation, may have had other effects on populations, discussed below.

THE NORTHWARD MOVEMENT OF ENVIRONMENTAL ZONES

Marked changes in resource availability would occur with the replacement of birch by oak between the Early and Initial Late Mesolithic and the more gradual replacement of oak by lime in the Terminal Late Mesolithic. An obvious interpretation of the ecological effects of the gradual spread of different woodland types is that populations might adapt by shifting their exploitation areas in line with gradual alterations in environments (and given the rates of tree spread, these shifts would indeed be gradual). The potential for population movements in line with changes in environments *after* initial colonisation has received little attention, however there are a number of complex problems with considering such an adaptation.

Before even considering the evidence, a number of challenges to assessing the possible movement of populations are evident. The first is an historical one, since after the excesses of the 'culture history' phase of archaeological interpretation (when interpretations of mass migrations were the norm), migrations have been an unpopular explanation for observed changes in material culture (although migration as an explanation is starting to be re-assessed, Clark 1994). The second is one of interpretation - that even with the best archaeological evidence, population movements are genuinely difficult to identify archaeologically. Movements of population, especially if gradual, are not necessarily accompanied by changes in the archaeological record, especially since neighbouring groups may have very similar material culture. Moreover, changes in material culture may equally be caused by the diffusion of ideas or the adoption of common adaptations. Since our archaeological record is both biased and patchy, as demonstrated in chapter two, these are very real problems.

The argument against population movements

The argument against population movements in line with changing environmental zones, that is one that supports a long term continuity of population, has been based on the long term continuity of site locations and adaptations in the uplands. The similarities in site locations have even recently formed part of an argument for even longer term continuity into the Neolithic in South Wales, put forward by Tilley (1994). As noted above, however, the question of continuity requires re-evaluation, and it was demonstrated in chapter two that the argument for the continuity of site locations, and of upland adaptations, as discussed above, in fact has little basis.

A more difficult argument to counter is that interpretations of population movements are too ‘environmentally deterministic’. To suggest that populations moved when environments changed has been taken to imply that environments forced movement, whilst in contrast hunter-gatherers are known to be able to sustain marked environmental changes through changes in exploitation techniques or, in the short term, by relying on systems of social obligation. Nonetheless though populations may have been able to adapt to environmental changes without changing resource-use areas, this does not necessarily mean that they would choose to do so as a general rule. In fact the very mobility and constant adaptation of subsistence strategies of known hunter-gatherers would suggest that moving exploitation patterns may in many cases have been an easier option than the most ‘costly’ one of intensifying exploitation patterns.

The archaeological and ethnographic record suggests that, rather than being rare, movements of population in line with changes in resources may have been commonplace. In fact in the archaeological record there is clear evidence for quite rapid movements of populations in line with changing environmental zones into *unoccupied regions* right across Mesolithic Western Europe. These types of population movements seem clearly allied to changes in environments and/or resources in areas such as Southern Scandinavia (Bratlund 1996), Southwest Norway (Bang-Andersen 1989; 1996) and Denmark (Holm 1996). It is difficult to assess the relationship of these movements to those within *occupied* areas, although the latter are potentially governed by very similar processes of ‘push’ and ‘pull’ factors in terms of available resource opportunities and constituents. The presence of existing populations may have had an effect. Nonetheless, although the ethnographic record is largely limited to short term adaptations, and migrations spurred by colonial contact, what evidence is available for more ‘typical’ movements suggests that opportunistic relocations of populations were quite common (Briggs 1970; Burch 1980; Binford 1983; Rowley 1985).

Another factor to take into account is that, rather than being rapid ‘forced’ movements (such as twentieth century migrations of populations from war zones) movements of Mesolithic populations could have been quite slow adaptations and, like movements recorded for other animal species, need not have been either a rapid or a ‘planned’ process. A gradual shift in the edges of exploitation areas (perhaps as northerly areas became less intensively used by northerly groups) would, over time, see a shift in populations. Shifts in the spread of woodland types would indeed be ‘slow’, and adaptations to these changes clearly need not have been ‘planned’. In that ‘migrations’ of tree species, without a planned purpose, are better described as ‘spread’ (Bennett 1985), the movements of populations might also be better thought of as a ‘spread’, brought about as people preferred to preserve their accustomed way of life than to adapt to new, possibly more constrained, conditions.

Slow movements in line with movements in environmental zones do present a problem however - that is that these movements may be very difficult to identify. The differences between the archaeological records left by changes in population and those by the spread of the ideas may be very subtle, even if definable. An additional problem is that, since ways of identifying movements of populations into already occupied areas have received little attention, there is little clear body of theory to address these issues (Rouse (1986) being one example). It is unlikely that any evidence, however detailed, would allow us to determine with any degree of certainty that population movements did take place, or how wide a region was affected. Nonetheless, population movements at the time of the Early to Late Mesolithic transition in northern England are at least a real possibility.

This evidence for the nature of changes at the Early to Late Mesolithic transition itself are discussed below.

The argument for population movement at the early to late Mesolithic transition

Although there is little evidence for any marked changes associated with the appearance of lime, marked changes in lithic industries do occur at the Early to Late Mesolithic transition. From a large scale perspective the timing of arrival of 'Late Mesolithic' industries is the most immediate line of evidence. It was noted in chapter five that the spread of oak is associated with the appearance of Late Mesolithic industries in northern England. More than this however, Late Mesolithic technology appears to have spread from the south (the origins for the Late Mesolithic in England may even be found in the south with the so called Horsham culture, Jacobi 1976), and to the north the earliest Late Mesolithic sites also coincide with the spread of oak woodland into Scotland (as shown in **figure 2.11**). As noted above, the spread of different technologies with environmental changes may be explained by other mechanisms, such as common adaptations to similar environments or through the spread of ideas rather than people. The nature of the transition itself may provide further insights.

The Early to Late Mesolithic transition in northern England has consistently been noted as a remarkably marked change (Buckley 1924; Jacobi 1976; Myers 1986; 1987; Woodman 1989), with distinct and rapid changes in raw material use, tool types and reduction strategies occurring simultaneously. Interestingly however, the transition in the south of England is much less marked (Jacobi 1976), with Horsham industries potential transitional types. This marked contrast doesn’t appear to be a result of only a limited sample of sites at each side of the transition, as the contrast is particularly marked where the densest records of Mesolithic sites are found (such as in the Pennines). In one area (Marsden moor, discussed in chapter two), where well over 100 assemblages have been recovered from only 3km^2, the Early and Late assemblages here are not only completely different, but even stratigraphically quite distinct (Buckley unpublished; 1925; Spikins 1995b; Spikins, Ayestaran and Conneller 1995). If ideas were being spread, we might expect changes to be gradual, and intermediate industries to be found. However, even where excavated sites include assemblages from both periods (because sites have been re-occupied at a later date), ‘Early’ raw materials are only used to make ‘Early’ tools and vice versa (the rare exceptions appearing to be cases of cores exhausted in the Early Mesolithic being re-used in the Late to make the much smaller microliths that characterised this period, Myers 1986 and pers. comm.). Of course there are no guarantees that groups didn’t adopt new techniques and raw material sources very rapidly, or that transitional industries do not remain to be discovered. However movements of population, in line with shifts in environmental zones, might account for the presence of Early Mesolithic industries in Scotland (Myers 1986; Woodman 1989; Finlayson and Edwards 1997), especially at Morton and Lussa Wood (Bonsall 1988) which appear to be later than the same types of industries in northern England

Movements of populations are always a difficult subject archaeologically. Suggestions that populations moved in line with changing environments are always prone to criticisms of being environmentally deterministic, and it will perhaps never be possible to be certain that in any situation population movements are the main explanation for change. Nonetheless, it is clear that movements of population did take place, and it is also likely that many of these were into already occupied areas. It is possible that research into the genetics of modern populations may in the future hold some clues to past population changes (Cavalli-Sforza, Menozzi and Piazza 1994). In the interim, the archaeological record is the main source of evidence. Whatever the mechanism, whether movements of population or a rapid spread of ideas, a northward shift of *adaptations* (of which a change in the role of the uplands is potentially an important component) appears to be a clear response to changes in environmental zones.

The last effect to consider, rather than a shift in the location of major resource zones, is changes in the structure of Mesolithic environments. These changes would also pose challenges to Mesolithic populations, which might entail equally as dramatic adaptations.

THE FRAGMENTATION OF RESOURCE-RICH ENVIRONMENTS

As resource-rich woodland environments were pushed northwards and upwards, we also see an increase in the complexity of the environment, with altitudinal zonation presenting an increasingly varied upland environmental mosaic, and a fragmentation of the resource rich zones. Whilst not more *productive* overall, the *mosaic* nature of Late Mesolithic upland environments may have reduced the risk of catastrophic 'poor years', as if key resources 'failed' closely spaced ecozones would increase the likelihood that other backup resources were locally available. These changes would not necessarily allow population densities to be any higher in this zone, but may rather have changed the nature of adaptations. Populations may have no longer needed to keep up such long distance connections with distant groups, or mutual networks of exchange or obligations, to provide guarantees of resources in very poor years (a social means of risk buffering, as described by Wiessner 1982; Gamble 1982; Cashden 1985; Whitelaw 1990, which appears to be characteristic of adaptations by groups colonising new areas). Environmental changes also appear to have led to an increasingly fragmented distribution of major resource zones, with broad areas of upland forest in the Pennines and North York Moors, for example, separated by dense lowland forest. Dense lowland forests would not only have been a difficult environment in which to find resources, but also potentially difficult to travel through. Communication between different groups may have become more difficult, or rather more costly. Though for different reasons, adaptations to both changes would be likely to lead to an *increasing isolation and regionalisation of local groups*, with a reduced intensity of contact between groups encouraging the development of different styles of material culture.

The argument against regionalisation of lithic industries as a response to environmental fragmentation

One problem with identifying these adaptations is that, whilst recorded, increasing regionalisation (like marked changes in material culture) can have other explanations than the adaptations to the ecological changes outlined above. In fact, increasing regionalisation of lithic industries is a common feature of changes in the Mesolithic more generally. Throughout Europe the appearance of regional industries, like those of the north European Plain (Price 1980: 220), North-western Europe (Gendel 1984; Verhardt 1990), Denmark (Vang Petersen 1984), and the rest of the British Isles, (Jacobi 1979), has been interpreted as reflecting reducing territory sizes in line with increasing populations. The factors affecting the distribution of different 'style zones' are, however, clearly more complex than just population density. Some authors relate regionalisation to environmental changes. Madden (1983: 193), suggests that increasingly distinct *'social network systems'* in Norway may occur *'under conditions of resource stress'* and Yesner links an increasing localisation of lithic styles in the woodlands of Eastern North America to the increasing regional variability in early Holocene environments (1996: 251). Neither explanation, however, provides a possible mechanism for such changes. For reduced communication between groups, associated with lowland forest density and upland environmental mosaics, to provide that explanation requires a link between specific environmental changes and regional industries.

The argument for regionalisation of lithic industries as a response to environmental fragmentation

There is some evidence that environmental changes and a reduced intensity of communication, rather than an increase in population density, fostered the development of regional industries in Britain. For one thing, the separation of certain lithic styles are already acknowledged to relate primarily to isolation. The separation of British lithic industries from those on the continent and the development of distinctive industries (with 'Bann' flakes) in Ireland, are two particular developments which appear to have been prompted by isolation. The break-up of other style zones could, like the separation of Britain from the continent, have been created by a similar process of isolation *through the development of dense lowland woodland*, though this mechanism is obviously less absolute than a sea barrier. In fact, it is possibly significant that the separation of British industries from those on the continent (at about 8,700bp) correlates better with the increasing density of oak over the exposed land area of the North Sea Plain between 9,000 and 8,500bp (Birks 1989), than the flooding of the landbridge, which occurred between 8,000 and 7,000bp (Lambeck 1995). The spread of dense forests may be a more permeable barrier than rising sea-levels but could have been comparably effective. Furthermore, the main 'routes' through the lowland forest across the North Sea Plain, via the main river system, would have run North-South to the North Sea delta, *against* the path of connections to the rest of Europe.

Aside from the timing of development of distinct lithic 'styles' in northern England, their distribution also appears to mirror ecological changes. Early Mesolithic industries, like the birch woodland zone, were remarkably uniform across northern and southern England, but by the Late Mesolithic northern England itself develops its own style -'Northern backed bladelet technology' (Jacobi 1976; 1979), apparently separated from those in the south by the lowland Midlands (see chapter two). Particular regional grouping within these industries appear to relate to upland resource rich zones. 'Rod' microlith dominated industries, for example, are found in only two areas - the Pennines and North York Moors (Switsur and Jacobi 1975; 1979). These areas are the two largest zones of upland oak in the model (because of the low plateau topography of the two regions, see **figures 5.15-5.17**), other areas to the North and South Pennines having much higher proportions of pine. Perhaps significantly, these two characteristic style zones, which appear to have developed very late in the Late Mesolithic (Spikins *et al*., in prep), are only found above 300m OD, with no similar industries recorded from the lowland 'lime' zone (although it is possible that lowland rod sites remain to be discovered). Furthermore, the raw material sources used by these industries are also predominantly local, whilst raw materials in the Pennines in the Early Mesolithic come almost exclusively from different sources, much farther away in the Lincolnshire Wolds. Further possible confirmation that these two areas may have been particularly significant also comes from the fact that these two particularly abundant resource zones are also the areas with the highest density of recorded Mesolithic sites (as discussed in chapter two), and the main areas from which pollen cores showing clearance patterns have been recovered.

The argument for regionalisation of lithic styles as a response to changes in the structure of environments is a strong one, but the changes in the structure of environments described, and the other ecological changes discussed above, cannot explain all the changes taking place in the Mesolithic. Other patterns of 'styles' of material culture may not be explained by ecological changes. In particular the limited distribution of 'pear' microliths in one valley in the Pennines - Marsden moor, and in a restricted area of the Lincolnshire Wolds (Jacobi 1976) relate to a finer resolution than environmental zones modelled here. Other ecological changes than those discussed would also be taking place, and moreover some changes may be prompted by purely social, rather than ecological, factors. There is obviously much potential for taking the model further to consider other ways in which environments were changing (changes in seasonality, or the potential responses in animal behaviour to changes in the structure of environments), but these changes will have to be left to a later date.

WIDER IMPLICATIONS

There appear to be a number of changes taking place throughout the Mesolithic in northern England, the evidence for which has been 'hidden' by various preconceptions and means of interpretations.

- The evidence for changes in the role of the uplands (whether this implies simply more intensive use, or changes in the structure of settlement) is very suggestive.
- There is good reason to consider the possibility of population spread with environments, not just into new areas, with the initial phases of colonisation, but throughout the Mesolithic.
- A strong argument can also be made for a regionalisation of lithic styles as a response to changes in the structure of environments (irrespective of any changes in territories or population densities)

There are also a number of wider implications. Perhaps the most obvious is that the picture which emerges of Mesolithic societies is a very different one from the traditional perspective. Rather than the traditional interpretations of long term stability and gradual change, a consideration of responses to ecological changes accounts for observed patterns in the archaeological record by positive dynamic adaptations to continually changing environments. The insights gained from this ecological approach may also be relevant to questions such as the colonisation of neighbouring regions, the changes taking place at the Mesolithic-Neolithic transition, and, of course, the question of gradual population increase.

THE COLONISATION OF NORTHERN REGIONS

Spratt (1993) suggests that in the Early Mesolithic the North York Moors would have been a frontier zone between occupied areas and unoccupied zones to the north, with northern England only fully occupied in the Late Mesolithic. The ecological model described here gives no support to this notion, with resources in the Early Mesolithic woodland abundant throughout northern England. To be fair, the idea of a climatic limit of settlement at this latitude dates to when the accepted notion of climatic changes included a very slow post-glacial warming, implying very cold Early Mesolithic climates, which (as discussed in chapter five) both coleopteran and ice core data show to be unlikely. It seems reasonable to suggest that any 'lack' of sites further north can only be the result of the reduced collection in this less populated area, alongside only very limited upland erosion (the uplands to the far north have suffered much less from pollutants and overgrazing, as described in chapter two). In any case, Early Mesolithic artefacts have been found further to the north, in Northumberland (Young and O'Sullivan 1993), and though the relationship to other finds is contentious, in Scottish sites (Myers 1986; Woodman 1989; Finlayson and Edwards 1997; Wickham-Jones 1994) such as Morton and Lussa Wood (Bonsall 1988).

Can the ecological model shed any light on the question of this colonisation even 'further north'? Whilst other routes for the colonisation of Scotland have been considered, (Wickham-Jones 1994), that from northern England (or the North Sea continent) appears the most likely, certainly for the earliest sites which lie in southern Scotland.

The earliest secure dates (at around 8,500bp at Kinloch and Fife Ness, see Wickham-Jones and Dalland 1998) appear to relate closely to the spread of oak and pine forest (see **figures 5.10-5.11**). It may be that these dates reflect the earliest colonisation. However it is difficult to understand why oak or pine wood should have been so essential for *survival* in Scotland, resources would have been available in the post-glacial scrub and later birch woodlands, and successful settlement was clearly possible in northern England well before the arrival of pine or oak. Moreover, the settlement of similar latitudes with similar environments in Scandinavia is several millennia earlier (Bang-Andersen 1989; 1996; Larsson 1996; Thommessen 1996; Bratlund 1996; Holm 1996), in many cases soon after the retreat of glaciers. A consideration of the spatial biases in the locations of sites, and the spatial processes influencing changes in resources may provide some insights.

In terms of the spatial biases in the locations of sites, the *visibility* of sites in southern Scotland is very different from those in northern England. The dominant agriculture in the highlands is pastoral farming (leaving sub-surface sites undisturbed by ploughing), these regions suffer much less from upland peat erosion than the Pennines and North York Moors (so that sites are less likely to be exposed) and moreover are thinly occupied in comparison (so that exposed scatters are less likely to be recorded). It seems likely that many sites, including potential early sites, have been 'hidden' by much more intact soil cover over much of the highlands compared to the Pennines (as noted by Woodman 1989). It thus should not be surprising that most sites, and the earliest known sites, lie on the most obvious erosion zone of the coast (which, unlike that in northern England, has in many areas not been submerged since the Mesolithic).

In almost all regions coastal resources tend to be abundant and stable (see chapter four) and coastal sites may represent the first occupation in Scotland. However, it is also possible that the spread of pine or oak woodland may be influencing the visibility of Mesolithic settlement in some way. Possibly oak or pine woodland facilitated specialised marine exploitation (perhaps important for the construction of canoes, paddles or fishtraps etc.) rather than an *ad hoc* exploitation which would leave little evidence. A similar explanation has been put forward for marine adaptations in Tierra del Fuego and the arrival of Nothofagus woodland (Orquera *et al.* 1984, Orquera and Piana 1987). Alternatively, the spread of population with the movement of environmental zones (as discussed above) may equally have prompted a more intensive exploitation of coastal resources. Either scenario could explain the development of complex coastal sites with the stratigraphic contexts necessary for secure dates. Whatever the explanation for the apparent association between the spread of distinctive environments and the visibility of Mesolithic settlement, the spatial-ecological perspective developed here for northern England may be a potentially useful avenue of research.

THE MESOLITHIC-NEOLITHIC TRANSITION

The nature of changes taking place from what are here termed the 'Early Mesolithic', 'Initial Late Mesolithic' and 'Terminal Late Mesolithic' may also be relevant to discussions of the Mesolithic-Neolithic transition. Specifically, the ecological model described above suggests that by the Terminal Late Mesolithic, dense woodlands with a significant lime component would be covering much of lowland northern England contrasting with more open, diverse oak (much affected by clearances) in the uplands. The uplands would thus have been an important resource-area for hunting and gathering activities, but in contrast, the lowlands, with more fertile soils and warmer temperatures would have been the most suited to agricultural activity.

Various lines of evidence suggest that the nature of upland and lowland environments affected the adoption of agriculture, and the relationship between hunting and farming. Young (1989) for example, demonstrates (on the basis of the dates of the elm decline, intensive clearances and the appearance of cereal grains) that in the North East, agricultural activity appears first in the lowlands later spreading to the uplands. He suggests that upland mixed lithic scatters in this region may result from the interaction of hunter-gatherer and farmer communities and from adoption of certain aspects of 'Neolithic' technology by 'Mesolithic' populations. Evidence for a similar process also comes from northern England, where very late dates from a 'rod microlith dominated' site at March Hill (with a typical Mesolithic assemblage) put this site later than evidence for lowland Neolithic occupation (Spikins *et al.* in prep). In this case, this and other (typically very 'late') rod microlithic dominated sites may suggest a distinctive 'very late Mesolithic' occupation (and interestingly display a reduced range of raw materials than other Mesolithic sites). Whether 'Mesolithic' or 'Neolithic' represent genetically distinct populations or contrasting (though potentially overlapping) adaptations remains to be resolved. However, it is clear that the environmental/landscape context of this transition is an important theme to consider.

Lastly, but by no means, least, the insights gained from considering spatial changes in environments can be turned onto the question outlined at the start of this volume – that of gradual population increase.

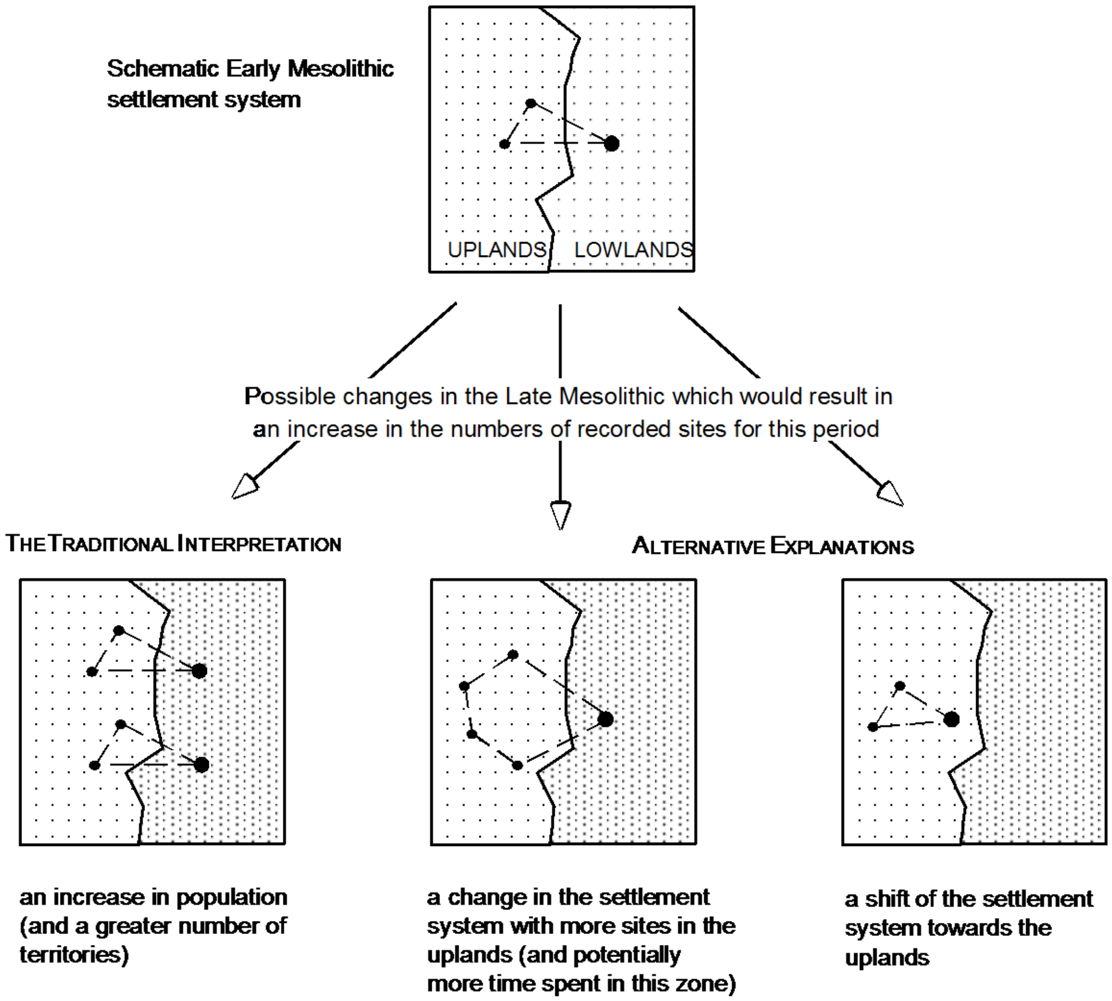

Figure 6.7 Alternative explanations for increases in recorded Mesolithic sites.

POPULATION INCREASE RE-ASSESSED

From the discussion in chapter one, it was clear that many of our interpretations of the changes taking place in the Mesolithic of northern England are based on the concept of gradually increasing populations. This concept began as a preconception, derived from unilinear assumptions about the effects of gradually 'ameliorating' environments after the last Ice Age, and developments leading up to the adoption of agriculture, until recently explicitly tied to the assumption of population pressure forcing changes in resource exploitation. The main evidence to support the idea of population increase came from an assumption of *increases in available resources* as environments changed, and from *increases in the numbers* of recorded Mesolithic sites.

In chapters two to four the important building blocks of this concept (and other assumptions of Mesolithic activities) were questioned, starting with the reliability of the archaeological evidence, and continuing with the validity of interpretations based on patterns perceived in ecological and ethnographic analogies. Very real problems with many common interpretations of the period were noted. Thus, as a way of 'moving forward', the last chapter, and further considerations above, addressed the detailed ecological context of changes in environments and resources. A re-consideration of the question of gradual population increase, drawing together each of the previous perspectives - the archaeological record, ethnographic and environmental analogies, and ecological changes - is now possible.

ARCHAEOLOGICAL EVIDENCE FOR INCREASES IN POPULATION

It was clear from chapter two that direct interpretations of the archaeological 'evidence' for changes taking place during the Mesolithic are problematic. The picture painted by a direct reading of site distributions may be very misleading. Moreover, misplaced interpretations are easily perpetuated when supported by preconceptions about Mesolithic activities. The idea of a continuity in the use of the uplands, for example, was demonstrated in chapter two to have little real basis in site distributions, given the present day biases in operation. Since the archaeological evidence appeared to fit expectations (that is that sites would exhibit preferences for south facing sites, near to water, with a good view), this 'evidence' was given little scrutiny. The concept of gradual population increase, based on the 'evidence' of increases in the numbers of sites, is no exception, and a closer consideration of this evidence demonstrates serious limitations.

First, site based evidence for population increase is problematic because the *distributions of sites* are clearly biased. Most sites in northern England have been recovered from the uplands, where peat erosion has revealed sites. Increases in the numbers of these recorded sites can result from several different processes (**figure 6.7**), not only an overall increase in population numbers, but also changes in the settlement system, with an increase in the length of time spent in the uplands or a shift of focus of the whole settlement systems towards this zone. Either of the latter seem more appropriate adaptations to the environmental changes outlined above.

Secondly, as noted in chapter four, changes in the numbers of sites in any area through time *may not necessarily reflect populations*. Different exploitation patterns for example, can create very different numbers of 'sites' in any one year (regardless of population numbers). Rather than a continuity of activities, the evidence from upland clearance phases for an intensification of upland exploitation *does* suggest that exploitation patterns were changing.

Of course, populations may have increased, but because of the biased nature of the archaeological record and limitations to interpretations, there is little firm evidence for this from typologically or radio-carbon dated sites. Adaptations to ecological changes provide equally good, if not better explanations for the patterns observed.

ECOLOGICAL CHANGES

The supposed ecological context for increases in available resources leading to increases in population is also questionable. The later stages of woodland development have, in the past, been interpreted as having brought increases in the abundance and diversity of woodland resources. However, as was seen in chapters three and four, this approach is rather simplistic, and biased by being based on misleading analogies with modern woodlands. In general ecological terms, each successive stage presents more difficult conditions and fewer resources for human exploitation, although, in effect, more productive resource zones continue in upland environments. As a consequence, Early Mesolithic woodlands would have been much more productive environments than previous interpretations suggest, with abundant understorey vegetation under open birch and hazel woodland. Conversely, in the Late Mesolithic, the increasing extent of shading of the forest canopy and decline of nut producing trees would have rendered resource exploitation in the lowlands increasingly difficult. Likely adaptations to the ecological changes described include shifts in populations and changes in exploitation patterns to accommodate challenges imposed by environmental changes, but not particularly population increase.

Of course changes in other resources - those available in riverine, marine and lakeside environments *may* have taken a very different track from those in the woodlands. There is, however, very little evidence that this was the case, with the eutrophication of inland lakes, silting up of rivers and rises in ocean temperatures. Nonetheless, resources *may* have become more abundant in certain situations, with certain marine or lakeside environments providing resource 'hot-spots' for example, and here these changes may have prompted gradual increases in population. The important point however is that the current evidence from changes in woodland types, the main argument for increases in resources, does *not suggest* population increase as a likely response.

OTHER CONSIDERATIONS - ADAPTABILITY

Without the support of ecological and archaeological evidence the concept of gradual population increase is rather insecure. In retrospect, it is clear that the idea of gradual population increase is difficult to relate to archaeological and ethnographic evidence for the *way* in which human societies adapt to environmental changes. One of the main conclusions of chapter four was that, contrary to many archaeological expectations, ethnographically recorded settlement systems are very variable in time and space, largely because human populations are very adaptable and adapt settlement strategies (within a range of possibilities) to take advantage of differing or changing environmental situations. We would expect the same type of adaptability and variability to characterise the archaeological record. In fact, rapid settlement and flexible adaptations do characterise the early colonisation of Northwest Europe and Scandinavia (Bang-Andersen 1989; 1996; Holm 1996; Larsson 1996) as well as many other areas of Europe. Whether populations were increasing or not, to suggest that population densities take *five millennia* to adapt to new conditions, or even that the same adaptations should characterise very different environments, seems counter-intuitive. In effect, the idea of *gradual* population increase is difficult to reconcile with the nature of human adaptation, whatever the trajectory of environmental change. It may be difficult to say for certain if there *were* more people in northern England at the end of the Late Mesolithic than earlier, but even if this were the case it is unlikely that the 'line' between the two in terms of population changes was a straight one.

Neither the archaeological nor the ecological evidence provide support for the idea of gradual population increase through the Mesolithic. Gradual increases in population are in any case difficult to square with the apparent adaptability of archaeologically and ethnographically documented foraging societies. That is not to say that populations necessarily declined - in fact the possible trajectories of changes in population are many and varied. For example:

The *internal limits on population growth* (the biological and social limits on reproduction) may have been so great that these internal rates, rather than the ecological changes described, may have placed the main constraint on population numbers. In this case we would expect population numbers to rise gradually. However, in view of the population growth rates in contexts of colonisation this seems unlikely.

If *resources constrained populations* then populations may have declined with the spread of denser woodland types, and the development of upland peat, alongside other changes not considered in detail such as the eutrophication of inland lakes. However environments are not necessarily so 'deterministic' of human responses.

It seems likely that populations *adapted to environmental changes*, and these adaptations may have included an intensification of exploitation patterns. Such an intensification may have allowed populations to remain stable or even to increase.

Personally, I suspect that population increase was at least initially a very rapid process, as adaptable societies expanded with abundant resources in the Early Mesolithic. It is likely that subsequently, different regions took on different trajectories of population change, with marked fluctuations depending on specific environmental changes.

Whatever actually took place, the important point is that an assumption of population increase has to be taken out of the equation in changes in Mesolithic societies in northern England, and quite possibly for many other areas of Europe. This is not a 'step back' for archaeological interpretations, but a stimulation to move forward, to recognise population change as a dynamic component of human adaptation, not a given, a component which requires subtle consideration. The idea of gradual increases in population has, in the past, placed restrictions on interpretations. First, because it structures the way in which changes throughout the period, and at the end of the period, can be conceptualised, and secondly because it acts as a 'blinker' to the possible variability shown by past hunter-gatherers which might potentially be visible in the archaeological record. Reconsiderations of demographic changes are one, among many, dynamic variables relevant to understanding past societies. An emphasis on other large scale changes in adaptation (as discussed above) may be more constructive and may open up the way for more complex and realistic interpretations.

CONCLUSIONS

The implications of the environmental changes described in chapter five for changes in resources for hunter-gatherer groups has been addressed. Changes in the shading of the forest floor and the types of associated resources with changing woodland types suggest that a number of significant ecological changes were taking place – a shift in the location of the most important resource zones from the lowlands to the uplands, a northward shift of environmental zones and a fragmentation of resource zones through time. Taken from different perspectives, the available archaeological evidence appears to support adaptations to these changes by hunter-gatherer groups. These adaptations put the nature of changes throughout the Mesolithic in a new light, and also have wider implications for the colonisation of northern regions, the nature of the Mesolithic-Neolithic transition and, most importantly here, the question of gradual population increase. In fact, adaptations to the ecological changes described are found to be a better explanation for increases in recorded sites in the Mesolithic than gradual population increase and this concept is revised in the light of these findings.