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CHAPTER THREE

Working 'Up' from Resources

The collection of shell-fish, fishing, and, on the sandy wastes, where the forests thinned out, the pursuit of small game supplemented by the collection of roots and berries were the only resources of the rather poverty-stricken folk of Western Europe in the Mesolithic Age'

Clark 1932 (9-10)

Beyond question the main source of food during the time of the Star Carr occupation was meat. Red Deer was by far the most important source.. [and also we can assume that] a certain modicum of food was obtained from plants, especially marsh plants, and from the occasional bird'

Clark 1972 (26, 28)

ABSTRACT

Interpretations of subsistence practices are a crucial element of models moving from environments, to resources, to population and settlement. However, the history of research into subsistence practices has tended to be one of isolating 'the resource' which is the most important or staple food, and which may define settlement patterns. In many cases, the proposed resource or suite of resources has been selected based on common assumptions about Mesolithic lifestyles, rather than any secure evidence. A detailed discussion of the range of possible subsistence resources demonstrates that focusing on any single resource in this way can be somewhat problematic. For one thing, any one of a number of resources could in particular circumstances have been a staple in Mesolithic Britain. For another, it may not be the 'staple' resource which is the most important archaeologically, population numbers are more normally defined by the resources available at the 'poor season' for example and certain resources, only available at specific locations or seasons, such as seasonally abundant salmon 'runs', may exert a major 'pull' on settlement. Developing a better understanding of possible Mesolithic subsistence strategies will depend on considering a number of characteristics, rather than just abundance, which are clearly important in determining how resources are exploited. Key important characteristics *can* be defined. However, due to the lack of understanding of factors such as past environments, the role of methods of resource exploitation in determining how resources were exploited, and the importance of the past history of societies in defining subsistence and settlement patterns, any absolute model of subsistence is probably beyond reach. Explicit methods for determining subsistence practices are discussed in chapter four, but it is clear that only a very 'coarse-grain' approach, concentrating on contrasts between different types of resource environment, would minimise the effects of a lack of evidence for specific subsistence resources and the pervasive influence of popular pre-conceptions of 'key' resources.



INTRODUCTION

Probable subsistence practices tend to be an integral part of the ‘first chapter’ of any study of the British Mesolithic. Subsistence often becomes the bottom rung of a ladder of inference used to build up an understanding of past hunter-gatherer societies, and the interpretations of changes in settlement and technology are based on ideas of changing subsistence. This is, at least in part, due to ample support for the importance of subsistence patterns in defining recorded hunter-gatherer demography and settlement (Birdsell 1953; Baumhoff 1963; Casteel 1972; Thomas 1981; Kelly 1995). It is particularly noticeable, for example, that abundant and reliable resources, most particularly coastal resources, are intimately linked with social complexity (Perlman 1980, Rowley-Conwy 1983; Keeley 1988) with accompanying characteristics such as storage, sedentism and extensive settlements (Price and Brown 1985: 11; Soffer 1989; Testart 1982; Yesner 1983). It is often suggested that ‘*complex hunters are likely to develop where a suitable array of migratory resources are available*’ Rowley-Conwy (1983: 118).

As well as being important in a direct sense, as one of the key factors influencing population and settlement, interpretations about subsistence practices also influence our perceptions of the Mesolithic. Clark (1932, cited above) for example clearly saw a diet of shellfish, roots and berries as indicative of a ‘poverty-stricken’ state. Subsistence strategies based on hunting of large game animals - such as deer or aurochs - are on the other hand seen as more noble or affluent. In fact, archaeologists themselves often prefer to research and make interpretations about the ‘dynamic’ hunting of large land mammals rather than shellfish or plant collection, and this is one of the factors which has tended to restrict or bias the range of interpretations made about the past subsistence (Ehrenberg 1989; Watson and Kennedy 1991).

There are several key elements to even a basic understanding of past subsistence strategies. The first question to address is simply *which resources* were exploited. Beyond this, the role of any resource in relation to other resources, its means of exploitation, and how the use of different resources may have changed seasonally, are also important questions to consider. Even these basic queries are difficult to address given the paucity of direct evidence for subsistence, and the problematic nature of evidence from analogous environments or societies.

The most obvious source of evidence for past subsistence is direct evidence of exploitation from archaeological sites. Examples of this kind of direct evidence might include faunal (bone) remains from the hunting and processing of game animals, charred nutshells from roasting nuts or the remains of discarded shellfish shells. However, direct evidence for the exploitation of specific resources is rare, especially in northern England with the poor preservation

conditions discussed in chapter two. Evidence for the exploitation of resources in neighbouring regions may be relevant, although clearly this needs to be used with care.

Other lines of sources of evidence may also be useful. One key element to consider is the *availability* of different food resources - how abundant they may have been and where and when they would have been available. The main source of evidence for this element is from modern environments similar to those of the Mesolithic. Records of the exploitation of different resources by modern hunter-gatherers, or historical records of traditional uses in the past may also provide a better understanding of how resources might have been exploited or the roles they might have played in subsistence.

Interpretations of subsistence practices in the Mesolithic have changed as perspectives on the period have altered, and as new evidence has become available. Early interpretations of subsistence practices tended to concentrate on the ‘most obvious’ or most visible resources. Early this century, for example, the presence of Mesolithic shell middens prompted assumptions that Mesolithic populations eeked out a meagre existence (Clark 1932), living largely on shellfish (as discussed in chapter one). The recovery of evidence for a range of other resources, particularly large game animals, prompted more carefully considered interpretations of Mesolithic subsistence practices (such as Clark 1972). However, though more considered, these interpretations were also biased by the nature of the evidence. Later interpretations suggested that less ‘visible’ resources which are rarely preserved, such as plant foods, were more likely to be the key elements in subsistence strategies. The most recent development (in the 1980s) has been the attention drawn to marine and coastal resources as determinants of social complexity. Though applying a greater appreciation of the biases in the archaeological record, almost all interpretations have tended to be geared towards identifying a single key resource, or group of resources, which would be of major importance. A central problem is that, although the selection of these specific resources *appears* to be lead by archaeological evidence or environmental or ecological models, it is actually very dependant on the ‘fashionable’ ideas of the time.

The discussion below is not intended as a complete review of Mesolithic subsistence resources, but rather as an illustration of the range of resources available to Mesolithic populations, and to demonstrate that the question of key subsistence resources, and of subsistence practices, is complex, and despite a series of proposals, is as yet unresolved. To make this discussion more approachable, resources are grouped into ‘common’ categories, rather than by taxonomy, and common names are used for all resources, with the Latin names referenced in **Appendix A**. The locations of the archaeological sites mentioned are illustrated in **figure 3.1**.



Figure 3.1 Sites in northern England mentioned in chapter three.



SUBSISTENCE RESOURCES

THE SPREAD OF FLORA AND FAUNA INTO THE BRITISH ISLES

The Early and mid-Holocene marked a period of substantial changes in plant and animal communities within the British Isles. Several lines of evidence (addressed in detail in chapter five) point to a rapid rise in temperature in northern Europe after the end of the last glaciation. Plant communities will however have taken time to spread from glacial refugia, with animal species thus following these changing habitats, rather than temperature changes *per se*. Nonetheless by the start of the Early Mesolithic (taken here as 10,000bp, approximately also the time when 'Mesolithic' toolkits begin to appear) 'open' woodland communities of plants and animals would have replaced grassland over much of northern England. With time, as slower moving tree species arrived in the British Isles, woodland communities will have become dense - more 'closed' -, and plants and animals better adapted to these closed woodland conditions would have gradually displaced more 'open' woodland species. The nature of plant and animal communities has also been affected by the severance of the 'landbridge', between Britain and the continent (and between Britain and Ireland) and the influence of humans themselves, through exploitation, and through accidental or deliberate introduction or encouragement of particular species.

Unfortunately our knowledge of the date of arrival of different species of plants and animals and their relative availability in Mesolithic environments is poor. The best evidence concerns the spread of tree species (recorded in pollen cores), although evidence also exists from pollen diagrams for the spread of understorey and herb flora (largely much faster than slow moving tree species). Evidence for the spread and availability of large fauna is however much more sparse, and largely dependant on assemblages from archaeological sites (which present a biased selection of available species).

Models of the spread of tree species as a basis for understanding changing resources, are discussed in detail in chapters five and six. Until then however an broad idea of the availability of different species of plants and animals is best given through a general discussion of what evidence exists for availability and exploitation of different types of resources. Evidence for changes in these resources through time is included where available.

LARGE LAND MAMMALS

Although the date of arrival (and in some cases the extinction) of large mammals is often difficult to define, the large land mammal component of past food resources is the most 'visible' in the archaeological record, and large mammals present the best evidence for *use* of resources. This is because faunal remains are the most common surviving direct element of subsistence practices, and of these remains the large mammal elements are most likely to survive post-depositional disturbance in an identifiable state. Since large

land mammals are such a visible element of past subsistence practices, and moreover a resource that is still 'hunted' today, many interpretations have also been based on a dominant role for these resources in subsistence.

The influence of large game in general, and red deer in particular, on subsistence and settlement, has formed the basis for several key discussions of Mesolithic settlement. The first explicit model was put forward by Clark (1972), as cited above. On the basis of the most frequent faunal remains at Star Carr, Clark suggested that populations in Britain in the Early Mesolithic would have been largely dependant on red deer. He also used red deer ecology to suggest patterns of Mesolithic settlement. Clark's ideas were a major influence on the idea of upland 'hunting sites' contrasting with lowland 'base camps' noted in chapter two. Thus, Jacobi (1978) and Myers (1986; 1989) also assumed a dominant role for red deer in subsistence and made similar interpretations about settlement patterns (which are discussed in more detail in chapter four).

Deer

Since Clark's (1972) model red deer in particular have played a key role in interpretations of Mesolithic subsistence strategies. One of the most famous statements made about Mesolithic subsistence is that one red deer carcass is equivalent in energetic terms to 52,267 oysters (Bailey 1978: 39), the resource previously assumed to typify Mesolithic economies. Bringing 'home' a large kill, such as a deer, is clearly important not only in practical terms, but also confers status on the hunter, who shares the meat with the rest of the group and gains prestige (Kelly 1995; Mithen 1990).

Two main types of deer, red deer and roe deer, would have been available to Mesolithic hunters. Red deer would also have been an important resource not only for meat but also for hides and for antlers, whereas roe deer antlers are usually too small to have been valuable. Both roe deer as well as red deer bones are typically recovered at Mesolithic sites where faunal remains are preserved. In northern England, red and roe deer remains were recovered from Star Carr (Fraser and King 1954), and in the rest of the British Isles, in Scotland at Morton, Fife (Coles 1971), Oronsay (Grigson and Mellars 1987), Carding Mill Bay (Hamilton-Dyer and McCormick 1993), and in southern England at Thatcham (Wymer and Churchill 1962; Wymer 1991: 27). In fact, in 1972, Jarman noted that 98% of European Mesolithic sites with faunal remains had been found to contain red deer remains (Jarman 1972). Although some analyses have shifted attention away from the red deer component of faunal remains at Star Carr itself (Legge and Rowley-Conwy 1988; 1989), recent analysis of a site very near to Star Carr, Barry's Island (Rowley-Conwy 1994), with a high proportion of red deer bones, has maintained the perceived importance of deer to Mesolithic populations.

The way in which deer would have been hunted is largely determined by the ecology and behaviour of deer populations. In forested environments, the size of deer groups varies with season and vegetation, with the sexes typically remaining separate for most of the year but coming together for the autumn rut (Jochim 1976: 105). Red deer and roe deer have slightly different behaviour patterns. Red deer

aggregate into groups of several does and young (and thus several animals might be killed at once). Roe deer on the other hand, live in smaller, primarily family groups (Jochim 1976: 106), in contrast to red deer they prefer to feed on the shrub layer in forests rather than on grasses.

The difficulties encountered in hunting red deer and the success of any hunt are essentially determined by the density of deer populations. The densities of both deer species depend on the density of available forage as well as on the intensity of predation. Roe deer are likely to have existed at lower densities relative to red deer and wild boar in Mesolithic forests as they suffer more from predation, and also compete poorly with red deer and wild boar (Jochim 1976: 102-3). Since deer thrive in open woodland, forests would have gradually become a less suitable habitat for deer throughout the Mesolithic as forest density and shade increased (Jochim 1976: 101) and as forage reduced in density. As noted by Keene '*contrary to popular belief, the climax forest is not good deer habitat*' (Keene 1981: 101).

Nonetheless, although deer has a prime role in interpretations of Mesolithic subsistence, especially in northern England, recently other large game animals have been recognised as being potentially as important. Legge and Rowley-Conwy (1988; 1989), for example, remarked on the potential importance of other large game at Star Carr. In other areas of Europe, analysis of faunal remains also revealed the importance of other species, particularly wild boar. In Denmark, Rowley-Conwy's (1984) analysis of Ertebølle faunas suggested that wild boar were particularly important in Late Mesolithic subsistence practices, with recorded kills of about 50% wild boar, 30% red deer and 20% roe deer.

Other deer which may have formed an element of Mesolithic economies include reindeer and elk. Although a famous, and vital resource for Upper Palaeolithic hunters, reindeer, if available in the Early phases of the Early Mesolithic would have been in decline. Elk however would certainly have been available in the Early Mesolithic, with elk populations reaching their maximum in the early stages of forest succession and declining rapidly with the spread of closed woodland (apparently becoming extinct at the end of the Boreal (Jones and Keen 1993). Elk is the largest of the cervids, with an adult male weighing up to 500kg (Chapman 1975). Remains of elk have been found in northern England at Star Carr (Legge and Rowley-Conwy 1988, 1989). They feed on a broad spectrum of shrubs and herbs and also aquatic plants (Chapman 1975: 41). Although much less numerous than red or roe deer even in open forests, elk may have been easy to hunt, being very timid and easy to approach (Jochim 1976: 98).

Wild Boar

Though smaller than deer, wild boar may have been a major resource, especially as they should have been more common in postglacial forests (Jonsson 1995: 152), particularly dense oak forests, and additionally wild boar populations can sustain much higher kill rates than can deer. Whilst wild boar may have been important for meat though, the skin is unsuitable for use for leather because of the high fat content and bristle penetration through the skin (Wijngaarden-Bakker 1989).

Wild boar is second only to deer as a component of most British faunal assemblages. Remains of wild boar have been recovered in northern England at Star Carr (Legge and Rowley-Conwy 1988; 1989), and in the rest of the British Isles at Oronsay (Grigson and Mellars 1987), Morton (Coles 1971) and Carding Mill Bay (Hamilton-Dyer and McCormick 1993) in Scotland and at Thatcham (Wymer 1991) in southern England. At Lough Boora in central Ireland, and Mount Sandel in northern Ireland, 98% of the mammal remains come from wild boar (Wijngaarden-Bakker 1989: 127), although the dominance of wild boar is partly a reflection of the lack of deer in Ireland. Wild boar is also a consistent component of most faunal assemblages in the Scandinavian Mesolithic.

A further important point is that, whilst deer densities would clearly have declined during the Mesolithic, as forest density and shading increased, wild boar would have profited from a spread of oak forest since acorns (alongside roots and grasses) are an important staple resource for wild boar populations, especially prior to the winter months. Tilley (1979: 24) refers to historical accounts (in Howes 1948: 173) of acorns being a primary autumnal food on which wild boar were fattened in central Portugal. Male wild boar are solitary, but during the rut in November and December they join the female groups, which with several females and young can then range from groups of 6 to 50 (Jochim 1976: 106). These large groups may have provided an important resource. The age/sex patterns of wild boar hunted (adult female animals and juveniles) suggests that Mesolithic hunters at Lough Boora and Mount Sandel took advantage of the reduced mobility of sows with young (Wijngaarden-Bakker 1989).

At Scandinavian sites it has been suggested that wild boar may have been semi-domesticated, perhaps not permanently penned but foraging around human settlements (Rowley-Conwy *pers. comm.*), although no suggestions of this nature have been made for the British material. Defining domestication and identifying this in the faunal record is a complex issue.

Other large game, particularly elk and aurochs, may have been less abundant, but being much larger than deer or wild boar may still have been important in Mesolithic subsistence practices.

Aurochs

Remains of aurochs (wild cattle) have been found in northern England at Star Carr (Legge and Rowley-Conwy 1988, 1989), Barry's Island (Rowley-Conwy 1994) and in the rest of the British Isles at Thatcham (Wymer 1991) and Morton (Coles 1971). Like elk, aurochs are also interpreted as largely an animal of grasslands and open forests, being discouraged by denser Atlantic forests with a lack of grazing (Jochim 1976: 97, after Waterbolk 1968), although they continued to be present in these latter environments. Unfortunately, given that no natural aurochs populations survive it is extremely difficult to make interpretations about their ecology or habits (Legge and Rowley-Conwy 1988: 19).



Horse

Horse, again an animal of more open grasslands, was '*rare in the postglacial of Britain but not unknown*' (Rowley-Conwy 1994: 3). Horse bones have been recovered from Barry's Island in northern England (Rowley-Conwy 1994) and Thatcham in southern England (Wymer 1991).

Brown bear

A vertebra of brown bear was recovered from the north-east of northern England at Star Carr (Noe-Nygaard 1983), but Jochim (1976: 99) considers that in general terms in Mesolithic forests bear would have been too rare to support a significant pattern of exploitation. Noe-Nygaard remarks on the decline of the species from Boreal to Atlantic times partly due to vegetation changes and also the isolation of Britain from the continent preventing new immigration. The occasional exploitation of brown bear in autumn and winter, when they have large fat reserves, may nonetheless have provided a welcome source of fat, as well as and meat and skins (Charles 1997). Nonetheless, bear has never been considered a major resource in any period.

DISCUSSION

Clearly different large land mammals species have very different characteristics and the relative importance of different species is a complex issue. In human terms it is not just the density of different species, or characteristics such as meat weights and other 'returns' such as hides and antler, which affect decisions about which species to target, but also how difficult species are to hunt and how frequently they are encountered. The paucity of archaeological sites with preserved faunal remains is legendary (especially in northern England where the two main sites, Star Carr, and Barry's Island, give conflicting evidence on seasonality and the relative importance of different species). The relative importance of different large land mammal species, or large land mammals in general, is thus largely a matter more of speculation than of informed conclusions.

Whilst opinions vary on the importance and exploitation patterns of different species, the dominant role of large land mammals in general is often seen as a logical conclusion given their 'attractiveness' as a resource. Killing a large mammal such as a deer supplies far more meat than killing a smaller animal (estimates put the meat of one red deer as feeding five people for ten days without needing to consume any other foodstuff). Moreover, meat from large game animals is also often a preferred food, Lee (1968: 41) for example records that the !Kung '*eat as much vegetable food as they need and as much meat as they can*'. Despite the attention that is often focused on meat from large animals however, both by archaeologists and by hunter-gatherers themselves, the actual contribution to diet of this resource for many known hunter-gatherers is often low (Kelly 1995). Large animals are difficult to catch and also, being unpredictable in their habits and precise location, are an unreliable resource (compared to fish or nuts for example). Studies of ethnographically documented hunters show that when specifically hunting large land mammals they often bring home smaller species or return empty-handed (Mithen 1987; 1989; 1990; Kelly 1995). In fact, the issue of the role

of large land mammals is complicated by the fact that hunters are often opportunists, bringing home whatever type of game - large or small - that is encountered.

Hence as can be seen, the role of large land mammals in Mesolithic subsistence may have been inflated, not only by the relatively high visibility of large land mammal fauna on archaeological sites, but also by preconceptions about past subsistence practices as well as by the nature of the ecological and ethnographic evidence for resource exploitation.

The problems with ethnographic and ecological evidence for the use of large land mammals are subtle but important. Analogies between modern coniferous forests and Mesolithic woodlands (especially those in the Early Mesolithic) form the basis for estimates of large game availability. Likewise, subsistence patterns of hunter-gatherer groups living in coniferous forests (especially the boreal forests of the Canadian sub-Arctic) form the basis for Mesolithic subsistence and settlement practices (such as Price 1973, discussed in chapter four). However, today, expanses of coniferous woodlands are largely present in the cold climates of high latitude regions (such as the Canadian Arctic) and at high altitudes. This means that these environments are a poor analogy for those in the Early Mesolithic, since Early Mesolithic climates would have been similar to those at present (Mayewski *et al.* 1996), with a restricted range of tree species present only because of slow rates of expansion of forest trees from glacial refugia (discussed in chapter five). Large game animals *are* the major resource for boreal forest groups in cold climate coniferous forests, but in Mesolithic forests, with abundant other resources available, this is less clearly the case.

Whatever their relative importance in diets however, large mammal resources are also important in that the study of faunal remains can potentially tell us about the *season* of occupation of archaeological sites, and thus potentially the season of exploitation of different large mammal resources. The season of occupation of many of the Mesolithic sites in Scandinavia which have yielded large faunal assemblages can often be determined with a reasonable degree of accuracy. In northern England however there are only two notable sites with large faunal assemblages, Star Carr and Barry's Island. Neither of these can give us a reliable assessment of the season of occupation of the area, the Vale of Pickering. For one thing there has been considerable disagreement about the season and function of occupation at Star Carr, (Legge and Rowley-Conwy 1988). Star Carr has been seen alternatively as a winter 'base camp' (Clark 1972), a butchery station or kill site (Caulfield 1978) a lakeside antler and skin working site (Pitts 1979) and a refuse dump from a nearby base camp (Price 1982), with occupation argued to be in late spring and summer on the basis of faunal remains (Legge and Rowley-Conwy 1988) or spring on the basis of charred plant buds (Day 1993). The faunal remains from Barry's Island (Rowley-Conwy 1994) suggests a winter occupation, even though the site is very near to Star Carr, making any broad determination of a 'general' season of occupation of this area, the only region with detailed faunal assemblages, almost impossible. The direct relevance of the archaeological evidence of large land mammals to

discussions of settlement patterns in this region is thus very limited.

SMALL MAMMALS

Small game resources are rarely credited with any significant role in Mesolithic subsistence practices. However, whilst being in smaller 'packages' than large game, small game can, in certain circumstances, provide a more important contribution to diets. This is partly because they are simply more abundant than large game (and therefore encountered more often when hunting) and also because they can be easily caught in traps and snares which require minimum energy investment. In forested environments, such as regions in Tasmania, small rather than large game are the primary inland source of meat (Lourandos 1997)

Small game in open woodland environments would include small herbivores such as hares, squirrels and hedgehog, as well as predators, such as badger, wolf, fox, wild cat and pine marten (which are often seen primarily as a source of hides but can also be a source of meat). Small mammals such as hares, squirrels and hedgehogs, as well as possibly being important in 'poor' seasons, might also play an important role after periods of extreme climatic conditions (particularly cold winters or dry summers for example) since they reproduce rapidly and recover quickly from population decline, rising back to high densities soon after a poor year or series of poor years (Flowerdew 1987).

The density of small herbivores and omnivores is generally dependant on available forage and small insect life (or, in the case of squirrels, nut production). However the relationship between the populations of predators and their prey can be complex and subject to multi-annual fluctuations (Flowerdew 1987; Mithen 1990). The main hare species found in Mesolithic Britain is likely to have been brown hare (rather than arctic hare), (Mayhew 1975). Hare bones were recovered from Mount Sandel in Ireland (Woodman 1978; 1985b). Hares prefer open environments, but are also found in forested situations, particularly boreal forests (Charles 1997). In contrast, squirrel densities, being largely dependant on nut production, would have been highest in open oak forest. Keene (1976) notes the hunter-gatherer populations in the Great Lakes of North America frequently exploited squirrels by catching them in traps or snares.

Hedgehogs are perhaps one of the most unusual resources which might have been exploited in the Mesolithic. Hedgehogs are distinctive however since they have quite fatty meat, which would be attractive at times when the meat of other game resources was lean. There is also some possible evidence of their exploitation. The midden at Morton, for example, contained the remains of a hedgehog (Coles 1971; Smith 1990: 145). Though hedgehogs were unlikely to be found at high densities, Jonsson (1995: 152) suggests that there were a valued resource. He suggests that the spread of the hedgehog (which requires open landscape and is hindered by hilly terrain) in Sweden was deliberately encouraged by human populations. Hedgehog certainly appears to have been introduced by humans to the island of Gotland in the Baltic (Jonsson 1995: 152).

Other very small mammals, such as mice, frogs etc. might have provided an additional resource at certain periods of the year, though given their small package size and difficulties in



capture they are unlikely to have been a significant subsistence resource.

With any small mammals it is always difficult to determine if the faunal remains recovered on archaeological sites were the result of human exploitation or were animals which died when hibernating, burrowing, or were brought to the site by predators. For example, though remains of red squirrel were found at Carding Mill Bay in Scotland (McCormick and Buckland 1997) it is not clear if these bones were an exploited resource or an intrusive element. Conversely, small mammal food resources could have been important in subsistence, although they are often overlooked on archaeological sites precisely because they are not commonly considered to be an element of diets.

In contrast to the problems of identifying exploitation of small omnivores such as squirrels, we can be much more confident about the direct exploitation of predator species - carnivores - from a number of British Mesolithic sites, since many of these bones have cut marks indicating butchery (Charles 1997). At Thatcham remains were recovered of badger, fox, wild cat, wolf and pine marten (Wymer 1991). Bones of pine marten, badger and red fox have also been recovered at Star Carr (Clark 1954; Smith 1990: 113). Nonetheless, although clearly *exploited*, the presence of carnivores in Mesolithic faunal assemblages does not necessarily signify their importance as a food resource. In Denmark, several specialist sites for the exploitation of fur-bearing mammals predominantly for their pelts have been discovered, such the site of Ringkloster (Rowley-Conwy 1984) which appears to have been a specialist camp for the exploitation of pine martens. Nonetheless, even if carnivorous mammals were not a preferred resource, they might still have been important in the 'poor season' or poor years.

The densities of small mammal predators could have been very variable in different environments. Whilst the densities of small herbivores and omnivores are dependant on plant food and insects, the densities of predators would be largely dependant on the availability of their prey. Diets of small mammal predators are often quite varied however, the diet of red foxes includes beetles, earthworms, birds, fruit and carrion (Charles 1997) as well as small mammals. Badgers also eat similar foods, predominantly exploiting earthworms. In general terms, the densities of small carnivores would be highest in open woodlands with a rich soil litter, as these environments would support a rich ground layer vegetation with densest insect and small mammal fauna.

In riverine environments, another small mammal, the beaver, would have been found. The bone remains of six or seven beavers, with cut marks, were recovered from Star Carr (Clark 1954; Fraser and King 1954; Charles 1997). Beaver could have been an important source of fat, since 30-40% of their body weight is fat, even in winter, as well as a source of meat, teeth and pelts.

Beavers inhabit lakes, rivers and streams, especially near the coast. They largely exploit tree bark, buds of willow and birch and various aquatic herbs and plants. Keene (1976) reports that the optimum season for beaver exploitation would be the winter, when they are slow moving and in

predictable locations, although Renouf (1989) states that they are also easy to catch in spring when they are lethargic. At Star Carr, the beaver recovered were largely immature and it is possible that a whole family may have been killed whilst in their lodge.

There are a number of historical and ethnographic examples of beaver exploitation. In northern Finland and Sweden, beaver were historically exploited in winter using cages, traps or nets (Broadbent 1979: 183). Beaver exploitation was also important amongst hunter-gatherer groups in northern North America, especially earlier this century, and particularly for pelts for the fur trade. Keene (1976: 99) after Kinitz (1965: 328) notes that among the Ottawa a good hunter would bring home as many as a dozen beavers in a day. Interestingly, many groups, such as the Ottawa, have been noted to deliberately conserve beaver stocks, by varying the lodges exploited each season and by leaving breeding pairs in a lodge (Keene 1976: 100 after Kinitz 1965: 237). However, Leacock (1954: 3) suggests that for the Montagnais of Canada, the conservation of beaver lodges might be a relatively recent practice adopted in historic times to preserve yields for the fur trade. However they were exploited, beaver lodges would probably be well known to Mesolithic populations and beaver could be especially valued as a source of fat in the lean months.

Beavers became extinct in the twelfth century or later (Jones and Keen 1993). However, otters, sometimes confused with beavers (although otters and carnivores rather than rodents) survive to the present. Otters largely exclusively occupy coastal environments, although they are also found in fast-flowing inland rivers. They are largely solitary animals and are today very difficult to approach in the wild. Like the small carnivores noted above, otters may however also have been an important source of meat, as well as hides. Butchery marks on the bones of otters at Cnoc Coig, Oronsay, Scotland (Mellars 1987) however suggest that these otters were taken principally for their pelts.

PLANT FOODS

It is noticeable that land mammals, and large land mammals in particular, have in the past not only been considered the main resource in early interpretations of subsistence practices, but moreover were seen as the *only resource of interest*. Two events changed perspectives on large land mammals, and introduced plant foods, rarely ever recovered and practically invisible on archaeological sites, as a potentially major component of diets. The first event was the 'Man the Hunter' symposium in Chicago in 1966 (Kelly 1995). Here, a range of archaeological researchers discussed general principles of hunting and gathering societies. Lee's work amongst the !Kung (Lee 1968; 1969; Lee and deVore 1968) was particularly influential in a re-appraisal of hunting and gathering. Mongongo nuts, rather than game animals, appeared to be a major staple for these people (who inhabited a semi-arid region of southern Africa). It was thus concluded that the role of large animals in contrast to plant foods in hunter-gatherer diets had been much inflated.

The second event, following on from this change in perspective, and from studies of the potential advantages of plant foods, such as Dimbleby's (1967) *Plants and Archaeology*, came Clarke's (1976) essay *Mesolithic Europe: The Economic Basis*. Clarke (1976: 464) pointed out the large numbers of edible plant species which should have been available in the Mesolithic (200-450) and the biased nature of an archaeological record in which faunal remains are the primary evidence of subsistence. He also made a fundamental point - that it is not just biased evidence that influences our interpretation of Mesolithic subsistence but also the current academic and social climate. Furthermore, Clarke (1976) also noted that the dominance of microliths in Mesolithic assemblages, interpreted as barbs for arrows used to hunt large game, had been a major influence on the concept of the dominance of large game in Mesolithic diets. Clark countered this perspective by suggesting that microliths might have performed other functions as plant processing equipment (1976: 453-456).

In view of this change of perspective, and although it is often difficult to determine with absolute certainty if 'native' plants were available in the Mesolithic (Mabey 1996), the discussion below demonstrates the range of possible plant foods available to Mesolithic populations, several of which have been recovered from archaeological sites in northern England, the British Isles as a whole, and in the rest of northern Europe.

Nuts

The key element in arguments for a major role for plant foods in hunter-gatherer diets has been nut resources, and in Mesolithic Europe specifically hazelnuts and acorns. Nuts would have been readily available, with nut producing trees being typically abundant in the wooded environments which characterised the Mesolithic. Nuts are high in protein and fat, moreover in the highly seasonal environment of temperate north-west Europe they are a storable resource. In fact, nuts are even known to provide a staple resource for certain hunter-gatherer populations. Baumhoff (1963: 223) has shown that in the California province of the American West

coast, acorns (alongside game) were a major predictor of population densities.

Unfortunately, plant foods are largely an 'invisible' component of diets. However, charred nut remains present something of an exception, and thus there *is* evidence for nut exploitation in Mesolithic northern England. Remains of charred hazelnuts have been recovered from four sites - Star Carr (Clark 1972), Blubberhouses Moor (Davies 1963), Thorpe Common (Morrison 1980) and Cass ny Hawin (Woodman 1987). Charred hazelnuts have also been found at twenty other British sites (Zvelebil 1994) and both charred hazelnuts and charred acorns have been recovered from Mount Sandel in Ireland (Woodman 1985b; Wijngaarden-Bakker 1989). Nygaard (1987: 149) even noted that in South-western Norway *'there is hardly a site without some remains of charred nutshells'*.

The availability of nut resources is dictated by the distribution and density of nut producing trees. Both hazel (producing hazelnuts) and oak (producing acorns) would have been common trees in postglacial forests, although the distribution of the two tree types varies somewhat and changed throughout the period. Hazel was a major component of Early Mesolithic forests (Iversen 1973; Birks 1989). It would probably even have grown as forest stands (Bennett *pers. comm.*) prior to competition from more shade-tolerant species. The spread of dense deciduous woodland in the lowlands from the Early to the Late Mesolithic would have restricted hazel distributions however. By the Late Mesolithic, hazel would still have been abundant in the upland zone, as a major component with birch of the upland forest, and as a scrub above the closed canopy woodland (Simmons 1996: 21) but would have been restricted to clearings or edges of climax woodland in the lowland zone (Simmons 1996; Keene 1981: 70). Oak, in contrast, arriving to Britain at the end of the Early Mesolithic, would have been a major component of these Late Mesolithic woodlands.

Both types of nut are ripe in autumn but there are distinct differences in availability, collection and processing of the two species. Whilst hazel produces nuts fairly consistently, oak typically produce a good 'mast' crop only every 3-4 years (Keene 1981). There is also a lot of *yearly* variation in acorn production, Park (1942) illustrates that total crop failure is common, production is spatially very variable and only 20-30% of oak trees bear fruit in any given year. The effects of competition from the many animals (such as squirrels or wild boar) which exploit nuts can also be important. Keene (1981: 70) for example notes that the Meskwaki of the North American Great Lakes collected nuts before they were ripe because of competition with animals. A further advantage of hazel is that hazel, unlike oak, can produce abundant nuts even when subject to heavy wildlife predation.

As well as collection costs, the costs of processing are another factor to consider. On top of being less predictable as a resource, acorns also require more intensive processing than hazelnuts. Both types of nut require time-consuming collecting, and shelling (although hazelnuts are easier to shell if dried, Keene 1981: 72), however acorns must also be leached (in hot water or in cold if previously broken) for



several hours to remove tannic acid (Keene 1981: 75), so the costs of processing are particularly high.

Paradoxically, though hazelnuts appear to be a more attractive resource, it is acorns, rather than hazelnuts, which are most commonly a staple food amongst historic native populations in the Great Lakes and throughout the Eastern United States (Keene 1981: 55) as well as California (Baumhoff 1963). However acorns may not have been the most important nut resource in the European Mesolithic. For one thing, American and European oak trees are a different species, with the latter not necessarily as suitable for exploitation (in fact acorns are rarely even fed to livestock in Britain because they are noted to give digestive problems). For another, the processing of acorns in the Eastern United States involves the use of mortars for which we have no evidence in Britain. A further factor is that it is, in any case, *hazelnuts* which are the most common charred nut remains on archaeological sites.

The main reason why nuts figure so highly in arguments for the importance of plant resources in diets is that the energetic 'returns' on nut exploitation are relatively high (ranking for some authors in the range of, and even above, small game animals - Perlman 1980, see table 3.2). Most other plant foods are less obvious candidates for being a major food source, with greens or fruit for example, showing relatively less energetic returns. Some other plant foods, being less 'visible' than nuts, are however overlooked and might nonetheless have been important. Roots and tubers, for example, are a valuable source of carbohydrate, and can be important in winter when other resources are scarce (Keene 1981; Dimbleby 1967). In fact, it is often these types of resources which, though not necessarily a major contributor to overall diets are often the major determinant of population numbers (Casteel 1972).

Roots and Tubers

There is little archaeological evidence for the exploitation of tubers, which normally decompose rapidly. One unique exception in Britain is in Scotland, at Staosnaig on Islay, where fragments of charred tubers of an edible species of buttercup were recovered (N. Finlay *pers. comm.*). Indirect evidence may survive however. It has been suggested that perforated antler or bone mattocks found in northern England, (Wymer 1991: 24, Wickham-Jones 1994: 94) or stone picks in southern England (Palmer 1977: 184), may have been used for digging up roots and tubers. Certainly, macroscopic wear traces and damage on antler and bone mattocks are consistent with their use as heavy duty digging tools (Smith 1989).

Whilst archaeological records for the exploitation of tubers are limited, historical records do document the exploitation of native tubers in Britain. Pignut roots, found in open woodlands are noted to have been a delicacy for example. Mabey (1996: 288) notes a comment that '*you could dig up enough [pignut] to feed four people in half an hour*'. Tubers were even important as a staple in times of famine. The roots of silverweed which would have grown in more open areas and waste or disturbed ground, were once eaten in upland regions and even dried and baked into a flour (Mabey 1996: 186) when wheat flour was scarce.

Tubers are in general most abundant in damp environments. Terrestrial tubers are commonly found at stream edges and in damp woods, and in Britain are associated with alder woods (Rieley and Page 1990: 66; Mabey 1996). Aquatic tubers would have been abundant at the edges of ponds, lakes and slow-moving rivers. White water lily for example, growing in relatively deep water would have produced productive storage organs throughout the winter (Tilley 1979: 19; Price 1989: 50). In shallower water, tubers of water plantain, water parsnip, and clubrush would have been available, with sedge communities also providing edible roots (Clarke 1976). At the coast, wild carrot could be locally abundant, with two species of wild carrot, one common on cliffs and the other on dunes and grassy places near the sea (Soothill and Thomas 1987). Other species of plantains and edible roots such as sea parsnip would be found on the muddy margins of intertidal rivers. Tubers are also found in less damp environments, wild parsnip for example would have been found on chalky soils (Mabey 1996).

Tubers are most abundant in late spring and autumn, with some species still potentially being important resources throughout the winter. Additionally many species, such as wild leek and wild onion in terrestrial environments, and white water lily in aquatic environments, also produce edible greens that can be used in the spring. In autumn, where tubers are concentrated, the time taken to gather and process this resource is the main limitation on exploitation rather than availability (Keene 1981: 85; Dimbleby 1967).

Though often overlooked, tubers *are* important for certain ethnographic populations. Tubers were even dried for storage by the historic populations of the temperate forests of the Great Lakes (Keene 1981: 83) and also figured very highly in the diet of groups in arid environments such as in areas of Australia (Cane 1987). Hence, as a resource, they would have been abundant in damp, open environments in the Mesolithic, even in the winter months, could have provided a valuable source of carbohydrate, and would generally not have been difficult to process.

Another resource which can easily be overlooked, yet can also be a source of carbohydrate available in winter months, are seeds.

Seeds

Seeds, like tubers, are rarely preserved. Nonetheless, wet-sieving of occupation levels in Scotland, at Morton in Scotland (Coles 1971) did reveal a few seeds typical of waste land (chickweed, fat-hen and corn spurrey). Fat-hen seeds (goosefoot or pigweed) were also recovered at Mount Sandel in Ireland (Zvelebil 1994; Monk and Pals 1985). Fat-hen is however typically associated with later prehistoric and historic occupation areas, its densities being limited in the Mesolithic since it is largely a coloniser of disturbed ground (although densities could be increased by burning). Paradoxically, although the main evidence for seed exploitation in Mesolithic Britain comes from a species typical of dry areas, the best potential environment for seeds is actually in aquatic and damp environments such as lakes and slow-flowing rivers. In these environments the yield of Clubrush seeds, for example, outstrip by 30% that of most

modern dry-land cereals (Phillipson 1966: 37). The seeds of many lake plants, such as yellow water lily and white water lily, are also known to be potentially important edible resources (Clarke 1976). In fact, yellow water lily seeds were recovered from excavations at Derravaragh in Ireland (Zvelebil 1994; Morrison 1980; Mitchell 1972). Moreover, at the coast other seeds would also have been available such as sea clubrush, growing in muddy inter-tidal rivers.

Fat-hen seeds were an important resource for hunter-gatherer groups in the Great Lakes (Keene 1981). They were gathered in autumn with the best yields being after the first frost. Nonetheless although seeds are very *productive* (as noted above for clubrush), the costs of exploitation are very high. Seeds are time-consuming to remove from husks, and also need to be cooked to make them edible. Thus, significant seed exploitation is a possible strategy for hunter-gatherer groups to adopt where resources are very limited, or where population pressure is intense. However, the processing costs of seed exploitation tends to make seeds less attractive than other resources, and groups which are heavily dependant on seeds tend to only be found in arid environments (Wright 1994) where other resources are often scarce.

Apart from nuts, tubers and seeds, most other plant resources could make only a minor contribution to diets in terms of energetic input. However, other plant resources often provide important nutrients, especially vitamins. As such, other plant resources such as greens and fruit might, for example, have dictated exploitation patterns in certain circumstances.

Greens

Like tubers, there is limited evidence for the exploitation of greens (the edible leaves of undergrowth plants). There is no evidence for the exploitation of greens in Britain, but sorrel has been recovered from Mesolithic occupation levels at Ageröd V in southern Sweden (Zvelebil 1994; Larsson 1983; Göransson 1983). Many species are however known to have been eaten in the historical past, such as sorrel, cowparsnip, dock and cress (Mabey 1996). Even the common nettle proved useful as a subsistence resource in the Irish potato famine and in the second world war (Mabey 1996).

Terrestrial greens would have been abundant in spring, alongside streams and in damp woods, although in general terms, greens would be available wherever sufficient openings existed in the forest canopy. Aquatic greens include edible watercress (Clarke 1976: 465) which can grow densely in lakes and in slow-flowing rivers, as well as marsh marigold, cress and sedges (Soothill and Thomas 1987). At the coast, wild cabbage, fennel and sea kale occur on sea cliffs, sea rocket and sea holly along the drift line, with wild celery in rivers and ditches near the sea. The most famous of coastal greens include some species of seaweed - such as dulse, Irish moss and laver - that continue to be eaten along the western coastline of Britain in the present (Mellars 1978: 379-380).

The major 'cost' of exploiting greens is in collection, especially as these types of plants are often widely scattered. The leaves also often need to be boiled (although sorrel can be eaten raw and is eaten in salads today). Though greens might seem an attractive resource, the greens which we eat

today from supermarkets are very different from their wild ancestors, wild greens such as sorrel and chicory are usually described as 'bitter tasting' or 'sour', or as in the case of wood sorrel, are slightly toxic in large quantities (Mabey 1996: 96).

Fungi

Like greens, many different species of fungi would have been available in Mesolithic forests, with most species of fungi preferring damp, dark environments. Edible fungi (such as puffballs, Bassett 1997) are generally collected in autumn, and tend to concentrate in the same locations each year as they grow from underground, thread-like *mycelium*. Fungi would also be a valuable source of additional vitamins and minerals, though again, like greens, of only minor energetic benefit.

Fruit

There is no direct evidence for the exploitation of fruit in northern England. However wild pear or apple seeds have been recovered in Ireland at Mount Sandel (Zvelebil 1994; Woodman 1985b), raspberry seeds at Newferry (Zvelebil 1994; Woodman 1978b) and in Scotland, barren strawberry seeds at Lussa River (Zvelebil 1994; Mercer 1970). Though hardly a dietary staple, fruit may have been an important source of vitamins and minerals in late summer and autumn as well as a source of dietary variety.

Fruit could generally either be available from shrubs (shrub fruit) or trees (tree fruit). Strawberries, on the other hand, would grow as an undergrowth plant. Most shrubs in open deciduous forest bear fruit, though not all of this fruit would be edible (Keene 1981: 76). Brambles may even form 70-100% of the cover in forest clearings. Though closure of forest openings takes 7-10 years, dense stands of certain species can even survive for around 15 years (Keene 1981: 77). Crop failure is not common with shrub fruit, and the time of ripening is consistent. However, the collection of shrub fruit is time-consuming, and, as with nuts, predation by small animals and birds on shrub fruit can be heavy. In reality, the presence of these thorny fruit shrubs in open forests may have been more of a curse than a blessing since brambles would have made access and movement extremely difficult. Tree fruit provide an alternative fruit resource. These tend to be found in open woodlands, since fruit trees, such as wild cherry, are shade intolerant. The cost of exploitation of tree fruit is also high however (Keene 1981: 82) as fruit ripens unevenly, is difficult to access, and mature trees tend to be widely distributed.

The availability of bush and tree fruit would have changed as forest types and distribution changed throughout the Mesolithic. Neither fruit shrubs nor trees are shade tolerant, and undergrowth plants supporting strawberries also need light conditions. The gradual closure of the lowland forest canopy would thus have restricted fruit distributions in the lowlands to gaps in the forest canopy caused by tree falls, or at the edges of rivers and lakes.

Fruit are sometimes collected by ethnographically documented populations for winter storage. Hawthorn fruit, growing in clearings and stream banks, were collected in autumn by Great Lakes populations and dried for the winter (Keene 1981). However in general terms, fruit are never a major resource, often being difficult to collect and in some



cases (particularly tree fruit) also unreliable with frequent crop failure.

One resource, strictly a 'fruit' although often classed as a nut, which might have been important is water chestnuts (Rowley-Conwy and Zvelebil 1989: 55). Water chestnuts have been recovered from a number of archaeological contexts in northern Europe, sites such as Ageröd V (Zvelebil 1994; Larsson 1983; Göransson 1983) and Skateholm (Zvelebil 1994) in Sweden. Although present in the British Isles in the Early Holocene, water chestnuts have not been recovered from Mesolithic sites. Like waterlilies they are found in lakes and ponds, like true nuts they could have been an important source of protein.

Other edible plant resources also exist, such as tree sap, shoots and bark, although these parts are not known to be dietary staples. Tree sap is known to have been eaten by several North American hunter-gatherer groups, including those in the Great Lakes (Keene 1981: 87), however there is no historical records of the exploitation of sap in Britain. Lucas Bridges (1948: 304) comments that whilst tree sap is eaten by the Ona of Tierra del Fuego, only very small amounts were consumed as sap can be difficult to digest. Even tree shoots can be eaten if cut young and boiled (Dimbleby 1967), nevertheless, like tree sap, tree shoots were probably not palatable in any great quantity.

Even if plants are not edible they may still be an important part of exploitation strategies. In the same way that animals are often exploited for bones, antler and skins as well as for meat, plants may also be exploited for different reasons, with many plants having important 'non-subsistence uses'.

OTHER USES OF PLANT RESOURCES

Although we are largely concerned with subsistence resources, it is worth noting that non-food plants may have been as important in influencing hunter-gatherer settlement systems as food plants in certain circumstances. Keene (1981) points out, for example, that of the 130 plants recorded by Yarnell (1964: 79-88) as economically important only 48 were used solely for food. Trees and bushes are perhaps the most obvious key plant resources. Although much of Mesolithic Europe was covered by forests, very specific trees and bushes with certain characteristics (such as strength or length of straight stem) would be required to make bows, projectile hafts, boats or canoes and shelters, and these specific requirements might only be met by trees in specific locations. Plants are also used to make traps and nets, shelters and means of transport (canoes such as that recovered at Friarton, in Scotland, Wymer 1991: 37) as well as containers and as a source of firewood. Certain plants can even perform very specialised functions, soft rush for example, can be dipped in fat to make lights, and soapwort can be used as a detergent (Mabey 1996).

A further non-subsistence use of plants is as medicines. Several mainstream medicines include remedies derived from native British plants, including aspirin (from willow bark), colchicine, used to treat gout (obtained from meadow saffron) and digoxin, used to treat heart attacks (obtained from foxgloves) (Mabey 1996). Those medicinal plants which were used in the Mesolithic may have included common comfrey amongst others. Comfrey is found by streams and rivers and its roots are usually exploited in the spring. Comfrey is also known as 'bone set', as it contains allantoin which promotes healing in connective tissue when applied (Mabey 1996: 307). It was eaten widely in the second world war but can cause liver damage in large quantities. Other remedies include common valerian, which can be used as a sedative and grows on the chalk downs as short plants, as well as on river banks and woodland clearings. Foxglove can also be used as a heart stimulant (although it can be lethal), and dandelion is a diuretic, which can be used to prevent gout. Lastly, hop grows on fens and river banks, it is recommended as an appetite suppressant, pain killer and sedative (Mabey 1996).

DISCUSSION

There would clearly have been an wide range of different plant resources available to Mesolithic populations, several of which could have been an important source of fat, protein and energy, as well as essential vitamins and minerals. Evidence for a range of plant resources has been recovered from archaeological sites. However, one problem with the archaeological evidence for plant exploitation is that whilst faunal remains may provide clear evidence of butchery, the presence of edible plants on a site is not necessarily evidence of their exploitation. Plants can be accidentally charred, and might have either grown near to a site or been brought to a site for non-subsistence purposes. A further limitation is that, even *evidence* of exploitation would not necessarily provide any indication of the relative importance of any species in particular or of plant resources in general.

There are several reasons why the role of plant foods in diets may have been overemphasised by the results of the Man the Hunter symposium, and by Clarke's (1976) essay.

The most obvious relates to the source of inspiration for the importance of plant foods. Many of the surviving (and studied) hunter-gatherers, specifically the !Kung, who formed the basis for ideas about typical subsistence practices, tended to live in the most arid regions of the world. These are the regions where plant foods have been found to be relatively more important in hunter-gatherer diets than in other environments (Kelly 1995), and because of this the wider role of plant foods is often overemphasised. Kelly thus points out that the '*generalisation that hunter-gatherers rely primarily on plant food is the result of differential ethnographic documentation*' (Kelly 1995: 70). Equally, the factors governing the exploitation of different resources are now realised to be much more complex than was initially assumed. Those who supported the idea of a dominant role for plant foods focused particularly on the abundance and high yields of plant resources. However, the importance of plant foods in the subsistence strategies would be affected by several criteria, not only abundance, yields and nutritional value (whether calories, protein, fat or minerals) but also search time, ease of procurement and processing as well as location in relation to other resources (water or good areas for hunting game or fishing) and of course, palatability. Animal foods in general are much less time consuming to process than plant foods, and animals, being higher up the food chain than plants, provide a mix of complex nutrients more similar to our own than any plant resources (Kelly 1995), thus often being a preferred resource.

Another point to consider is that, though the range of plants available to Mesolithic hunter-gatherers is large (Clark 1976) not all plants would have been edible. Dumbleby (1967) and Simmons (1996: 163), for example, propose that bracken was a major edible plant food resource, with Simmons even classing hazel and bracken as the most important plant foods (1996: 192). Bracken rhizomes can of course occur in large numbers in unforested and open forest habitats. However, Mabey does not include bracken as an edible plant and no records have been made of the use of bracken for food in Britain. Mabey (1996: 17) describes the young shoots being eaten as food in the Near East, but bracken is toxic to all

animals and carcinogenic if eaten in excess. Even where plants are strictly edible when leached or boiled, like acorns, many may be toxic without processing.

The issue of the role of plant resources in Mesolithic diets has been one over which there has been little academic agreement. Several authors have maintained the importance of large land mammal resources in their interpretations. Smith (1990: 15) for example considers that subsistence practices in the Mesolithic might reasonably be taken to comprise 80% ungulate meat, with the rest being derived from small game, waterfowl and fish, as well as plant foods. Rowley-Conwy (1980: 189) suggests that diverse plant foods would have been scattered and '*unlikely often to have been as overwhelmingly important as Clarke makes out*'. On the other hand plant resources are considered to be of prime importance by other researchers. Wymer (1991: 24) proposes that '*on the basis of ethnographic parallels, it would not be surprising if the diet of Mesolithic peoples consisted of a very high proportion of vegetable food*'. Simmons (1996) accords an important role to many plant foods including not only hazelnuts but even bracken rhizomes. Zvelebil (1994: 58) proposes that the contribution of plant foods to the diet was probably greater than the 15-20% estimate which is commonly used, and the use of plants more intensive than has been supposed. He makes a case for '*wild plant food husbandry, rather than the opportunistic use of plant foods, across Europe in the Mesolithic*'.

Interpretations of the importance of plant foods in Mesolithic subsistence are also affected to a great extent by preconceptions of the period, as much as by what very limited evidence exists for subsistence practices. Though the proportions of plant foods in diets are often estimated with confidence, these estimates vary widely, from 5% (Rozoy 1978 for France and Belgium) to 80% (Clarke 1976) with 15-20% being the most common estimate (Jochim 1976 for south-west Germany, Price 1978, for the Netherlands, Zvelebil 1981 for Southern Finland), as noted by Zvelebil (1994: 58). Explicit models have been used to determine the relative role of different resources, however these approaches are seriously limited by biases in ecological and ethnographic evidence used to construct them (see chapter four). Certain key characteristics clearly influence which resources are exploited, and how they are exploited, but specific regional and historical circumstances make precise determinations of subsistence difficult (discussed below).

Whatever their overall contribution to diet, plant resources may nonetheless have been important however because they are an abundant, predictable and an easily managed resource. Plant resources may provide reliable resources in very variable environments, and also may be vital as a backup resource in poor seasons, either through the exploitation of surviving tubers or through storage, for example of nuts. In fact, plant resources may also exert an influence on settlement systems which is not necessarily proportionate to their subsistence contribution. Known hunter-gatherer societies commonly operate on the basis of a division of labour, with women tending to be more responsible for the collection of reliable resources such as the gathering of plant foods and collection of fish and small game, and men being concerned with hunting larger prey (Jochim 1988). Although



the extent to which women are involved in hunting either in communal hunts or in the routine hunting or trapping or snaring of small mammals does vary, the resource exploitation system is nonetheless planned to accommodate the procurement of both 'male' and 'female' resources. It is these 'female' resources, predominantly plant foods, which, being heavy and bulky, have the most influence on the location of long term occupation sites ('base camps'). Thus the distribution of plant resources (largely in damp environments and open woodland) is crucial in that it is these resources, whatever their contribution in calorific terms, which often determine the location of these larger and longer term occupation sites.

Apart from their direct relevance to discussions about Mesolithic subsistence practices, suggestions that plant foods played a major role in subsistence have also had the indirect effect of broadening the scope of discussions of subsistence. One other major group of resources, marine resources, which in all but select locations are also invisible in the archaeological record, subsequently came to take over from plant foods as the 'crucial but often overlooked resource' in the 1980s. Marine resources (or coastal resources in general) began to be seen as the key not only to subsistence practices of coastal groups but also to the important social changes taking place in the Mesolithic.

MARINE RESOURCES

Academic attention has been focused on marine resources following the recognition of the importance of these resources to sedentary and semi-sedentary hunter-gatherers, such as groups on the Northwest coast of North America. For these groups, the availability of year-round resources at the coast, particularly marine resources such as sea mammals and fish, resources at the shoreline such as shellfish, and migratory resources, especially salmon, appeared to be the key factor sustaining sedentary communities and allowing the developments of elements of 'social complexity' such as storage, distinct territories and cemeteries (Price and Brown 1985; Keeley 1988; Rowley-Conwy 1986).

As discussed in chapter one, the main focus of our discussion is on inland groups. However, a consideration of coastal resources is nonetheless important, partly because these resources may have been an element which was included in the seasonal exploitation schedule of inland groups, as well as because some resources which are typically considered as coastal resources, such as salmon, are also exploited inland, and equally because models of subsistence and settlement which have been built around the exploitation of coastal resources provide a key contrast to models proposed for inland settlement systems (discussed in chapter four).

We shall start with the largest and most obvious marine resources available to Mesolithic populations, that is, large sea mammals - such as whales, porpoises, dolphins and seals.

LARGE SEA MAMMALS

Whales (such as sperm whales or rorquals) are the largest sea mammals which might have been exploited in the Mesolithic. Whale bones were recovered in Scotland from Caisteal nan Gillean midden on Oronsay in the last century, and at Priory Midden in more recent excavations (Smith 1990: 150; Mellars 1987). McCormick and Buckland (1997) also note the remains of stranded whales at the Forth of Firth, dating to between the mid-eighth and mid-seventh millennium bp, associated with red deer antler mattocks which may have been used to dismember the carcasses.

Different species of whale are present off the coast of Britain at different times depending on their migration patterns. Although it is not *impossible* for whales to have been hunted at sea using boats, this would have been an extremely difficult and treacherous operation. Vorren and Manker note that the coastal Sami in Varangerfjord did hunt small whales driven up to shore by killer whales, by using spears and pointed sticks from boats and *'might get up to ten small whales this way'* (Vorren and Manker 1962: 59, cited in Renouf 1989). In general, for these people *'whaling was a rather ... fortuitous business and mostly consisted of keeping an eye open for the carcasses of dead whales which washed ashore'* (Vorren and Manker, as above).

Whilst not a predictable resource, stranded whales would nevertheless have been an extremely valuable resource, which because of their sheer size could feed a group for a long time. The opportunistic exploitation of the fat of beached whales could have been important particularly in times when only lean protein was available (the winter *'protein metabolism problem'* described by Speth and Spielman 1983). Lucas Bridges (1948: 313) comments that for the Ona of Tierra del Fuego *'a whiff of a whale from leagues away was their intimation of this vast treasure of food; and they never wasted time in hastening to the scene'*. At certain locations opportune, if not predictable, beachings might have been common. At Gressbaken in Varangerfjord (in the far north of Norway and so not within the map area of **figure 3.1**) a large number of whale species were represented in the Mesolithic faunal remains. It may be no coincidence that the coast at this point is conducive to whale strandings, with shallow waters and a gradually sloping foreshore that would distort echo signals (Renouf 1989: 210).

Dolphins, another large sea mammal resource, like whales, would also have been difficult to exploit at sea, but unlike whales are not susceptible to beachings. Remains of dolphin or porpoise were recovered from Cnoc Coig midden on Oronsay (Mellars 1978; 1987), though it is unclear if these animals were hunted or isolated examples of opportunistic exploitation of dead animals washed ashore.

Seal bones were also recovered from the Oronsay middens. In fact, remains of grey seal, at least nine or ten individuals including pups and adults, make up about 60% of the fauna recovered from this site. Seals, like whales and dolphins, are also difficult to exploit at sea, but unlike whales or dolphins they do come to shore at predictable times and locations where they would have been much easier to exploit. In the

breeding season (September to December), and in summer when onshore with young, large concentrations of animals would be present in coastal locations. Two main species of seals would have been available, grey (or Atlantic) seals and common seals. Grey seals collect on rocks in large colonies where they can still be seen all round the British coast except in the South. The smaller common seals, still found off the east and north-west coast of Britain today, are more likely to be found in small family groups in sheltered bays. Another difference in the possible exploitation of these two species is that whilst grey seal pups would have been on shore for two months before going to sea, common seal pups go to sea almost immediately (making them more difficult prey).

Though it is generally assumed that seals were caught at the coast, they might potentially also have been caught up-river. In Norway, seals move up-river in autumn following abundant salmon runs (Renouf 1989: 34) and in historic times they were caught in these locations in nets.

Seals could thus provide an important and potentially storable source of meat and fat as well as hides. Unlike large land mammals, seals are much less susceptible to over-hunting, and even winter seal meat is very fatty (whilst terrestrial mammals are normally very lean in winter months). It has been suggested that seal hides were particularly important in Ireland, as red deer did not colonise the island until late in the Mesolithic, and the main other large terrestrial mammal - wild boar - does not have hides suitable for use (Wijngaarden-Bakker 1989).

Apart from direct evidence for seal bones on archaeological sites, there is also possible indirect evidence for the hunting of large sea mammals. Bone or antler 'harpoons' which might have been used for hunting seals, as well as fish, are characteristic of the British Early Mesolithic. Several bone harpoons were recovered from Star Carr (Clark 1954).

Marine environments also support other, potentially equally as important resources, including marine fish. As is the case with whales and dolphins, a lack of knowledge of the sea-faring capacities of Mesolithic populations and their precise means of exploiting different resources limits interpretations of the potential importance of marine fish.



MARINE FISH

Fish bones are not often preserved on archaeological sites, and methods of excavation are in any case rarely thorough enough for the recovery of fish bones. Like other marine resources (such as whale, dolphin and seals) the main evidence for the exploitation of fish in Mesolithic Britain comes from recently excavated Scottish coastal shell middens. Often one fish species dominates others at these sites. Over 90% of the identifiable fish bones at Morton were of cod, for example, (with haddock bones also recovered, Coles 1971). Mellars (1978; 1987) even suggests that the main reason for the occupation of the midden sites of Oronsay would have been marine fish, rather than shellfish. Whilst saithe make up 95% of the fish remains from Cnoc Coig (Mellars 1978; 1987), it is suggested that the shellfish recovered at the site may actually have been used as bait for catching saithe in inshore waters. Sea fish were also well represented at Risga, including skate, grey mullet and haddock (Wymer 1991: 37).

Several species of marine fish, such as cod, whiting, haddock, pollack, and saithe, could potentially have been caught not far from the shore using boats in autumn and winter. Since they are available in winter, marine fish could potentially provide an important 'poor season' resource. In fact Casteel (1972) has demonstrated that for the Chipewyan, fish availability was the main determinant of population numbers. Furthermore, fish are also potentially important as a potentially storable resource. Amongst marine fish, cod and saithe could be dried directly, but more oily fish would need to be salted to be stored.

The 'returns' on sea fish exploitation are clearly heavily dependant on the technology used (with large nets for example making the exploitation of large numbers of fish possible). Evidence for the technology of fish exploitation in Britain includes a dugout canoe found at Friarton, in Scotland. This canoe, apparently capable of offshore transport, was about four and half metres long and a metre wide and made from pine wood (Wymer 1991: 37). Whilst bone or antler harpoons may have been used to spear fish, there is only one certain fish hook known from the British Mesolithic, this was recovered from excavations on Oronsay (Mellars 1978; 1987; Wymer 1991: 37). In Scandinavia however there is much more extensive evidence for fishing techniques, with waterlogged sites yielding nets, canoes, paddles (such as those at Tybrind Vig, Andersen 1985) and even eel traps (such as at Ageröd V, Larsson 1985), although it is difficult to assess how relevant the suite of techniques used in Scandinavia are to the British Isles.

One particular fish has drawn the greatest amount of archaeological attention, that is salmon. Although perhaps more appropriately seen as a riverine, rather than a marine fish, salmon spend most of their lives in the marine environment. They would however have been predominantly exploited at the riverine stage of their life cycle, when migrating up-river in annual salmon 'runs'. Salmon are a key element of discussion of possible sedentary societies, having been a major resource for American Northwest coast hunter-gatherer groups.

Salmon

The importance of seasonal salmon 'runs' in providing abundant storable food for semi-sedentary and sedentary Northwest coast populations in North America has attracted attention to the potential importance of salmon for Mesolithic populations. As noted above, fish bones are in general rare on Mesolithic sites, but in Britain those of salmon are particularly scarce. Bones of either salmon or trout (since it is difficult to distinguish the two) were however the dominant species among the 1800 fish remains at Mount Sandel in Ireland (Wijngaarden-Bakker 1989).

The relatively scant evidence for salmon exploitation contrasts markedly with their potential availability. Salmon would have been found in all British rivers in the Mesolithic, with the largest salmon runs tending to be on the largest rivers. There is a long history of salmon exploitation in Britain in general and in northern England in particular. In fact, in 1806 almost all the main rivers in England were prime locations for fishing for salmon - notably the Thames, Severn, Mersey, Trent, Medway, Exe, Usk, and Wye (see **figure 1.1**). Even a single angler could catch a phenomenal weight of salmon on these rivers - one man, Robert Pashley, hooked 9,800 salmon from the Wye between 1906-1951 (Netboy 1968). In fact, salmon were so abundant in the rivers of northern England that they have until recently been seen as a peasants' food - Thomas Bewick, a wood engraver in the 1760s in Newcastle, had an article inserted into each contract of apprenticeship that apprentices should not be forced to eat salmon more than twice a week, the same bargain being made with servants (Netboy 1968).

Salmon would be available at times of salmon 'runs' when fish migrate from the Atlantic and North Sea to the sources of major rivers to breed. In Britain today, the west coast rivers have mostly only summer-autumn runs, whilst in the east coast there are spring runs as well (Netboy 1968). This might have been a significant contrast in the Mesolithic, although it is uncertain if salmon behaviour was similar to that today, particularly given early postglacial changes in river flows, and rising sea levels. For the Tolewa of Oregon, Deith noted that groups based on rivers with a single salmon run were more dependant on acorn-gathering and hunting than those groups based on rivers with two salmon runs (Deith 1989: 74).

In general terms, where spring runs exist, early fish are in prime condition in the spring, schools of smaller 'gristle' appear later, with runs of full grown salmon peaking in July and tapering off in hot August days. Salmon runs resume in September to October (spawning November to January) and salmon arrive upstream by October-November in poor condition (at this time lower pools are empty). Although salmon runs rarely fail, the timing and productivity can vary markedly. Rowley-Conwy and Zvelebil (1989) illustrate the present variability of up-river salmon runs on the Clwyd and the Dee as a potential model for variability in the Mesolithic. Variable salmon runs are determined by climatic variability, mild winters for example will result in more spring fish than colder conditions, with salmon reaching the upper reaches of rivers earlier (February-March), and after a cold winter salmon will not reach upstream until April-May.

The main reason why salmon productivity in northern England today is low is due to both over-fishing and industrial pollution. Although the effects of over-fishing were already being felt in 1215, when legislation in the Magna Carta ensured that weirs were removed and salmon had free passage to spawning grounds (Netboy 1968), it was industrial pollutants and canalisation which sealed the fate of British salmon, particularly for the productive rivers of northern England. The major decline of the fish stocks occurred last century. By the time of the report on the salmon fisheries of 1869, of those English rivers that should have been productive, only a quarter produced any salmon (Netboy 1968).

As a resource salmon are potentially important because of the very large quantities of protein that can be collected in a very short time. Salmon runs in the Dee and the Don supplied London with over 700,000lb of salmon in 1817 for example. Their overall importance as a potential dietary staple in the Mesolithic however depends on whether they were collected to be stored during salmon 'runs' or simply exploited opportunistically to provide a seasonal resource.

Indirect evidence has been claimed as support for the role of *stored* salmon in subsistence practices at Mount Sandel in Ireland. Woodman (1978; 1985a) and Wijngaarden-Bakker (1989) suggest, on the basis of evidence for occupation at several different seasons (the presence of migratory fish species, the age of hunted wild boar and the presence of burnt hazelnuts), and on the basis of heavily built hut foundations, that Mount Sandel was occupied for most of the year, with winter occupation being dependant on stored salmon. Posthole arrangements at the site are interpreted as possible fish drying or storage racks, and several large pits may also have been used for storage (Woodman 1985a). Mount Sandel is ideally placed to exploit migratory salmon resources, and is close to other terrestrial and marine resources. The question of potential salmon exploitation is a difficult one however, since neither the presence of pits and hut floors, nor evidence for occupation at different times, provide significant evidence for either the intensive exploitation of salmon stocks or for permanent occupation.

However salmon is not the only riverine fish that could have been exploited. Other riverine fish include trout and eels. Sea trout also have optimal catches in the summer, but not with the densities of salmon 'runs'. In Norway, sea trout ascend the rivers later than salmon, usually about the end of July (Renouf 1989: 34). In contrast, brown trout do not migrate and are territorial. Brown trout can however reach high densities in Irish rivers today (Wijngaarden-Bakker 1989) and trout appear to have been one of the resources exploited at Lough Boora in Central Ireland, where a salmonid vertebrae could be provisionally attributed to brown trout.

Eels could also have been potentially important as a seasonal resource. Eel bones were recovered in Scotland from Risga (Wymer 1991: 37), and in Ireland at Mount Sandel and Lough Boora (Wijngaarden-Bakker 1989). In fact, of 200 identifiable fish remains at Lough Boora in Central Ireland, 77% came from eel. Eel runs are confined to the autumn months, with a maximum occurring in October. Unlike

salmon, eels spend most of their life in freshwater lakes and streams, only upon reaching adulthood do they migrate to the sea to spawn and die (Wijngaarden-Bakker 1989: 129). Eels might have been caught using pronged forks (eel forks) where they were visible in clear lake waters. Examples of such potential eel forks exist in Germany (Wundsch 1962 in Wijngaarden-Bakker 1989). They could however also have been caught in muddy waters by using nets or baited lines. At Ageröd V, fragments of a large wicker cage is likely to have been an eel trap (Larsson 1983).

Although trout and eels might also have been important resources, salmon appears to have been clearly the most abundant migratory fish resource in the Mesolithic. Nonetheless, the marine resource that has perhaps most characterised the Mesolithic however, regardless of its productivity, as noted in chapter one, has been shellfish.

Shellfish

Varying opinions have been voiced for the importance of shellfish in prehistoric diets, from being of 'minor dietary significance' to being a 'major food supply' (Bailey 1975: 45) - a discussion not dissimilar to that over the relative contributions of plant and animal resources.

There is evidence for the exploitation of shellfish at selected coastal sites in the British Isles. At the Scottish coastal site of Morton, Fife, cockle and Baltic tellin were the most common shellfish in the midden (Coles 1971; Smith 1990). At Oronsay the middens were largely dominated by limpet shells (Mellars 1978; 1987) and periwinkles and limpets with some crabs were recovered in the midden at Culver Well, Portland, Dorset (Wymer 1991: 35). Remains of crab were also recovered from Cnoc Coig midden on Oronsay (Mellars 1978). Crabs may not necessarily have been an immediate resource but, like shellfish at the Oronsay middens, may have been used as bait to catch marine fish.

Shellfish in general would have been most common on rocky shores, alongside other shoreline resources such as crabs, and a range of plant resources (discussed earlier). Shellfish would have been available year-round, but the condition and 'meat weight' do vary. For example, in Norway, shellfish are avoided when spawning, and are preferred in the Winter, around Christmas (Renouf 1989: 33).

The location and methods of exploitation of shellfish, as well as the optimum timing for exploitation, would vary between species. Inter-tidal species can be collected by hand, whereas those species that inhabit deeper water have to be collected using tools used from a boat (Renouf 1989: 33). Cockles prefer sandy environments and can be collected on beaches at low tide, whilst the periwinkle is tolerant of a wide range of conditions, including algae covered rocks, small stones, soft mud and occasionally sand (Renouf 1989: 32). The time at which species spawn also varies in different regions with cockles in Wales spawning earlier than those in Scotland (Rowley-Conwy 1984, after Hancock and Simpson 1962: 38; Chambers and Milne 1979). Rowley-Conwy (1984) notes that the optimum season for the exploitation of oysters coincides with a low point in the availability of other coastal resources in Denmark. Oysters are in good condition in February to April, and most accessible because of spring



tides, he thus suggests that they plugged a 'gap' in resource availability for the coastal Ertebølle (1984: 306). The low overall calorific value of oysters does however argue against their role as a key seasonal staple, at least unless supplemented by other resources such as tubers or even terrestrial game.

Shellfish are frequently stored by Northwest coast hunter-gatherer groups. However in Europe shellfish are smaller than in north America (with the exception of oysters) and winter storms do not restrict access to the shore, so storage appears less advantageous (Deith 1983). Shellfish were probably most important as a source of minerals rather than for their calorific value, on shellfish alone 700 oysters or 1400 cockles would only provide for one person for one day (Bailey 1978). Shellfish might also have added some variety to diets. Deith (1989: 73) notes that northern Northwest coast populations exploited a wide range of shellfish which were often small and had little food value, largely because their diet was dominated by salmon, and shellfish added dietary variety.

The relative importance of shellfish economies may have varied throughout the Mesolithic. It has been argued that shellfish may have become relatively more important through the Mesolithic of Cantabrian Spain (Clark 1983; Straus and Clark 1983), an argument which would tie in with a progressive diversification of the Mesolithic subsistence base (discussed in chapter one). In several Mesolithic shell middens in this region, both a decrease through time in size of limpet shells and an increasing representation of less easily accessible molluscan species are recorded (Bailey 1983: 162). The issue of progressive intensification is a difficult one however, as shellfish can be shown to be very susceptible to slight changes in ocean currents or salinity (N. Milner *pers. comm.*)

One further coastal, though not marine resource, which is often overlooked, but which, like salmon or seals may have provided an important seasonally abundant resource, are migratory birds.

MIGRATORY BIRDS

Seabirds can provide an abundant and predictable resource at coastal sites when nesting. At Morton, in Scotland, eleven species of birds were identified among the 217 bird bones recovered (Coles 1971; Smith 1990: 145), the most common being guillemot, gannet, cormorant and razorbill - birds which nest on rocky cliffs in the summer. Over thirty species of bird have also been identified from the Oronsay sites (Mellars 1978: 379) and again many would typically nest on cliff sites. Even quite large migratory birds may have been available. Bones of the now extinct great auk also were recovered from the Casteill-nan-Gillean midden on Oronsay (Clark 1948), and also from Risga (Wymer 1991). The great auk would have been a large bird and relatively easy to catch (which contributed to its extinction). Although a bird typically of shorelines in northern seas, remains of great auk have been found as far south as the Mesolithic site of Téviec in France (Clark 1948) and thus this species might well have been exploited at now submerged coastal sites in northern England.

Despite the pressures of industrialisation, pollution and impinging human settlement, major concentrations of migrating birds and of seabird colonies still collect at specific points along the coast in northern England today. Examples include several seabird 'colonies', such as over 1,000 breeding pairs of puffins, guillemots and kittiwakes at the Farne Island in the far north-east of northern England, and several sites for waders (such as the Dee estuary and the Humber estuary) where well over 25,000 individuals of any single species can be recorded (Soothill and Thomas 1987). The concentrations of these birds would be likely to have been much greater in the Mesolithic.

Concentrations of coastal birds were an important resource for some recorded hunter-gatherer populations. Although almost impossible to catch at other times, hunter-gatherer groups often exploit coastal birds when they are nesting as they can be clubbed or snared with a noose. Lucas-Bridges (1948: 332) described three different methods which the Ona of Tierra del Fuego use to catch cormorants when they were nesting on cliffs. Practised hunters could catch hundreds of birds at their nesting sites while they were asleep. At Mesolithic coastal sites in Denmark, similar specialised procurement of migratory birds appears to have been practised at specific seasons (such as whooper swan at Havnø in winter, guillemots and gannets at Ølby Lyng in the same season) as well as more opportunistic exploitation (such as of mute swan and mallard probably exploited in the summer at Mullerup) (Grigson 1989).

Although apparently a 'small package' resource, planned (or 'logistical') exploitation of coastal birds could provide an abundant and potentially storable resource. However, many other coastal resources such as salmon, trout, eels or seals for example, also have the same potential for exploitation and storage. Determining what role different coastal resources actually played, is clearly a difficult matter.

THE ROLE OF DIFFERENT COASTAL RESOURCES

The first issue in comparing the advantages of different coastal resources is that the 'returns' of each resource varies greatly with the method of exploitation. Many fish for example, can be exploited more efficiently using nets, rather than line fishing. Equally, the usefulness of large marine mammal resources, such as seals, depends on how effectively they could be hunted. Unfortunately, though there is some archaeological evidence for different methods of exploiting marine resources, such as canoes, fish hooks or even nets, this evidence is insufficient to build up a clear picture of exploitation strategies.

Whether resources were exploited intensively also depends on more than just available technology. What determines the subsistence strategy of any hunter-gatherer group, including whether resources are stored, are such factors as the structure of coastal environments (Rowley-Conwy and Zvelebil 1989), and also the history of subsistence choices taken by any population. Lourandos (1997) for example, notes that though abundant marine fish were available to hunter-gatherer populations in Tasmania, they were not exploited for cultural reasons. Another factor affecting whether resources are systematically stored is that storage often leads to sedentism, which is not an easy step for hunter-gatherers in coastal environments, since sedentism generates its own problems, such as localised reductions in large terrestrial mammal densities (Kelly 1995) and problems of diseases amongst large permanent populations.

The characteristics of coastal resources are of some relevance for predominantly inland populations. Coastal populations in northern England might have remained at the same occupation sites throughout the year, through exploiting both the abundance and storability of coastal resources as well as the winter availability of resources such as fish and shellfish. If this were the case, then given the dense populations and territorial nature of present sedentary coastal groups (Keeley 1988), we might reasonably expect coastal resources to have been largely unavailable (except by trade) to inland groups. If, on the other hand, settlement systems at the coast were more mobile or more fluid, then predominantly inland groups might exploit coastal resources as one element of a seasonal exploitation system, much like the Ona of Tierra del Fuego exploited coastal resources for limited period in winter (Bridges 1948; Borrero 1997). As discussed in chapter one, it seems unlikely, given the distribution of raw materials, that inland groups, such as those exploiting the Pennines, would have a subsistence strategy which involved a substantial coastal component. Certainly it is assumed here that marine resources did not constitute a *substantial* component of the diet of inland groups. The question of potentially sedentary coastal populations, and the use of coastal resources is nonetheless an important one which is addressed in more detail in terms of models of coastal populations described in chapter four.

The main resources of interest to us are however those in inland environments. Large land mammals and plant foods in open woodland environments have already been discussed, as have plant foods concentrating in damp and river and

lakeside situations, and riverine fish. There are however a whole suite of resources available in inland environments which are often overlooked, namely small mammals, and lake fish and birds.



LAKE FISH AND INLAND BIRDS

At inland lakes, lake and river fish resources themselves would have been potentially important resources. As previously noted, fish remains are only rarely recovered. No fish remains were recovered from Star Carr, although the presence of birds which depend on fish, red breasted merganser, red throated diver and great crested grebe make a complete absence of fish in Lake Pickering unlikely.

A number of different species of lakeside fish can be especially abundant in small or shallow lakes. Keene (1976) notes that the productivity of inland lakes of is a function of the amount of fertile shallow water and that small lakes tend to have a higher yield per unit area than large lakes. Lake fish could be caught by pole or line as well as by nets. Grigson (1989) notes that in Denmark, most inland sites on bogs or at lake edges show evidence of exploitation of pike. Fish resources in inland lakes would also attract wildfowl, such as ducks.

Swans and geese would be one of the largest 'package' bird resources, with ducks providing another potentially abundant bird resource at inland lakes and rivers. There are no records of exploitation of large water birds in Britain but a third of the bird bones at Mount Sandel in Ireland consisted of ducks and divers (Wijngaarden-Bakker 1989). Bird remains at Thatcham were also mostly of waterfowl, including mallard, teal or garganey, goldeneye and possible smew (Coles 1971; Smith 1990: 122). Both goldeneye and smew winter in Britain (breeding in northern Scandinavia and Britain). At Star Carr, a number of birds were recovered including water birds such as red-breasted merganser, red-throated diver, great crested grebe, little grebe, and duck as well as lapwing, crane and white stork (Clark 1954). Crane was also identified at Thatcham (Coles 1971; Smith 1990: 122)

Some water bird species are year-round occupants, but many migrate, providing large concentrations of resources at certain seasons. Furthermore, migration patterns are usually quite consistent. Whooper swans, for example, breed in swamps and marshy tundra in northernmost Scandinavia and Russia, but over-winter in Britain and in areas near the North Sea. The faunal assemblage at Aggersund suggests that was a special purpose camp for procuring swans when they gathered there (Rowley-Conwy 1983 after Møhl 1978) with all the 257 bird bones being of whooper swan (Grigson 1989: 66). Keene (1981) notes that in the Great Lakes migrating duck would also occur in large numbers, with flocks of up to 26-50,000 along their migration routes (Jochim 1976: 117). The Ertebølle site of Sølager appears to have been a similar special-purpose camp concentrating on ducks (Rowley-Conwy 1983 after Skaarup 1973: 77).

The optimum time for exploiting water birds would be at the annual moult, as many species are unable to fly for a period of three to five weeks (Keene 1981: 118), when they could be caught in large numbers especially with the use of nets. Also of importance are small water birds, which, although thought of as small package resource, can be an abundant resource with special purpose exploitation, such as the use of nets. Other less 'logistically organised' means of capture are recorded in recent hunter-gatherers. The Yahgan of Tierra

del Fuego for example caught ducks individually using a captive duck as a decoy to lure other ducks near enough to kill (Lucas Bridges 1948: 97).

Though it is coastal environments which are often considered valuable ecotones (regions crossing different ecosystems), inland lakes, and also inland rivers, would clearly have supported a wide variety of aquatic resources. Fish, as well as waterfowl at lakes, and beaver or otter in rivers, would have been available alongside plant resources with edible tubers and seeds, with terrestrial mammals also concentrating near more open woodland at riverine and lake edges. Schadla-Hall (*pers. comm*) even suggests that lake resources may have allowed permanent occupation within the area of the Vale of Pickering in the Early Mesolithic.

Inland open woodlands would also have been environments which supported a mix of plant resources and game animals, though not the variety supported by lakes and rivers. Some bird species, particularly small song birds and capercaillie would also have occupied open woodland. Capercaillie, a native of pine woods was amongst the faunal remains at Ertebølle (Rowley-Conwy 1983, Clark 1948). Pigeons would also be found in open woodland, with pigeon numbers and migrations patterns dependant on woodland nut production (Keene 1976). Pigeon is the main species of bird recovered at Lough Boora in Central Ireland and is present in 95% of the bird samples, with the jay coming in second place (Wijngaarden-Bakker 1989).

Other birds, such as grouse, would be found in higher areas. Remains of both grouse and ptarmigan were recovered at Lough Boora, central Ireland (Wijngaarden-Bakker 1989). Birds of prey are also found in these open environments. Some of these birds of prey, such as eagles, might have provided a source of good feathers for fletching arrows (Clark 1948: 128), a possibility which is reinforced by the Scandinavia site of Øgaaarde which appears to have been a site for the specialised procurement of eagles.

Even in inland woodlands, there are far more resources than a brief survey of interpretations of subsistence practices might conclude. Other than large mammals and plants, small mammals, fish and birds might have been important resources. No one resource seems obviously more attractive to hunter-gatherer populations than any other. Hence, defining which resources may have been particularly important and how any resource fitted into an exploitation strategy is a difficult and complex issue.

WHAT WAS THE ROLE OF DIFFERENT RESOURCES?

Having considered the range of different resources available to Mesolithic populations, and the evidence for their exploitation, it is clear that many different resources could potentially have been a dominant or staple food. However, no one resource, or group of resources, is obviously 'the' key element in subsistence patterns. In the forested environment of the inland Mesolithic, large land mammals would presumably have been available and a much-prized resource, but, following a consideration of the range of other available resources, it is no longer self-evident that the meat from large game should be a dietary staple.

The issue of a 'staple' resource is itself a problematic one, since it is clear that certain resources may take on a major role in survival (resources noted to be available at the 'poor season' for example) whilst not contributing the largest proportion in overall terms. Equally, certain resources may determine settlement systems because they are highly focused and abundant for a short interval, such as salmon 'runs', or because they are considered essential, such as medicinal plants for example, or even because they have a symbolic as well as practical importance, perhaps the furs of certain small mammals, whilst they may neither be represented in the archaeological record, nor ever have been a major staple.

Mesolithic populations appear to have exploited a wide range of different resources. Taken as a whole, the evidence from northern Europe suggests the potential inland exploitation of a wide range of plant, large and small mammal, fish and bird resources. The precise importance or role of any particular resource in northern England is difficult to determine however, especially given the range of different resources considered above. There is very little direct archaeological evidence for the exploitation of food resources within northern England itself, and the evidence in neighbouring regions is of questionable relevance. We *can* make very general observations of the likely ecology and availability of different resources in the past, but moving from these general observations to comparing different resources in terms of the benefits or costs of exploitation either in general terms, or at different seasons, and to generating a model of subsistence, is problematic for a number of reasons.

The most immediate problem is that any model depends on isolating important characteristics of resources, which can be compared to assess which resource is the most attractive at any time. Several potentially important characteristics have been discussed. These might include the season at which resources are available or easiest to exploit, the yields in terms of fat, protein or energy, and other characteristics such as how predictable they are, whether they are susceptible to over-exploitation, and whether they could provide potentially storable resources. It is already clear that no single characteristic is clearly the most important in defining how attractive any resource may have been.

Incorporating the different characteristics of different resources into a model is not straightforward. For one thing,

different characteristics may be important in different circumstances. Large land mammals, for example, traditionally seen as the mainstay of Mesolithic economies, may be attractive because of the large 'package' of protein and fat which they provide, however they are a very unpredictable resource, which are difficult to capture. If it is important to bring home food, hunter-gatherers may opt instead to exploit more ubiquitous smaller game (Mithen 1987; 1989; 1990) or perhaps even very reliable resources which may be time-consuming to exploit such as nuts. Equally, resources such as hedgehogs or beaver, whilst only small 'packages' and possibly difficult to catch, may have been preferred in the lean winter season as they provide a source of fat. A further complication is that, as was clear in the discussion above, different plant or animal species, which appear to be similar, may have very different characteristics. Some waterbirds are migratory, and so would be available as abundant concentrated resources at certain seasons, being not only a potential source of short term food but also a potential source of storable food for the winter months, whereas non-migratory water birds would have very different characteristics as a resource, being available year-round, and potentially important in winter, but rarely in large numbers. It would be almost impossible to build a model based on the availability of every individual different species of plant and animal, whereas combining resources into groups would confuse different characteristics.

Perhaps the most serious limitation is that the preferences which hunter-gatherers exert over resources may not be predictable, but may be defined by particular historical or cultural circumstances or particular local or regional strategies. A pressure on available resources might perhaps encourage resources which are time-consuming or difficult to collect and process, and thus rarely exploited, to be included within diets for example. Subsistence strategies may even be governed by motivations which are not understandable today. As previously mentioned, Lourandos (1997) notes that Tasmanian population avoided fish, even though there were an abundant and potentially productive resource.

Even if key characteristics could be isolated, the information may not be available to reliably compare different resources. Since our knowledge of Mesolithic environments is restricted, quoted densities or distributions of available resources are often guesswork. Large mammal behaviour in the past may have been very different from that recorded today (which is in any case often very variable). Even immobile resources are often difficult to quantify, Perlman (1980) for example suggests that the present returns on collecting acorns are generally about 48,000-60,000 kilocalories per hour, whereas Rowley-Conwy (1984), using a different source, suggests much lower returns of 18,000-28,000 kilocalories. Without knowing methods of exploitation, it is equally difficult to assess how 'attractive' any resource may be.

The main limitations to reconstructing Mesolithic subsistence practices are however on a more fundamental level. This is because the question 'what was the subsistence pattern?' may not be an appropriate one. Essentially, whilst interpretations of Mesolithic subsistence practices tend to be very static, Mesolithic environments would be very variable.



For one thing, environments would vary substantially over different regions. Northern England for example has markedly different topography and geology in different areas, as discussed in chapter two. Most interpretations however tend to ignore regional variability or to simplify it into very basic categories such as upland and lowland, or coastal and inland. Bettinger (1993: 52) provides one explanation for the static and normative nature of many interpretations of subsistence and settlement by explaining that for archaeologists attempting to interpret regional differences '*the easiest way to cope with variability is to ignore it*' .

Variability in time would also have been substantial. Over short time-scales, differences between 'good' and 'poor' years would affect the relative availability and attractiveness of different resources. Rowley-Conwy and Zvelebil (1989) note the scale of potential short term variability in salmon productivity, and the fact that in certain years certain stretches of river may have been productive, whilst only having low salmon stocks at other times. Other resources may have been equally as variable, especially given the variability now recorded in Holocene climates (Mayewski *et al.* 1996). The potential effects of this variability on subsistence and settlement system is discussed in chapter four.

Over long time-scales however, there would have been marked changes in general climates and in environmental responses. Coastal environments would have been changing fundamentally, with rising sea levels and changing ocean currents, and inland environments would also have experienced fundamental changes throughout the Mesolithic as climates changed and plant and animal species spread gradually from glacial refugia. Although many interpretations of subsistence practices tend to portray a very static picture of Mesolithic economies, some interpretations have incorporated environmental changes into ideas about changing subsistence patterns. These interpretations are however either too broad to apply to a local situation (such as the idea of a diversification of resources discussed in chapter one) or are specific to a single resource (as is Clark's 1972 model of red deer ecology) which may not fulfil the role in subsistence practices which has been predicted. Most fundamentally, most interpretations fail to appreciate that changes in environments through time have different spatial effects, with some regions being more markedly affected by the spread of certain competitive species than others for example.

Complex changes in environments can be considered as a major limitation to developing models of subsistence. Alternatively, they may, in contrast, be considered as a core question themselves. It has generally been assumed that, since it is difficult to define precise subsistence patterns at any one time, the effects of changes in environments cannot be addressed. This is not necessarily the case, since changes in environments often cut across a suite of resources. Changes in the character of woodland, for example, would influence the character of many different woodland resources. A decline in nut producing trees or an increase in forest density would affect both small and large game and plant resources. Similarly the gradual in-filling and

eutrophication of inland lakes would, on the other hand, affect a range of different lake resources. Given the limitations outlined, it is clearly not possible to define a precise subsistence pattern at any one time, but it *may* be possible to discuss in general terms the possible challenges or adaptations that would have been faced, without defining the precise use of different resources (an approach discussed in chapters five and six).

