Book:

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THE RELATIONSHIP OF THE PHASES TO ARCHAEOLOGICAL CHRONOLOGY

In order to understand the relevance of the model, it is useful to introduce the large scale archaeological context. Early Mesolithic industries first arrive in northern England just after 10,000bp, and are replaced by Late Mesolithic industries from about 8,700bp at the earliest (Myers 1989). Thus in archaeological terms, the first main phase of woodland composition described above can be tied to the Early Mesolithic occupation (**figure 5.15**), when woodland types are dominated by lowland birch. The two further phases might conveniently be termed the Initial Late Mesolithic (**figure 5.16**), when lowland woodlands are dominated by oak, with an altitudinal zonation developing in the uplands, and the Terminal Late Mesolithic (**figure 5.17**), when much of the lowlands is dominated by lime, with oak in the uplands, and peat development on shallower upland slopes. Both the latter phases, created for convenience, are defined on ecological rather than artefactual terms, although there is some evidence to support the idea of an artefactually distinct final phase of Late Mesolithic occupation (which will be discussed in the following chapter, chapter six).

THE PATTERN OF CHANGING WOODLAND TYPES

Several fundamental changes in the character and distribution of woodland types are apparent. Essentially, as different woodland types spread northwards, an increasing diversity of different woodland types and a growing *complexity* of the woodland mosaic is evident. A further noticeable effect of this spread is that the character of both upland and lowland vegetation, and the relationship between the two zones, changes markedly throughout the period.

Upland environments develop an increasingly complex zonation through time. During the Early Mesolithic, upland environments appear to have been largely un-wooded, covered with a juniper-aspen type scrub vegetation, although some authors (Simmons *et al.* 1993) suggest that tree lines may have been higher than has been supposed. Through time, in the Initial Late Mesolithic, the altitudinal limits of birch rise, and pine and oak join birch in the uplands (with pine dominant at a narrow band of elevations). The arrival of oak is also approximately contemporary with the appearance of Late Mesolithic industries. Oak spreads to dominate the 'mid-uplands', though unable to compete with birch and pine at higher altitudes, through both phases of the Late Mesolithic.

On the other hand, Early Mesolithic **lowland** forests would have been dominated by open woodlands of shade intolerant birch, but by the Initial Late Mesolithic such shade intolerant species become restricted to upland locations and clearings. Birch is initially replaced by oak, and in the south and east of the region later by lime. Since oak out-competes pine in all except a narrow band of upland elevations and pine and oak spread into northern England from the south at the same time, in the model there is never any great expanse of coniferous (pine) woodland (contrary to the concept of early Holocene forests as a mixed birch-pine woodland and to analogies with modern Boreal forests). In the Terminal Late Mesolithic much of lowland northern England becomes dominated by lime woodland with ash on calcareous soils.

The possible implications of these environmental changes for human populations are discussed in chapter six. However, before proceeding, the remaining section of this chapter will be concerned with assessing the reliability of the environmental model outlined. That is to say, how much confidence can be placed in the model and how significant the uncertainties about *the timing of tree spread*, the *competitiveness of different tree types* and the *nature of climate change* are.

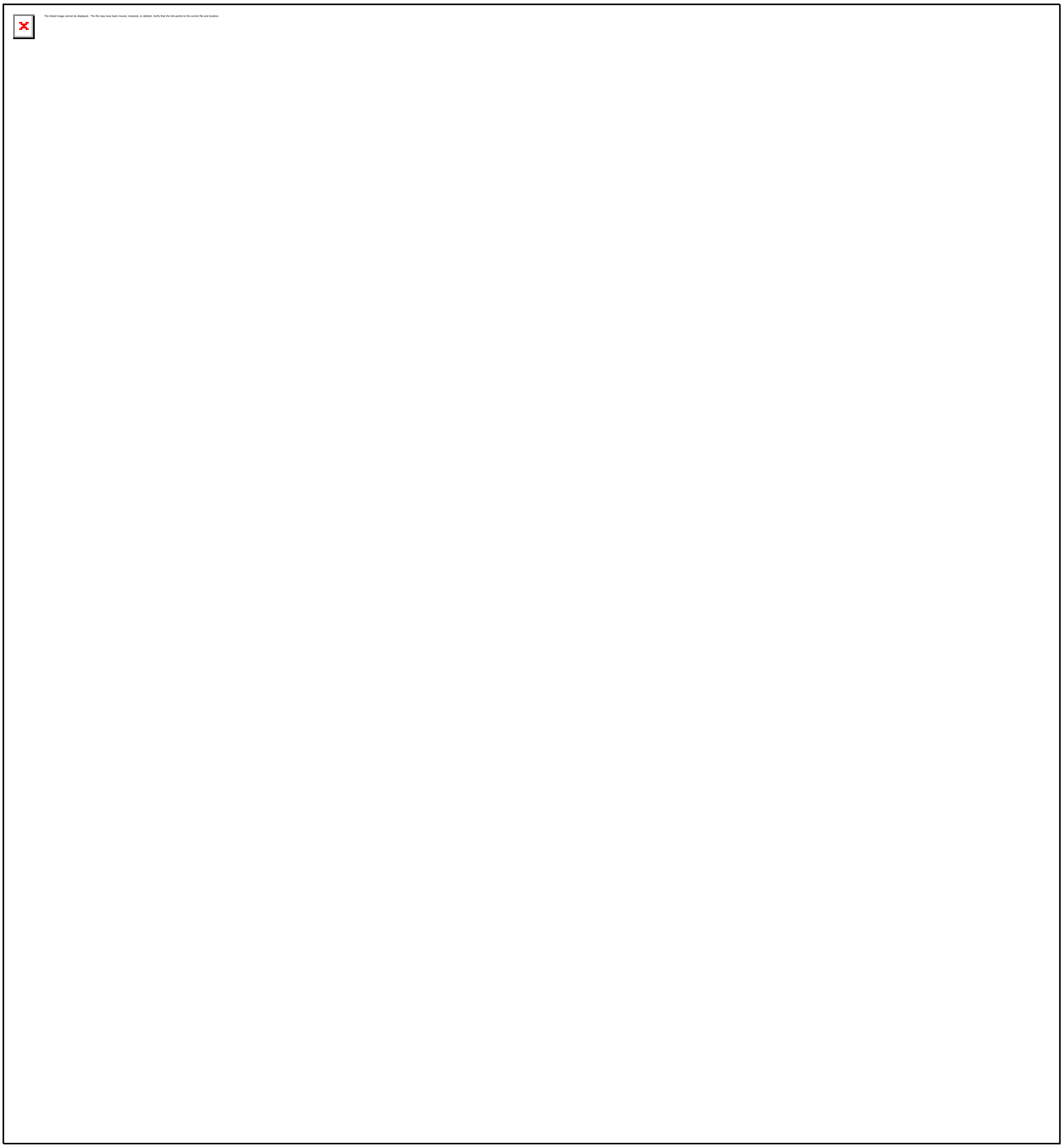

Figure 5.15 Model of Probable Dominant Woodland Types for the 'Early Mesolithic'.

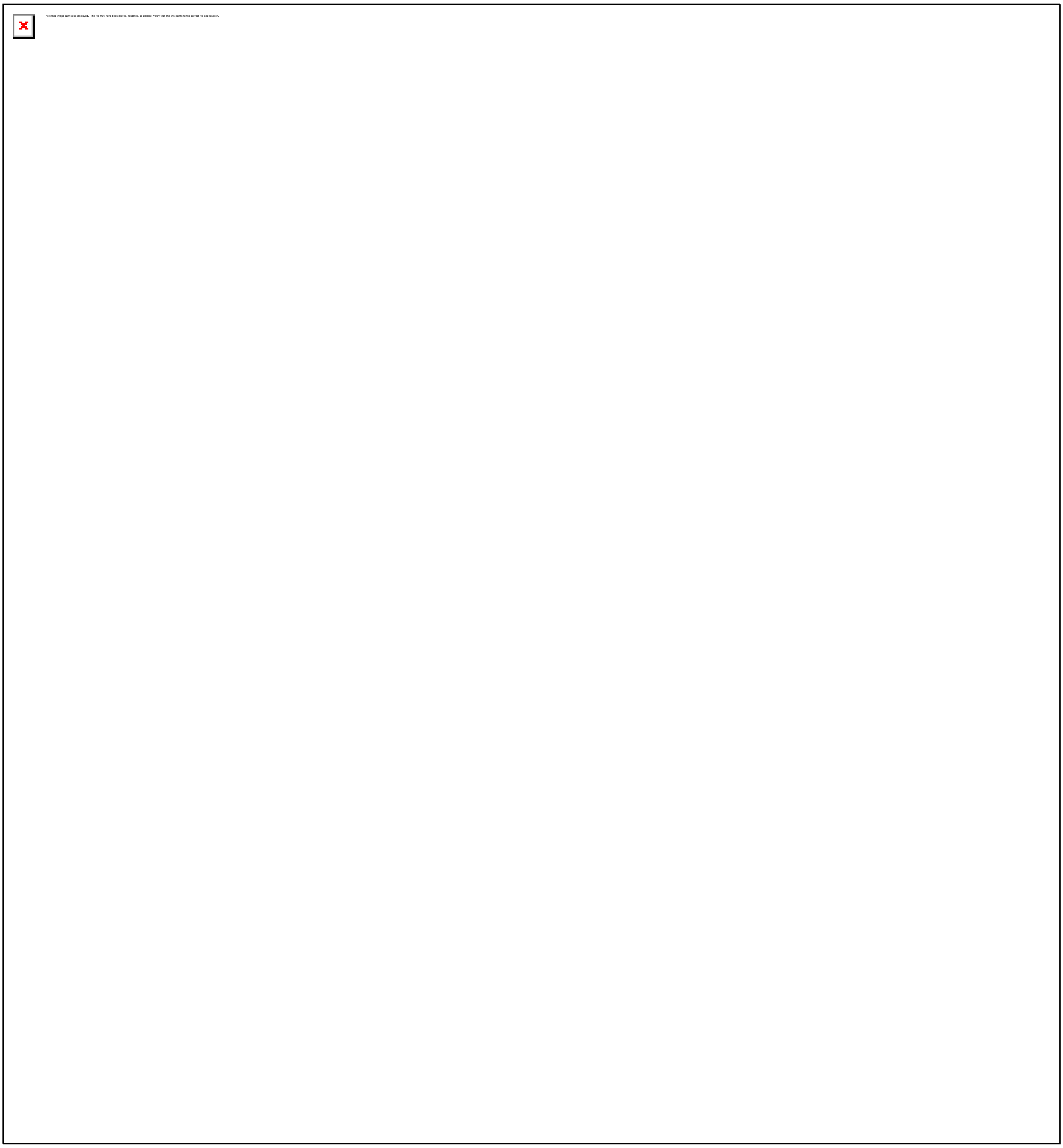

Figure 5.16 Model of Probable Dominant Woodland Types for the ‘Initial Late Mesolithic’.

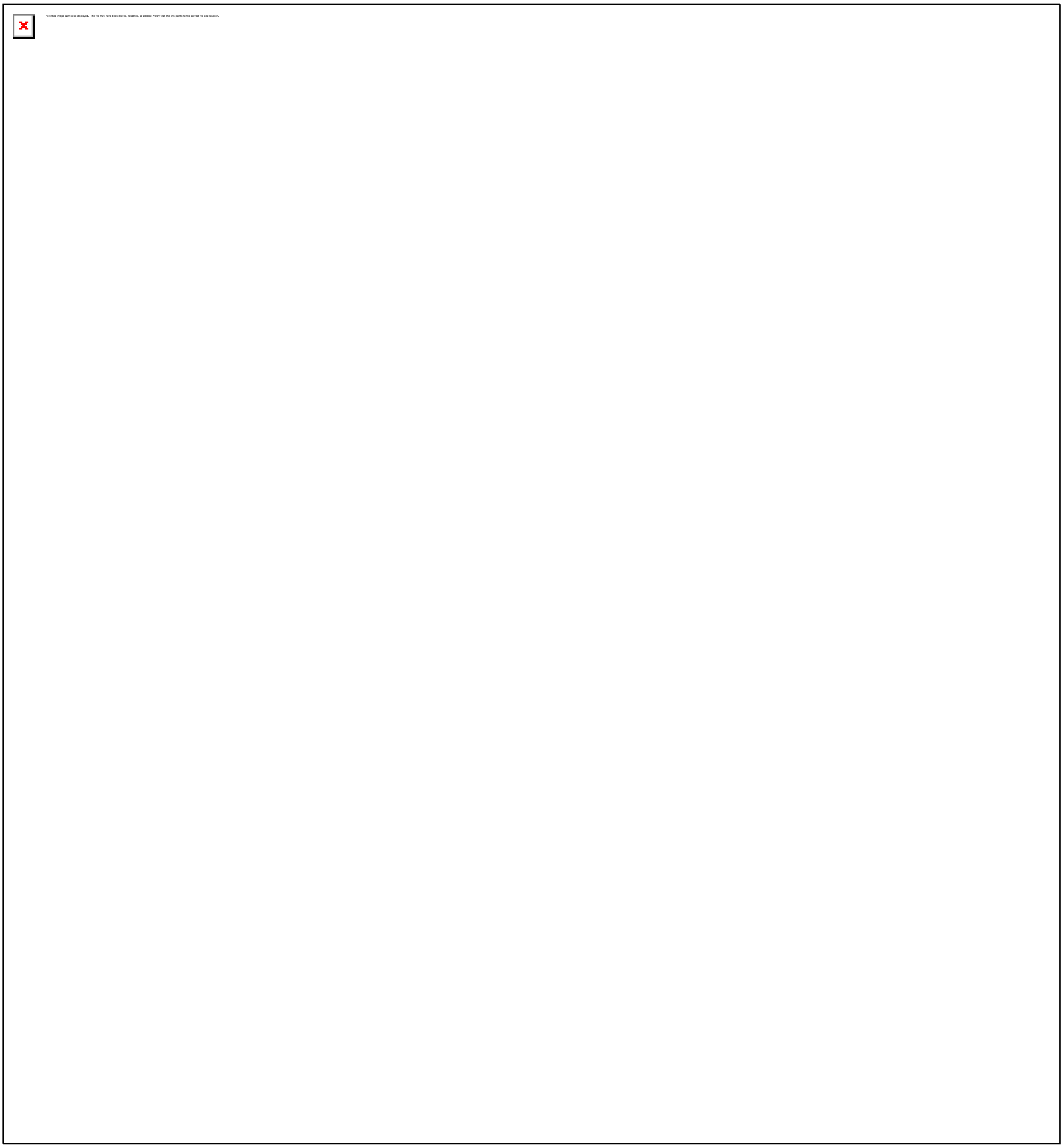

Figure 5.17 Model of Probable Dominant Woodland Types for the 'Terminal Late Mesolithic'.

THE LIMITATIONS OF THE MODEL

Any model of present probable dominant vegetation (such as Brzeziecki, Klenast and Wildi 1993) can be tested against the 'real world' distribution of vegetation. Unfortunately this 'real world' information is not available for the past. Intuitively it seems logical to 'test' the model against pollen evidence, however there are a number of reasons why most pollen analytical studies are inappropriate to use to test the model. For one thing, since the timing of tree spread, and in part altitudinal zonation, have been derived from pollen data, evidence from pollen cores is already incorporated into the model and hence cannot be used to test these aspects. There are unlikely to be sufficient 'new' cores to use to test Birks' (1989) maps in any case. Furthermore, systematic errors may be involved in interpreting pollen evidence (such as the way of identifying the first significant presence of tree types). A more fundamental problem is that pollen evidence relates to a much smaller scale than that of the model. Pollen cores are notoriously 'local' in scope (which is precisely why a model such as the one above is required in order to build up a picture of large scale patterns and changes). Thus pollen analyses, particularly single cores (such as Bush and Flenley 1987; Bush 1988) cannot be compared to the large scale descriptions of probable dominant woodlands. Even in the very few situations where many cores have been analysed over a large region, the interpretations are still very much linked to the local scale. Thus Turner and Hodgson (1983: 95) having analysed 38 pollen sites in the North Pennines region concluded that:

'*little of the variation could not be attributed to local site morphology and no evidence was found that each site was not receiving a large proportion of its pollen from within a short distance.*'

Hence, with the present restricted body of evidence, it is not possible to 'test' the model, but one alternative may be to assess the confidence in the model by reviewing the effect of credible variations of the factors used on the results of the model. In this respect pollen evidence *can* be used as an indication of possible variations, although it is obviously necessary to limit sources to those where regional vegetation and vegetation change have been extrapolated through a number of pollen cores.

The Timing of Tree Spread

The presence of tree species may be misrepresented. The dating of tree spread used (from Birks 1989) is limited by any problems with to the *identification of tree types* and by the *dating* of pollen cores. Trees may have been present in any area for a long period before being detected (Bennett 1986), and equally, the cores themselves may be biased as areas may by chance be selected where certain trees, for example, spread later. In fact the earliest individuals of a species are unlikely to have been detected as Birks (1989: 504) used a measure of persistent presence to identify the spread of each tree type (for high pollen producing trees this is the point at which the pollen curve begins to rise to sustained high values, and for low pollen producing trees this is the consistent presence of pollen in a series of samples). However the consistent presence and *not* the first appearance is probably the most appropriate measure to use in the model in any case, since it incorporates a degree of abundance for each tree type, thus preventing records of early 'outliers' from making an unrepresentative impact on predicted dominant woodland types.

A further limitation is the process used by Birks to define the contours of tree spread, which is problematic as lines were simply drawn between cores where a tree type arrives at approximately the same time. This is compounded by limitations in the *dating* the cores themselves which are also problematic. The *dates* derived may be skewed by problems with dating peat based sediment for example (with considerable leaching occurring) and because the dates themselves are derived from interpolation.

Despite these limitations, though there may be some 'uncertainty' in the exact timing of tree spread recorded by Birks, the *relative* timings of tree spread are confirmed by the spread documented in the rest of Europe (Huntley and Birks 1983) and the processes of tree spread occurring for similar species elsewhere in the world, such as North America (Davis 1984; Delcourt and Delcourt 1983; Bennett 1993). Uncertainties about the dates of spread have only limited effects on the model as the *succession* of different tree species is clear and it is this succession (rather than absolute dates) which determine the important characteristics of change (i.e. the replacement of lowland shade intolerant species by shade tolerant ones).

Soil Types

The soil types used in the model were based on large scale maps of rock types. These maps are very coarse and different published maps will show slightly different distributions (although the major types and locations are the same). Past soil types may also have been somewhat different because soil development was very slow (an unusual dominance of pine recorded in pollen cores in the Northeast, for example, may be explained by shallow poorly developed soils: Turner and Hodgson 1979; 1981), or because other factors such as leaching or erosion removed or altered soil cover. There are also problems with the wetland soil determinations, both because the real stream network would have been much more dense (with many small streams breaking up the lowland forests) and because the spread of alluvium was probably more important in defining the initial spread and overall distribution of alder than time transgressive spread (Chambers and Elliot 1989; Bennett and Birks 1990). The spread of alder may thus have been very different on different river networks, depending on flow rates and the accumulation of alluvium. The fact that Bennett's (1989) map of probable woodland types for 5,000bp (creating using a modern soil map) does not fundamentally differ from that in the present model however, argues that overall distribution of different woodland types according to rock types is reasonably realistic.

The main difference between using modern soils (Bennett's 1989 map) and rock types is in fact in the extent of alluvium and thus woodland dominated by alder. A re-run of the model for the Terminal Late Mesolithic (6,000bp) based on the present distribution of alluvial gley soils is shown in

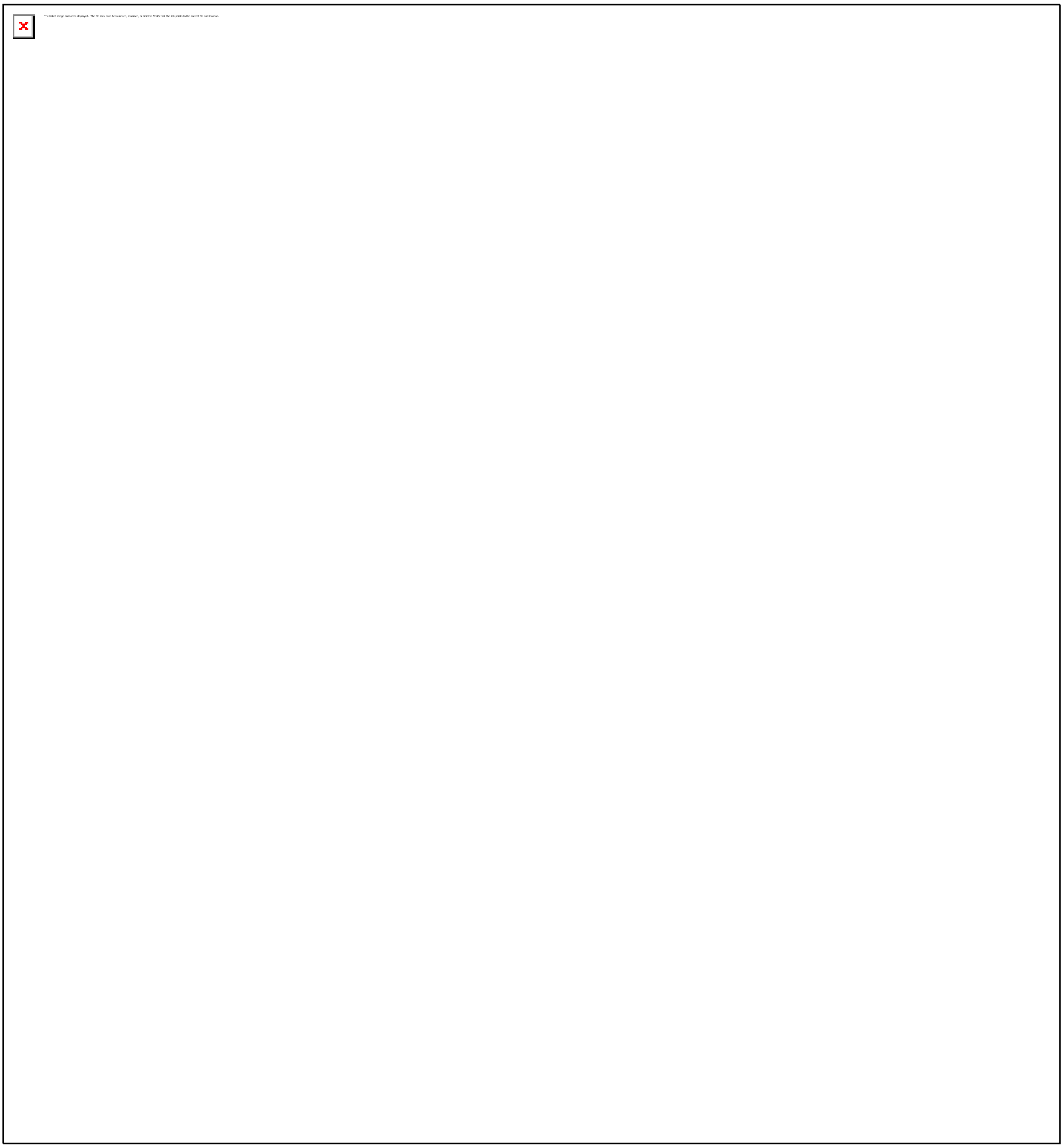

Figure 5.18 Terminal Late Mesolithic (6,000bp) model based on the present distribution of alluvial gley soils.

figure 5.18 (although of course modern soils are formed from alluvium which has accumulated *since* 6,000bp as well as before). This re-run does show a larger area of alder woodlands in the lowlands and at the coast, although this difference is largely limited to the Humber estuary.

Inter-specific Competition

There are two aspects of inter-specific competition which may be misrepresented, the dominance of tree types under specific conditions (influenced by climate and soils, and based on modern species preferences), and the altitudinal zonation or effect of competition along an elevation gradient.

Competition in Similar Environments

In the lowlands, in the model, birch is initially replaced by oak and oak then later replaced by lime in the southern and eastern part of the region on the richer soils. Although the displacement of birch by oak in the lowlands in the Initial Late Mesolithic is shown clearly in many analyses (Rackham 1976; Peterken 1981; Birks 1986; Simmons *et al.* 1996), the relative dominance of lime and oak in the Terminal Late Mesolithic is more problematic given the difficulties in interpreting the different pollen rain produced by the two tree taxa. Grieg (1982) and Rackham (1976; 1980) point to a number of lines of evidence independent of pollen data for the importance of lime in the 'wildwood', both from place names and from the continued presence of lime in some

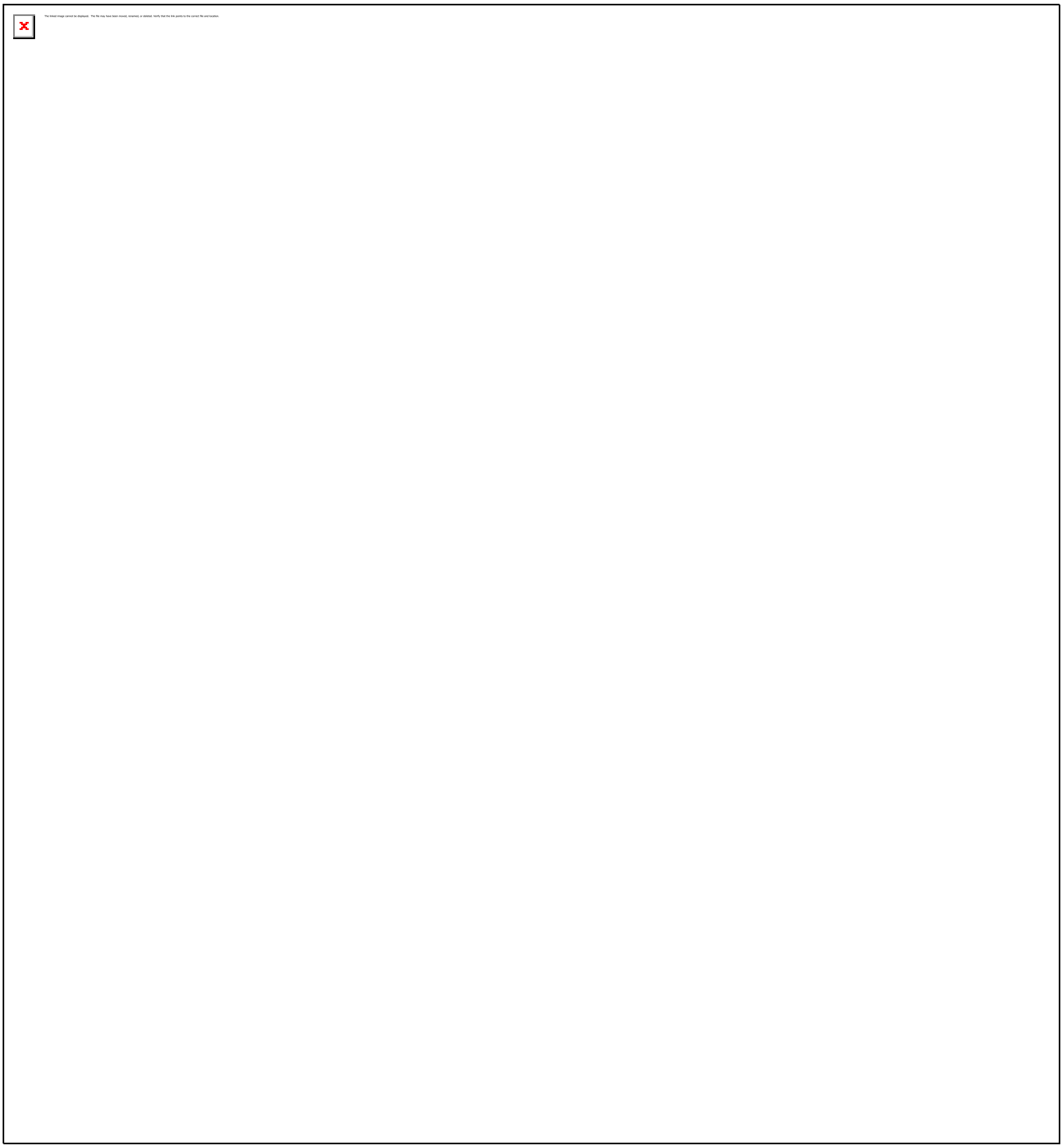

Figure 5.19 Early Mesolithic (9,500bp) model with rapid early Holocene temperature rise.

regions today. Rackham, in fact referred to much of central and southern England as a 'lime province' on a large scale, and Simmons (1996: 13) described lowland Britain in the Late Mesolithic as a 'lime-oak' province on a continental scale, contrasting with 'oak-hazel' of the uplands. Even *if* lime were less competitive than has been envisaged, the increasing shade of lowland forests would remain a valid conclusion, since oak forests would have been denser than birch, and since even if not dominant, increasing proportions of lime would also increase the shade cast on the forest floor.

The only exception to the birch-oak-lime succession in the lowlands is in the far north-east where pine arrives before oak in the model and is dominant in a small area. Turner and Hodgson (1979; 1981) do in fact note that pine was relatively abundant in Teesdale and in parts of the Derwent valley in the early part of the period. Pine appears to be important here for some time however, and the effects of latitudinal differences in climate may also be influencing this distribution. Turner and Hodgson (1979; 1981) suggest that the abundance of pine may be related to local shallow soils or the cold climates of the north-east of England, and it is difficult to distinguish these two factors. The extent of pine modelled in this region would have been greater had the north-south climatic gradient across northern England been included in the model and thus the pollen evidence for this area illustrates that further models might benefit from including the climate differences with latitude as well as altitude.

Climate Changes

The effect of climatic changes in *constraining* the spread of tree types may have been important, but these are taken into account in the model by using Birks' evidence for tree spread rather than a mathematical model. The effect of climatic changes on competition between lowland tree types is likely to have been limited, although it would be difficult to distinguish recorded discrepancies from the model arising from local climatic as opposed to sedimentary causes (as illustrated by the case of pine in the north-east). The *height of the tree line* (the main effect of climate in the model) is more problematic, and in fact Turner and Hodgson (1979; 1983) find no evidence for a tree line in the North Pennines throughout the period, and Turner (1984) interprets pollen evidence from the uplands at Cross Fell (893m) in terms of an open herb-rich birch woodland. In contrast, tree lines in the South Pennines (Tallis and Switsur 1990) and North York Moors in the later phases (Simmons 1996: 20) appear to be as low as 400-500m OD. Simmons (1996) suggests that this irregularity may be a result of human impact through woodland clearances. Given the evidence for rapid warming in the early Holocene derived from ice cores, the potential for the ecological limit of tree lines to have been similar to today from the start of the period must be taken seriously. The general height of tree lines calculated from either traditional interpretations of changes in temperature or from ice cores or beetle evidence would be similar from the Initial Late Mesolithic. Thus uncertainties about the rapidity of climatic changes only affect the character of vegetation modelled in the Early Mesolithic. **Figure 5.19** shows the effect on the model for the Early Mesolithic (at 9500bp) of a very rapid rise in temperatures to those of today (with the modern tree line heights). Though the character of Early Mesolithic uplands is clearly different in this version, with greater proportions of birch and hazel woodland rather than juniper-aspen scrub, the general pattern of differences in upland and lowland environments across the three phases is still maintained.

Although the precise patterns of woodland changes is likely to have varied from those in the model, the overall long term changes are remarkably robust to variations in the parameters, and we can have a good deal of confidence in a coarse reading of the model. Nonetheless, we should not forget that pollen reconstructions, though confirming the general trends, do provide important additional (particularly local) information that cannot be extrapolated from the model. In particular, the complexity and diversity of woodland types recorded in pollen cores emphasises that the model only illustrates the tendencies for changes in dominant trees and is far from an absolute record of 'on the ground' vegetation.

Altitudinal Changes

Limitations might also be introduced by incorrect altitudinal zonation assumptions. However comparable *altitudinal relationships* have been cited in pollen analytical work with birch and hazel clearly dominant above pine and then oak in the North Pennines (Turner and Hodgson 1979) and North York Moors (Simmons and Innes 1988), thus fitting well with the South Pennines analysis used (Tallis and Switsur 1990). The exact altitudes are more problematic, although since the relative competition is clear, then the effect of changing precise heights will only 'compress' or 'expand' the Late Mesolithic upland zone, and thus the extent of this zone, rather than the character, would vary. Very radical changes in altitudinal limits would be required to 'wipe out' what appear to be important regions of mid-upland oak in the model (changes such as a lowering of the altitudinal limits of oak and replacement by pine as low as 200m OD for example), and there is no evidence for variations from the model on anything similar to this scale. Simmons *et al.* (1993) describe woodland largely dominated by oak in one of these mid-upland regions, the North York Moors, but find no evidence for altitudinal zonation. In fact this observation supports rather than refutes the model, as in the model the North York Moors are described solely by a region of upland oak, not being high enough for pine or birch to be competitive.

POTENTIAL IMPROVEMENTS AND APPLICABILITY

Given access to more detailed environmental or ecological data, there would be a number of improvements which could be made to this version of the model. The resolution of the data on tree spread would be improved with the addition of further dated pollen sequences for example, and future models could be built using GIS-based interpolation of 'isopollen' surfaces from dated pollen cores, rather than the hand drawn surfaces used by Birks (1989). With such data in a raster based version of the model, any periods (and not just 500 year intervals) could be selected and modelled. Also, if more detailed ecological information were available from both present and past environments, sub-dominant tree types or more detailed characteristics of woodland composition could be assessed. Apart from further dated pollen sequences, other sources of evidence for past woodland composition may also be available in the future, one such potential source being evidence from preserved submerged forests (Heyworth 1978), although the study of these is as yet in its early stages.

The construction of the model may have a wider applicability for other areas where changes in vegetation zones appear to be a key component of changes in human adaptations. Within Britain, changing vegetation may be relevant to the colonisation of Scotland, and within Europe to the colonisation of Scandinavia (Larsson 1996) or changing adaptations during the Mesolithic of areas such as Southwest Germany (Jochim 1976). Potential examples of a wider international relevance may include the relationship between woodland spread and the marine adaptations in Tierra del Fuego (Orquera et al 1984; Orquera and Piana 1987; Borrero 1996), or changes associated with the spread of different woodland types in North America (Yesner 1996). The model might also be a useful tool for defining potential large scale changes before more detailed botanical or pollen analytical studies are made, especially by allowing different scenarios of factors affecting vegetation changes to be explored.

CONCLUSIONS

Even though a number of studies have provided a detailed picture of local environments in the Mesolithic, our knowledge of Mesolithic adaptations has been hampered by the lack of a large scale model of changing environments. This chapter has described the development of one such model of probable dominant woodland types from what can be called a 'reasonable and logical set of assumptions'. The model is limited by uncertainties associated with the main influencing factors - soils, climate and tree spread - in past environments. However even when a number of credible variations are considered, the coarse grain patterns described by the model remain valid. The next chapter considers the likely effects of these changes on available resources and their distribution, and defines possible paths of adaptation by Mesolithic communities. The significance of these changes for a re-evaluation of common concepts of change in Mesolithic populations opens up whole new areas of discussion.