CHANGING PLACES:
LANDSCAPE AND MORTUARY PRACTICE
IN THE IRISH MIDDLE BRONZE AGE

By

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Abstract

This thesis explores an Irish Middle Bronze Age landscape using quantitative spatial analysis as a starting point for broader contextual discussion. The main data set is the distribution of a concentration of ring ditches, which are one end product of a complex burial rite. The concentration was formed throughout the second millennium BC. Other data on terrain variation and change was also important. Three statistical techniques are used to examine clustering – kernel smoothing, k-functions and raised incidence modeling. In addition, Site Catchment Analysis has been upgraded to explore terrain factors in a standardised, statistically robust fashion.

The results are discussed under the headings: scale, terrain sensitivity, integration and tempo. The pattern is unusually clustered at many but not all scales. Important concentrations of ring ditches were sited in the previously unused foreshores of small glacial lakes. Futher investigation of these foreshores produced an Late Bronze Age date for a larger, newly identified, burial monument type.

I conclude that an iterative process, with no central design, but potentially based on kin groups, formed this concentration of sites. Further, the availability of well-drained soil is an important factor in the distribution of sites. There is a separation of domestic activities, burial, and other community rituals. However, this is not a 'ritual landscape'. In the Late Bronze Age this separation became more pronounced, possibly indicating increased social centralisation. These landscape changes may also indicate a changed role for the area in regional trading networks.

The thesis contributes to an understanding of increased social complexity in a period of environmental change. It also indicates the value of quantitative landscape analysis in such discussions.

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Chapter 1: Introduction

Introduction

The realm of social action is culturally constituted in the physical world (Braudel 1969). This realm between culture and environment can be studied as landscape. In this dissertation I construct a model of a Middle Bronze Age landscape by studying the distribution of a group of mortuary sites. I design and use a framework for describing landscape in a concrete and comparable fashion. Within this framework I analyse a large but tightly clustered group of ring ditches in south east Limerick, clarifying its spatial structure and exploring the relationship between this and location in the terrain. The research focuses around three main concerns: the use of formal spatial analysis in studying prehistoric landscapes; the analysis of mortuary sites as an aid to understanding wider societal issues; and the landscape changes associated with the Middle Bronze Age in Ireland.

In this chapter I describe the research and set it in a theoretical and methodological context. After identifying the initial research question I briefly examine the position of landscape within archaeological theory. This leads to a proposal for a framework for comparing landscapes. The cultural and chronological context of the research is then explored and four themes are identified for exploring the Irish Middle Bronze Age: increasing inequality; climate change; and the role of monuments in structuring the landscape. I then justify the choice of data and identify its opportunities and limitations. Finally I discuss the analytical techniques used to bring the data to bear on the question.

The research question

The initial research question stemmed from a set of striking data. In the southeast corner of County Limerick, in a block measuring 375 km^2, there are 487 shallow annular ditches ranging in diameter from 6m to 21m. Excavations have shown that these sites form part of the Middle Bronze Age burial ritual. While scattered examples of this type of site can be found throughout Ireland, nowhere else do they mark the land with such density, such persistence. Why?

This basic question, 'what circumstances led to the unusually dense distribution of ring ditches?' required answers to some more fundamental questions: Why did people construct these sites? How do these mortuary sites relate to other sites, such as houses, field systems and other foci of ritual? At what scales is the phenomenon of clustering identifiable? What factors condition the placement of these sites within this landscape? Bringing these questions together in a coherent fashion depends on the theoretical context of the question. The larger question is 'why should we care about variation in landscape?'

Theoretical Context

Landscape archaeology can make contributions to three areas of interest in archaeological theory; the relationships between humans and their environment, patterns of long term change, and the links between different scales of social interaction.

The idea that the relationship between humans and the environment that they inhabit varies has a long tradition in anthropology (Trigger, 1968). The nature of that variation, however, has long been an assumption against which other social developments can be measured. More complex societies were thought to exert more control over nature, while less complex societies were seen to be at the mercy of their environment (Ingold 1987). Landscape can be defined as the interface between humans and their environment and can therefore be used to study this relationship more explicitly. Since landscape is complex, both in its concepts and its manifestations, many existing studies are rich in detail but less useful for studying variation as it relates to social and ecological change (Entrekin 1991; Ryden 1993).

When Steward described cultural ecology he suggested that it was possible to study only those aspects of the environment which "bear upon the productive patterns" of a society (Steward 1955, 123). The problem has been identifying which aspects these are. "Because archaeological evidence is presumably the product of both natural processes and behavioural processes, rather than the product of either one of these alone, there is disagreement amongst archaeologists over what kind of record the archaeological evidence forms" (Patrik 1985, 34). This debate, and its relation to the present discussion can be seen in the works of its two principle proponents.

Postprocessual, or contextual, archaeologists often use textual analysis as a metaphor for cultural analysis (Patterson, 1990). In describing material culture as text Hodder is arguing that archaeological data are primarily the results of social action. So "archaeological data provide an ideal arena for investigating relationships between major events and the large-scale texts to which they relate" (Hodder 1988, 69). Further, "the impact of the early text on later activities is also seen in the overall settlement pattern" (Hodder 1988, 71). In the relationship between humans and their environment, humans have the upper hand - the environment is the stage on which social relations are played out.

Binford, in contrast, sees the environment - an asocial concept of place - to be the major determinant of settlement pattern. "I am interested in sites, the fixed places in the topography where man may periodically pause and carry out actions. I am concerned with *site patterning* both in the frequency with which occupations occur at different places, and in the processes which generate associations among archaeological materials at sites" (Binford 1982, 6) (emphasis original). This concern with the ways in which the archaeological record is produced as a largely unintentional product of human activity is common to the processual approach. The activities of 'man' are only of interest in as far as they produce 'associations among archaeological materials'.

The study of landscape addresses both concerns since landscape is what humans perceive their environment to be. Although it is a cultural construct is not synonymous with culture; it is what culture creates from the surrounding world. "Culture mediates or transmits the force of social action on the physical world, and is conditioned by pressures born of the tension between social and ecological factors" (Ingold 1987, 32). There are no 'natural landscapes' though there is variation in the physical modifications which humans make to the world around them. Landscape archaeology deals not only with the distribution of archaeological remains in terrain, but also attempts to understand the perceptual frameworks which lead to that distribution (Crumley 1979).

Landscape data is a palimpsest, which highlights time depth and this allows consideration of change (Muir, 2000). Cooney has discussed the fact that monuments are enduring features of the landscape, which allow us to consider time depth in detail (Cooney 1990). A place has a function in everyday life, is a marker for directions and at the same time it is a link with the past, and with other worlds. Societies manipulate elements of earlier landscapes illuminating their perceptions of change. The current destruction of British Army installations in the North of Ireland expresses the desire for rapid transformative change. The retention of late 19th century industrial complexes in the same landscape reflects a desire for continuity in social structures.

Landscapes can be used to integrate and differentiate different aspects of social structures because they operate at several different scales simultaneously. Lawrence and Low have discussed the fact that Gidden's notion of structuration, so central to the concept of social meaning in place, requires and allows the movement from one scale to another. Action, which takes place at an individual level, links structures, which exist at a society wide level (Lawrence and Low 1990, 489). The multiple scales of landscape reflect and shed light on the multiple scales of social interaction.

A framework for comparing landscapes

The study of landscape can clearly make contributions to central theoretical questions within archaeology. The richness and complexity of landscape, however, have made it difficult to compare landscapes and understand the ways in which they vary.

A major difficulty resides in the concept of 'Place'. Too abstract for an agreed definition, too concrete to be held by abstraction, places are a vital element in the composition of human society (Relph 1976, 33-6; Keller 1994; Robinson 1995). People construct them by imbuing their environment with meaning (Cosgrove 1984; Jackson 1984). The processes involved in this construction are so complex that each place is unique. One defining feature of places is that they are distinct, recognisably different from other places (Stoddart 1987). But patterns can be found which draw places into a web that holds images of a culture or a way of life.

Some researchers advocate a 'thick description' style narrative as the most fruitful approach to exploring places (Entrekin 1991; Daniels 1992). Unfortunately, such narratives can increase the sense of place without increasing the understanding of how that place is articulated historically and socially (Ryden 1993). Entrekin attempts to increase the role of analysis through a discussion of 'emplotment' (Entrekin 1993, 109-128). This clarifies analysis of a single landscape, allowing for consideration of long term change, but makes no provision for comparison of different landscapes. If we wish to address environmental relationships, or differing scales of social interaction we need a framework to compare synchronically as well as diachronically.

For this work, I have designed a set of dynamics for describing landscapes which are designed to highlight the three theoretical concerns discussed above. They do not encompass all landscape concepts. In particular they do not address the meanings attached to particular places and the construction of place as a spiritually significant event. This complex issue is too intricate for a study of broad landscape variability. I have chosen and defined these dynamics in order to clarify landscape variability so that it can be studied as an exploration of the relationship between humans and their environment.

The first dynamic is *scale*. Although landscapes work on many scales at once the transition between these scales is not continuous. Crumley and Marquardt have used the term 'effective scale' to refer to a "scale at which a pattern may be recognised and a meaning inferred" (Crumley and Marquardt 1987, 2). Many archaeologists assume that there are basically three scales: the household, the village and the regional scale (Trigger 1968). Recognising that these scales vary and there may be other useful scales as well is important because the scale of analysis influences results in many different ways. It is common for archaeologists to rely on regional or even national scale mapping of environmental variables (Wagstaff 1990) which may not correspond to the landscapes under study.

In many landscapes domestic patterns may be understood by looking at the scale of a single house, and then again at a group of two or three houses which were the home of a social group (Grogan and Eogan 1987; Hayden and Cannon 1982). If a scale was used between these two levels, say one and a half houses, the pattern would be incomprehensible. These scales are not universally applicable. An apartment building would not necessarily be comprehensible using those scales, nor would a cliff dwelling. This is not to say that similar social groupings do not exist, but the scales at which they are expressed vary. At larger scales the variation is more noticeable. In some landscapes thousands of square kilometres can be seen to form a pattern (Myers 1991). In others the pattern ceases to make sense outside a few hundred square kilometres (Eogan 1991).

Crumley and Marquardt have emphasised the importance of shifting spatial scales of analysis (Crumley and Marquardt 1987). This is related to the way in which people experience landscape.

> "As investigators change the effective scale of their analysis, they frame a different web of relations. The unevenness in these relations will disappear at different scale as a new pattern of unevenness appears. Social groups also live and act in a world of varying scales, and their position vis a vis others changes as their scale of reference changes" (McGuire 1992, 170).

The second dynamic is *sensitivity to terrain*. Terrain is the physical variation of the landscape. It differs from landscape in that humans do not construct it, though it may be affected by their constructions. The terrain influences all landscapes, but some are more closely related to it and some are more oblivious to it. This dynamic describes the way in which the terrain plays a determining role in the pattern of human activities. Some examples of terrain oblivious landscapes are the Roman cadastral system (Jackson 1984), Neolithic field systems in North Connaught (Caulfield 1983) and southern Ontario today. Hunter-gatherers are often assumed to have terrain sensitive landscapes, cultural behaviour patterned completely by variation in the terrain (Binford 1982, Rossignol and Wandsnider 1992). This may be true for some groups but it is not necessarily true for all hunter-gatherers (Ingold 1987). Terrain sensitive landscapes are also found amongst agriculturalists, indeed the European landscape is more terrain sensitive than the North American landscape (Wilson 1990, Jackson 1984).

Often terrain oblivious landscapes utilise large-scale constructions, such as water reservoirs and levelled road surfaces, in order to allow cultural needs to determine the use of the terrain. Such constructions, however, are also found in terrain sensitive landscapes, such as the Aran Islands today. Here a complicated field system responds closely to the bedding planes and erosional patterns of the karst terrain, but the construction of the field walls and the production of soil is the result of much labour (Robinson 1995, 10-15). By the same token, since landscape is composed of material and non-material elements, stories, maps can serve to describe and construct the landscape for human purposes with reference to, but little deference to the terrain. It could be argued that the in songlines of the Aboriginal Australian landscape the social groupings and actions of social beings are more important than the terrain features whose genesis they describe (Myers 1991). It is easy to equate terrain oblivious landscapes with a dominance of nature and terrain sensitive landscapes with passivity, but this is not necessarily the case. If the two are considered as extremes of a spectrum then the aspects of each can be recognised in any landscape.

The third dynamic is the *integration* of different activities within the landscape. As archaeologists attempt to integrate the different aspects of the archaeological record landscape integrates different social activities and environmental zones. Spatial association of sites with different functions or many functions within one site indicates a more heavily integrated landscape. Clearly, social activities are always integrated in a social structure but their expression in the landscape may be differentiated. Many North American cities deliberately separate industrial, retail and domestic functions (Holston 1989). Again, all landscapes have elements of both integration and differentiation but the importance and expression of each varies. The degree of landscape integration demonstrates demarcations both between social groups and between humans and their environment.

There has been a good deal of research done on 'ritual landscapes' like the complex of monuments in the Cranbourne Chase area of southern Britain (Barrett *et al* 1991). Other landscapes integrate many functions. The Neolithic field systems of North Connaught both contain and are ordered by contemporary tombs and houses (Caulfield 1983, 1988). Modern landscapes have constant tension between integration and segregation. The urban theorist Jacobs argues that integration is essential to the health of North American cities, but town planners continue to segregate urban centres (Jacobs 1978).

The last dynamic is *tempo*, the speed at which the landscape is produced or replaced (Barrett *et al* 1991, 8). Landscape change is not congruent with cultural change. Many landscapes use elements of earlier landscapes (Cooney 1990). This is where the notion of history, the passing of time, fits in. Landscape data is a palimpsest. This is a positive thing. Instead of factoring things out we are seeing time depth and this allows consideration of change, trajectories.

Earlier burial cairns are regularly present in Irish Hillforts and may have been an important feature in siting choice (Raftery 1970, 197; Mallory and Warner 1988; Grogan and Condit 1994, Condit 1998). The North American urban landscape has a very fast tempo. There is little reference to earlier uses of the land, a lot of replacement and the construction of important landmarks takes as little as five years. Aside from its importance in recognising time as an important part of landscape, this dynamic is also helpful in determining response to environmental change, a topic that is receiving increasing attention.

The Irish Middle Bronze Age

Until recently The Irish Middle Bronze Age (1700 - 1100 BC) was only identified in metalwork typologies, wider discussions did not recognise a Middle Bronze Age (Eogan 1964; O'Kelly 1989, 149). Current research, however, indicates that this period is the key to understanding significant differences between the Early Bronze Age and the Late Bronze Age (Cooney and Grogan 1994, 123-142; Grogan 1989, Doody 1997). Since the Middle Bronze Age forms the focus of this study, the archaeological picture from the surrounding periods will set it in context and identify what issues are of interest. Chapter 2 contains more detailed discussion of the Middle Bronze Age.

The Early and the Late Bronze Ages can be contrasted socially, the former as a slightly ranked lineage system the latter a more heavily stratified system based on commodity exchange (Shennan 1982; Rowlands 1980; Eogan 1995). There are also major environmental changes, declining temperatures and increasing rainfall, which have been cited in some accounts as the cause of the social changes (Champion *et al* 1984). Both social and environmental changes can be seen in landscape changes.

Issues for the Irish Middle Bronze Age

Increasing inequality

The Early Bronze Age in Ireland is now seen as part of the same cultural continuum as the Later Neolithic (Cooney and Grogan 1994). Slightly ranked social structure based on control of land and ancestors had grown out of the fairly egalitarian social structure of the Early Neolithic (Renfrew 1976; Bradley, R. 1984). The transition to the Bronze Age is marked by wider exchange networks, which brought new technologies to Ireland and distributed Irish artefacts throughout Europe (Taylor, J. J. 1970; Cahill 1995).

The social basis of these networks had already been established in the Later Neolithic, evident in the distribution of stone axes, Grooved Ware pottery, and increasingly elaborate megalithic tombs (Cooney and Mandal 1998; Eogan and Roche 1994; Bradley, R. 1984, 61-67; Cooney 2000, 231). These are seen to be the result of peer polity interaction, elites both competing with each other and increasing local prestige through control of exotic material (Sheridan 1985/6, Cooney 2000, 224-233). The continuing base of power in control of ancestral lands is seen in the increasing emphasis on megalithic tombs in the later Neolithic and the reuse of these tombs for new burial rites in the Early Bronze Age (Thomas 1990; Cooney 1992, 1997; Mount 1995; Cooney and Grogan 1994, 58). Throughout the Bronze Age burial became less visible archaeologically and less than ten burials are known from the Later Bronze Age in Ireland. This has been taken to indicate less emphasis on ancestral power (Cooney and Grogan 1994).

The development of metalwork has been used to argue for a similar set of social changes (Bradley, R. 1984; Cooney and Grogan 1994). In the Early Bronze Age most of the bronze work is confined to decorated flat axes with a small number of knives, razors and daggers (Harbison 1969a; 1969b). There were, however, several classes of ornamental goldwork, such as lunulae and sun disks (Taylor, J. J. 1970; Cahill 1995). The emphasis on ornament is consistent with exchange in a peer polity model. The Middle Bronze Age saw an increase in the amount of bronze produced as well as a significant diversification of types. Technology was more complex and there was an increase in weapon types such as rapiers, halberds and spearheads (Eogan 1964; O'Carroll 1986). Interestingly, there is no known goldwork from this period. The Later Bronze Age saw further developments in casting technology, which allowed for socketed implements (Eogan 1964). The weapons arsenal expanded to include slashing swords (Eogan 1965). There was a flourishing of goldwork with bracelets, collars and complicated ornaments such as lock-rings demonstrating considerable goldsmithing skill (Eogan 1969; 1995). This specialisation is thought to indicate regional elites controlling commodity based wealth (Eogan 1995).

The domestic evidence, while patchy, indicates a low but perceptible level of inequality in the Neolithic (Cooney and Grogan 1994, 42-7; Grogan 1996a; Cooney 2000, 52-85). The existence of co-axial field systems is sometimes taken to indicate central planning and control (Bradley, R. 1977; Flemming 1982; Caulfield 1983, 1988). There is a variable settlement pattern, which may be related to social differentiation. Some domestic sites seem temporary in nature (Liversage 1960), others are quite substantial (Gowen and Tarbett 1988) and some show evidence for large scale agglomerated settlement (O'Kelly 1983, fig. 8; Grogan and Eogan 1987; Roche 1989; Eogan 1991, 108, fig. 2; Bergh 1995; Grogan 1996a). Sites with a large number of houses, however, show little variability within the group.

At Lough Gur, where there are both enclosed and unenclosed houses, both groups show the same range of sizes. Nonetheless, the very fact of enclosure may have marked higher ranking families and there is some indication that enclosed houses had more exotic artefacts (Grogan and Eogan 1987, 189).

By the later Bronze Age this variability became more distinct and is clearly related to centralised control and ranking. A three tiered settlement hierarchy has been identified in Southeast Clare (Grogan *et al.* 1996). Relatively small, low stone enclosures occupy the lowest tier. Next are hilltop enclosures, larger and more substantial. At the top in this area is the massive trivallate hillfort of Mooghaun. The larger enclosures are also closer to the high status hoards of metalwork. In other parts of the country, unenclosed settlements have also been excavated (Doody 1991; O'Kelly 1989, 308-309), suggesting that the system may have been even more complex. Hillforts exist across the country and are considered to be a sign of military control (Raftery 1976; Condit 1995)

Climate

There are two major climatic trends recognised for prehistoric North West Europe: a warmer phase and a phase of 'deterioration'. While the evidence for these two trends is variable they are used in the construction of an explanatory framework which ties social change to environmental change (Champion *et al* 1984, 278, Cooney and Grogan 1994, 141). Since the notions of optimum and deteriorating climates are themselves a product of our sensibilities the exact nature of climate, as a combination of temperature and moisture, referred to is often difficult to determine.

The 'postglacial climatic optimum' refers to a period during the Atlantic Period (between the 8th and the 5th Millenium BC) when the summer temperatures were approximately 2 degrees warmer than the present. In some accounts this period was also somewhat drier than the present day, while in others it was wetter (Mitchell 1986, 65; Champion *et al* 1984, 114). The identification of the phase is based on lake sediments. Early work was done on temperature sensitive molluscs in Scotland. This became a broad field of study for paleoenvironmental research. Subsequent work also suggested lowered lake levels in Lough Neagh in north west Ireland (Mitchell 1986, 65). The end of this phase is not well documented (Mitchell 1986, 66) but it seems to coincide with the advent of the Boreal period around 3000 BC

(Champion *et al* 1984,90). "The generalisations are difficult and regional and local variations are likely to have been substantial" (Champion *et al* 1984, 114).

The notion that this 'optimum' was followed by 'climatic deterioration' is fuzzier and more difficult to establish. "If we picture that the 'climatic optimum' was a time of relatively continental climate with warmer summers and fewer rain-days, then we can envisage any subsequent 'deterioration' as involving falling temperatures, more rain days and lower evaporation rates generally" (Mitchell 1986, 125).

In general this change is inferred from changing patterns of peat growth. When the moisture content in the bog is lower the peat humifies more thoroughly than in wetter conditions. A change from a dry phase to a wet phase is marked by a 'recurrence surface' where more humified peat is covered by less humified peat (Mitchell 1986, 125). Although such recurrence surfaces are commonly found throughout North West Europe, their significance in marking a climatic change is dubious since so many factors other than rainfall affect both the drainage patterns and the growth of bogs (Champion *et al* 1984,90). Different peat cores give widely differing dates so that the 'deterioration' is seen as striking anywhere from the beginning to the end of the second millenium BC. While O'Kelly sees the change as effecting Early Bronze Age settlement patterns (O'Kelly 1989, 217), Megaw and Simpson see the same period as "warmer and drier than before or after" (Megaw and Simpson 1979, 17).

In Ireland the dendrochronological sequence is also used to to support the idea of decline. In addition to this overall trend there are dramatic cold spells inferred from extremely small growth rings. These have been associated with dust clouds from major volcanic eruptions in other parts of Europe. Since these studies rely on a single species, often collected from marginal growing conditions, the interpretations face the same difficulties as those based on peat growth. Nonetheless, major eruptions around 1628BC and the Hekla 3 eruption in 1159BC have been identified in the growth rings of Irish oaks (Baillie and Munro 1989; Baillie 1988).

While many European descriptions hold that this was a disaster agriculturally (Burgess 1989, 325), some Irish archaeologists see it increasing Ireland's international contacts and the consequent prestige of the elite (Mitchell 1986, 139). Mitchell also indicates an increase in arable agricultural activity in the Later Bronze Age including an increasing use of upland areas and the development of the plough (Mitchell 1986, 137-44). O'Kelly remarks on "evidence of an upsurge in agricultural activity has been noted for the period c 700 BC ... in spite of the fact that widespread climatic deterioration involving increased humification and declining temperatures has been observed all over Europe for the period in question" (O'Kelly 1989, 223).

Using the term deterioration implies specific cultural responses. In particular the dramatic volcanic events have been given explanatory power by Baillie (Baillie 1988; 1989; 1995) and by Woodman (Woodman 1992, 310). The increasing importance of wetland for ritual activity and hoard deposition has been related to the increasing presence of wetlands (Coles and Harding 1979, 484). The decreasing number of hoards in the Early Iron Age has been linked to the same phenomenon (Mallory, 1983, 68). Cooney and Grogan point out that cultural responses to climatic change are complex - the tempo and the severity of change need to be considered in the context of contemporary subsistence practices in order to assess potential impact (Cooney and Grogan 1994, 141, 181).

Landscape

Research in the Later Neolithic landscape suggests an increase in the highest effective scale. The units suggested by the distribution of tombs in the earlier period implies a local focus for ritual (Woodman 1992, 304). In the later period some tombs became foci for large areas (Eogan 1991) and cemeteries of many tombs came to mark important places (Cooney 1990). If this pattern is compared to the distribution of hillforts another shift upward in scale is evident. There is a line of large trivallate hillforts which crosses the country and may indicate very large spheres of influence (Condit 1995, Condit and Gibbons 1988b). This idea is reinforced by regional styles in metalworking (Cooney and Grogan 1994, 168-172; Grogan 1996b).

Increasing variability also implies an increased number of effective scales. The residents of a small house group such as Tankardstown (Gowen 1988) would have a different local scale than those people living at the larger agglomeration at Lough Gur (Grogan and Eogan 1987). This would clearly be more pronounced in the Later Bronze Age where there is greater diversity. The hierarchical nature of the settlement structure in the later period would also produce more effective scales since the landscape would be nested.

The Later Neolithic/Early Bronze Age appears to be less terrain sensitive than the Later Bronze Age. While the Neolithic landscape does respond to terrain differences, social requirements for spatial layouts are prominent. The most obvious example of terrain oblivious behaviour in this period is the coaxial field systems of North Connaught (Caulfield 1983, 1988). A single orientation covers an area of many square kilometres without reference to topography or soil type. The entire system appears to be centred around a single tomb (Caulfield 1983). Although there is a perception that passage tombs are regularly sited on hill tops in response to the terrain, Cooney has shown that they occur at a wide range of altitudes (Cooney 1983). It is difficult to assess this dynamic for the Early Bronze Age since the location was not recorded for so much material from this period. Nonetheless the common re-use of earlier tombs points to a continuity of siting preferences. Since the labour input into these monuments was "an essential method in constructing and maintaining group cohesion" social concerns were paramount in their placement in the landscape (Cooney and Grogan 1994, 73).

The greater sensitivity to terrain of the Later Bronze Age is indicated by the regularity of placement for different classes of site; the increased use of unmodified places for ritual activity and the integrated system which these elements form. The different classes of settlement are firmly linked to different parts of the terrain. There is even a class of domestic site specifically connected to small lakes (Henken 1942; O'Kelly 1989 299; Williams 1978; O'Sullivan 1998). It is increasingly obvious that the landscape was highly socially differentiated with access to certain places controlled. Wet places were used for ritual deposition in a regular pattern; usually ornaments were placed in small lakes and fens, while weaponry was placed in rivers (Cooney and Grogan 1994). The association between these places and high status domestic sites has been noted (Cooney and Grogan 1991). At King's Stables, Co. Armagh, a small lake was constructed for the purpose of ritual deposition, no doubt connected to the nearby hilltop enclosure Haughey's Fort (Lynn 1977; 1986). The layout of the large hillforts is also sensitive to terrain, the ramparts follow the contours of the hills they occupy (Condit 1995; 1998). The field systems of this period are smaller and are not coaxial, responding more to changes in topography and soil type (Cooney and Grogan 1994, 99).

While there are aspects of integration and differentiation in the landscapes of both periods, the earlier period seems to be more integrated than the later. There is a separation between domestic and ritual space in the Later Neolithic/Early Bronze Age, but it is not very dramatic (Cross 1991). In North Connaught houses and tombs are found intermingled with the field system (Caulfield 1983). The greater differentiation of the Later Bronze Age is partly related to the increased scale. Nonetheless, a wider range of terrain zones is used and there is more use of areas with varied resources such as uplands and wetlands (Raftery 1990; I.A.W.U. 1993a; O'Kelly 1989; Cooney and Grogan 1994, 153-155; Cross *et al* in press). In the area around Mooghaun hillfort, there is evidence for a separation of many kilometres between the high status/ritual zone of the landscape and the main zone of agricultural production (Grogan *et al* 1996).

The continuity between the Later Neolithic and the Early Bronze Age is indicative of a slow tempo. When power is based on control of ancestral lands, it is no surprise that patterns change slowly and much reference is made to past landscapes. While there is some evidence of deliberate changes in use at certain important sites the labour involved suggests that they were slow to be effected (O'Kelly 1985, Eogan 1991). Change of usage also shows that the place itself remained important and so the structure of the landscape changed less than the activities performed there. In the Later Bronze Age the tempo is more complicated. It seems that some of the large hillforts were built in one episode, which would have changed the landscape both dramatically and quickly (Grogan and Condit 1994; Mallory and Warner 1988; Mallory 1991; 1995; Lynn 1986, 14; Raftery 1976,347). In contrast, many of the large hoards from the period show deposition over many centuries (Eogan 1983, 154-6). Since no structures have been found with these hoards tradition must have played a heavy role in the ritual use of the landscape. The regular occurrence of Neolithic cairns and tombs within hillforts also indicates reference to past landscapes was important in this period (Grogan *et al* 1996; Lynn 1994; Raftery 1976,347; Condit 1995).

Themes

In studying the Middle Bronze Age I use the four dynamics of landscape to examine the interaction between increasingly damp and cold climate and ranking of society based increasingly on commodity exchange. Three issues within these dynamics are therefore of special interest : first, the role of wetlands; second, the integration of ritual and domestic activities; finally the differentiation of the territories of different social groups and the scales at which they are expressed. Some of the dynamics will move smoothly from Early to Late Bronze Age, others may move in different directions through the Middle Bronze Age.

Choice of Data

One feature of the Bronze Age is that bronze is almost never found on domestic sites (Cooney and Grogan 1994, 96). Correlating domestic, burial and metalworking evidence is proceeding slowly and there is no reason to expect that a change in one realm will necessitate a change in another. Nonetheless it is important to think of society in an integrated fashion and the three sub-periods, based on metalworking typologies, provide a useful framework for understanding the significant changes which occur in the second millenium BC. Choosing material to study the Middle Bronze Age landscape reflects the compromises of chronology. To study the four dynamics which I am interested in I needed an area with a large number of Middle Bronze Age sites, distributed in a varied terrain, and a mixture of domestic and ritual sites. Since the analysis was intensive the area needed to be well studied both in terms of terrain and archaeological material.

A significant concentration of barrows has been identified in the southern part of County Limerick and especially those along the valleys of the Morningstar, Camoge and Mahore Rivers, which form the eastern part of the Maigue River system. The place of these barrows within contemporary burial practice and tradition is in the wide variety of mortuary practices and funerary ceremony recorded for the Irish Middle Bronze Age. At this time barrows, which had been in use sporadically from the Neolithic period, appear to have become increasingly the main focus for funerary activity (Cooney and Grogan 1994, 131). While as yet no detailed chronological sequence for the construction and the use of the barrows (and the associated unenclosed pit cemeteries and isolated pit interments) is available, the excavated sites in the area show a clustering in the Middle Bronze Age (c 1300 - 1100 BC) (Gowen 1988; Grogan 1989). Other landscape elements in the area, such as *fulachta fiadh* (or burnt mounds) and habitation sites, have been shown to be contemporary with this phenomenon

There is a wide range of prehistoric sites in the area including habitation sites, *fulachta fiadh*, and standing stones. The main archaeological features, however, are funerary sites called ring ditches, which can be grouped into cemeteries. There are a small number of Neolithic sites, mostly single burials, including two barrows with a possible Neolithic date. These are mostly found in the upland areas and are often associated with Early Bronze Age barrows. In the Middle Bronze Age the focus of burial activity seems to shift down onto the flood plain itself, although there is some continuing use of the earlier sites in this period and some of the earlier sites are also found on the flood plain. This shift in positioning is associated with a change in the nature of the burial rite. In the Middle Bronze Age sites there are more single burials; grave goods are less common; burial becomes more ephemeral; and the monuments themselves are slighter.

There are more ring ditches in one field in Mitchelstowndown West, Co. Limerick than there are in the rest of the country. The data set that forms the focus of this research is the largest concentration of barrows of any sort in Ireland by a factor of ten. Although Ireland is a small island, such regional variability is a prominent feature of all periods. The pattern of sites in the study area cannot be taken to be representative of all of the Irish Middle Bronze Age, nor can they be dismissed as an anomaly. When assessing the results of this study in the broader context, some elements will and other will not generalise.

Exact locations for each of these sites is stored on a Geographic Information System (GIS) established by the Discovery Programme's, North Munster Project. Additional survey data was recorded for about one third of the barrows. Excavation information is available for a small percentage of the sites. Detailed mapping of soils and geology and drainage for the study area is also stored on the GIS. While the emphasis on funerary sites is stronger than I would wish for a well rounded project, domestic sites are extremely rare in Ireland and the few sites in the study area are better than for most areas. This area has been intensively studied by many different archaeological projects and offers a well researched data set with which to model a Middle Bronze Age landscape. (Westropp 1897; O'Kelly 1942; 1943a; 1943b; 1944; Ó Ríordáin 1936; 1940; Gowen 1988, Grogan 1988b; 1989; Daly and Grogan 1993; Doody 1995; Grogan *et al* 1996)

Analytical techniques

The main analytical approach of this dissertation is quantitative. While modelling of ancient terrain and theoretical structures concerning spatial perception have both advanced considerably recently (Thomas 1990; Daniels 1992; Whittle 1990; Bradley *et al* 1993), techniques of spatial analysis have yet to be used as efficiently as they could (Orton 1982). This is partly because early archaeological uses of quantitative spatial analysis lacked the computing power for sophisticated approaches to large data sets. Flemming's influential paper on Bronze Age Wessex, for example, although insightful was not able to deal with different scales or consider terrain variation (Flemming 1971).

Further, there is a perception that spatial analysis atomises landscape and dehumanises interpretation.

> "To proceed we need a set of terms to describe the geometry not of abstract, isotropic space, but of the substantial environment in which humans and other animals move, perceive and behave. Thus ... we speak of surfaces rather than planes, paths rather than lines, and places rather than points"(Ingold 1987, 147).

Yet this criticism is only a problem if the use of spatial analytical techniques supersedes all other analyses. It is possible to pull back from data and consider only certain aspects. There is nothing inherently wrong with abstraction. I make use of statistical analysis as the first step in an integrated analysis. This can be more effective for thoroughly considering the structure and pattern of 'places' than any amount of holistic description.

Hägerstrand has discussed the uses and limitations of quantitative analysis while reflecting on his classic study of diffusion through Monte Carlo simulation:

> "This archival work, together with a complete landuse inventory, had by around 1945 created in my mind a graphic picture of interwoven human and homestead trajectories, thinkable but impossible to reproduce on paper. Computer people today, who work on parallel processing, are beginning to grapple with the kind of vision I had developed five decades ago. Now I knew my region in a peculiar way, in fact I knew much more than I could use in a study of the kind that

> was expected. I had discovered the poverty of both verbal language and statistics as a means of lifting my universe into the open" (Hägerstrand 1992, 543).

Though abstraction may simplify a complicated data set, it should enrich our understanding of the changes present in the archaeological record. "The study of archaeology thus requires a constant movement from abstract to concrete, and our understanding of the past comes from that movement and not from the pauses that we make in it" (McGuire 1992, 146). Using spatial analysis does not require continual abstraction, but it moves discussion beyond descriptive speculation which overlooks the role abstractions play in human perception. Methodologically this dissertation draws on all of these things, deliberately switching between the scales and abstractions in which landscape exists.

GIS is helpful in maintaining this balance since points need not be separated from the data which relates to them in order to be subjected to analysis (Marble 1990). Thus sites can be considered as point data without losing their status as point source data or even surface data at another analytical scale. Analysing the spatial pattern of these points is no more atomising archaeological information than looking at any other variable. The GIS allows me to analyse a very large volume of data at many different scales.

Methodology is discussed in detail in Chapter 3 but the relationship between the specific analyses and the questions is laid out here. Site Catchment analysis is used for examining terrain sensitivity, integration of different site types and tempo. All of these issues can be addressed by measuring the terrain features and archaeological sites within set distances of each site. Statistical analysis of these measurements identifies trends within the distribution of sites. The use of Site Catchment analysis for descriptive purposes has been productive elsewhere (Schermer and Tiffany 1985). The major advances here are the much larger data set and a more thorough statistical analysis.

Next there are descriptive spatial statistics, useful for studying scale, as well as integration and the differentiation of territories. These are statistical summaries of the distribution. They indicate if and where the sites form clusters and at what scales these clusters are evident. The results are functions, frequency distributions and maps.

Mathematical modelling brings scale, integration and terrain sensitivity together. It is particularly useful for examining specific relationships between sites and terrain features. The models make use of the results of the other two analyses and test explicit suggestions for relationships. These models were developed for use in environmental epidemiology (Diggle and Rowlingson 1993). This is their first use in an archaeological context.

These three types of analysis allow me to discuss the four dynamics of this Middle Bronze Age landscape in a concrete and comparable manner. The interpretations in Chapter 5 take into account many things that could not be included in the formal analysis. The nature of individual sites is taken into consideration, as are the results of studies of similar cemeteries elsewhere (Woodward 1978, Hall *et al* 1987). The final result is an assessment of the relationship between the terrain of Southeast Limerick and the people who inhabited it in the Middle Bronze Age.

Chapter 2: Data

Introduction

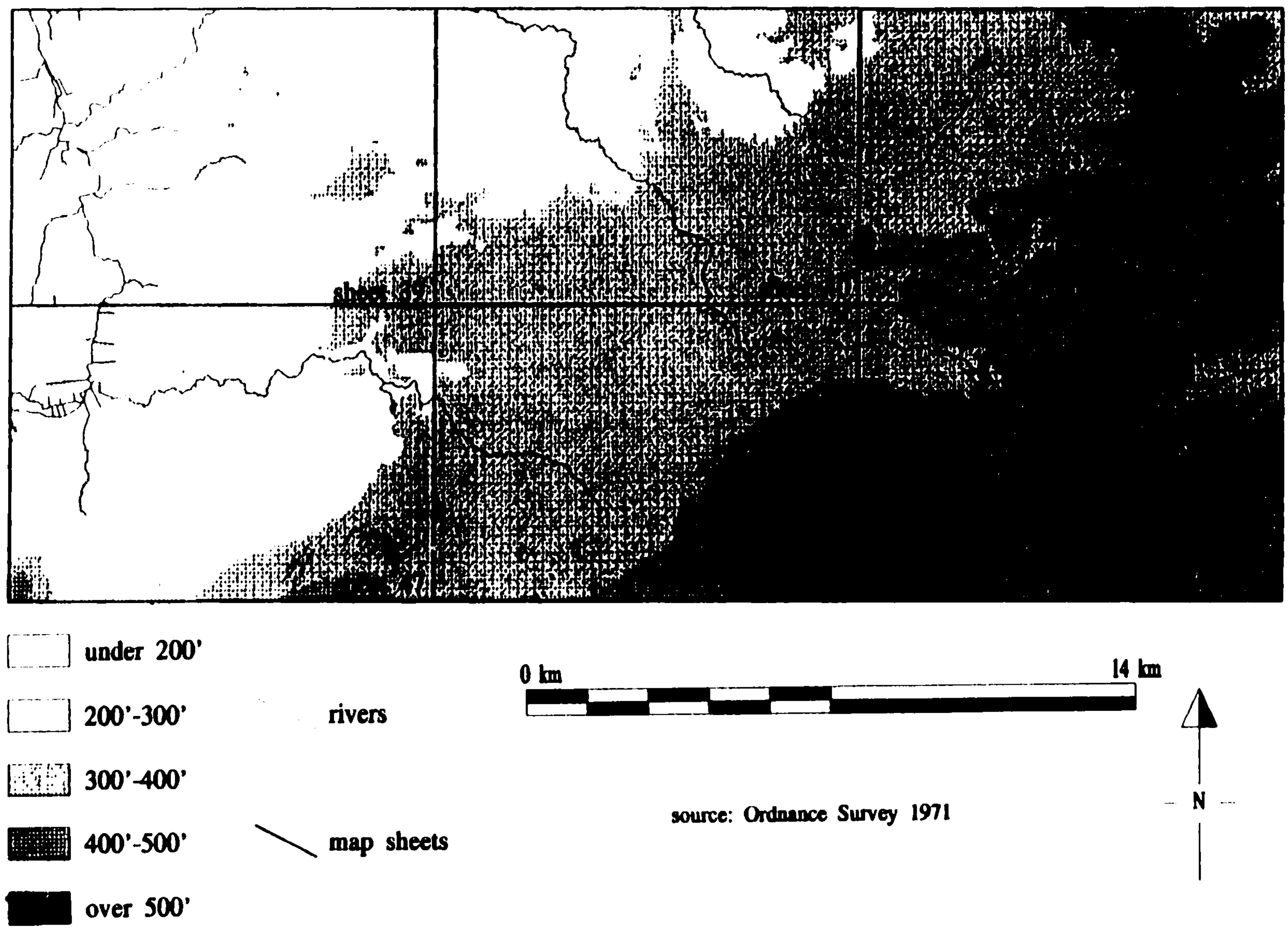
The study area encompasses 375 km^2 in south east Co. Limerick and small portions of Co. Tipperary and Co Cork. Ordnance Survey 6" sheets define arbitrary boundaries. It is designed to encompass the main concentration of barrows and to take in a variety of terrain features. Since it is one focal area of the North Munster Project, a long term landscape research project forming part of the Discovery Programme (Grogan *et al* 1996), a wide range of information is available. The area is dominated by large flood plains and valleys associated with the Maigue River and its tributaries the Camoge, the Morningstar and the Loobagh. It is bounded on the south by the Ballyhoura Mountains, and a few low hills, which break the terrain (Figures 1, 2).

The purpose of this chapter is to highlight important aspects of the data, and discuss features that need explanation. It also clarifies my priorities and the strengths and weaknesses of the data set. Details on the soils of the area are in Appendix A and archaeological material in Appendices B, C, and D. Here I emphasise terrain features because they are more complicated and less well known than the archaeological material. Most of the analysis of the archaeological material will be based on location and function; details of form, stratigraphy and finds will receive less attention. The terrain information provides a surface which is known, the archaeological material provides a key to understanding that surface.

Since my analysis is largely quantitative, descriptions are based on classification and measurement. Balancing this with an appreciation of the qualitative sense of place will be the result of analysis. "In describing geographical data it is valuable to be aware of these three distinct types of measurement- fundamental categories, user-defined categories and continuous measurements- as their information content varies" (O'Brien, L. 1992, 32). Topography is a continuous measurement as are some of the measurements of sites. The nature of drainage forms a fundamental category. The other measurements, such as soil types and site classes, are user defined categories. I am not claiming that

Figure 1: Location of the Study Area

Figure 2: The Study Area



these were the categories of terrain that structured the Middle Bronze Age landscape, they are the categories with which it can be quantified.

NAMING

Both sites and soil series are named for townlands. The townland is the smallest unit of land division in Ireland, similar to the parish or the township. The system and many of the names date to the 17th century - although some are much older and a few may date back to the prehistoric period. Townland names describe that landscape: terrain features - the word *derry* refers to oak trees; social features - Bishopsfield describing ownership; and archaeological sites as landmarks - the word *rath* refers to ringforts and other earthworks. Some work has been done using the naming system for understanding the proto-historic landscape (Hammond 1983, Ó Maolfabhail 1990). Sites are given with their townland names and numbers with cross references to National Grid Co-ordinates and Sites and Monuments Record (SMR) number in Appendix B. Soil series are named by the national soil survey. Their names refer to the townland in which they are most clearly expressed. The most commonly referred to townlands are labelled on Figure 3.

Terrain Features

TOPOGRAPHY

The two main hills in the southeast of the study area are Slievereagh and Duntryleague. These foothills of the Ballyhoura Mountains drop away sharply - most of the study area is within the 400' contour (Figure 4). Within this plain there are extraordinarily flat river terraces and some slight knolls surrounding the former glacial lakes. There are also some small hills where limestone is outcropping such as Knocktwo and Raheenamadra. Glacial drift eroded through drainage produces a mottled terrain. The rise between the major rivers is greater than is obvious in Figure 4.

Figure 3: Important Townlands

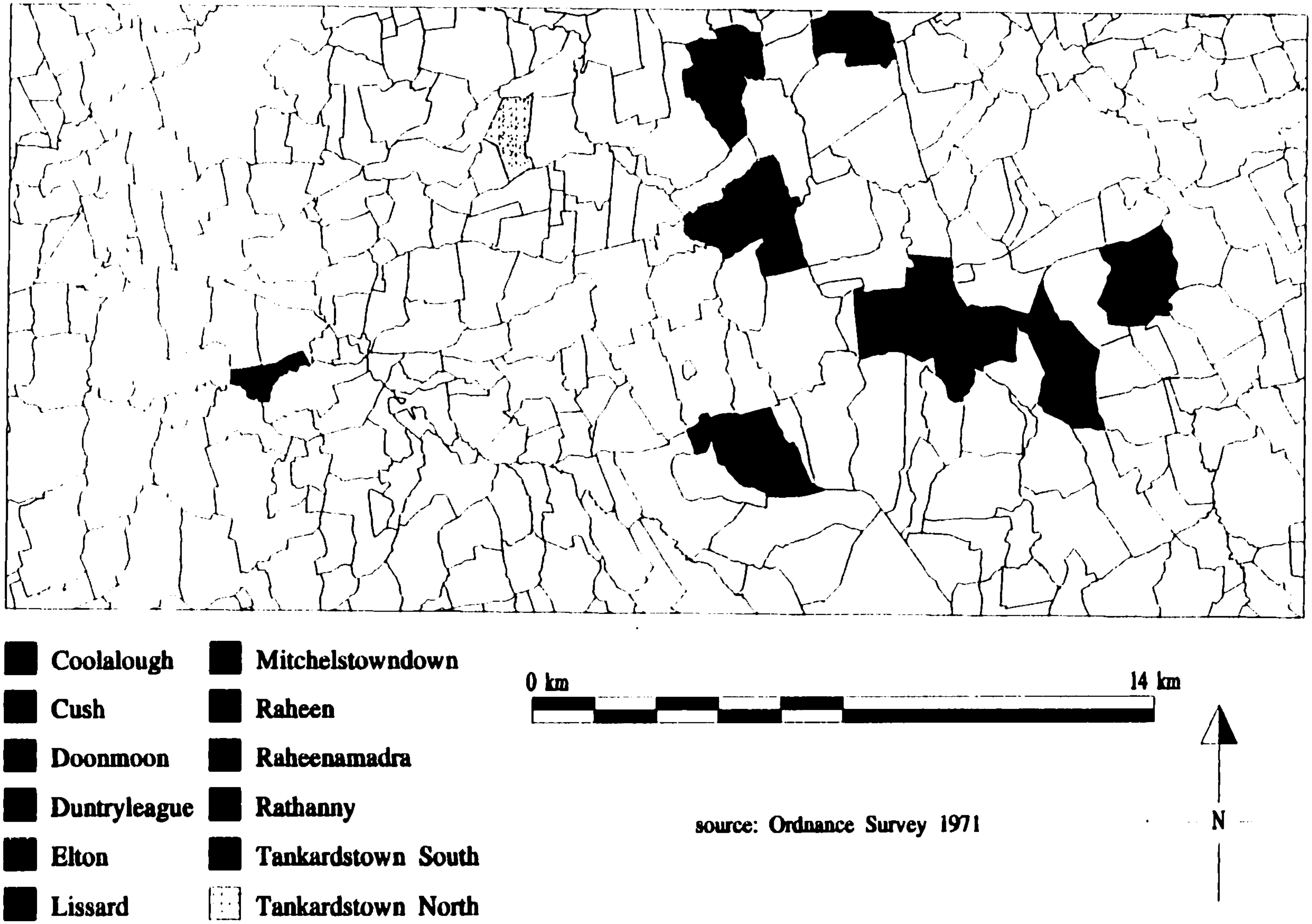
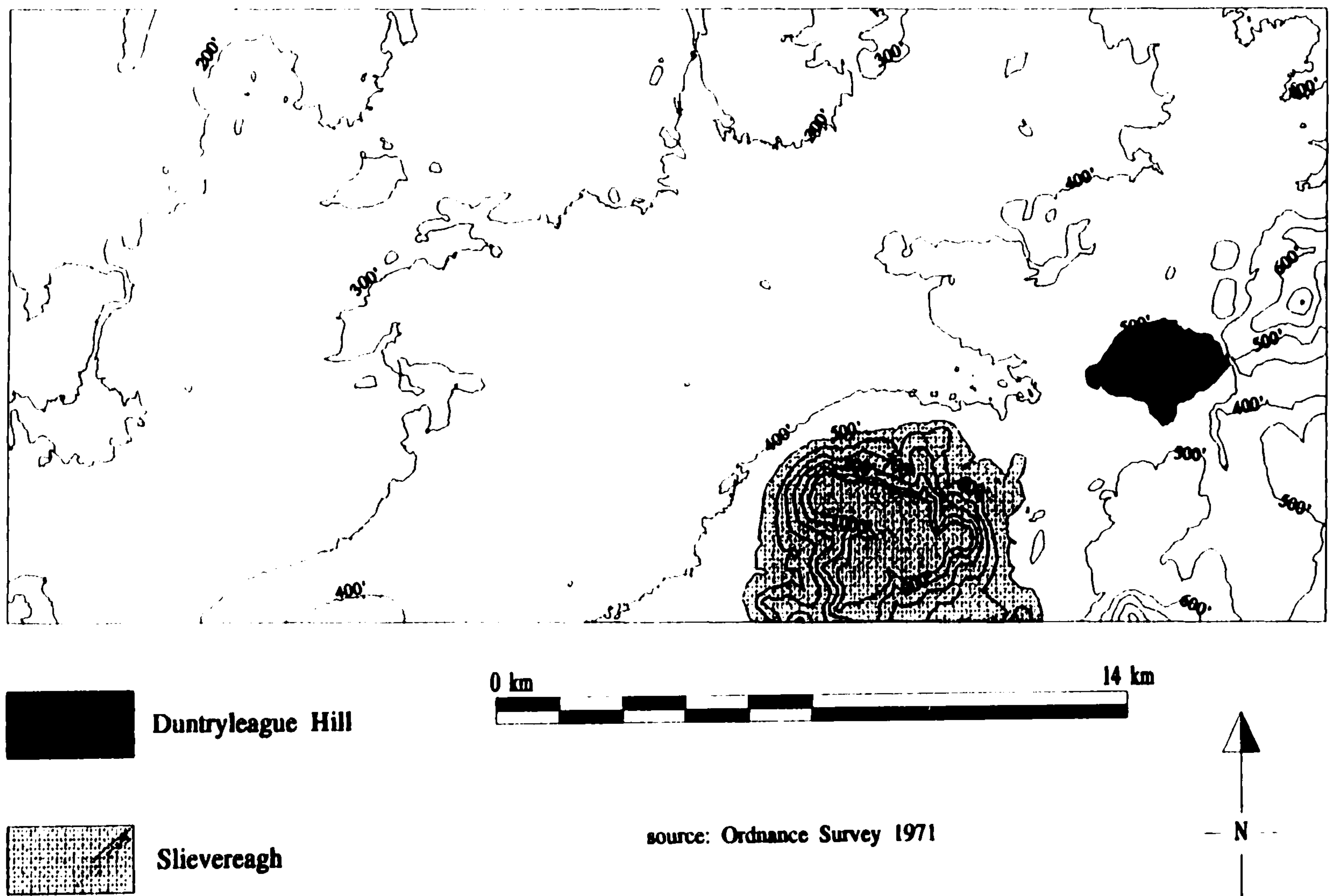


Figure 4: Topography



source: Ordnance Survey 1971

GEOLOGY

Basal Geology

The most important feature of the solid geology in the study area is a fault running below Duntryleague and Seefin in the southeast (Figure 5). This effects topography, drainage, and soils. The basic geological structure of Ireland is saucer shaped. The midlands are a low limestone plain while the coasts are composed mainly of volcanic and metamorphic uplands (Mitchell 1986, 5-9). The study area has been chosen to cover both zones. It is just on the edge of the Hercynian province of the South West (Herries-Davies and Stephens 1977). Old Red Sandstone hills rise out of a Carboniferous Limestone plain.

Glacial Geology

During the last full glacial period in Ireland (75, 000 – 10, 000 years ago) most of the island was glaciated with the exception of a strip running to the south of a line from the Shannon estuary to Dublin Bay. Metamorphic slopes stopped the advance of ice from the north and only a small area in the extreme southwest of Ireland was affected by an independent ice cap (Finch and Ryan 1966, 15; Mitchell 1986, 43-46). Once again the study area has both glaciated and unglaciated sections. The sudden change in slope in the southeast stopped the glacial advance and the terminal moraine of the Weishcel (or Midlandian) glaciation follows this line of slope. The moraine produced small sandy hillocks interspersed with glacial lakes (Finch and Ryan 1966). This feature underpins most of the terrain variation within the study area.

DRAINAGE

Rivers

Most of the study area is in the catchment of the River Maigue, which joins the Shannon estuary just west of Limerick City, but some of the southeast is in the catchment of the River Aherlow, which joins the Atlantic near Cork City (Figure 6). The Morningstar is the longest river in the study area. It runs through lower land than the Camoge and the Loobagh and has been subject to more modern drainage.

Figure 5: Basal Geology

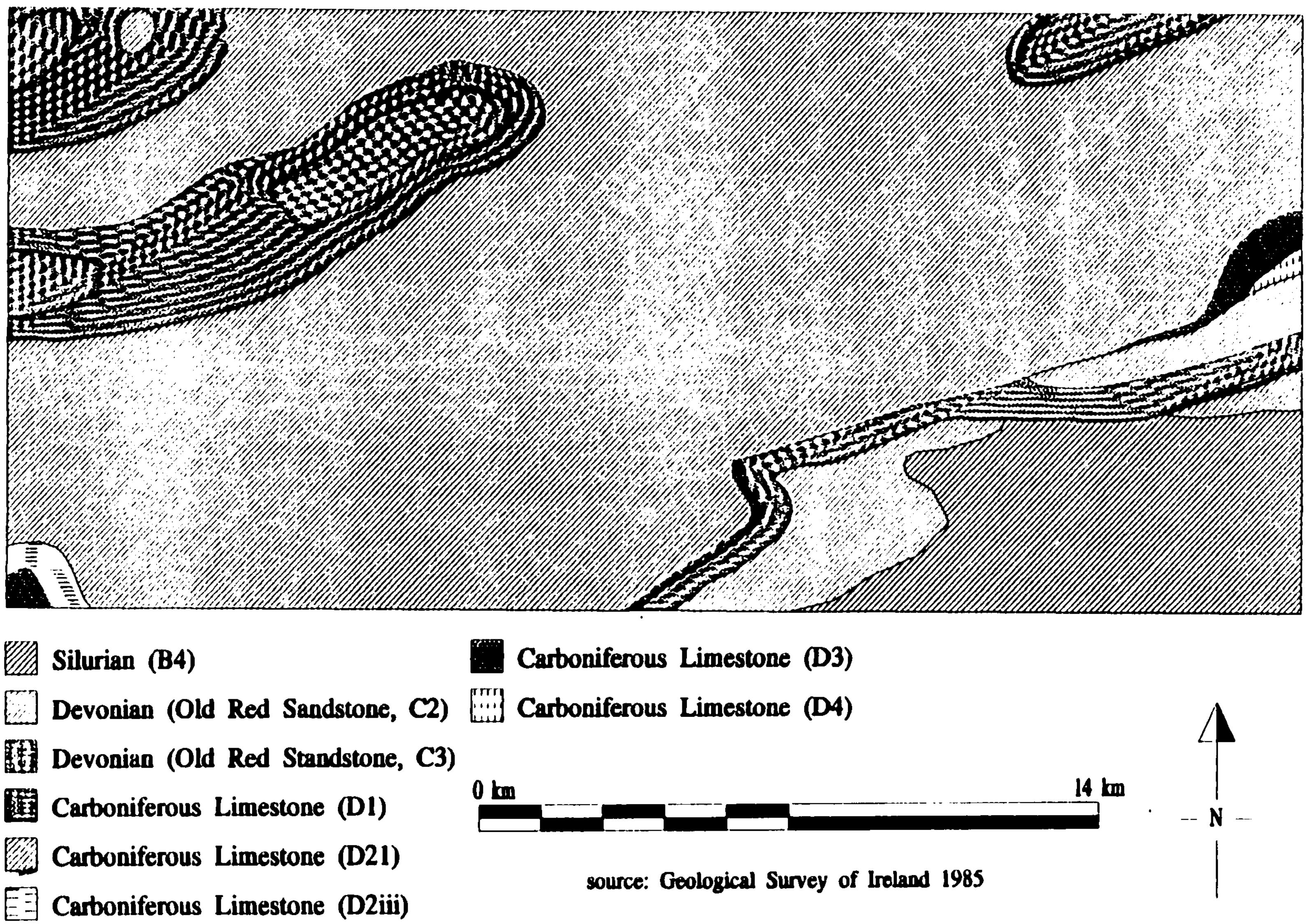
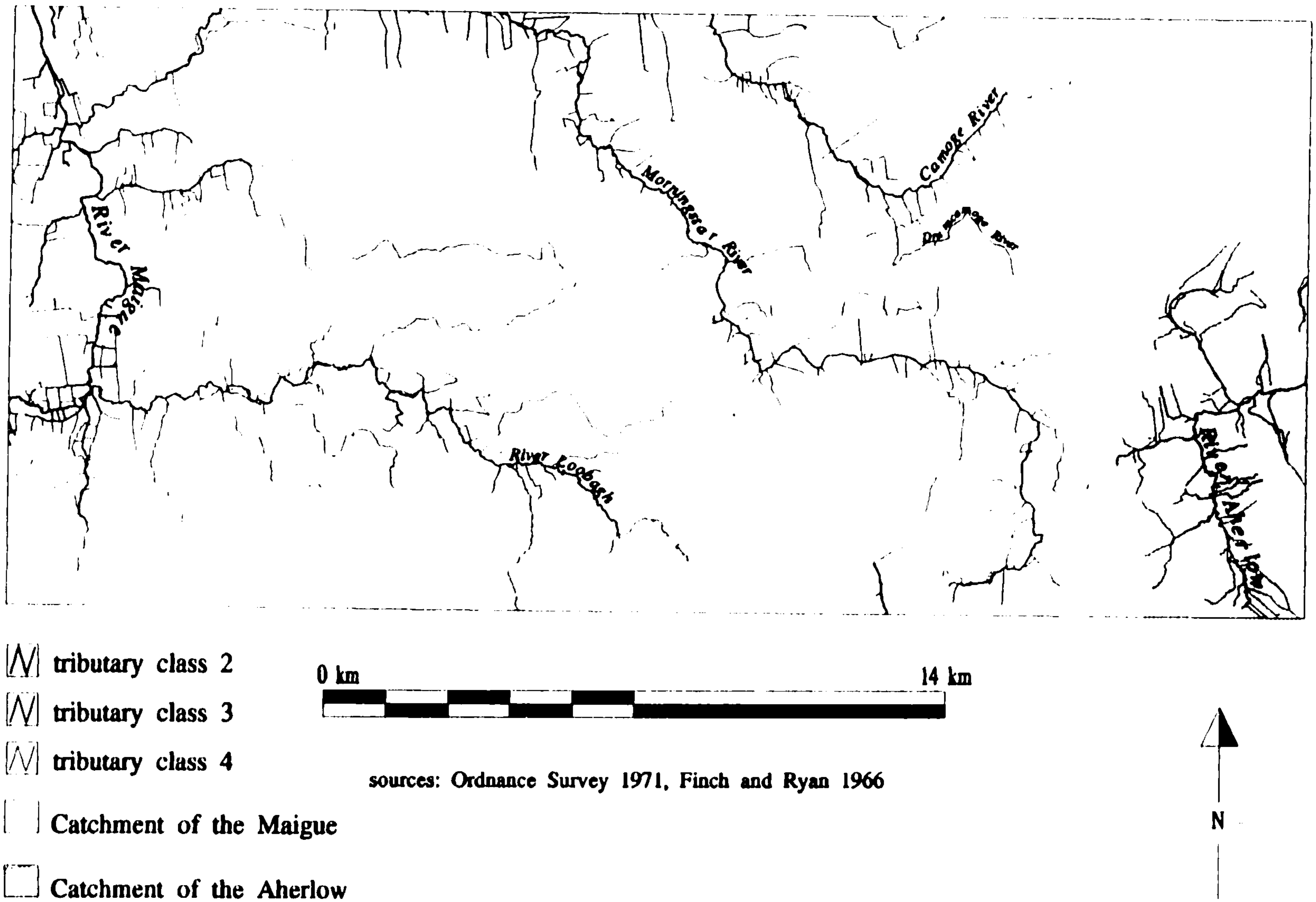


Figure 6: Arterial Drainage



sources: Ordnance Survey 1971, Finch and Ryan 1966

The floodplain of the Morningstar is determined by position of glacial lake beds, discussed further below. The Loobagh and the Camoge have less confined floodplains as can be seen in the pattern of surrounding soils. Agricultural programmes in the 1950's included lowering the bed of the Morningstar by up to two metres. Many of the smaller channels surrounding fields are ditches, which take advantage of natural drainage routes (Figure 7).

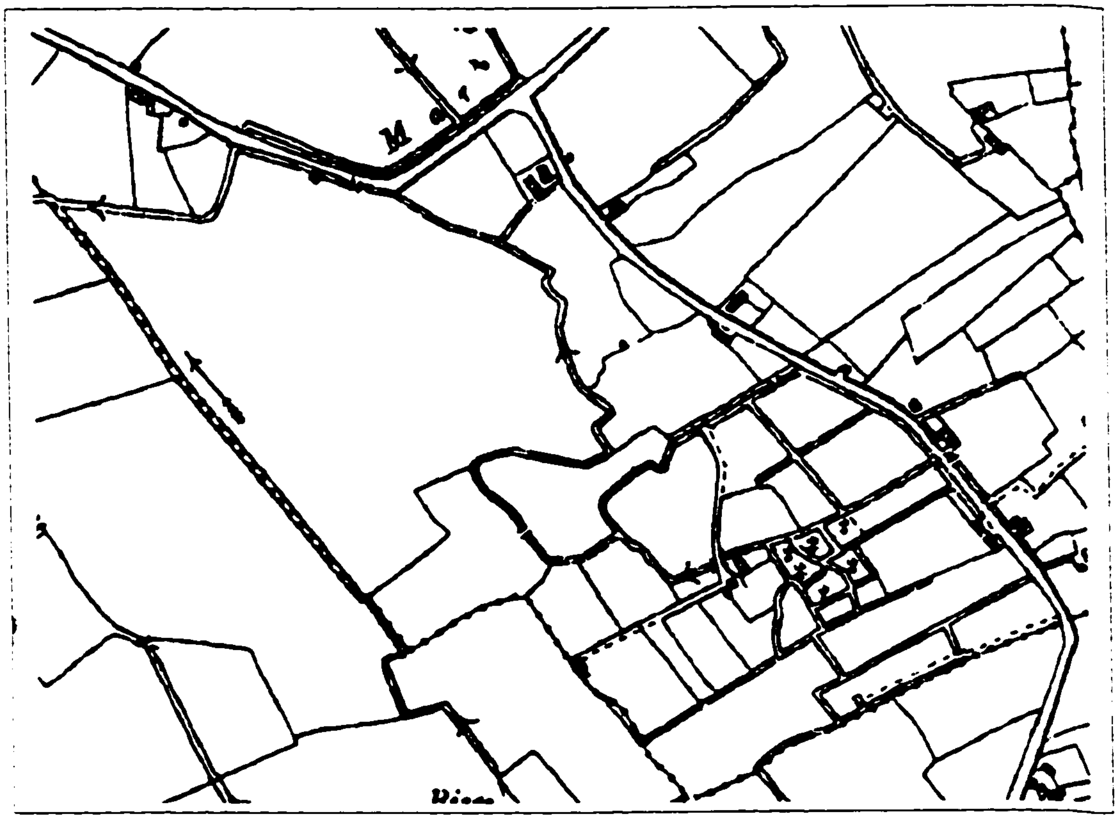
The course of most streams and rivers has been changed but they may well have been present in prehistory. Since there is no chronology for these changes, the drainage coverages show all watercourses (Figure 8). I have classified these by how many channels water must run through to reach the sea. So the Maigue is classed as 2, the Camoge 3 and the Drumcamoge 4 (Figure 6). Of the 1415 km of waterways in the study area, the Maigue makes up only 20km. The Morningstar the Loobagh and the Camoge combined constitute a further 122km. The vast majority, 820 km, is in the 2989 watercourses of the next three levels of tributaries (Figure 9). Further levels of tributaries are more likely to be the result of modern drainage interventions (Figure 7)

Lakes

Though the area has no extant lakes it is now clear that it was lakeland in the later prehistoric period. Early archaeological research in the area referred to folklore concerning 'lost lakes' (Westropp 1897). Small glacial lakes in the area were still open water until the early modern period (Finch and Ryan 1966). In 1921 there was still a small pond mapped by the Ordnance Survey that has now drained completely (Figure 10). Three soil series in the area are based on lake alluvium (see below). Investigations at Coolalough (LI039-031) recovered a layer of fen peat, dated to 875 BC, growing directly on lake marl (Appendix D and C). This indicates fen encroaching on one of the larger glacial lakes. These points combined show that the area had lakes during the later prehistoric period.

The boundaries of the alluvium based soils can be used to determine the distribution of these 'lost lakes' (Figure 11). Further, some soil composites on the moraine may indicate places where smaller lakes dotted the landscape (Figure 12). Drainage proceeded at different rates but these are a good guide to former distributions. Viewing South East Limerick as a lakeland in the later prehistoric period is a

Figure 7: Drainage, Martinstown, Co. Limerick



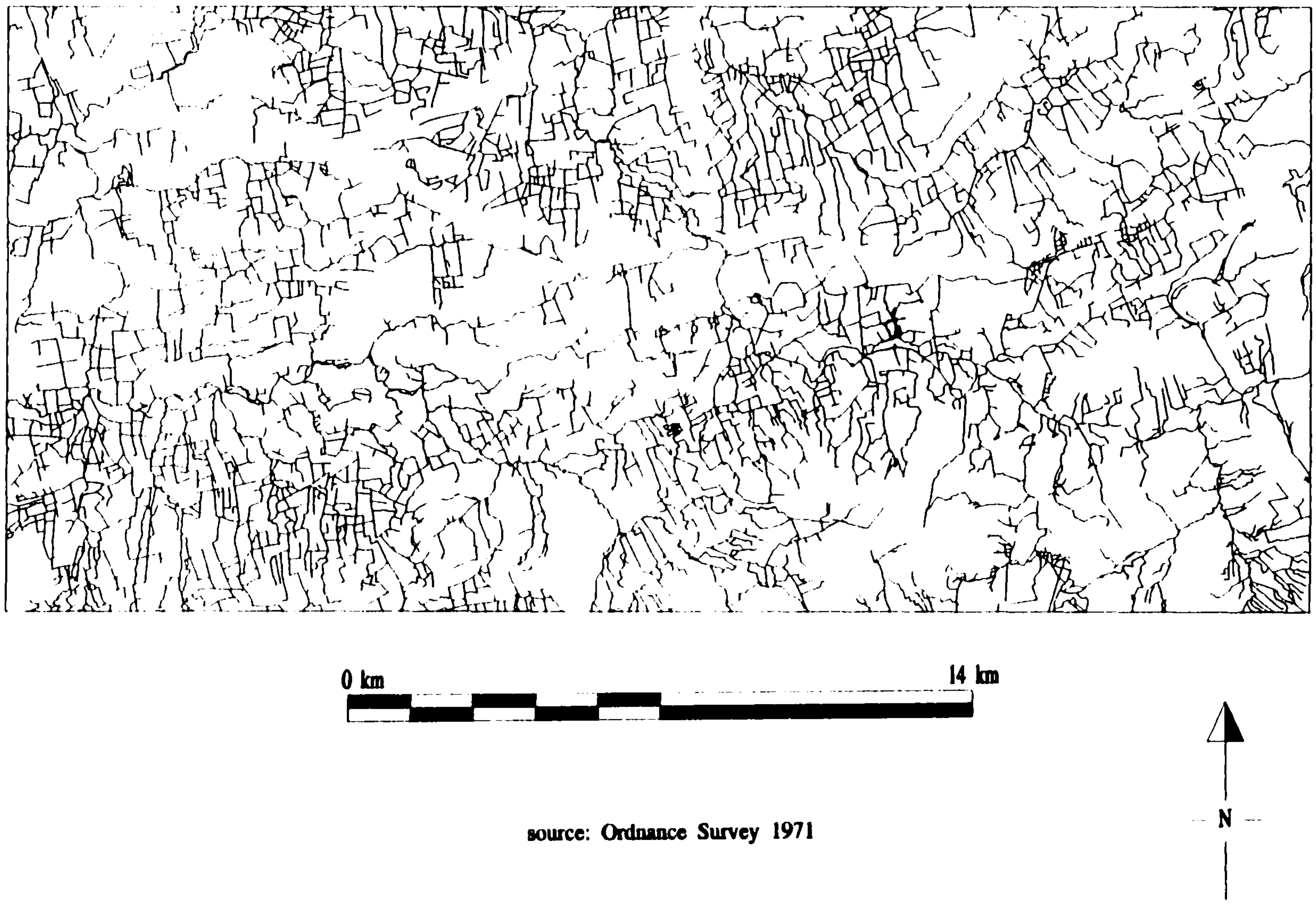
0 m 600 m

source: Ordnance Survey 1971

— N —

Many of the drains are based on streams. The tight weave of ditches in the lower right may be bringing water to those fields for cultivation of sallys rather than draining an overly high water table.

Figure 8: All Present Water Courses



source: Ordnance Survey 1971

Figure 9: Tributary Classes 4, 5, 6

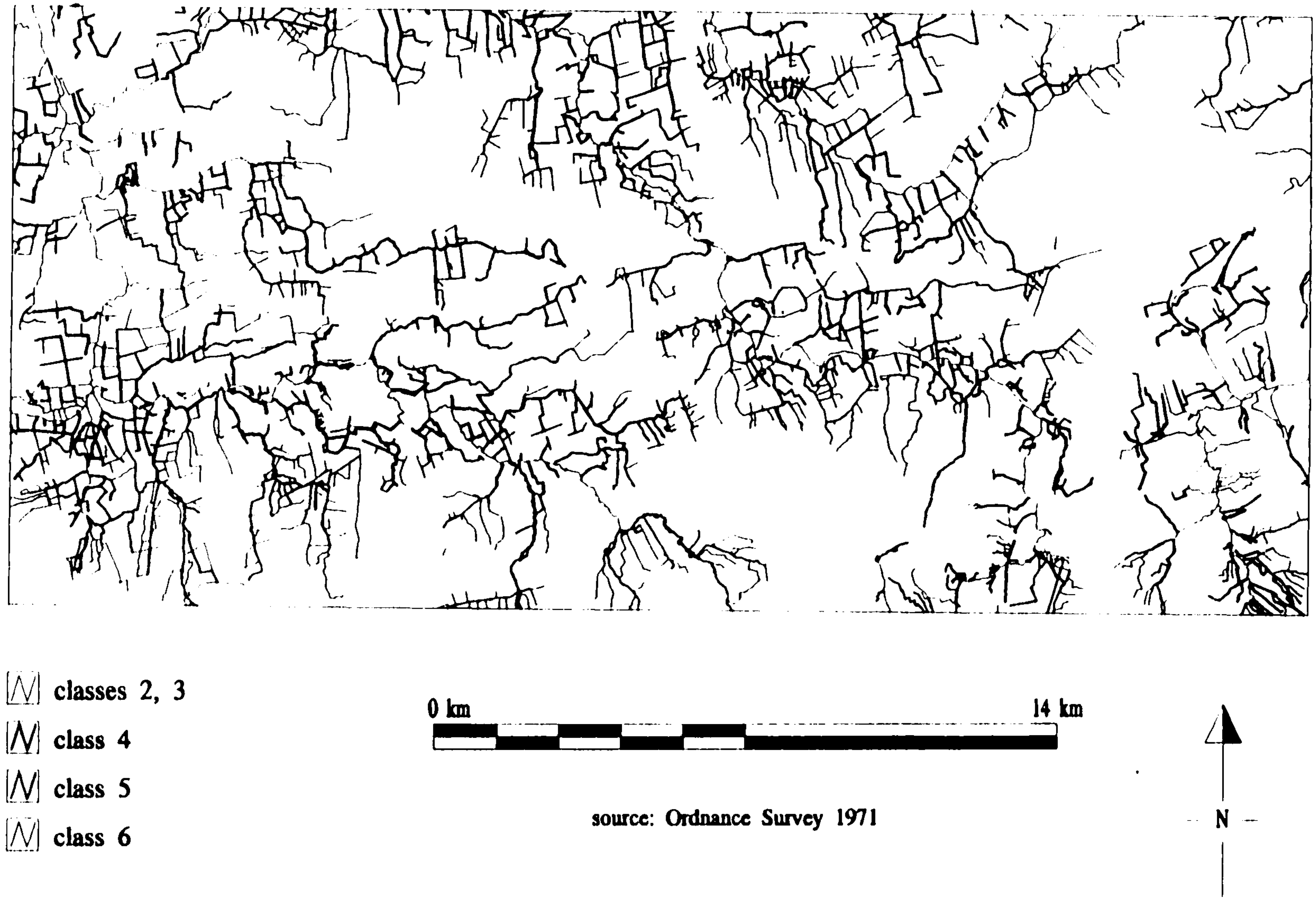
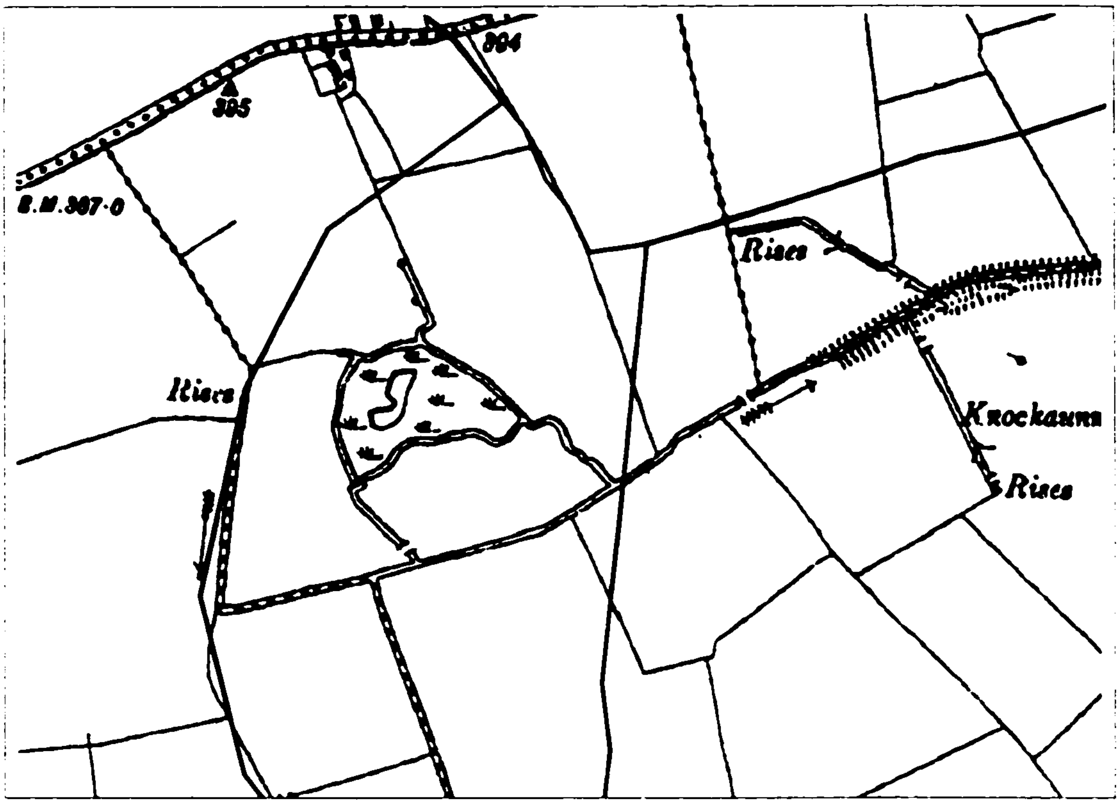


Figure 10: Lake at Ballinvana, Co. Limerick



0 m 600 m

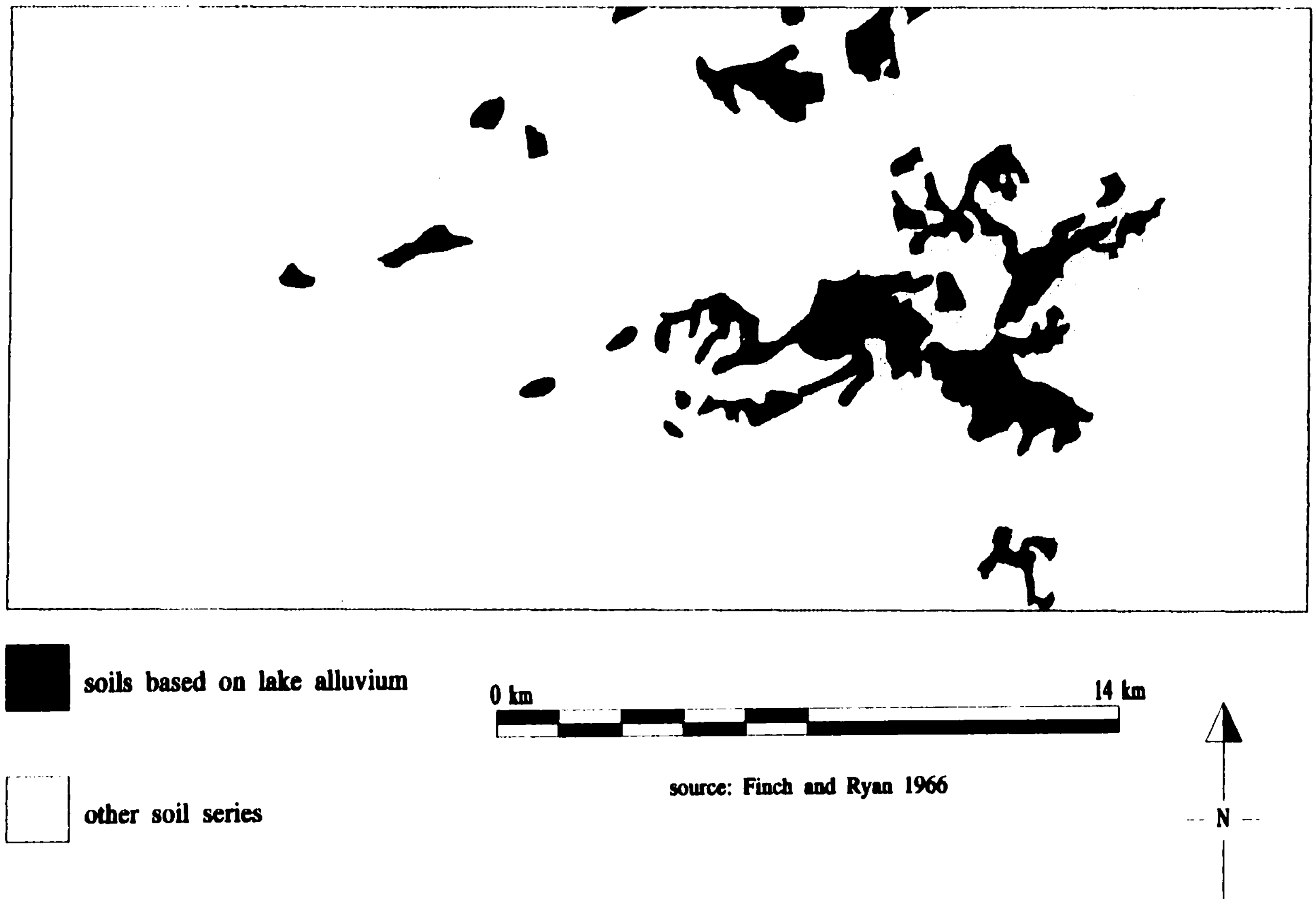
sources: Ordnance Survey 1971
Finch and Ryan 1966

boundary of lake alluvium

boundaries of other soils

N

Figure 11: Lake Alluvium



significant departure from conventional assessment. Using the distributions of these lakes in analysis allows me a fresh point of view.

SOILS

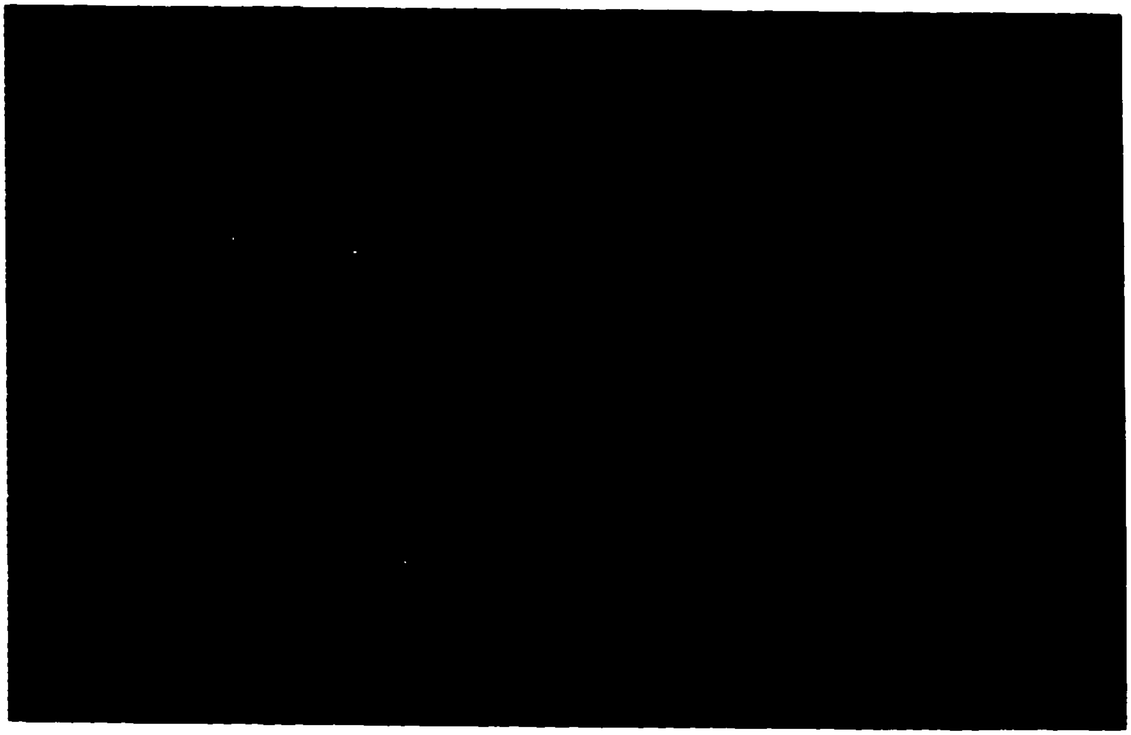
The study area has been particularly well covered by the National Soil Survey (Finch and Ryan 1966). Three of the map sheets were the first in the country to be surveyed. They were studied at ten samples per hectare while the rest of the National Survey was carried out at the more economical interval of three samples per hectare (Finch and Ryan 1966) (Figure 13). Much of the fine detail is lost in the published version, but staff at *Teagasch* kindly made the field maps available. The enthusiasm of the survey is also evident in the published bulletin and many of the observations made in this area form the basis for understanding soil development in Ireland as a whole (Finch and Ryan 1966; Gardiner *et al* 1980). The emphasis on present agricultural usage highlights the human input into soil development and acknowledges changes during the modern period.

Many studies have only considered great soil groups when looking at the relationships between sites and soils (Cooney 1979; Woodman 1985; Grogan 1989; Bradley and Hart 1983). This is partly because of uneven data availability, partly an overriding concern with resource procurement and finally unease with the idea that prehistoric groups recognised such refined distinctions between soils. I base my analysis on soil series because I have a high quality source of data, because soils of the same group can have very different properties and histories and because it moves the discussion beyond resource procurement. It is unlikely that prehistoric groups used these classifications, but a similar range of soil variability could well have been recognised.

Soil Development

The most common parent material of Irish soils is glacial drift, allowing for quite fertile soils to develop (Finch and Ryan 1966, 25). While the primary woodland cover existed the island would have had a fairly even cover of brown forest soils (Mitchell 1986, 70). Calcareous parent material from the

Figure 12: Detailed soil composites, sheet 49 north west



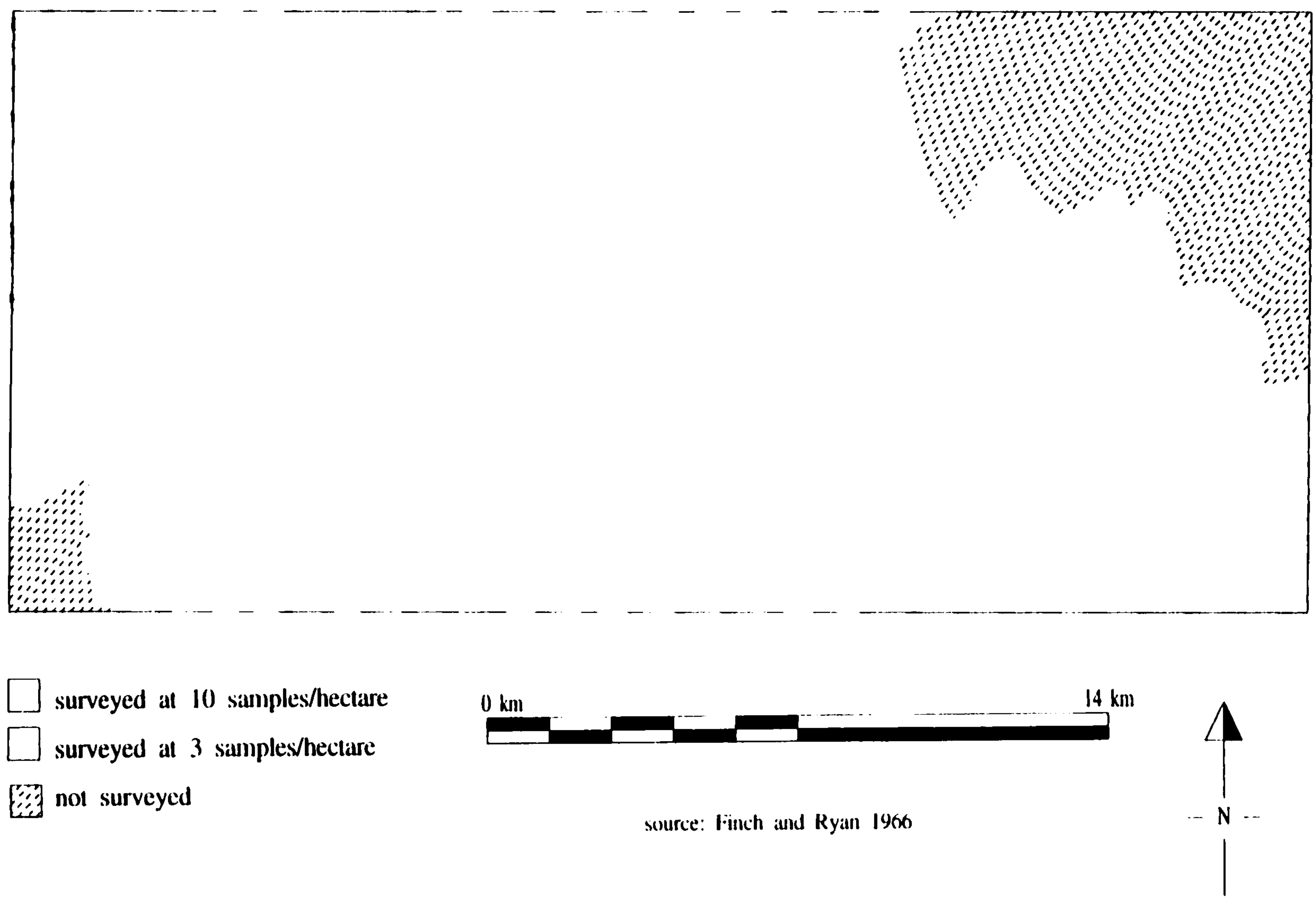
0 km 3 km

source: National Soil Survey field maps

- Elton
- Howardstown
- Baggotstown
- Ballyvohereen
- Coolalough
- Griston
- Doonglara
- Gortaclareen
- Elton/Howardstown
- Elton/Baggotstown
- Ballyvohereen/Gortaclareen
- Peat
- Howardstown/Peat
- Ballyvohereen/Peat
- Coolalough/Peat

N

Figure 13: Extent of detailed soil survey



limestone bedrock combined with high rainfall makes podsolisation the predominant soil formation process. Deforestation, increasing rainfall and changing drainage regimes caused leaching in the brown forest soils producing the present pattern of soils (Edwards 1985). Currently, waterlogged gley soils cover most of the lowlands with better drained grey brown podzolics on low hills and lithosols in the uplands (Mitchell 1986, 176).

Drainage and glacial history are the two most important natural factors influencing the soil pattern in the study area. The majority of soils are Gleys reflecting the overloaded drainage system (Figure 14). The best soils for modern usage are the drier lighter soils of the upper slopes since many of the heavier soils can only be used for a few months a year. The effects of glacial history can be seen by examining the soils of the terminal moraine. The unglaciated uplands in the southeast have a completely different soil pattern to the glaciated lowlands. The terminal moraine is a complex pattern of glacial deposits, hummocks and hollows. The glaciated lowlands to the north and west of the moraine have a comparatively simple pattern with lake alluvial soils in the beds of drained lakes. Further west, where the terminal moraine is in the distant south, the pattern becomes more simple still. Drainage is the main determining factor here (Figure 15). All of the soils of the study area are described in Appendix A.

Soil Series

Elton is the most common well-drained soil series in the study area. It is a Grey Brown Podzolic based on glacial drift. It occurs in association with Howardstown, a Gley on the same parent but with a different drainage regime (Finch and Ryan 1966, 49-50, 58-59) (Figure 16). Both series are slightly podsolised showing that they had similar developmental patterns. While they occupy different soil groups today, they may have been more similar in the Bronze Age due to changes in drainage. Where these soils are intermingled they are mapped together by the Soil Survey. Since the distinction is drainage dependent, this mixture indicates more broken topography.

Ballylanders is the most common well-drained soil south of the fault line. It is similar to Elton in character but based on a glacial drift from the previous Saale glaciation (Finch and Ryan 1966, 37). This structural difference and the different drainage history have produced a Brown Earth. Ballylanders is

Figure 14: Great Soil Groups

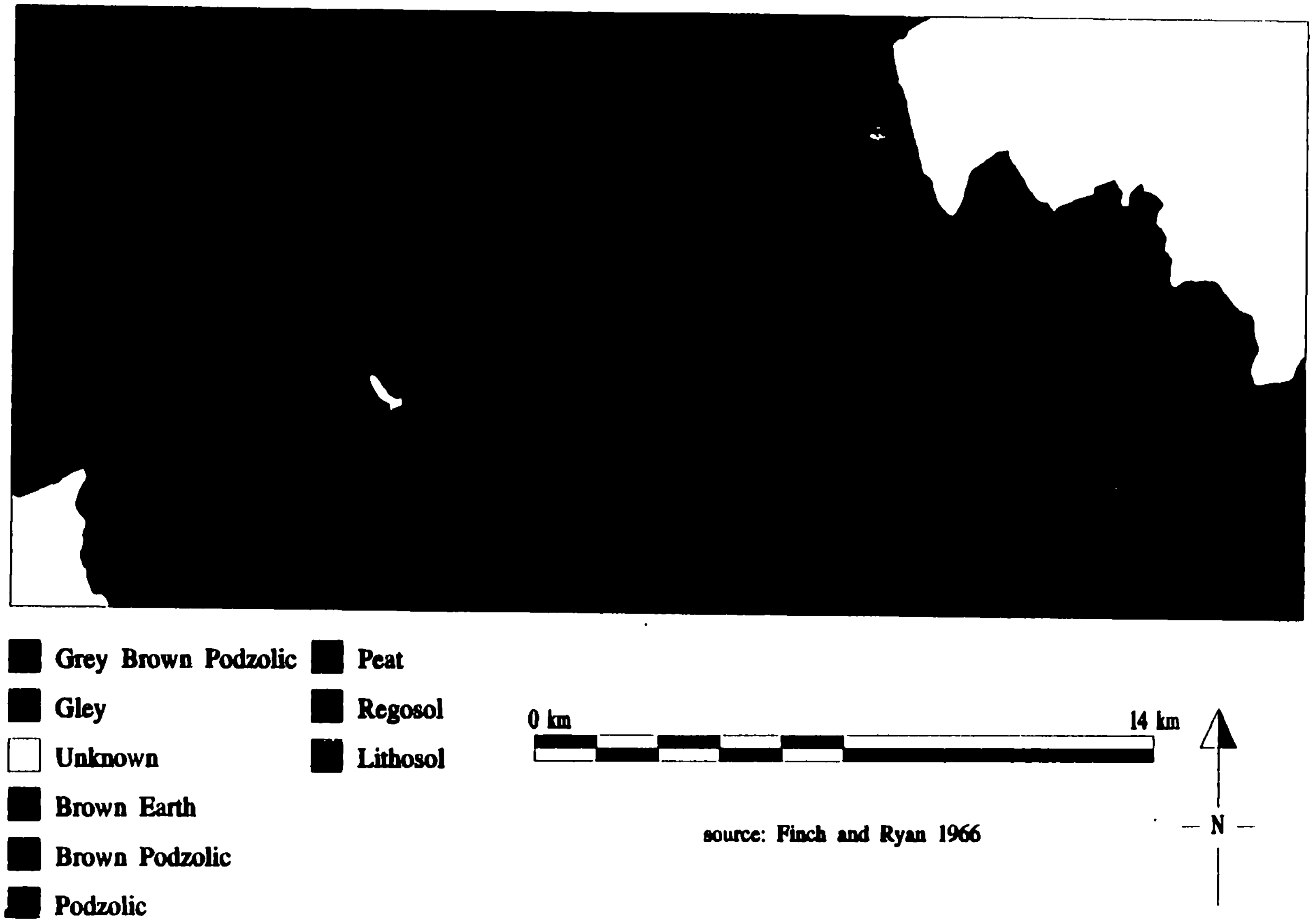
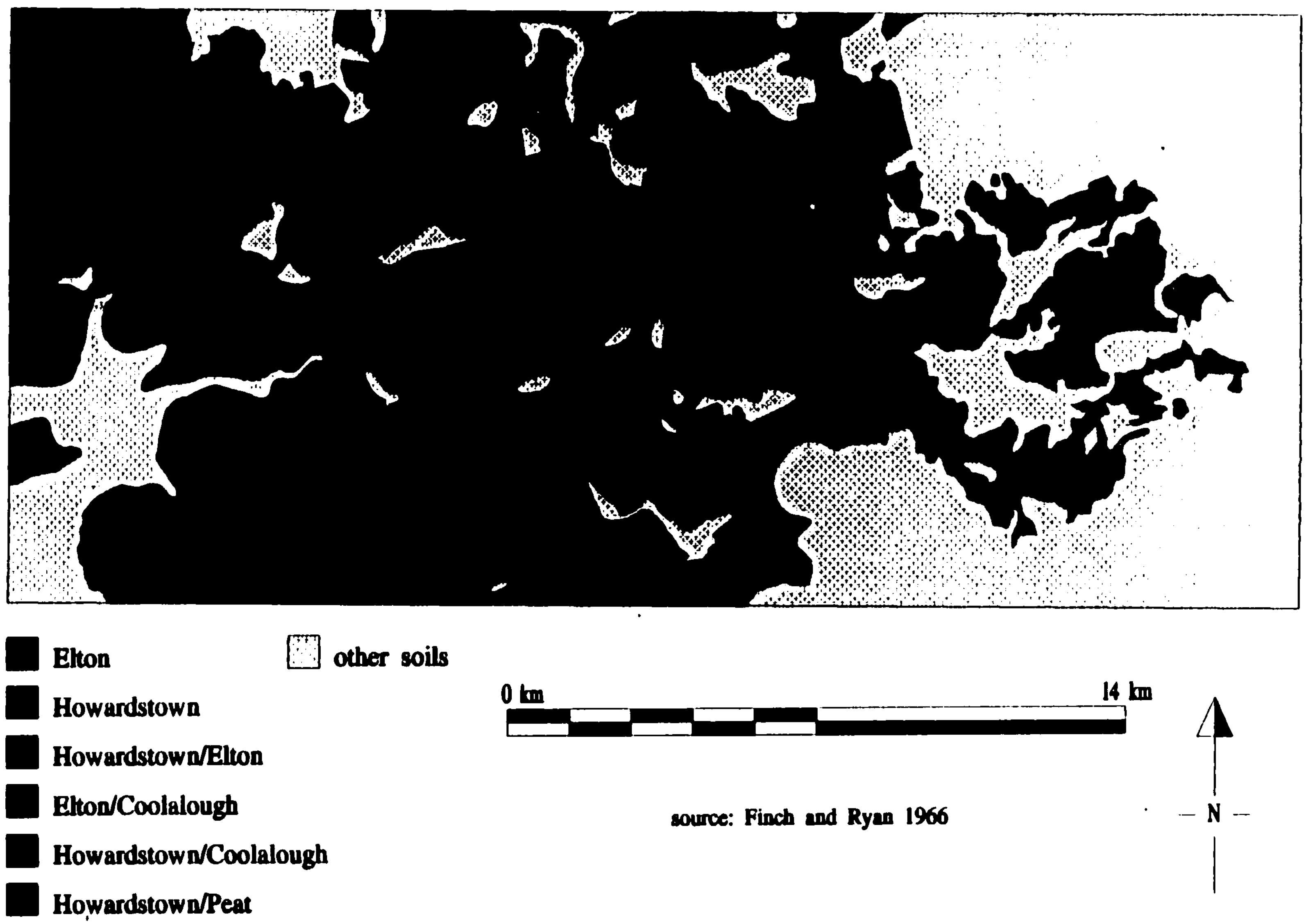


Figure 16: Elton and Howardstown Soils



source: Finch and Ryan 1966

found in association with the Gley soil, Puckane, in a similar relationship as Elton and Howardstown (Finch and Ryan 1966 62-63) (Figure 17).

Coolalough, Griston and Drombanny are all heavy Gley soils based on lake alluvium (Finch and Ryan, 1966 74-75, 77-78, 76-77) (Figure 18). These soils represent lake beds which were beginning to drain in the later prehistoric period. The nature of the alluvium varies slightly. Coolalough has a higher moisture retention factor, making it heavier than the other two (Finch *pers comm*). This would have resulted in open water remaining later into the prehistoric period. These soils are important in analysis, but little of their present form is of interest.

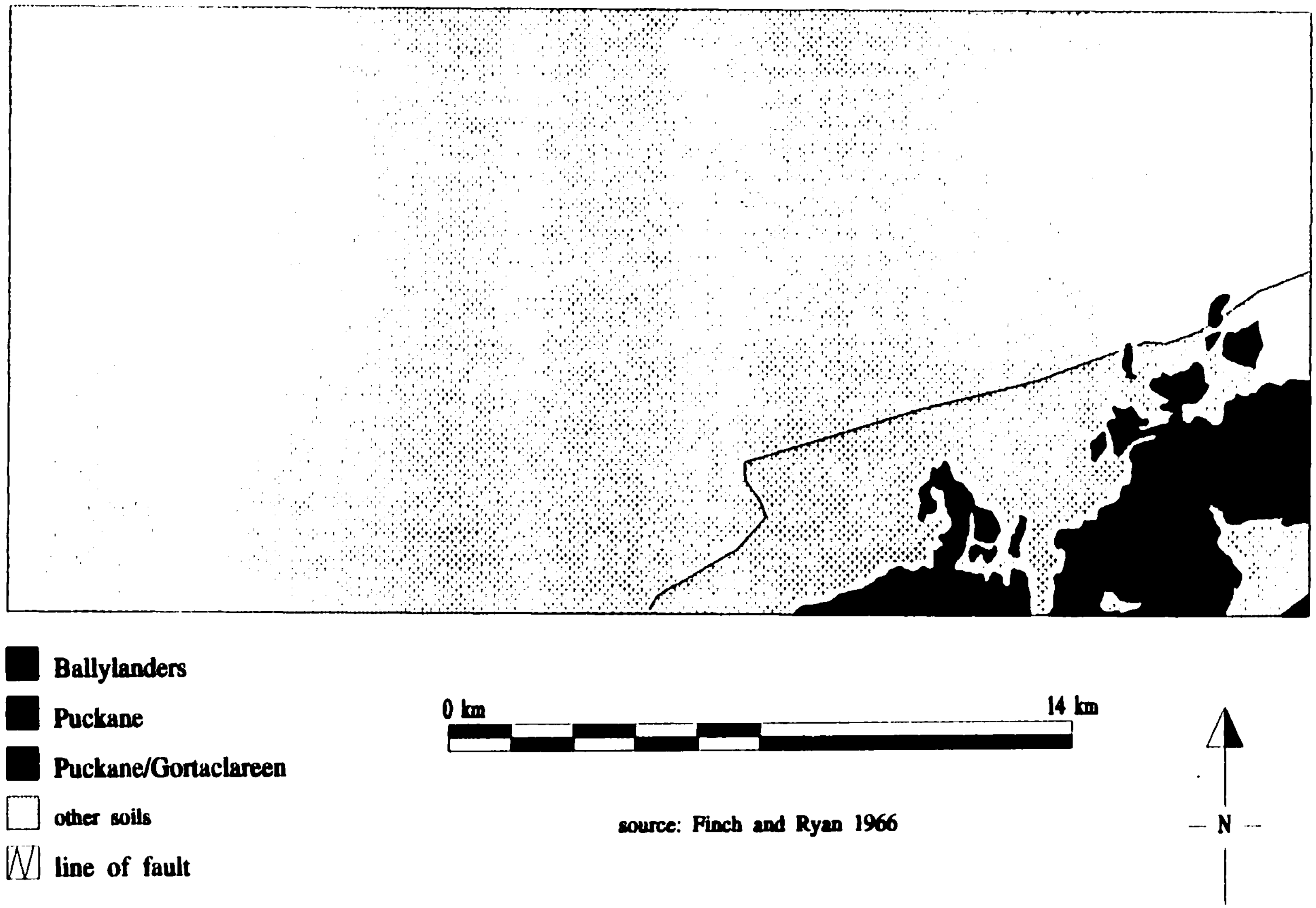
Camoge is a Gley soil based on river alluvium. Like the above soils it is heavy and frequently flooded (Finch and Ryan 1966, 79-80). Found in narrow strips bordering the main rivers and in larger areas near the confluences, it marks areas where arterial drainage is poor. South of the fault line it is mirrored by the Lyre series (Finch and Ryan 1966, 82) (Figure 19). While waterlogging would have always been a problem with these soils they are likely to have been soils and in prehistory. All of these alluvial gleys have only seasonal utility for pasture and are essentially wetland in winter months.

The Brown Podzolic series Doonglara is found on the lower north slopes of Slievereargh and Duntryleague (Figure 20). It is a robust well-drained soil, which is presently suffering from leeching (Finch and Ryan 1966, 65-66). These soils directly overlook the end moraine and the patchwork of lake beds and knolls of drier land found there. The complexity of the soils in this area cannot be reproduced at the published scale of the soil maps. More detailed survey and mapping at larger scale shows the intricacy of the pattern (Finch *pers comm*) (Figure. 12).

VEGETATION

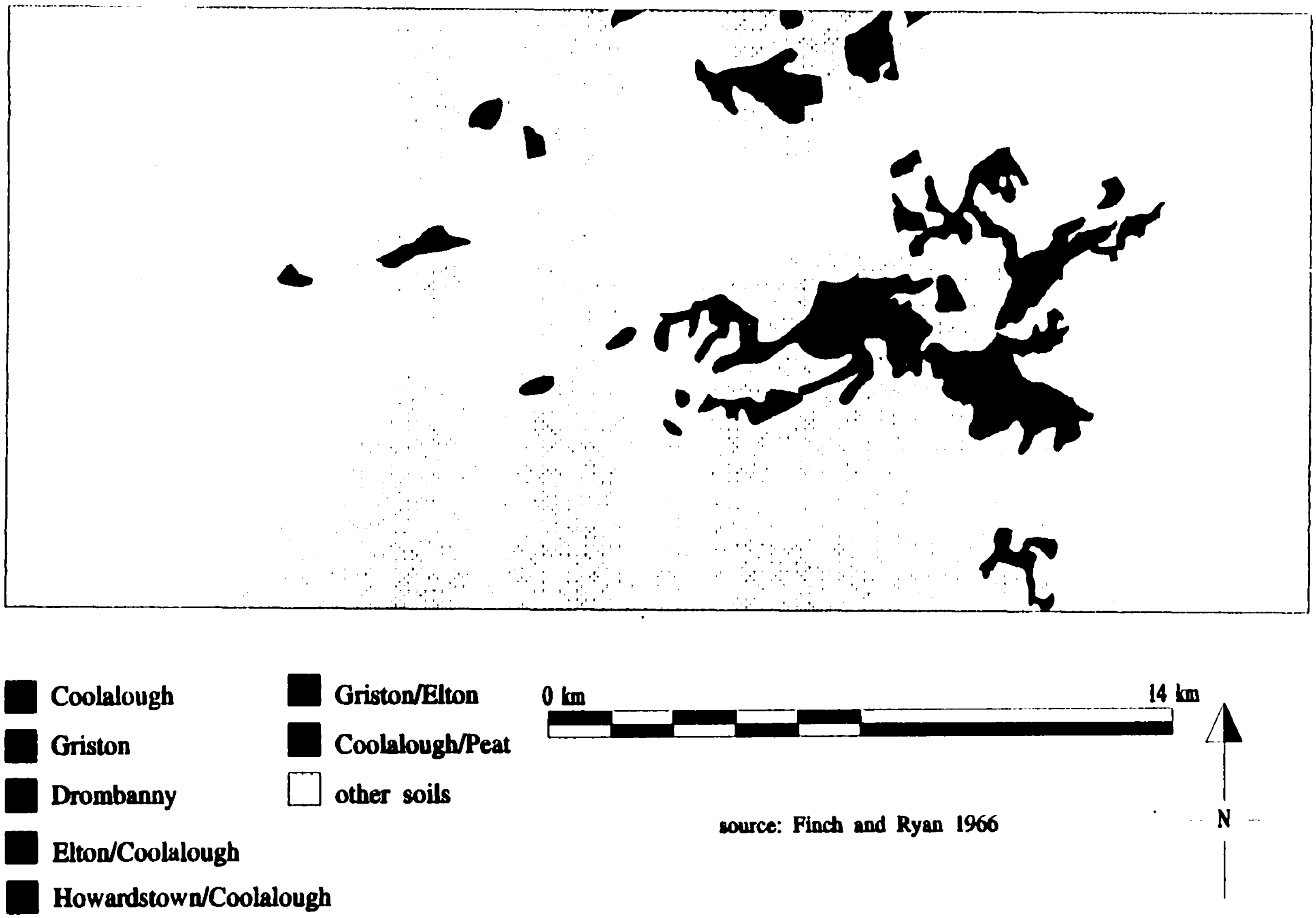
Since pollen diagrams show the vegetational history of such local areas, it is difficult to construct a vegetational picture for the whole island, yet since work in the study area has been limited the wider picture is key to understanding local vegetation (Monk 1986; 1988). Cross correlation of many diagrams

Figure 17: Ballylanders and Puckane Soils



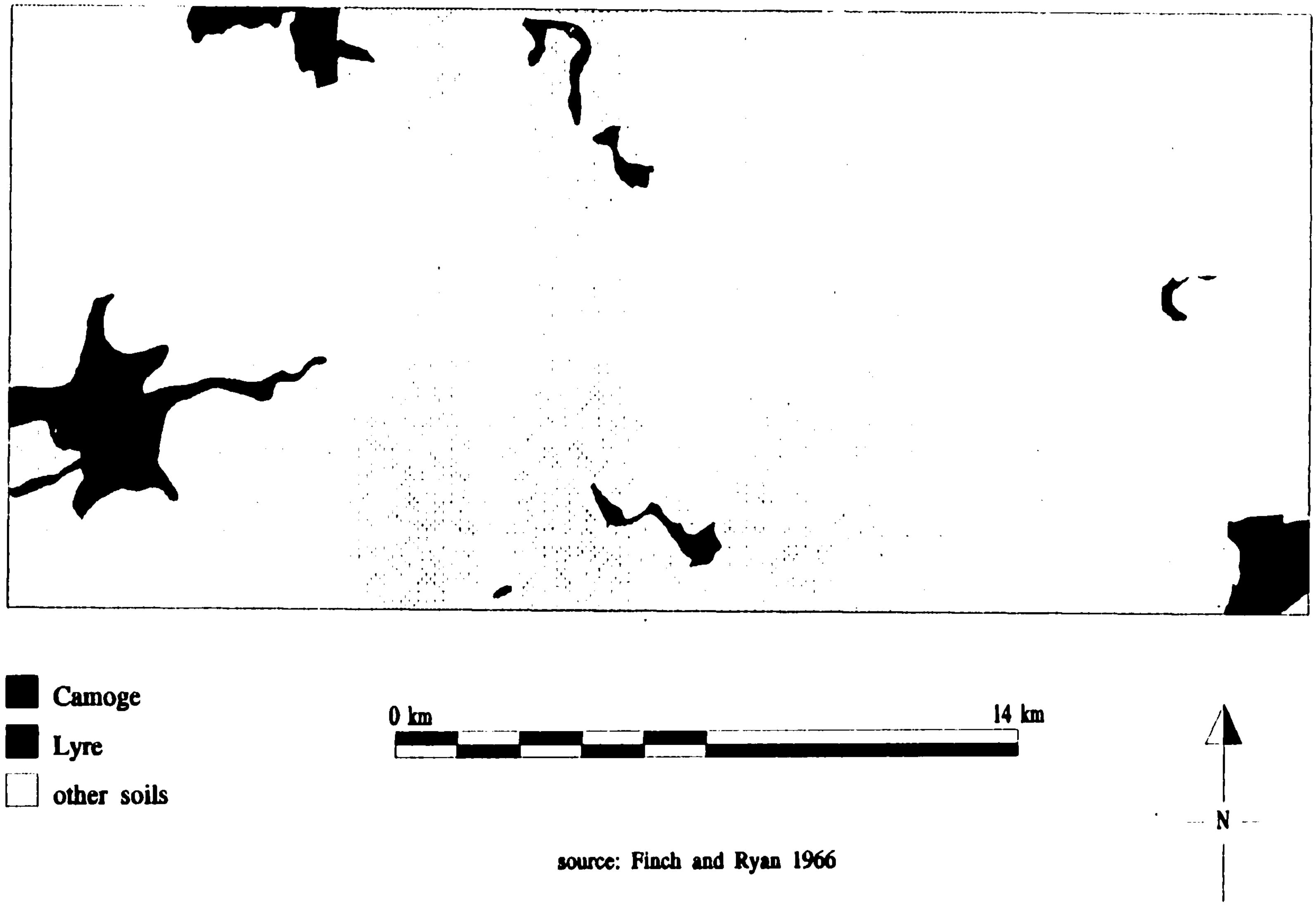
source: Finch and Ryan 1966

Figure 18: Coolalough, Griston and Drombanny Soils



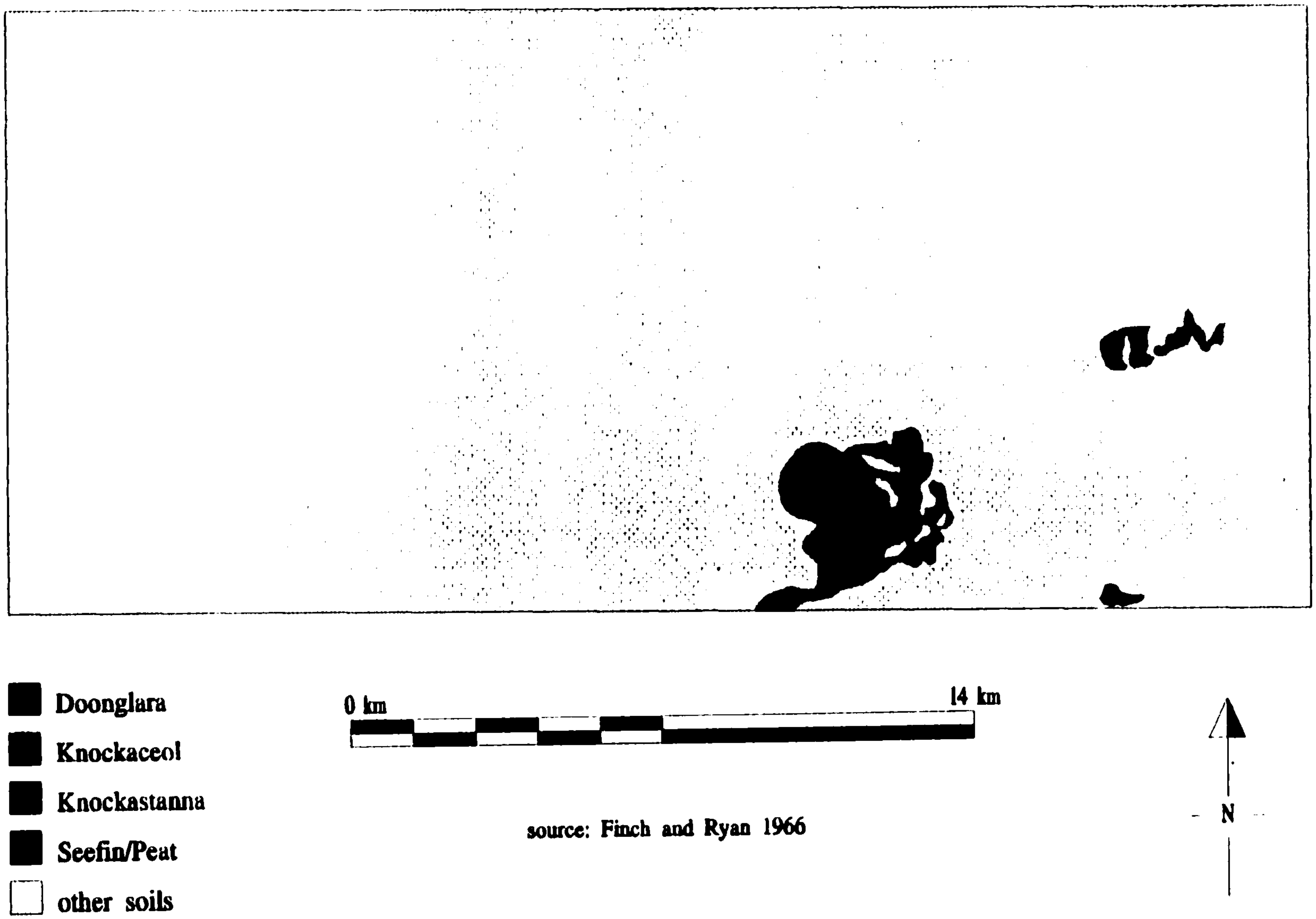
source: Finch and Ryan 1966

Figure 19: Camoge and Lyre Soils



source: Finch and Ryan 1966

Figure 20: Doonglara and Podzolic Soils



source: Finch and Ryan 1966

with insight from site specific charcoal studies provides a framework for vegetational history (Weir 1995, 81).

Woodland

Primary Atlantic forest in Ireland was a mixture of oak, pine, elm and hazel (Mitchell 1986, 77). Although many pollen diagrams show woodland clearance in the Neolithic, that clearance is envisaged as being small scale, confined to light soils, and temporary (Groenman-van Waateringe 1983, 227; Mitchell 1986, 100; Weir 1995, 101). Charcoal samples from Mesolithic and Neolithic sites suggest that wood was taken from mature oak forests (Monk 1986).

By the Early Bronze Age, however, this primary woodland had been depleted (Mitchell 1986, 104-5). Edwards has suggested, on the evidence of soil developments, that the primary forest cover would have been gone by early second millennium BC (Edwards 1985, 207). Secondary woodland contained more hazel and other 'scrub' trees such as ash (Mitchell 1986, 120). While there was still a significant amount of woodland present it would have had a more open structure (Mitchell 1986, 121).

The primary forest of the study area had a larger amount of pine than the country as a whole (Mitchell 1986, 104). The Neolithic houses at Tankardstown south were built with substantial oak planks suggesting both primary forest and a certain amount of clearance (Gowen 1988; Gowen and Tarbett 1988; Grogan 1988a; 1988b). Charcoal deposits from Bronze Age settlements suggest scrubby woodland rather than substantial oak, showing the change to secondary forest cover (Scannell 1988).

Agricultural Land

Large regions of clearance and permanent population centres were common by the Neolithic (Herity 1974; Cooney 1991). This can be seen by extensive coaxial field systems (Caulfield 1983); elaborate megalithic tombs and other monuments (Eogan 1991); and long term continuity within settlement sites (Grogan 1988b; 1989). A closer look at pollen diagrams suggests further regularity. Groenman-van Waateringe (1981, 288) has suggested that hedgerows would have been present and the continuing presence of oak pollen through clearance episodes can be used to suggest woodland management (Groenman-van Waateringe 1984; Cooney and Grogan 1994, 42).

Weir points to a steadily declining amount of arboreal pollen from 2300 BC onwards (Weir 1995, 102). This clearance is interpreted as evidence for grasslands and pasture, rather than large scale arable farming, because of the relatively small amount of cereal pollen present (Monk 1986; Wier 1995, 101). The expansion of arable farming took place during the Middle Bronze Age, but this expansion cannot be seen as simultaneous development across Ireland. Increases are at approximately 1880 BC (Weir 1993) and many diagrams show peaks from 1300 - 1100 BC (Weir 1995, 103).

In the study area charred grain from Tankardstown South shows that arable agriculture was practised here in the Neolithic. While this site has not been linked to field systems "it is probable that the organisation of the landscape into fields around settlements is likely to have been the rule rather than the exception" (Cooney and Grogan 1994, 41). Middle Bronze Age sites also produced both barley and wheat (Monk 1988, 191). Field systems associated with ring ditch cemeteries may date from this period and would indicate organised farming, probably a mixture of grassland and arable (Daly 1994).

Wetland

The spread of peat also accelerated during the Bronze Age period, both as raised bogs and blanket bogs. There is some argument concerning the role of human activity in this spread. Some suggest that farming of soils with such delicate structures led to podsolisation and subsequent peat growth (Mitchell, Edwards 1985). Others maintain that the spread of peat was due to climatic deterioration and that human activity actually helped stem this tide (Caulfield 1983, Caulfield *et al* 1998).

Peat growth is usually associated with the increasingly damp conditions discussed in Chapter 1. In the study area, however, it is the draining of lakes in the later prehistoric period that would have started this process. The lakes probably were ringed with encroaching fen and were more varied in their flora and fauna than in preceding periods. The relationship of human activity to this change in vegetation is entirely unknown. Since the national pattern is for wetter conditions it remains possible that deliberate drainage took place at this time. Since the lakeland and fen has only been recorded during the course of the present research, details have yet to be filled in.

Archaeological material

DATA QUALITY

Many different researchers have studied this area (Westropp 1897; O'Kelly 1942; 1943a; 1943b; 1944; Ó Ríordáin 1936; 1940; Gowen 1988, Grogan 1988b; 1989; Daly and Grogan 1993; Doody 1995; Grogan *et al* 1996). This has led to a large number of sites being recorded. Nonetheless, the data presented here is not a complete record of prehistoric sites in the area. I have three main concerns about the data quality: underrepresentation of domestic sites; the visibility of ring ditches; and uneven intensity in archaeological research.

Underrepresentation of domestic sites

The vast majority of sites in the data set are barrows, funerary sites. Including information from Mesolithic, Neolithic and Bronze Age contexts there are under 10 sites with any domestic elements in the entire study area. While this imbalance is frustrating it is extraordinarily common in the Irish archaeological record. Monuments are better recorded because of their high visibility, their role as modern landmarks and more recently because of their destruction through land reclamation (G. Barrett 1992; Bradley, R. 1993)

Domestic sites have only been excavated when their visibility has been heightened in some way. This can be by having stone architecture, as at Lough Gur, Co. Limerick (Ó Ríordáin 1954; Grogan and Eogan 1987), or being sealed beneath other sites - as at Ballyglass, Co Mayo (ÓNualláin 1972). With intensive field survey, aerial survey, and the large scale excavation associated with the modern construction industry, domestic sites are becoming more common. All of the domestic material from the study area was uncovered during archaeological work for the Bord Gáis pipeline (Gowen 1988).

Visibility of ring ditches

The ring ditches are low visibility sites (Figures 21, 22). A scattering of these sites was recorded through thorough field survey, often on the basis of rushes growing in their shallow ditches (Ó Ríordáin 1936). Most were not recorded until aerial survey of the study area was undertaken (Gowen 1988; Grogan 1989). The first aerial survey of the area was conducted by Cambridge University in the 1930's and is known as the Bruff coverage. It consists mostly of large scale, black and white, oblique photographs. These photographs form the main data set of another Discovery Programme research project (Doody 1993b). The second aerial survey was conducted in the late 1980's by Bord Gáis Eireann in advance of the construction of a gas pipeline through the study area (Gowen 1988). These photos are also large scale and oblique and were analysed as part of PhD research by Grogan (Grogan 1988b;). Further less formal aerial survey has been conducted as part of the North Munster project and is being analysed currently (Condit and O'Sullivan 1996). Each set of photos shows a different set of sites. Worse, different printings of the Bord Gáis photos showed a different number of sites. Because these sites are so slight, varying vegetation, light conditions and even the exposure of photographic prints have an impact on their identification.

This was disturbing at first. While field survey confirmed sites, it was not possible to verify each example. This is because many sites are not visible on the ground, being little more than crop marks. Some sites do not even show that much. After taking visible sites into consideration, the Bord Gáis pipeline still ran through several ring ditches (Gowen 1988).

My compromise was to accept every site that had been recorded by previous researchers as well as those that I had actually seen. In some cases two sources agreed on numbers, but disagreed on exact positioning. In these cases I made a judgement call on which source should be trusted. I have no doubt that there are more ring ditches to be found in the area but I do have confidence in the overall distribution.

Data collection

When I began this research most of the data collection had already been completed. Although I was involved in some verifications and investigations, other researchers carried out most of the field survey. My main input before analysis was defining and compiling the data set. My primary source was

Figure 21: DTM of ring ditches, Coogaun, Co. Limerick

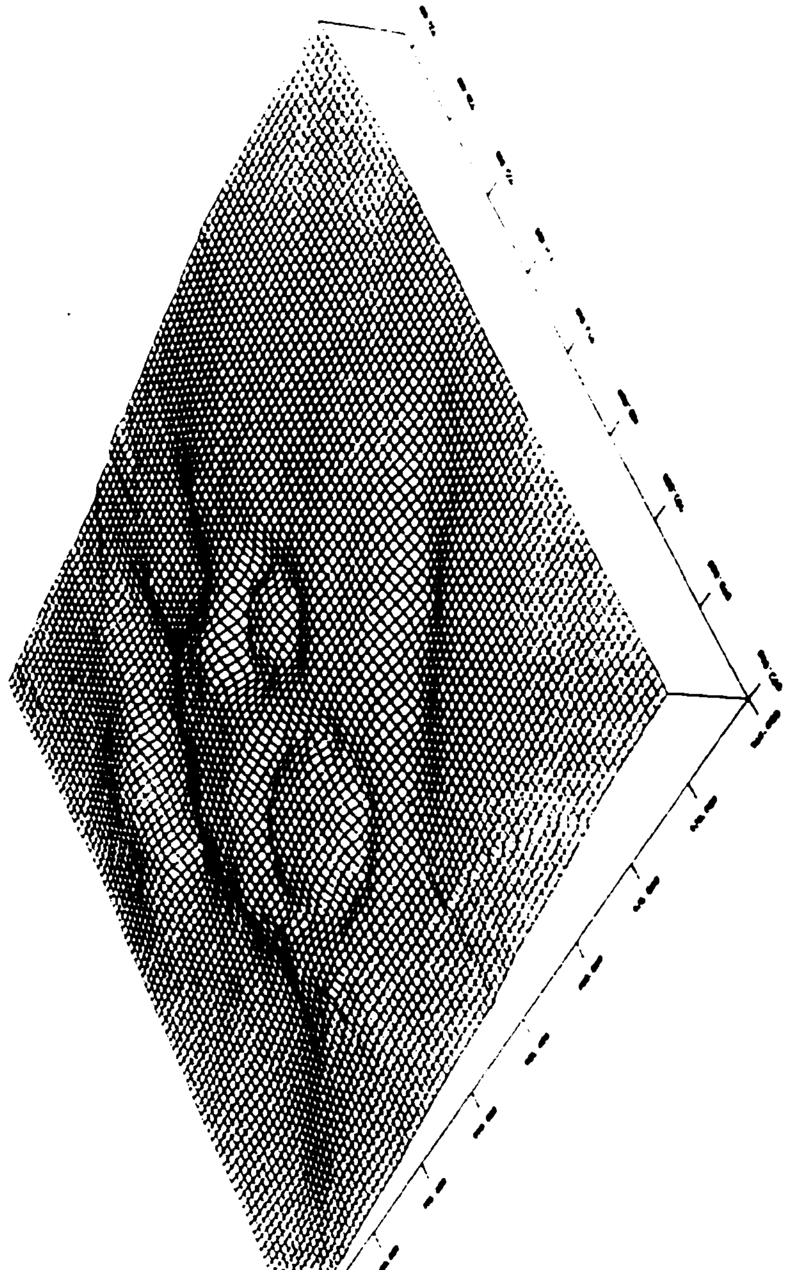
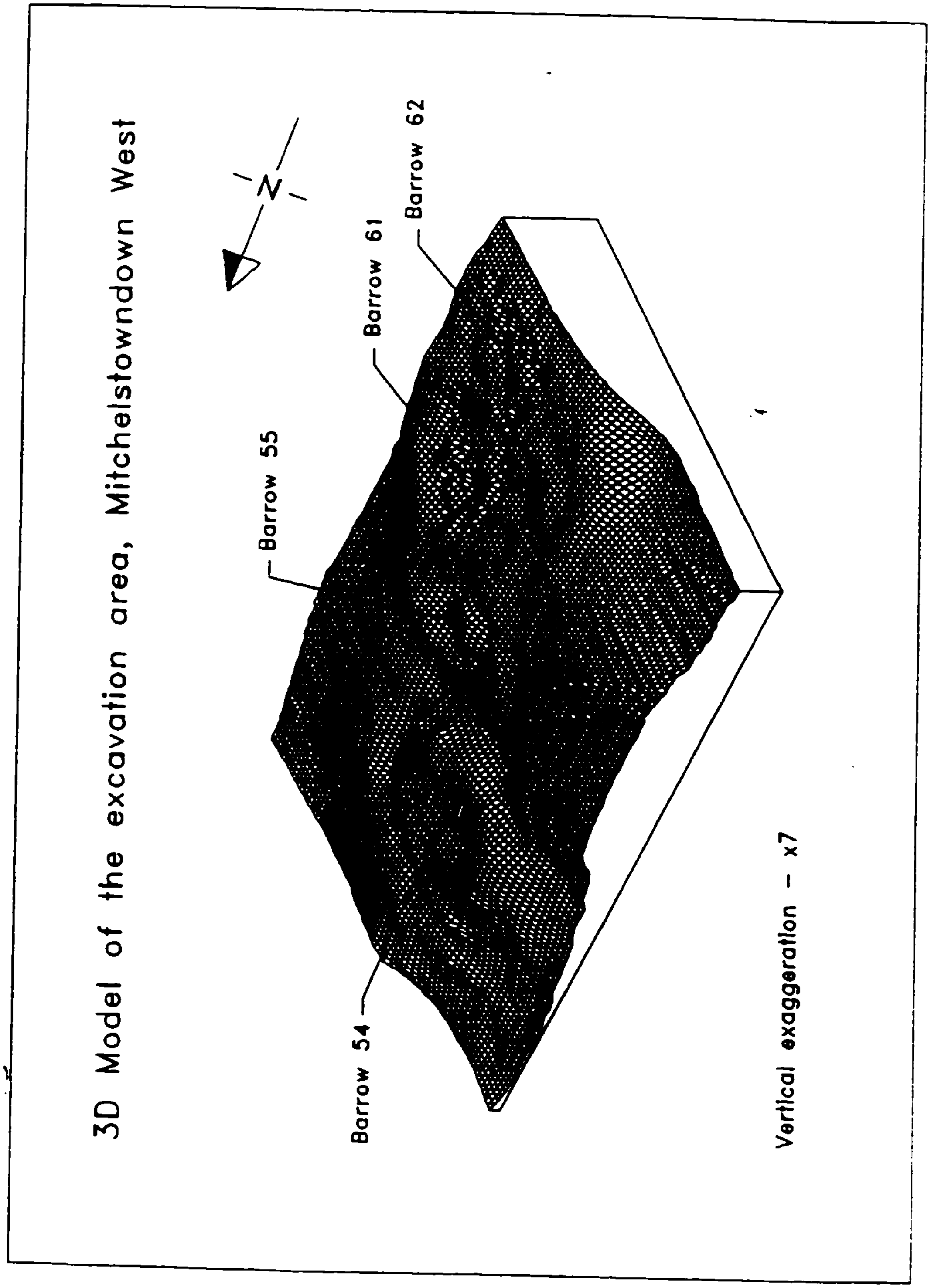


Figure 22: DTM of excavated ring ditches, Mitchelstowndown, Co. Limerick



the Sites and Monuments Records (SMR) for the relevant counties (Kirwan 1991; Stout, G. 1993). I added to and corrected these with the results of other researchers (Grogan 1989, Gowen 1988, Daly 1994, Doody 1995) and with further investigation where necessary.

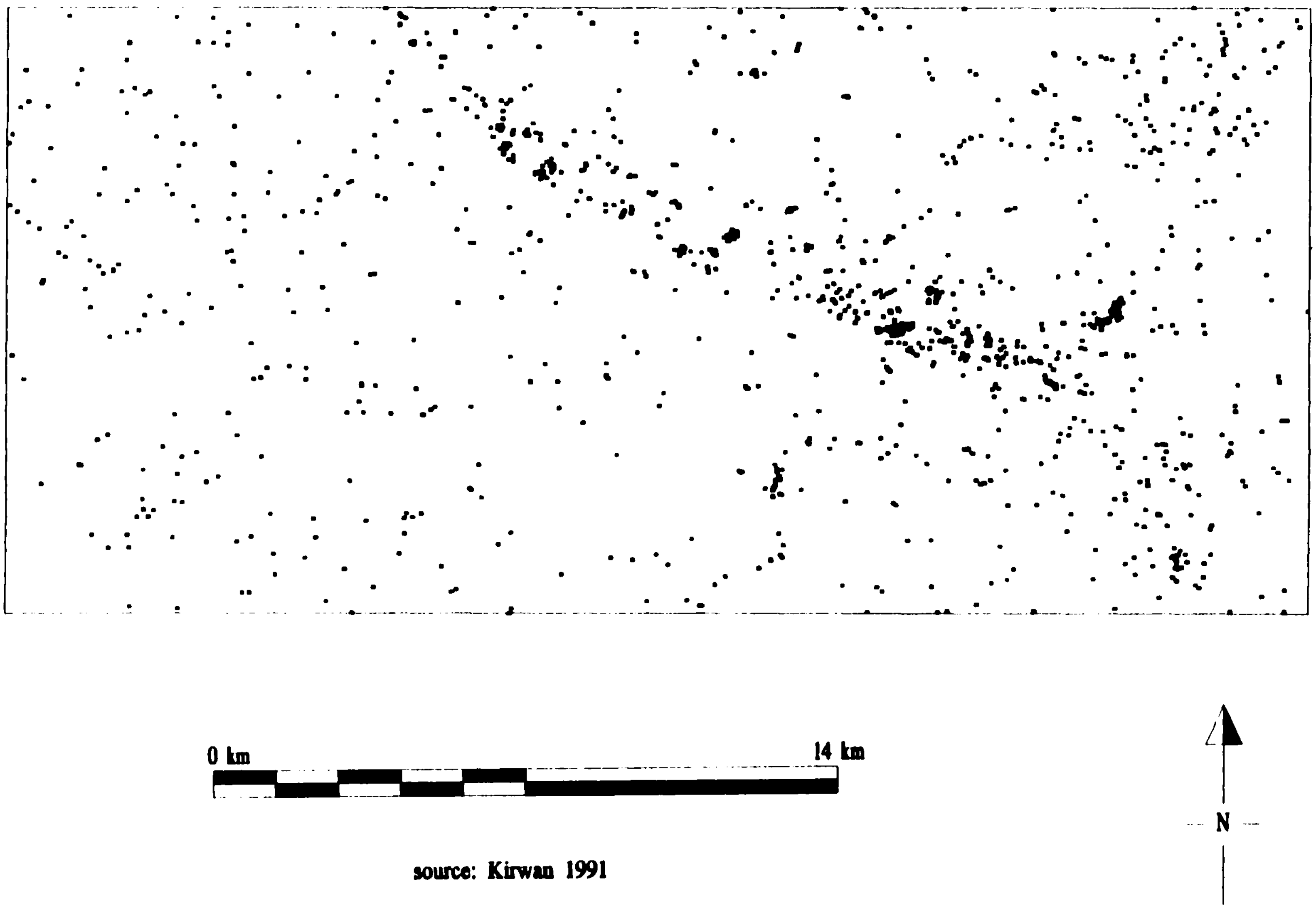
The main problem in identifying sites of interest from the SMR was the classification 'enclosure'. Since this classification can refer to anything from a ring ditch to a hillfort and sometimes even mounds, I did some analysis of aerial photos and Ordnance Survey maps to refine these definitions. The main changes came from the identification and recording of rathanny enclosures, a site type recently identified by my colleague Tom Condit. I also corrected the positioning of sites within cemeteries and added more recent data, including that recovered by the North Munster Project.

The most complete survey in the study area was conducted as part of the construction of the Bord Gáis pipeline (Gowen 1988). Grogan used the aerial photography from this survey for a full assessment of the area (Grogan 1988b; 1989). A first glance at the map suggests that this survey creates a false clustering of sites along the line of the pipe (Figure 23). Closer examination shows that, while there is an effect, this survey picked up a real change in distribution (Figure 24). The same team conducted both legs of the survey so the gap in the south west leg must be a real difference that can be used to understand siting choices.

The boundaries of other research projects can also be seen in the distribution of sites. Compare the area covered by the Limerick SMR with the Tipperary SMR (Figure 25). Where the pipeline coverage was available, the Limerick coverage is good, but the drop in site densities near the county border is likely to be an artefact of recovery. The coverage in Tipperary is more even and these sites are also more closely identified with fewer classed as 'enclosures'. The other major influence on the distribution is the Bruff survey, which was used for the compilation of the Tipperary SMR (Figure 26) (Daly 1994). This resource is still being assessed and its effects may well be as dramatic as those of the pipeline survey (Doody 1993a).

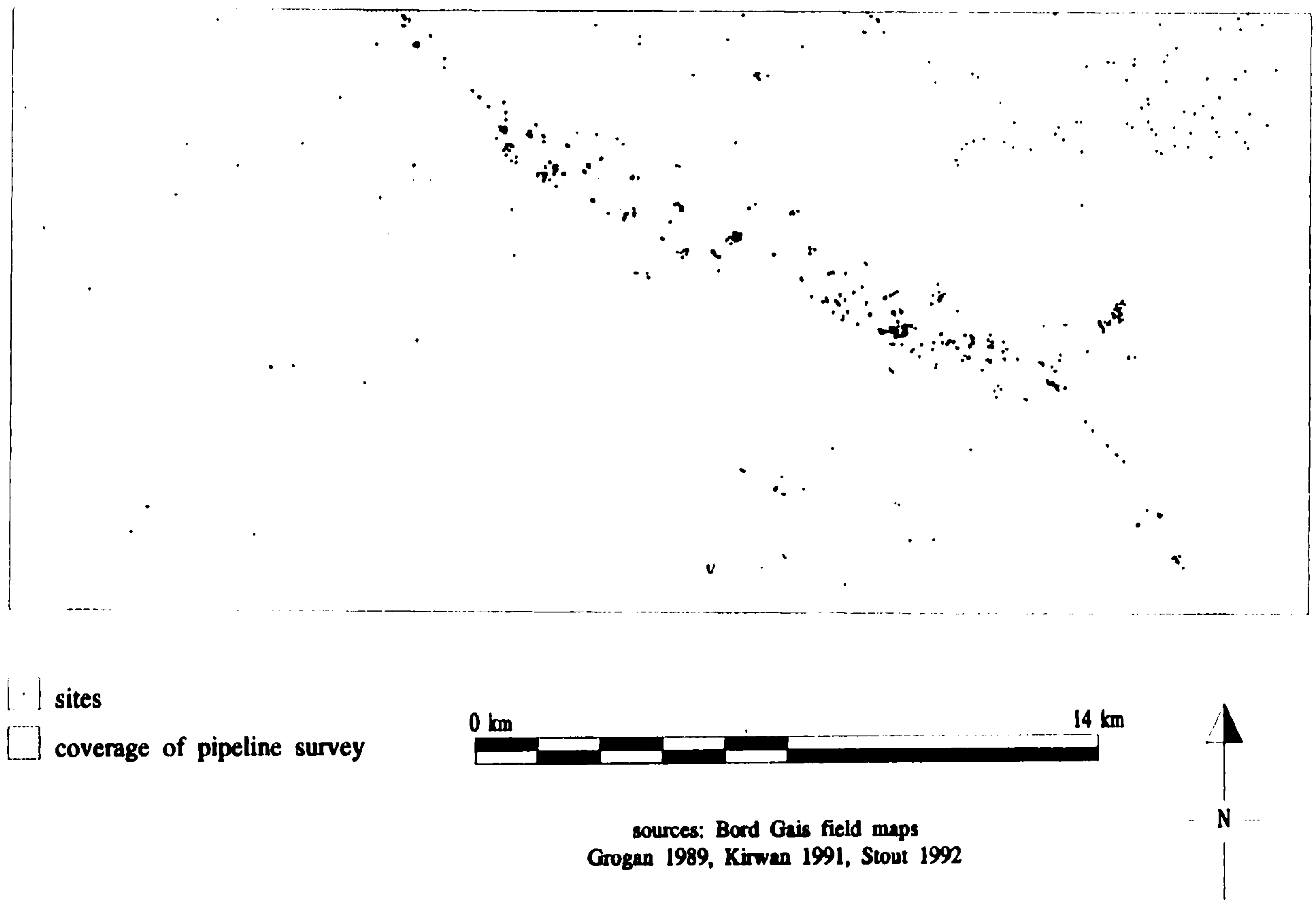
For site catchment analysis and general discussion I have considered the whole study area. This makes the most of its variable terrain. For the spatial statistics and modelling, however, I have used only

Figure 23: All Known Sites



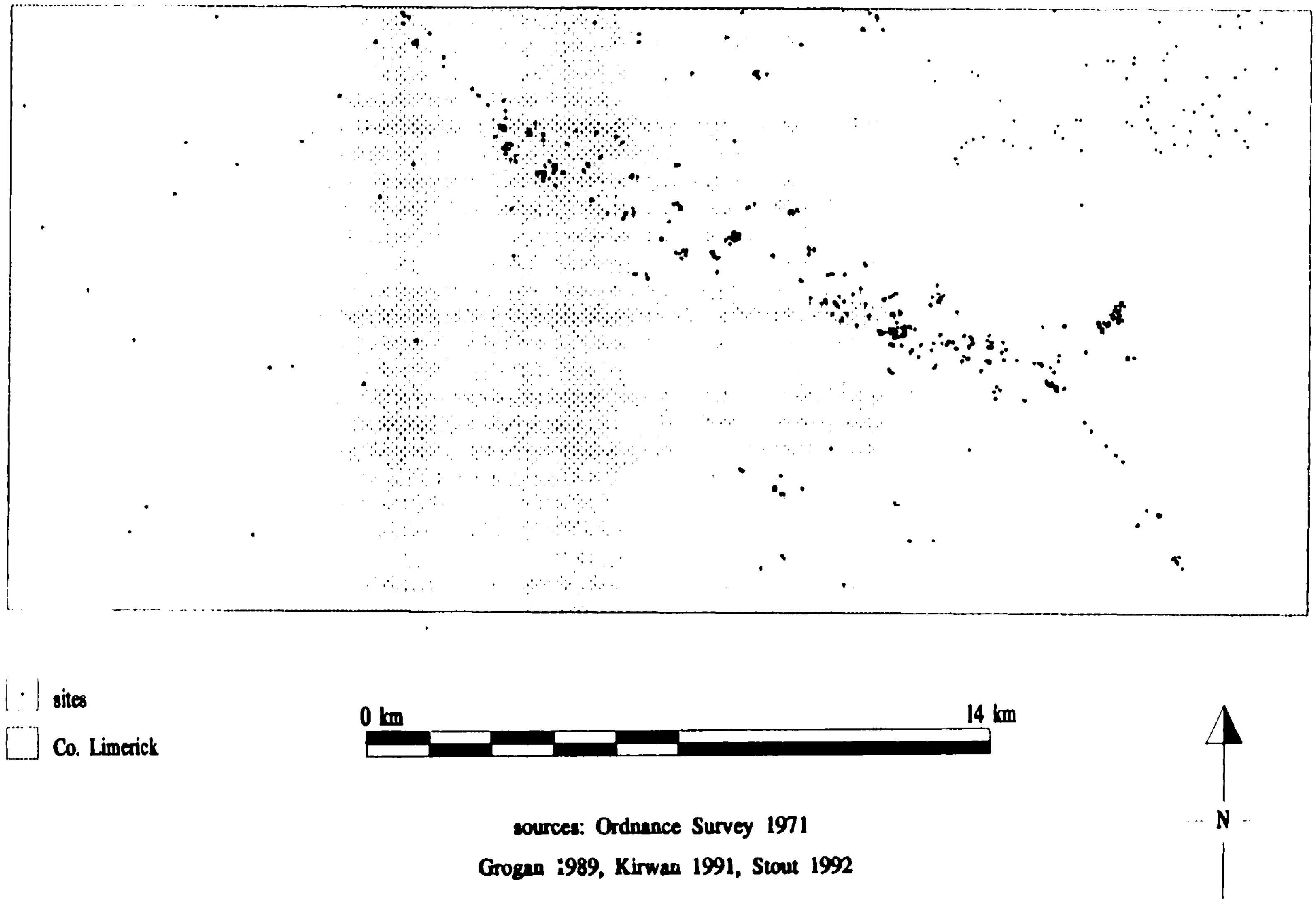
source: Kirwan 1991

Figure 24: Prehistoric Sites and the Gas Pipeline



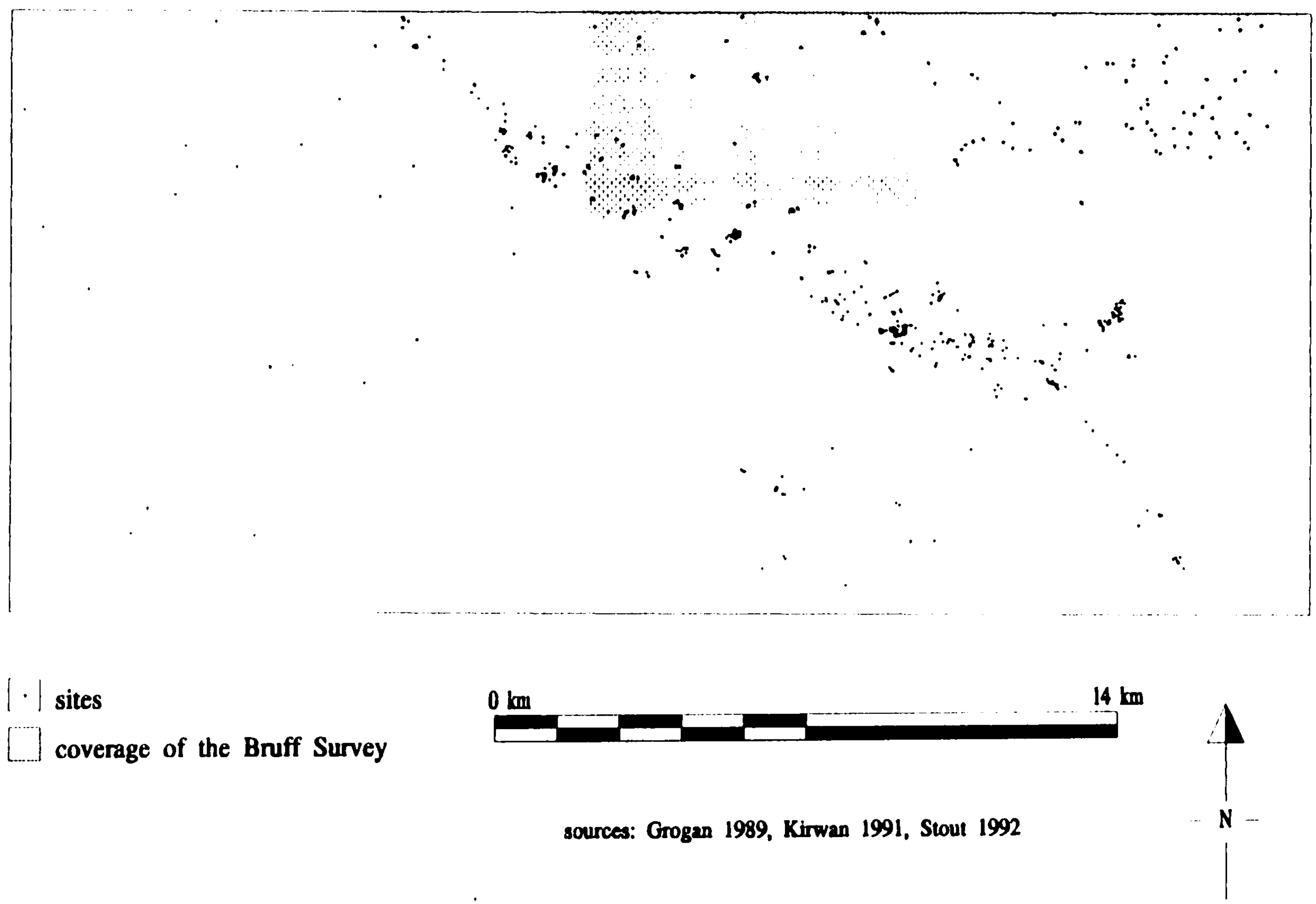
sources: Bord Gais field maps
Grogan 1989, Kirwan 1991, Stout 1992

Figure 25: Prehistoric sites and the county border



sources: Ordnance Survey 1971
Grogan 1989, Kirwan 1991, Stout 1992

Figure 26: Prehistoric sites and the Bruff Survey



sources: Grogan 1989, Kirwan 1991, Stout 1992 the area covered by the pipeline. This is because these analyses are more sensitive to the kind of background noise that is created through variable coverage (see chapter 3).

SITES

Many types of site in the area are only represented by a few examples. Sites from other parts of Ireland are also discussed here to make use of more information and set the data in context. This discussion is laid out chronologically and by site type, while Appendix B is laid out by position in the study area. Where specific sites are discussed, they are cross-referenced to the appendix by their SMR numbers.

The Mesolithic

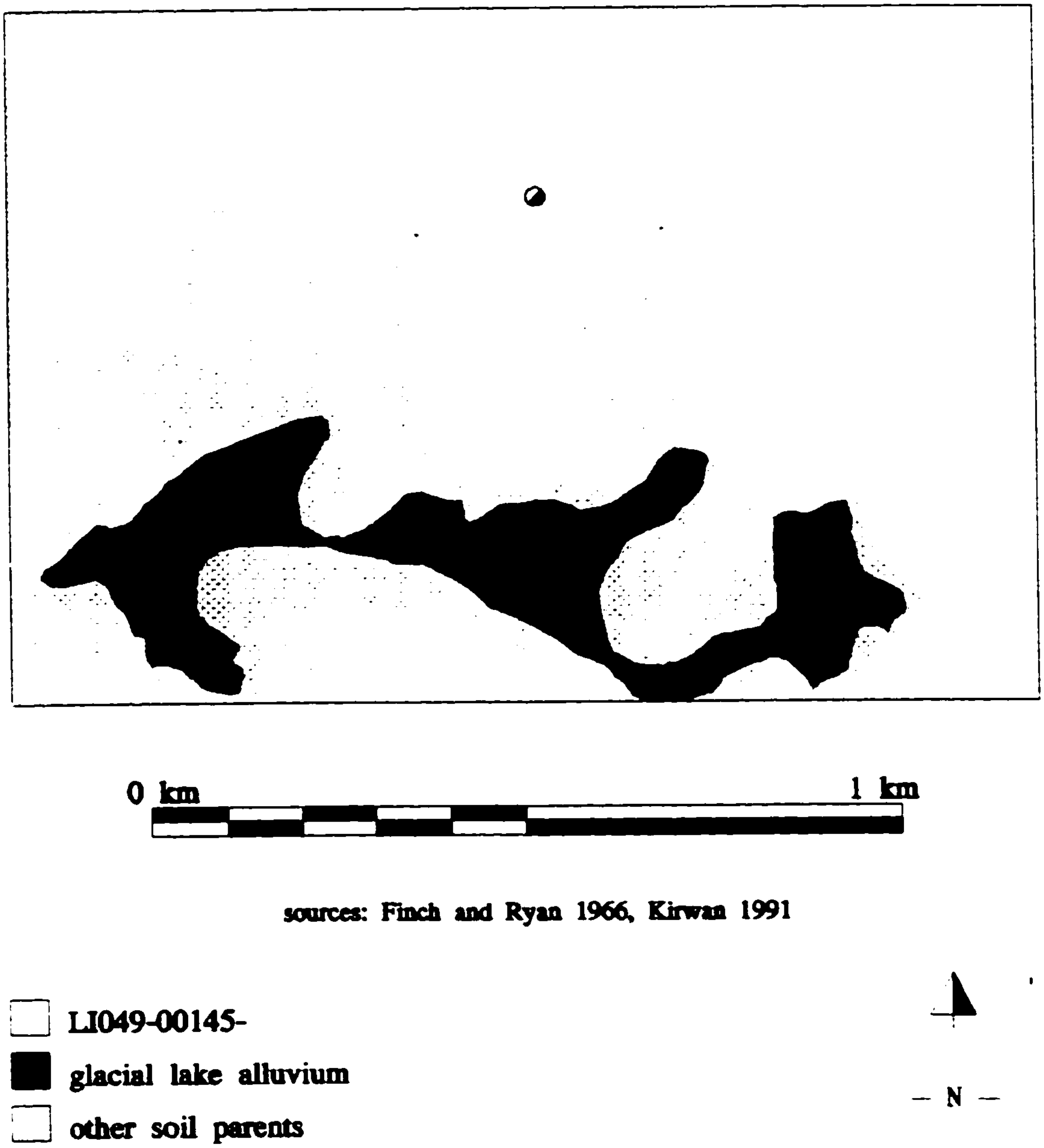
There is one site from this period known in the study area, at Mitchelstowndown East, Co. Limerick (LI049-00145). This site was uncovered during the pipeline investigations (Gowen 1988,197) but was not identified as Mesolithic until after publication of the results (Appendix C). The site consisted of an oak platform associated with a cattle tooth (McCormick 1988, 184). The positioning of the site near a glacial lake is unusual for known sites of this period in Ireland (Figure 27) (Woodman 1985, Woodman and Anderson 1990). The significance for the present study is that it shows that the area had been occupied from this time and that the waterlogged nature of the terrain was not a block to settlement.

The Neolithic

Domestic evidence

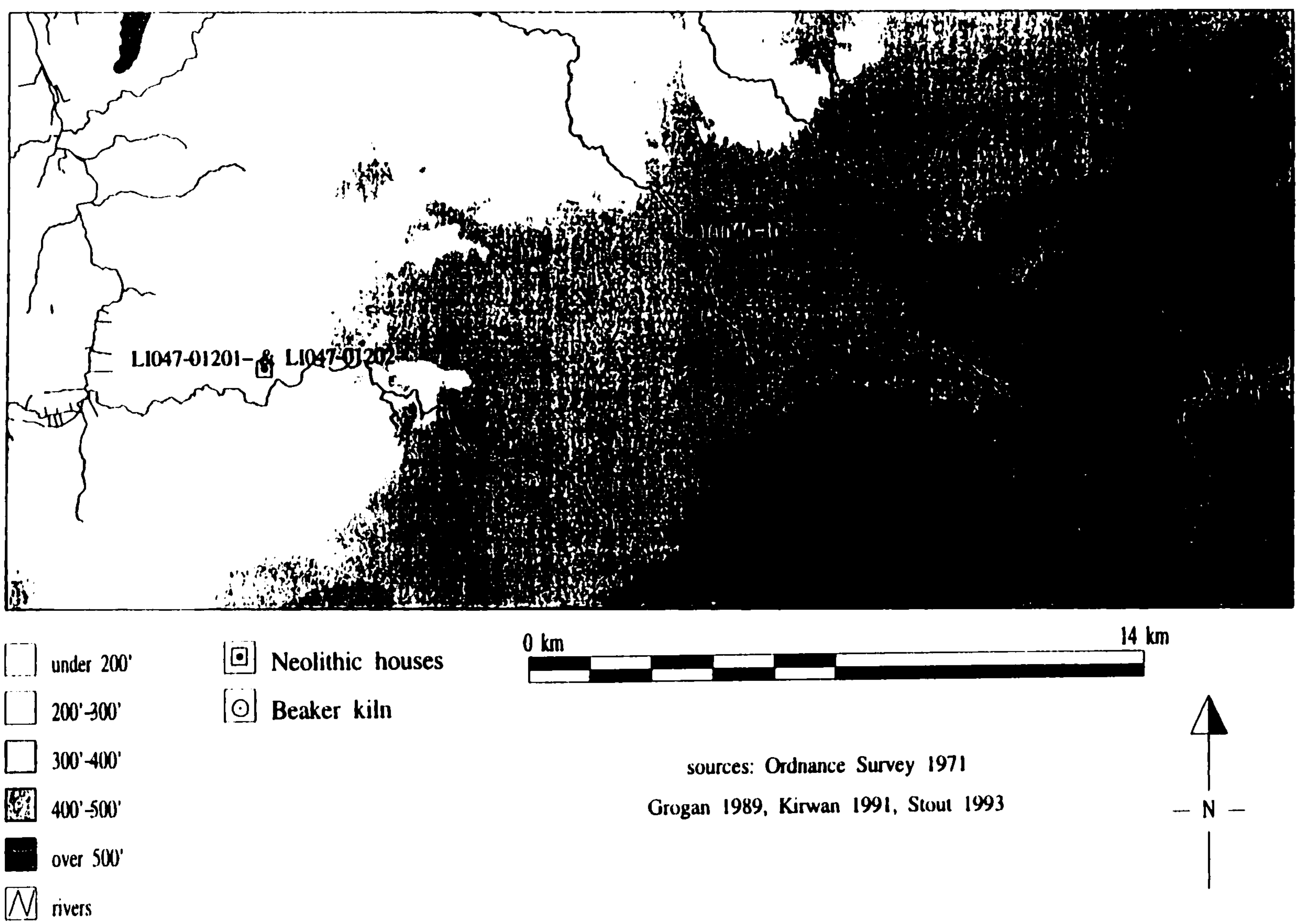
The two substantial house structures at Tankardstown south are the most well known sites of the study area (LI047-01201, LI047-01202) (Gowen 1988, 26-42; Gowen and Tarbett 1988; Grogan 1988a). Excavations were initially carried out because of construction of the Bord Gáis pipeline but the significance of the sites prompted further work. It is possible that there are more houses in this group. At Doonmoon, to the North East, there is also a kiln site from the Final Neolithic or Beaker period (LI040-108) (Gowen 1988, 54-71) (Figure 28). While not a house, it does represent domestic activity.

Figure 27: Mitchelstowndown East, Co. Limerick
Mesolithic site and glacial lake



sources: Finch and Ryan 1966, Kirwan 1991

Figure 28: Neolithic domestic sites



Over fifty houses associated with Neolithic material have been found in Ireland. At least fourteen are rectangular and over forty circular or oval. While excavation strategies have concentrated heavily on the outlines of these structures, the recovery of associated features or indeed further houses has been limited. Associated features are always recorded when large-scale excavation is conducted (Grogan 1996a; Cooney 2000, 52-85).

Construction varies. At Lough Gur, Co. Limerick the houses and enclosures had a stone footing with a sod or wooden superstructure (Grogan and Eogan 1987, 468). The other most common construction technique is split oak planks set in rectangular wall trenches. This is the technique used at Ballyglass, Co Mayo (Ó Nuallain 1972) and at Tankardstown South in the study area (LI047-01201-, LI047-01202-) (Gowen 1988, 26-42; Gowen and Tarbett 1988; Grogan 1988a). There are also less substantial structures, such as the two post built structures at Slieve Breagh (Grogan 1996a) and the group of 'possible houses' at Lough Gur where there were many post holes, hearths and pits, but no definite ground plan (Grogan and Eogan 1987, 468-469).

The largest group of sites is on Knockadoon peninsula in Lough Gur approximately 10 km north of the study area. This group of fourteen sites indicates possible village patterns. It contains both rectangular and circular houses associated with other features such as paving, external structures and storage pits. The floor area ranges from $19m^2$ to $97m^2$. They are considered to have housed single families of 5-10 members. Some of the houses at this site are surrounded by small enclosures (Grogan and Eogan 1987, 469).

Megalithic tombs

Megalithic tombs form the largest body of information available for the Neolithic. They are stone built monuments for successive communal burial. The burial rite is a mixture of inhumation and cremation with a good deal of manipulation of remains (Herity 1974). There has been a lot of discussion on the role of these monuments in the landscape (Renfrew 1973; Cooney 1983; Sharples 1985; Bradley, R. 1991, 1998). They are often considered to be centre makers for territories of either segmentary (Renfrew 1976) or ranked communities (Sheridan 1985/6). There is also interest in the complex manipulation of rituals embodied in their form (Thomas 1992, Cooney 1993). Each type of tomb, court tombs, passage tombs, portal tombs and wedge tombs suggests different rituals (De Valera and O Nuallain 1961). The differences are both chronological and spatial (O'Kelly 1989, 85-121; ApSimon 1985/6).

There is one definite megalithic tomb in the area, the passage tomb at Duntryleague (LI049-077). Another three possible tombs are recorded along with four cairns and four mounds, which could be either Bronze Age barrows or megalithic tombs (Figure 29). None of these sites has been excavated and nothing is really known about their layout. I am interested in their place in the landscape and its relationship to ring ditches.

The Bronze Age

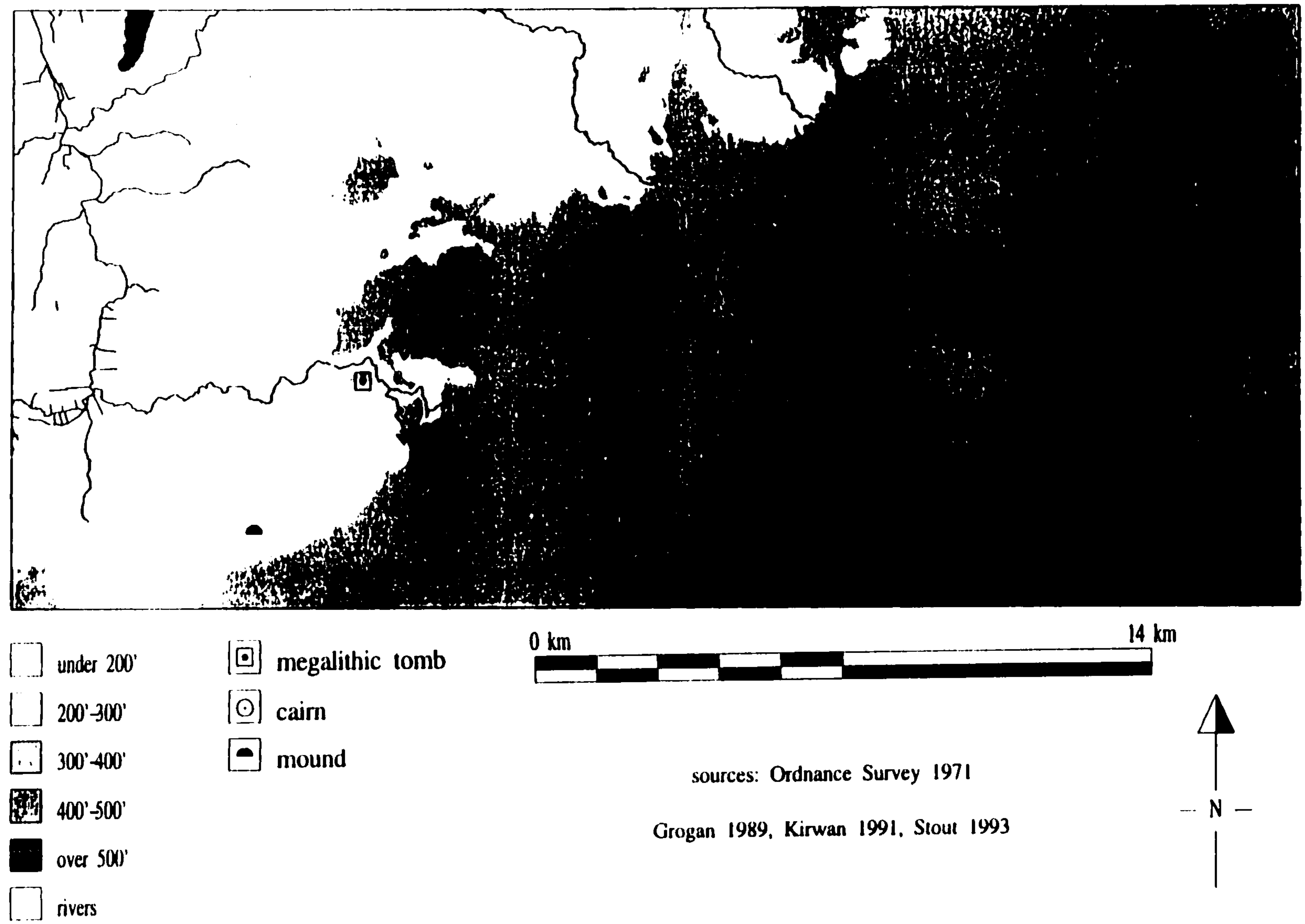
Houses

There are three sites in the study area which have hearths, pits and sometimes indications of structures and may date to this period (Figure 30). Although these can be interpreted as domestic sites they are different in character from contemporary sites in other parts of Ireland. A site at Raheen (LI049-273--N) (Figure 32) has a double ditched broken enclosure surrounding a hearth, a pit and associated with a range of domestic material, coarse pottery, a mould fragment of a palstave axe and cattle, pig, and sheep/goat bones (Gowen, 1988, 84-94).

The excavator felt that the enclosure at Duntryleague (LI049-269--N) (Figure 31) was likely to be ritual in nature since the structural evidence was fragmentary (Gowen 1988, 78). Nonetheless, the hearth and the large number of postholes suggest at least temporary domestic activity. In this ambiguity it is similar to Chancellorsland, Co. Limerick, discussed below. There are four other pits in this townland which could be either funerary or domestic; they contain cremated bone, but it is not possible to determine from what species (Ó Donnabháin 1988, 192).

There are three different possible domestic elements uncovered in fragmentary excavations at Elton, Co. Limerick south of the ring ditch cemetery (LI040-07801). The first consists of a pit, a hearth and some postholes, associated, but not forming a recognisable pattern. The second is an arc of stake holes, which the excavator feels may have been too light for a domestic structure. Such stake holes are

Figure 29: Neolithic burial sites



sources: Ordnance Survey 1971

Grogan 1989, Kirwan 1991, Stout 1993

Figure 30: Bronze Age Domestic Sites

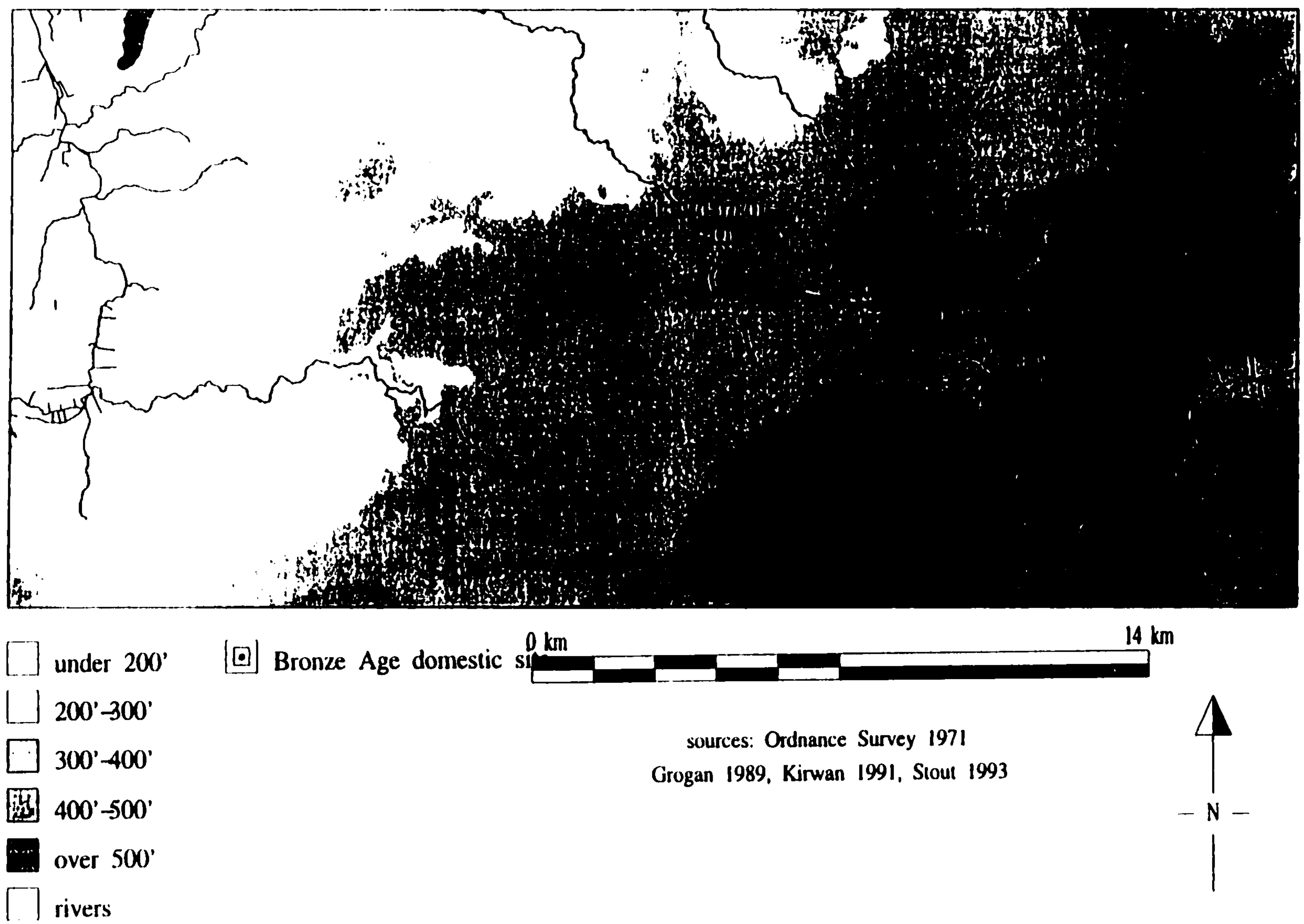


Figure 31: Duntryleague (LI049-269) excavated features (after Cooney and Grogan 1994)

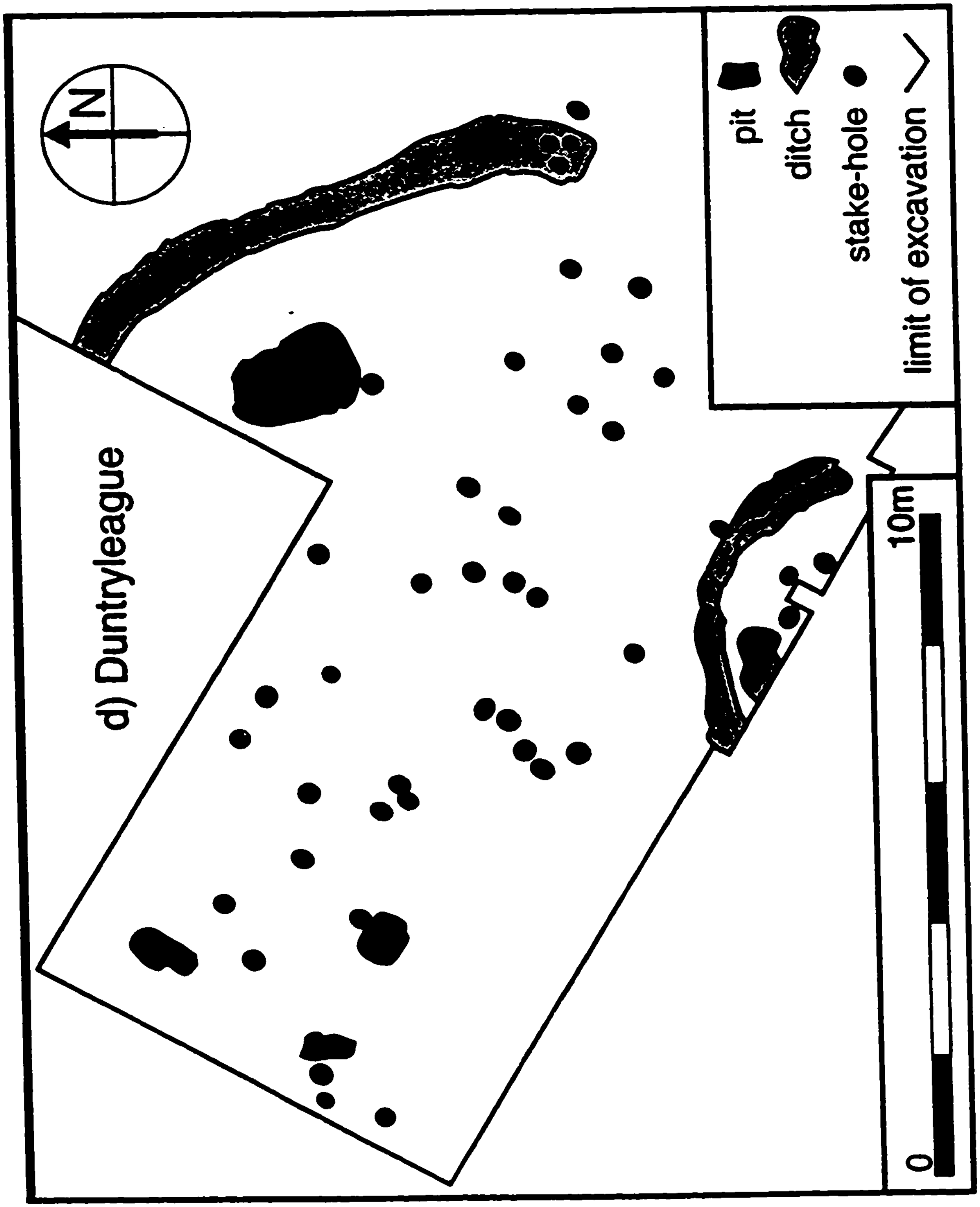
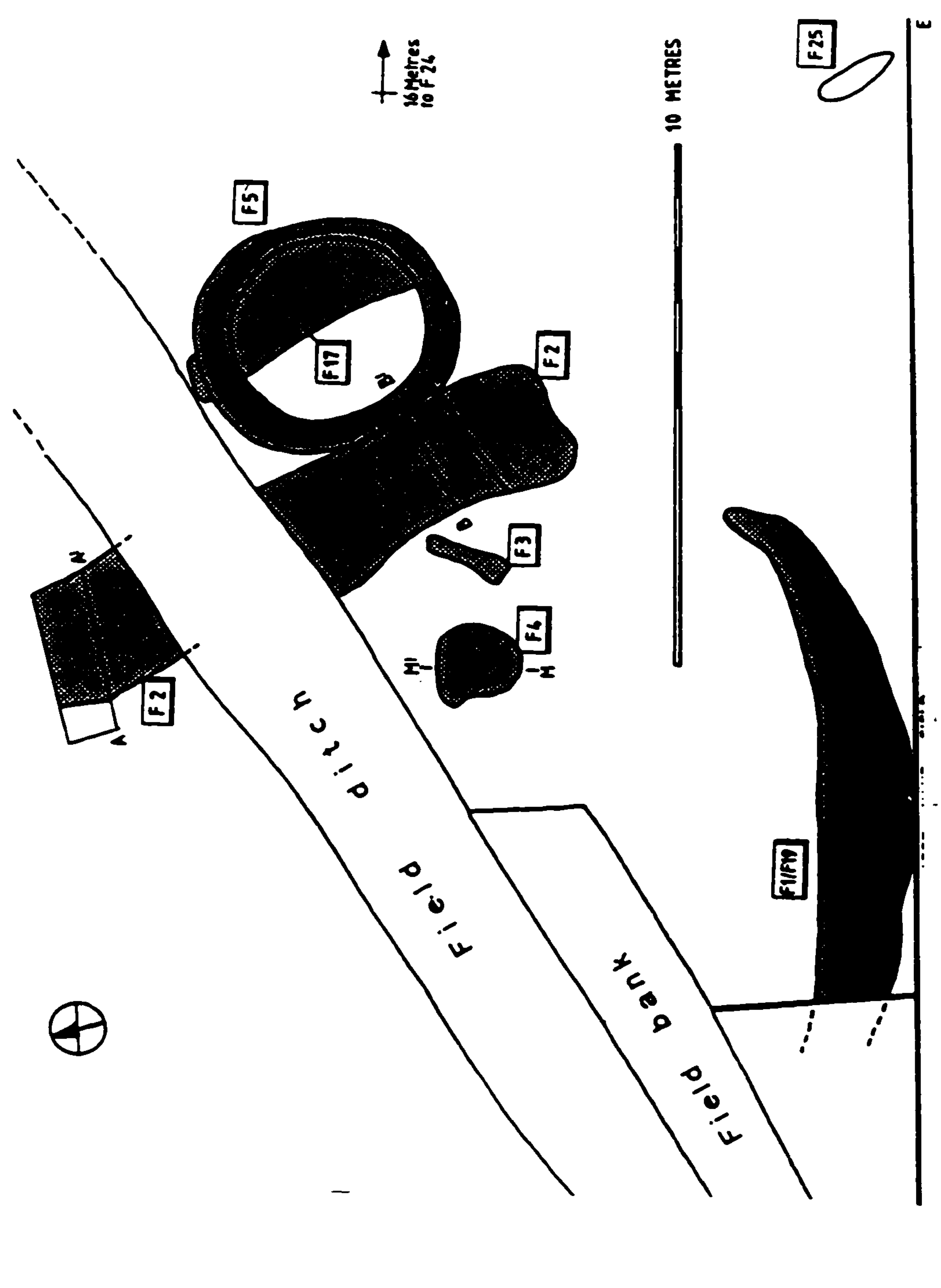


Figure 32: Raheen (LI049-273—N) excavated features (after Gowen 1988)



often found on British ritual sites from this period (Fox 1927, 121; Clare 1986, Hall *et al* 1983, Barrett and Bradley 1991). Finally, there is a set of agricultural furrows running below and at different angle to a historic set. While none of these features could be dated, all the artefacts recovered were Bronze Age in date (Gowen 1988, 61-67).

All of these sites were uncovered by excavations for a pipeline routed to avoid visible archaeology. Their ephemeral nature cannot be taken to represent domestic sites from this period. Recent excavations in other parts of the country have uncovered a large variety of settlement sites from a range of environments. Further, some of these sites can be recognised as upstanding sites in the field, increasing the understanding of settlement in this period (Grogan *et al* 1996).

There is a wide range of construction styles. Carrigillihy, Co. Cork was originally considered to be a ring fort dating to the early historic period. This two period site has recently been re-dated to the Middle Bronze Age. An oval drystone wall enclosing a circular stone built house dated to 1510-1220 BC, was replaced by a square stone house dated to 1130-840 BC (O'Kelly 1989, 222). Aughinish, Co Limerick is another enclosed settlement site excavated prior to modern construction. The site consists of two low stone enclosures with houses inside. No radiocarbon dates are published for the site but it is dated through metalwork and pottery to the Later Bronze Age. It is near the shore of the Shannon estuary but still on dry land (Kelly 1974).

At Chancellorsland, Co Tipperary an enclosure was formed by enhancing a low natural platform. The site, associated with nearby ring ditches, produced evidence of at least eleven structures, many of which overlap, suggesting frequent rebuilding. Structures were recognised by both foundation trenches and scattered postholes (Doody 1995, 14). There is one external hearth and the excavator suspects that not all structures present were houses (Doody 1995, 15). The site has been dated to 1427-1267 BC (Doody 1995, 18). Doody has recognised many other sites that appear similar on aerial photographs of the region, and suggests that this may describe a common complex (Doody 1993b).

Less substantial settlements are also recorded outside of the study area. At Ballyveelish, Co. Tipperary a roughly rectangular enclosure delimited by a shallow ditch was dated to 980 -390 BC. Like

Chancellorsland, discussed above, this site is associated with a ring ditch which has been dated to 2120-1770 BC. Although there was a large amount of domestic debris, structural evidence was disturbed (Doody 1987). At Coney Island, Co Armagh two rectangular buildings identified by wall trenches and traces of sod walls produced both Food Vessels and Cordoned Urns (Addyman 1965). Here a date of 1880-1420 BC was determined from timber in a pit with Early Bronze Age pottery (Smith *et al* 1971, 99; O'Kelly 1989, 349).

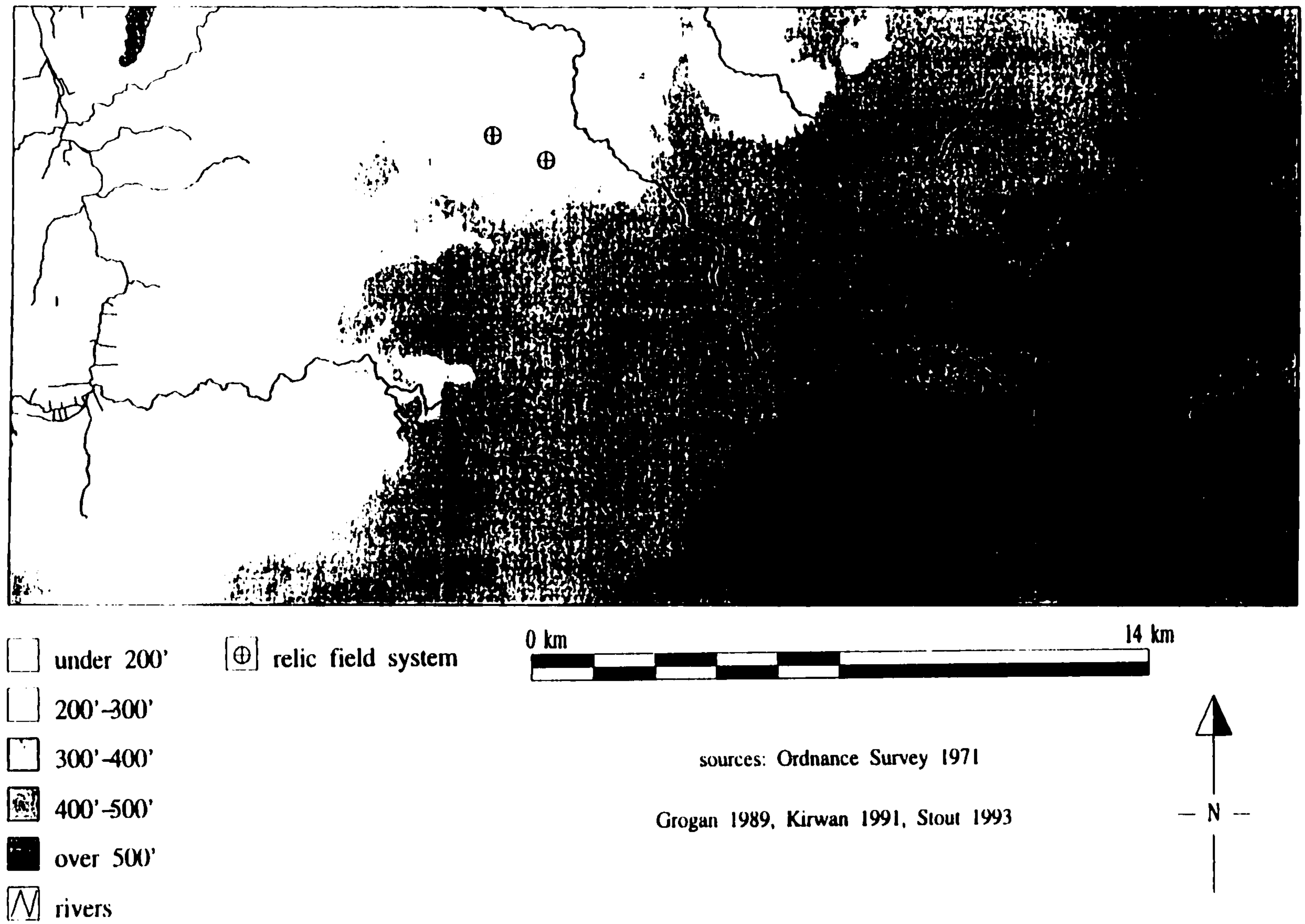
Field systems

There are ten field systems in the study area that may be prehistoric (Figure 33). They are composed of low earthen banks forming a pattern different from the modern system (Figure 34). There is nothing to date these features but their spatial association with ring ditches has led to the suggestion that they date from a similar period (Daly 1994; Condit *pers comm*). Prehistoric field systems are quite common in Ireland (Cooney and Grogan 1994, 39-41). While the systems in this area may not all date to the Later Prehistoric Period, I will consider them all since they represent an important and under recorded element of landscape.

The reasons for the land division embodied in these fields are unknown. Elsewhere, fields have been interpreted as pasture management systems, designed to prevent overgrazing (Caulfield 1983; 1988; Mitchell 1986, 97-99). They can also be used to protect arable crops. Given the delicate structure of soils in this area and their tendency to poaching when under pasture (Finch and Ryan 1966, 32) the fields could well be part of a pasture management system.

The fragmentary pattern of fields through the region is partly a result of destruction by more recent farming activities. It is unlikely, however, that these fields ever formed the kind of blanket coverage seen in the modern landscape. Field systems from the Bronze Age are usually smaller than Neolithic examples and more indicative of gradual land intake (Gibbons and Higgens 1988; Cooney and Grogan 1994, 99). There is also the possibility that these fields were token land divisions, organising the most socially significant land, rather than the whole landscape.

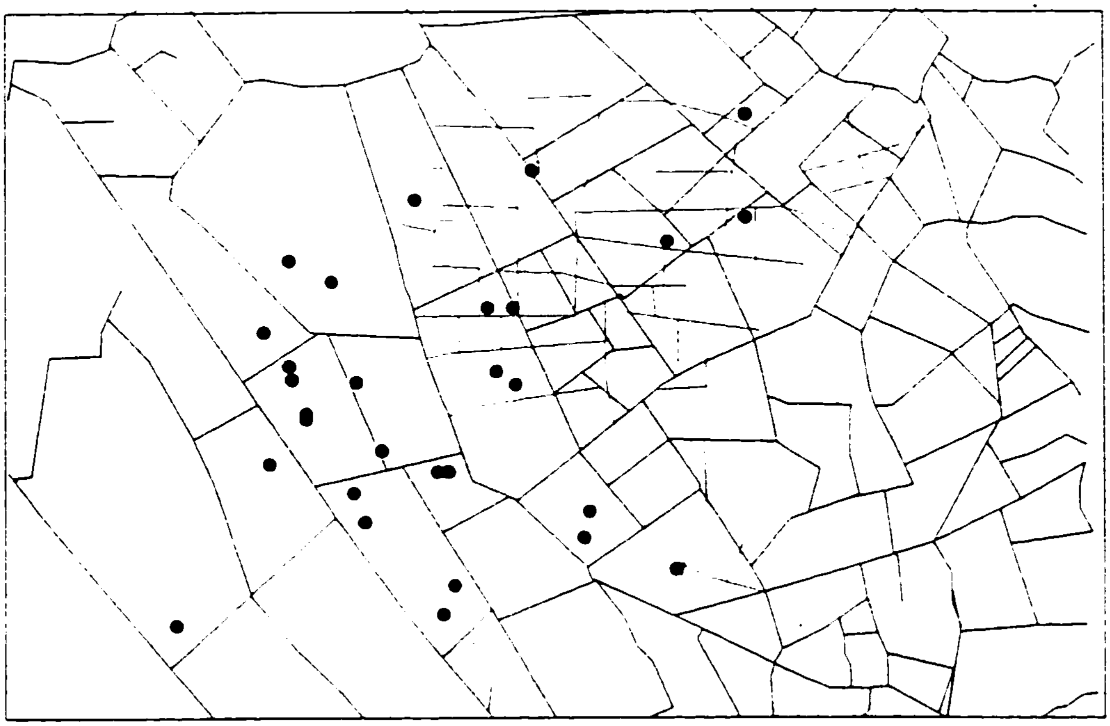
Figure 33: Relic field systems



sources: Ordnance Survey 1971

Grogan 1989, Kirwan 1991, Stout 1993

Figure 34: The Moanmore, Co. Tipperary, Complex



0 m 1500 m

sources: Ordnance Survey 1971
K. Daly 1995

Ordnance Survey field system

Daly's field system

ring ditches

– N –

Fulachta fiadh

A new type of site in this period is the *fulacht fiadh* - or burnt mound. There are over 4000 of these sites known in Ireland (Feehan 1991, 202, Ó Níell 2000a). They are recognised as heaps of heat shattered stone, measuring between 5m and 30m in length and 1 to 2m in height. When excavated they usually have a wood or stone lined trough. The name means 'cooking place of the wild' and refers to an association with travelling warriors from mythic cycles relating to the Iron Age (Ó Drisceóil 1990). A program of radiocarbon dating has placed them very firmly in the Middle Bronze Age (Brindley *et al* 1989/90).

Their social function is a matter for argument but they were clearly used for heating water. The suggestion that they were used as steam baths (Barfield and Hodder 1988) is undermined by the fact that no sites in Ireland have produced evidence of structures that would contain the steam (Ó Drisceóil 1988). The most common interpretation is that they were used for cooking meat and re-enactments have shown that each mound represents in the region of 100 boilings (Buckley 1990). Historical references and their siting on wet ground lead to a suggestion of seasonal use for feasting associated either with hunting or transhumant pastoralism (O'Kelly 1954; Feehan 1991). Since these sites are being recorded in increasing numbers, research into their functions and roles in the landscape is in its early stages (Ó Néill 2000a). They remain a slightly enigmatic feature particular to the Middle Bronze Age.

These sites are almost always found in areas where there is a water source that would fill the trough naturally, either a stream or a high water table. Feehan argues that in Co. Tipperary they were sited near small streams that would have been accessible in the wetter months, avoiding floodplains that would have been inundated in the winter (Feehan 1991, 203). In South East Co. Clare, however, they are regularly found on the shores of lakes and have been completely surrounded by water in the winter month (Condit 1996). This pattern is increasingly common in other parts of Ireland as well (Ó Néill 2000a).

Fulachta fiadh are associated with both standing stones and stone circles. The example at Drombeg, Co. Cork is within 50m of a stone circle and both sites have produced similar dates (Fahy 1959; Brindley *et al* 1989/90). Survey in south east Co. Clare has shown that 52% of *fulachta fiadh* are within

1km of a standing stone (Grogan *pers comm.*). Condit has shown a similar relationship in Co. Kilkenny and notes that that distribution is complementary to that of ring ditches (Condit 1990).

In the study area there are eight recorded *fulachta fiadh*. Three were excavated during construction of the gas pipeline (Gowen 1988, 129-135) and one was recorded as part of the present research (Figure 35). One of the excavated examples at Raheen (LI049-041) has two troughs separated by river alluvium. There are several lenses of alluvium throughout the site, which suggests a long period of use, punctuated by abandonment (Gowen 1988, 129-132) (Figure 36). As archaeologists become more aware of these sites they are being found in greater numbers. Because they are irregular in shape, they do not show up well on aerial photography. As there has been little recent extensive field survey it is likely that many more examples of this site type will be recorded in the future.

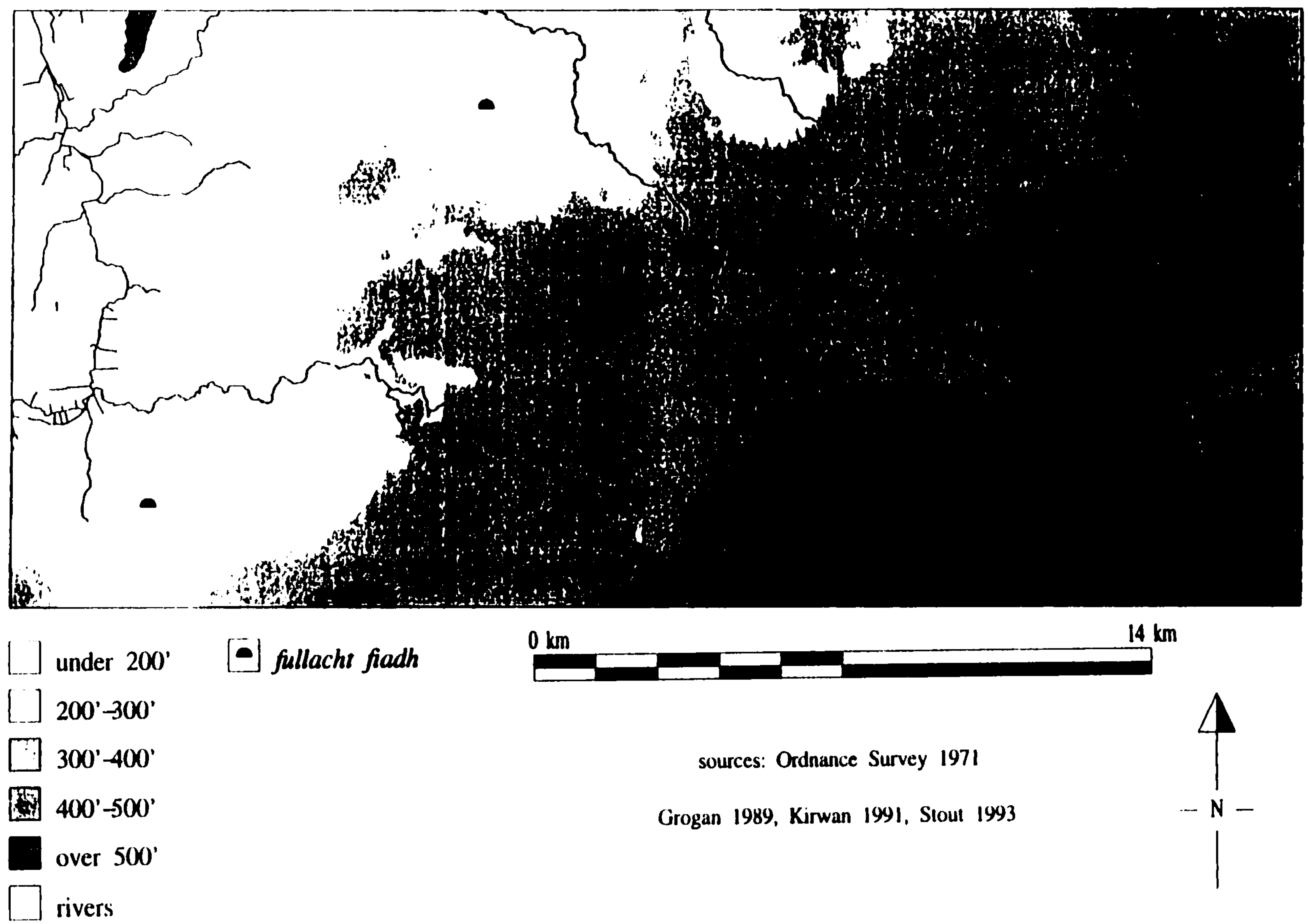
Burial

The burial record for the Bronze Age is complex and changes substantially from the beginning of the period to the end. The changes cannot be broken neatly into sub-periods; continuity and reworking are the framework for these developments.

The Early Bronze Age burial record is complex. The two major departures from Neolithic burial practice are a decline in the marking of burial and a increase in single burial. Single burials did occur in the Neolithic and the building of burial monuments declined at the end of the period. At the beginning of the Bronze Age single burial became the most common burial type. While secondary burials sometimes were inserted into earlier tombs, the monuments constructed in this period were much smaller and were not chambered. Flat cemeteries, with no surviving markers are also a feature of this period. The term cemetery refers to both a single mound with two or more burials, and to two or more burials found in close proximity without a covering mound (Waddell 1990).

The burial rite is a combination of cremation and inhumation. This is usually accompanied by complete pots of varying styles, and less often by non-ceramic grave goods such as daggers, razors, flint knives and boars tusks (Waddell 1990). In the early part of the period it is common for the burial to be

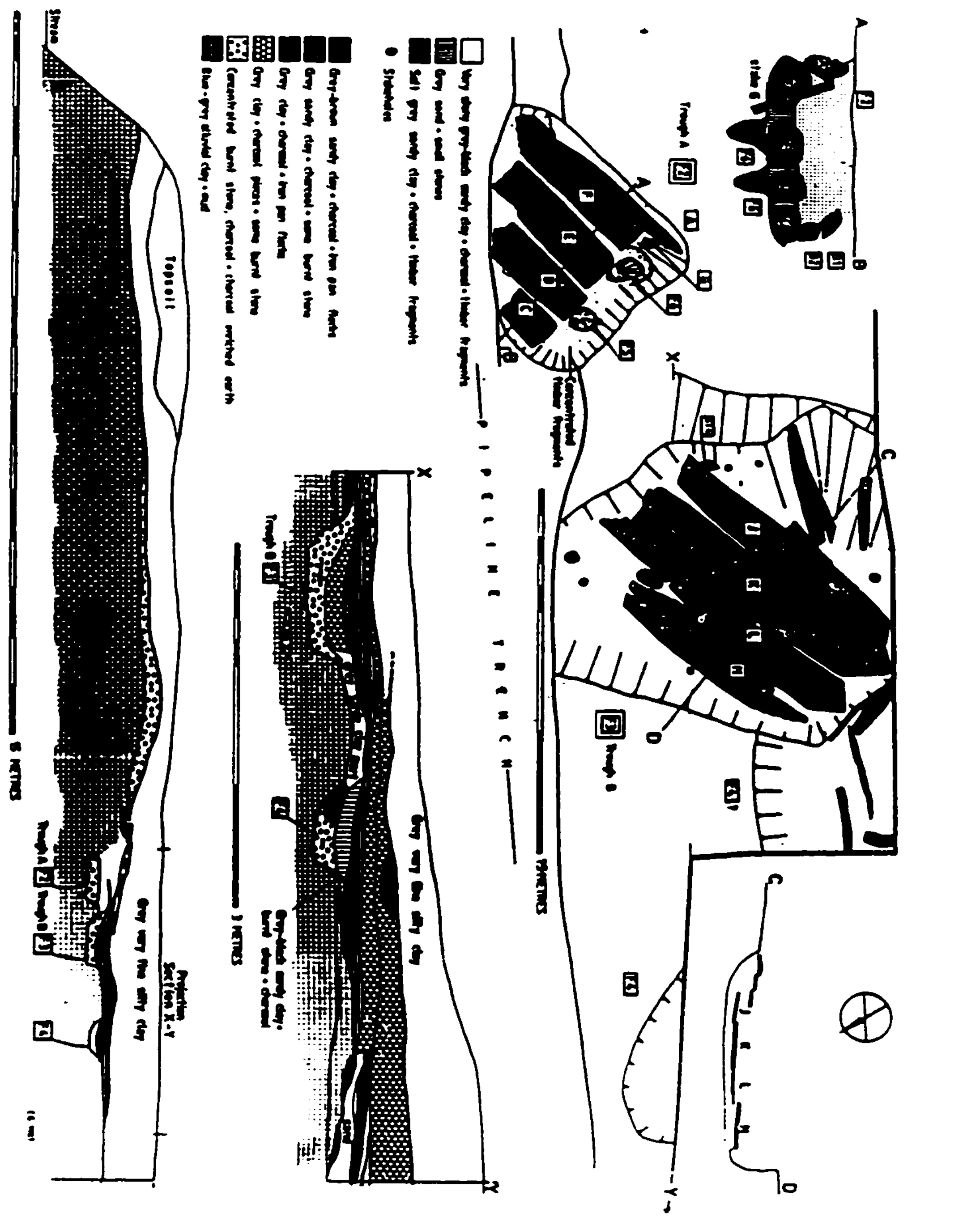
Figure 35: *Fullachta Fiadh*



sources: Ordnance Survey 1971

Grogan 1989, Kirwan 1991, Stout 1993

Figure 36: Raheen (LI049-041) excavated features (after Gowen 1988)



enclosed within a stone cist. In the later part of the period the cist becomes less common and large inverted cinerary urns cover cremated deposits. (Figure 37)

The Middle Bronze Age burial record has much in common with the Early Bronze Age and it is difficult to disentangle the two (Grogan 1989, 149). Cremation became dominant and the amount deposited became more token. The cremated remains were crushed after burning (Ó Donnabháin 1988, 192). The pottery included became coarser and was often fragmentary. Where complete pots were deposited, they were upright. Aceramic grave goods and cists became rare. Many sites show continuity of use with both the preceding period and the next one (Grogan 1990). Some of the dated sites in the study area were isolated pits, not all of which had recognisable human bone. A flat cemetery in Mitchelstowndown North (LI040-138) includes pits that have been lined with putty made from pyre material (Gowen 1988, 98-102) (Figure 38). There is increasing use of the type of site that forms the main focus of this study, the ring ditch.

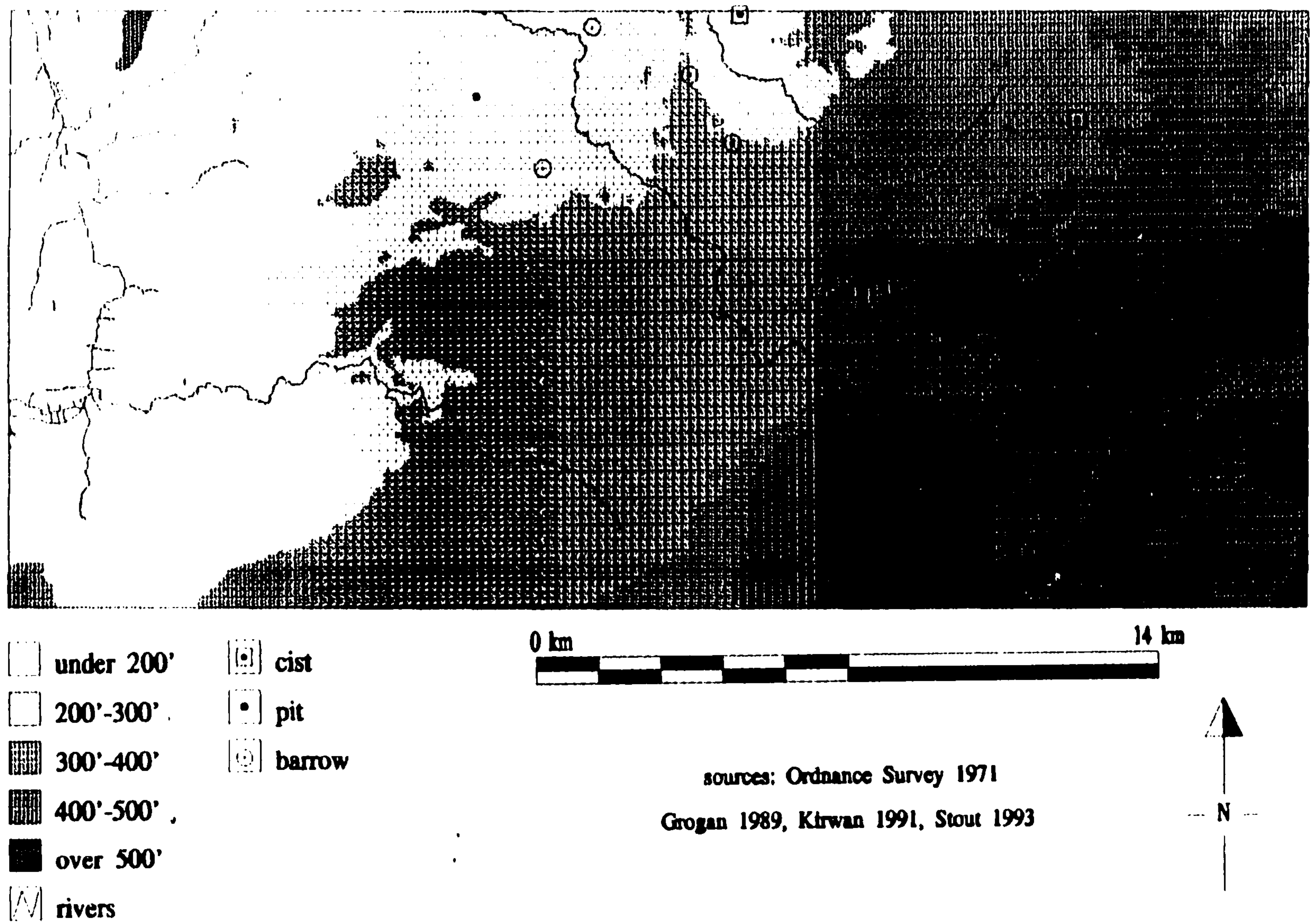
While there are only six burials in Ireland known to date to the Late Bronze Age all of them are small cremated deposits accompanied by coarse pottery in ring ditches (Mogey *et al* 1956; B. Raftery 1973; Lynn 1973/4; Mallory 1984; Williams 1986; Grogan 1990). The small number of known sites is most likely related to the simplicity of the rite and the low visibility of the sites (Cooney and Grogan 1994, 144). The rathanny enclosures, described below and in Appendix D, may be an exception to this pattern.

Ring ditches

Ring ditches are a type of barrow in use from the Later Neolithic through to the Iron Age but most common in the Middle Bronze Age (Grogan 1989, 159, 169). They are identified by an annular ditch, sometimes enclosing a very low mound (Figures 21, 22). The absence of an external bank distinguishes them from ring barrows, a more classically Iron Age form. Excavation usually uncovers a U-shaped ditch, occasionally a central pit and fragmentary evidence for burial (Figure 39).

There are 490 ring ditches and possible ring ditches in the study area, 23 of which are excavated (Figures 40, 41, 42, 43, 44). The largest number found in any other county in Ireland is 57, in Co. Meath. 93% of the measured sites in the study area are under 15m in diameter while only 2.4% of the

Figure 37: Bronze Age burial



sources: Ordnance Survey 1971

Grogan 1989, Kirwan 1991, Stout 1993

Figure 38: Mitchelstowndown North (LI040-138) (after Gowen 1988)

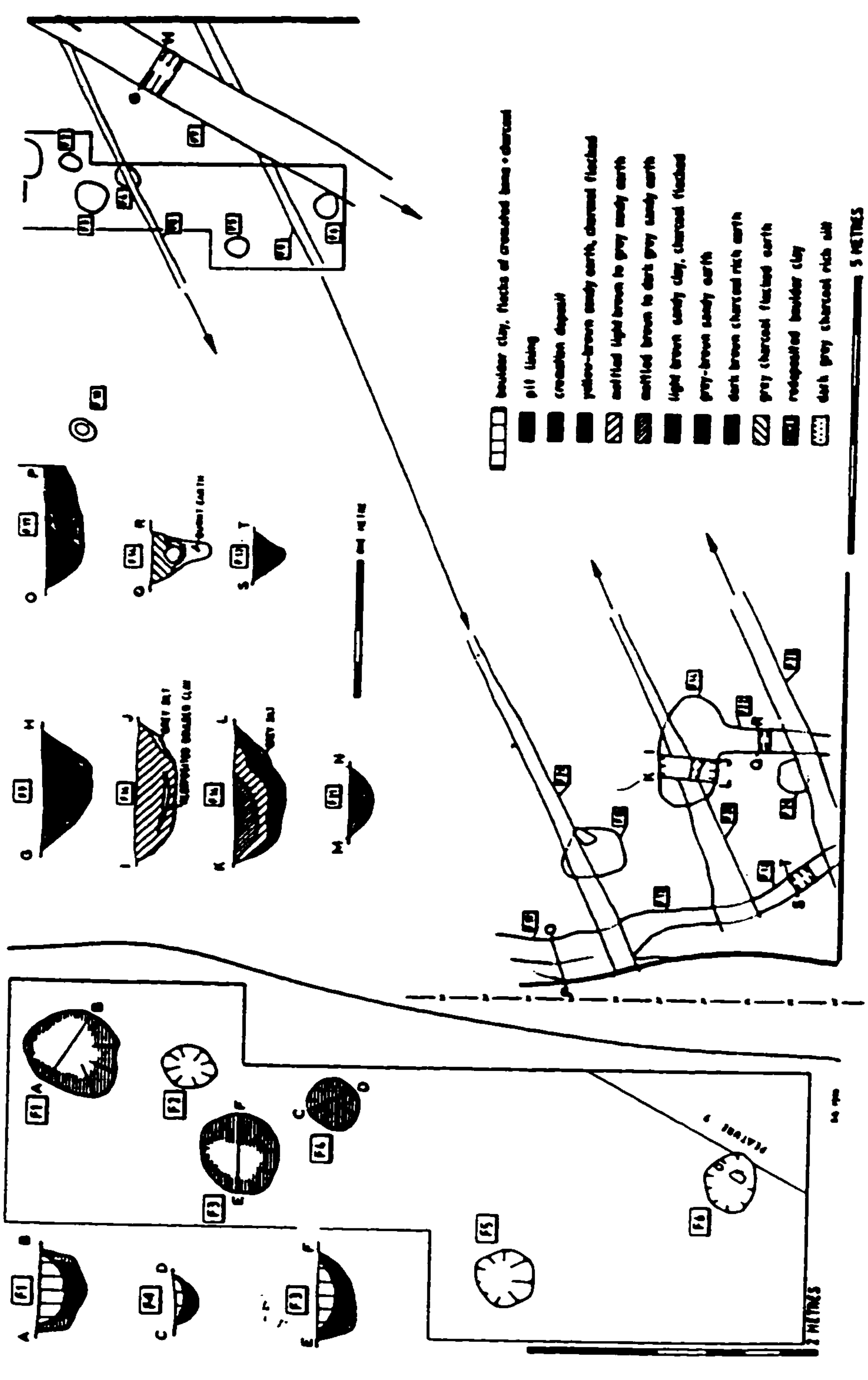


Figure 39: Mitchelstowndown West (LI049-230) excavated features (after Daly & Grogan 1993)

(Photo: Aoife Daly)

Figure 40: Ring Ditches

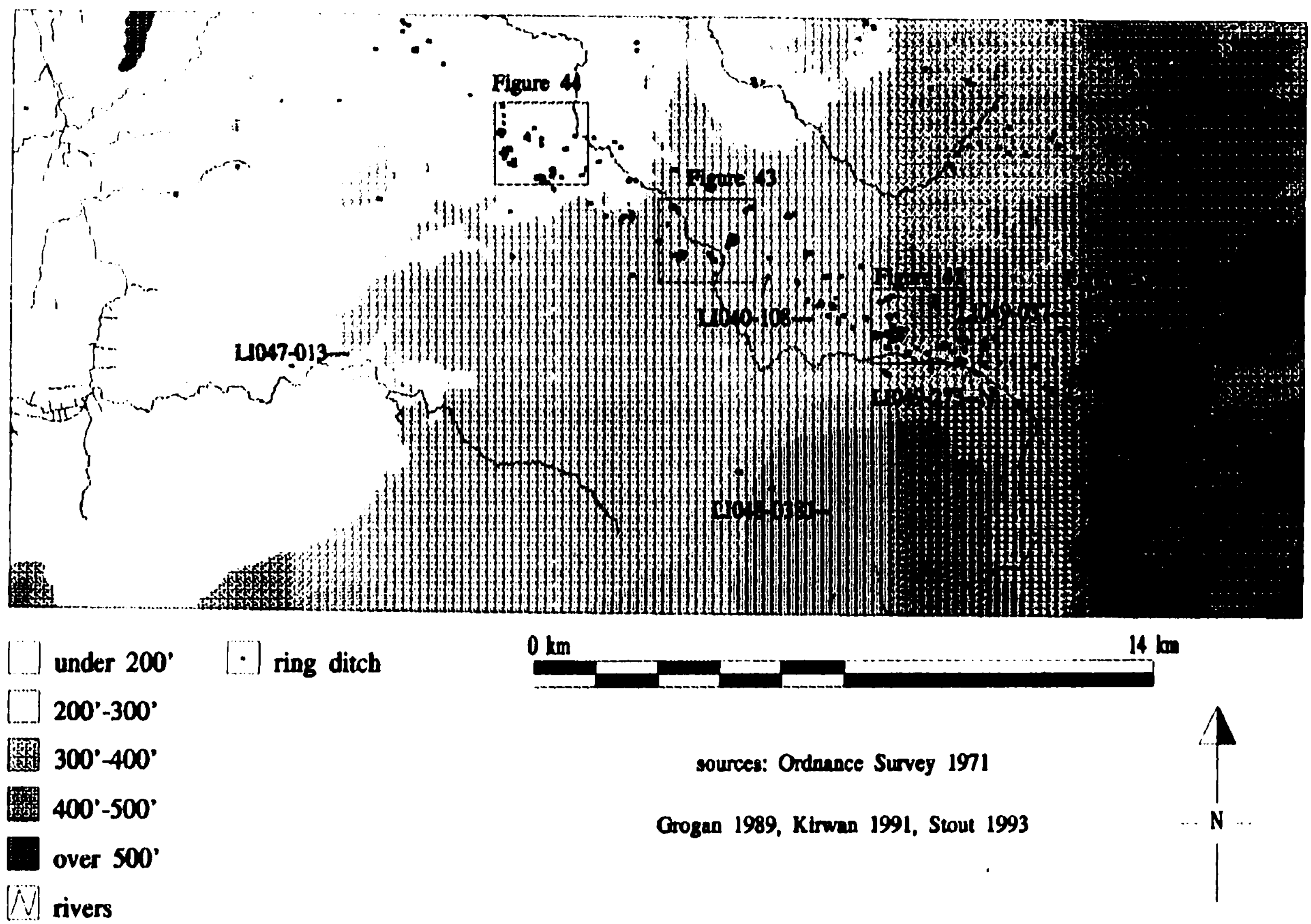


Figure 41: The Mitchelstowndown Cemetery

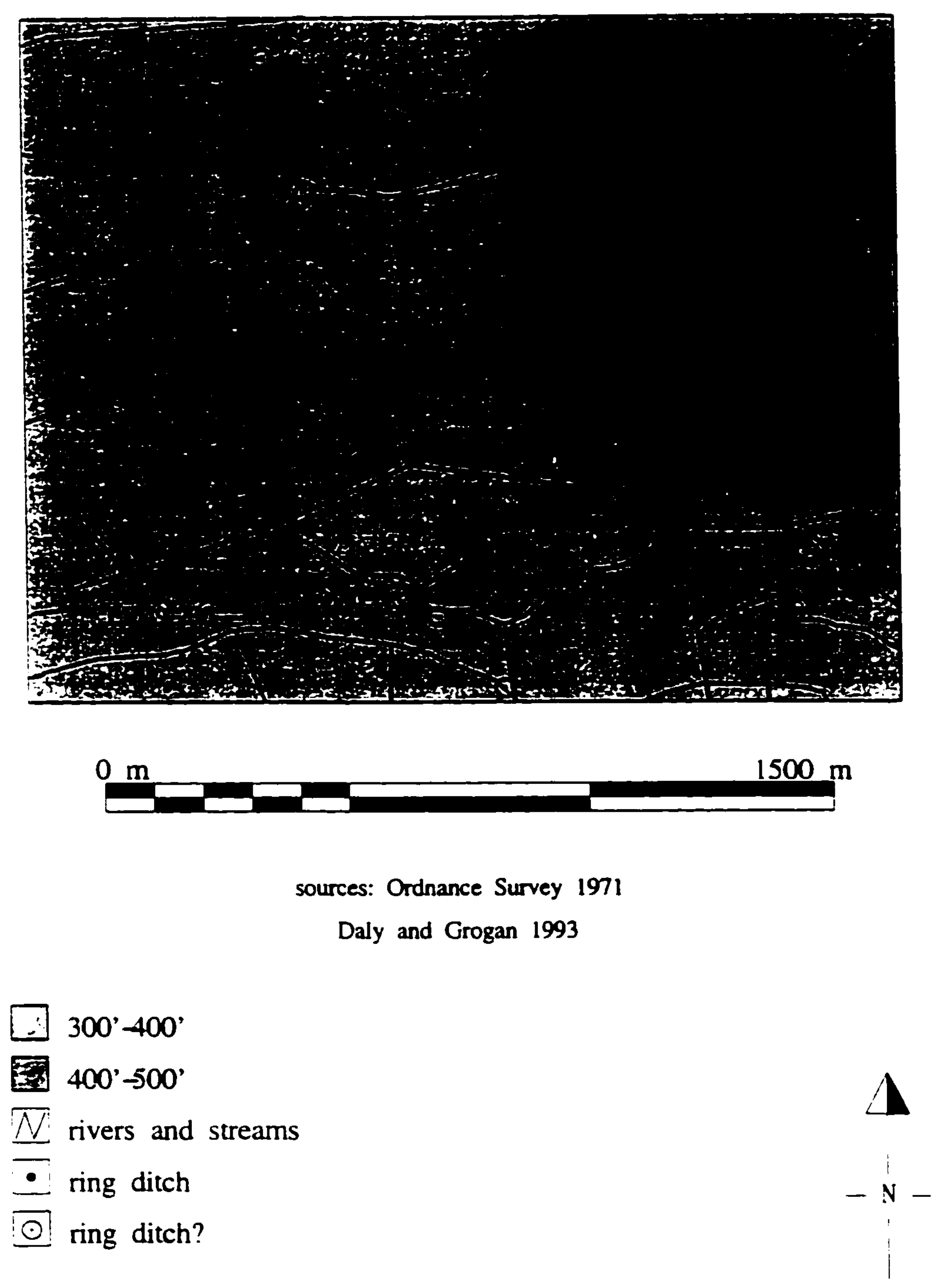
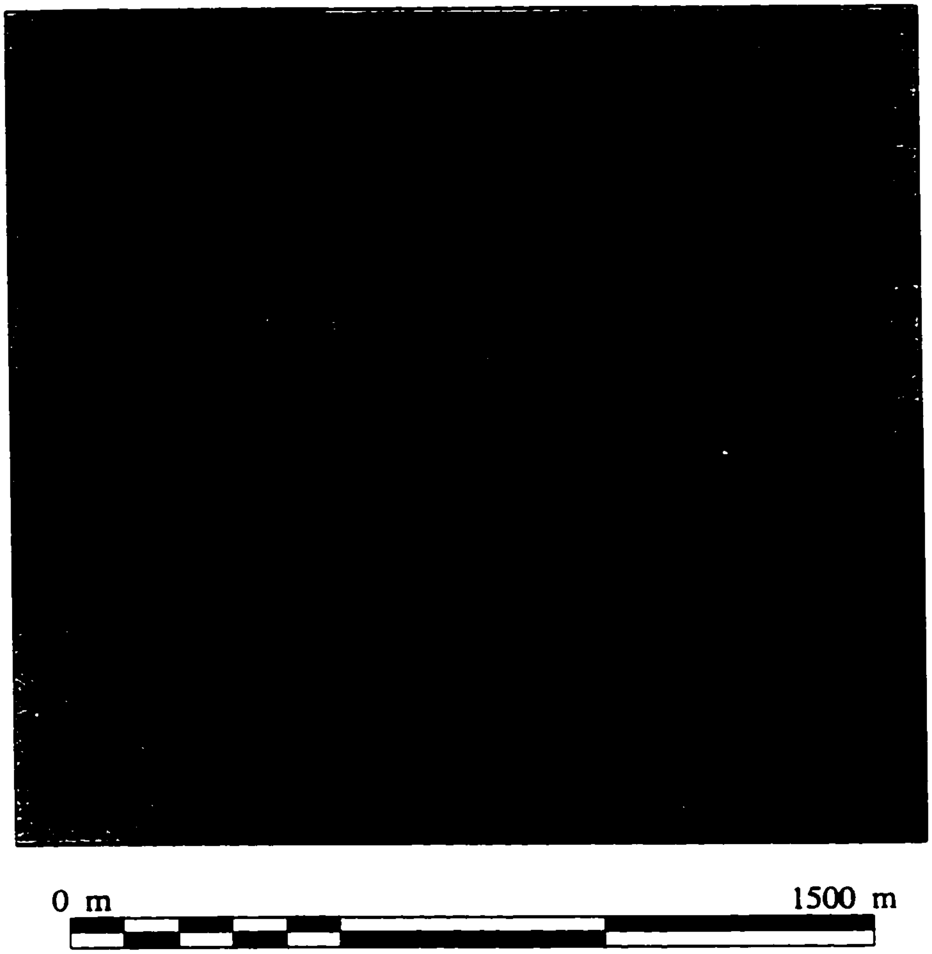


Figure 42: The Ballynamona Lissard Cemetery



sources: Ordnance Survey 1971

Grogan 1989, Kirwan 1991

400'-500'

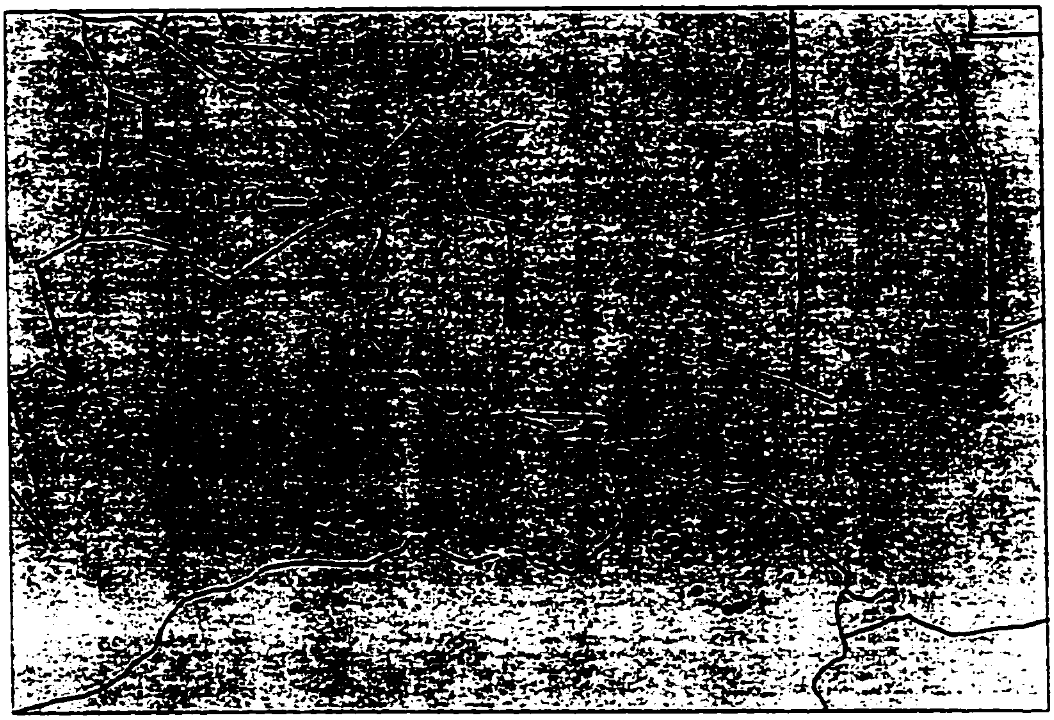
above 500'

rivers and streams

ring ditch

N

Figure 43: The Elton Cemetery



0 m 1500 m

sources: Ordnance Survey 1971
Grogan 1989, Kirwan 1991

300'-400'
rivers and streams
ring ditch

N

Figure 44: The Gormanstown Cemetery

sources: Ordnance Survey 1971

Grogan 1989, Kirwan 1991

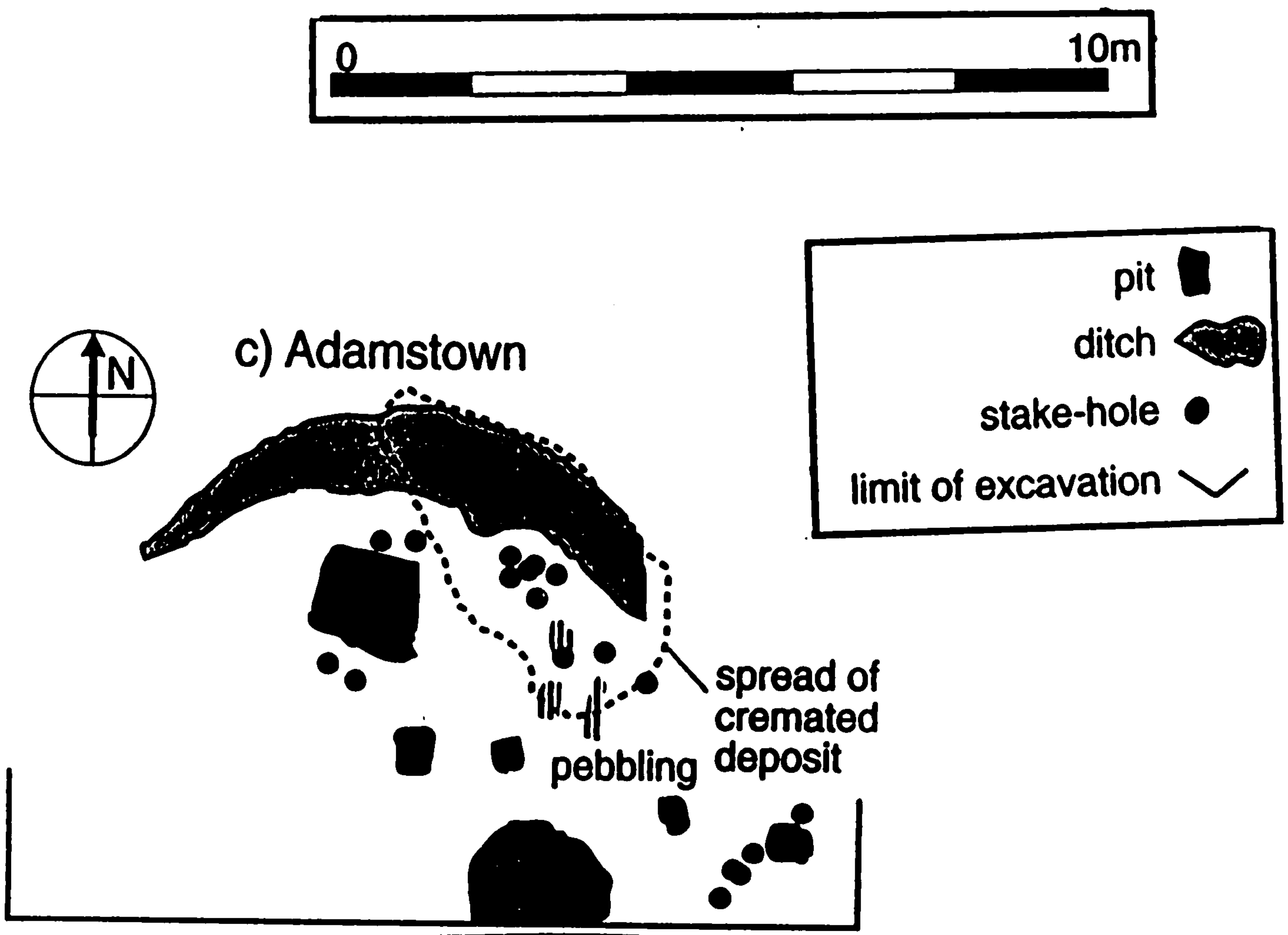
Meath monuments were that small, which suggests slightly different traditions (Grogan 1989, 164-165). In Britain there are a number of different areas with ring ditch cemeteries, notably the fens of the Wash, further up the Great Ouse and at Bromfield, Shropshire. The largest group in England is the 193 recorded sites in the Great Ouse River system of the midlands (Field 1974).

In the upper Severn Valley, sites of this type were in use from the Late Neolithic to the Middle Bronze Age (Warrilow *et al* 1986). At Rathgall, Co Wicklow (Raftery 1981, 175-6) and Mullaghmore, Co. Down (Mogey *et al.* 1956) the same pattern of burial is dated to the Later Bronze Age. The construction of ring-barrows in the Iron Age is similar in many respects (Raftery 1981, 180-181). In the study area, two sites have produced radiocarbon dates, both in the Middle Bronze Age (see Appendix C). Two sites, at Lissard (LI041-033) and Cush (LI048-03810) produced Vase Urns (ÓRíordáin 1936, 17-5; 1940, 133-137) a pottery type considered to be early Middle Bronze Age (Brindley 1980). Another ring ditch at Raheen (LI049-037) post dated the domestic site discussed above (Gowen 1988, 88). The palstave mould is from the same period as the Vase Urn (Herity and Eogan 1977, 164) and provides a *terminus post quem* for the ring ditch. Most of the sites are undated. Although they could date to any part of the Bronze Age, it is also possible that this large cluster comes from a specific flourishing of this tradition. I am studying them as a single phenomenon but am aware of the possibility that they were constructed over as much as a thousand years.

Excavation for the pipeline uncovered two clearly related sites with less regular morphology at Duntryleague (LI049-059) and Adamstown (LI040-076). These sites are part of the same tradition of burial, with comminuted cremated bone and small sherds of coarse pottery. The site at Adamstown also included a pit with a human mandible, the only evidence of interment associated with ring ditches (Gowen 1988, 96; Power 1988, 195). Adamstown and Duntryleague have been referred to as 'devolved' ring ditches, since they consist of fragments of curvilinear ditches, with no evidence of ever forming complete enclosures (Gowen 1988, 68) (Figure 45).

Only six excavated sites have produced human remains and there are two basic patterns. At Lissard (LI041-033) there was a central pit with a cremation in an urn (ÓRíordáin 1936). This is

Figure 45: Adamstown (LI040-07701) excavated features (after Cooney and Grogan 1994)



considered to be the classic pattern but the only other site to resemble this is at Doonmoon (LI040-108) (Gowen 1988, 54-71). The cremated remains here were too fragmentary to identify (Ó Donnabháin 1988, 192) and there was no urn. At other sites the evidence for burial consists of finely ground cremated deposits placed in the ditch (Ó Donnabháin 1988, 192-3). The site at Adamstown (LI040-07701) discussed above, had this pattern as well as the mandible, but the remains were too fine to be identified (Ó Donnabháin 1988, 194). The two patterns cannot be distinguished from surface indications. Individual burial ceremonies may have varied but the mark left in the landscape was constant.

The other seventeen excavated sites have no definite evidence for burial. In most cases, however, there is no evidence for domestic activity. The ditches have no postholes or other signs of structural elements and very rarely are there any artefacts. Mitchelstowndown West 56 (LI049-230), for example, produced one chert scraper, one worked chert pebble and two fragments of flint flakes. The only activity that there is firm evidence for at this site is the construction and destruction of the ring ditch itself (Daly and Grogan 1993).

Morphological consistency ties burial sites to those without human remains. They are so similar to sites with human remains that it seems likely that they had the same function (Ó Ríordáin 1936; Daly and Grogan 1993; but see Bradley 1998). When the burial rite associated with these sites is considered, the disappearance of the evidence seems less far fetched. Green said of a similar site in Britain that "had the burial not been deposited in a pit, only sieving of the modern ploughsoil would have produced evidence of the sepulchral function of the site" (Green 1974, 87). Ó Ríordáin claimed that it was the acid nature of the soil that had destroyed the calcined bone (Ó Ríordáin 1936). Finally, it has been argued that as the burial rite became more complicated the deposit became more token and the sites became cenotaphs, associated with funerals but not necessarily with burial (Cooney and Grogan 1994,126-133; Daly and Grogan 1993, 60).

Unexcavated sites are recognised by surface morphology. Given that those excavated for the pipeline had little or no surface indications, this may underestimate the number of sites in the area. To wait for confirmation by excavation before a site is identified as a ring ditch under utilises survey data.

Since these sites are so unproductive when excavated, it seems particularly important to make use of the unexcavated examples.

The positioning of these sites is the focus for my analysis. Two features, however, are impossible to show on distribution maps. First, four ring ditches are directly related to earlier sites. At Tankardstown South, a ring ditch (LI047-013) was placed on the site of one of the Neolithic houses, the ditch cuts through the foundations (LI047-01202). The ring ditch at Raheen (LI049-037) has a similar relationship to the house, though the house is from a later period than those at Tankardstown (LI049-273--N). The ring ditch at Doonmoon was five metres south of the Final Neolithic kiln (LI040-108) (Gowen 1988, 65). Cush is a multi-period complex with domestic and burial elements overlapping (Ó Ríordáin 1940, Rynne and O'Sullivan 1967). The ring ditch was cut into an Early Bronze Age cemetery mound with a central cist (LI048-03810) (ÓRíordáin 1940, 133-137; Grogan 1988b, 155).

The other feature is the positioning of many ring ditches on little platforms. These were thought to be raised ring forts by both Ó Ríordáin (1936) and O'Kelly (1943a) (Figure 46). Further research has shown that they are basically natural platforms caused by the flooding regime relating to the end moraine. While some of them, including the Duntryleague example, seem to have been enhanced, they are not enclosures. This does not diminish their importance for the positioning of these sites. It was not possible to explore this relationship further since aerial coverage showing both features could not be obtained. A detailed topographic survey of the Mitchelstowndown West cemetery was carried out, but the results were not conclusive.

The Later Bronze Age

Rathanny type enclosures

These sites were identified as a separate class in 1994 by Tom Condit of the North Munster Project. They consist of a large central mound surrounded by a series of circular banks and ditches with diameters of over 100m. (Figures 48, 49). While all of the sites were mapped by the Ordnance Survey and some were described as part of a wider group of defensive enclosures by O'Kelly (1943b) most were not

Figure 46: 7 ring ditches on a platform at Duntryleague (after Ó Ríordáin 1936)

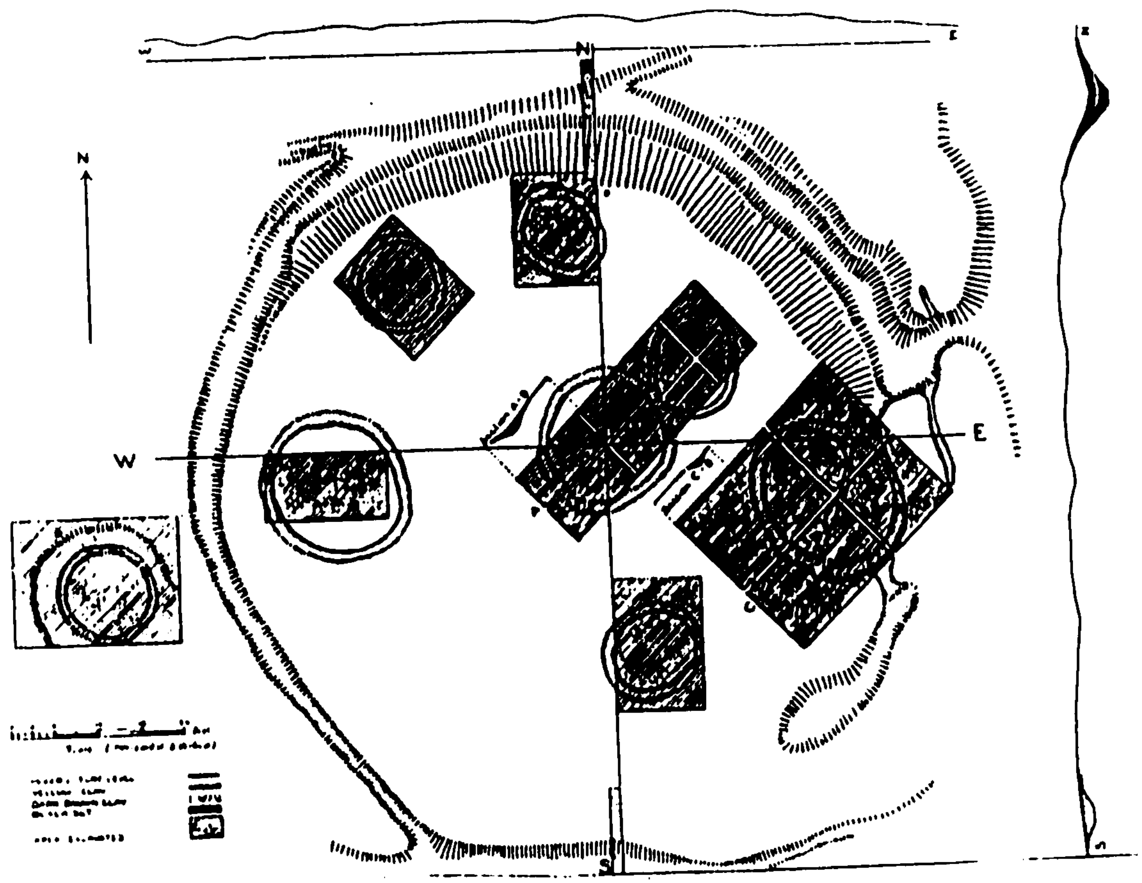
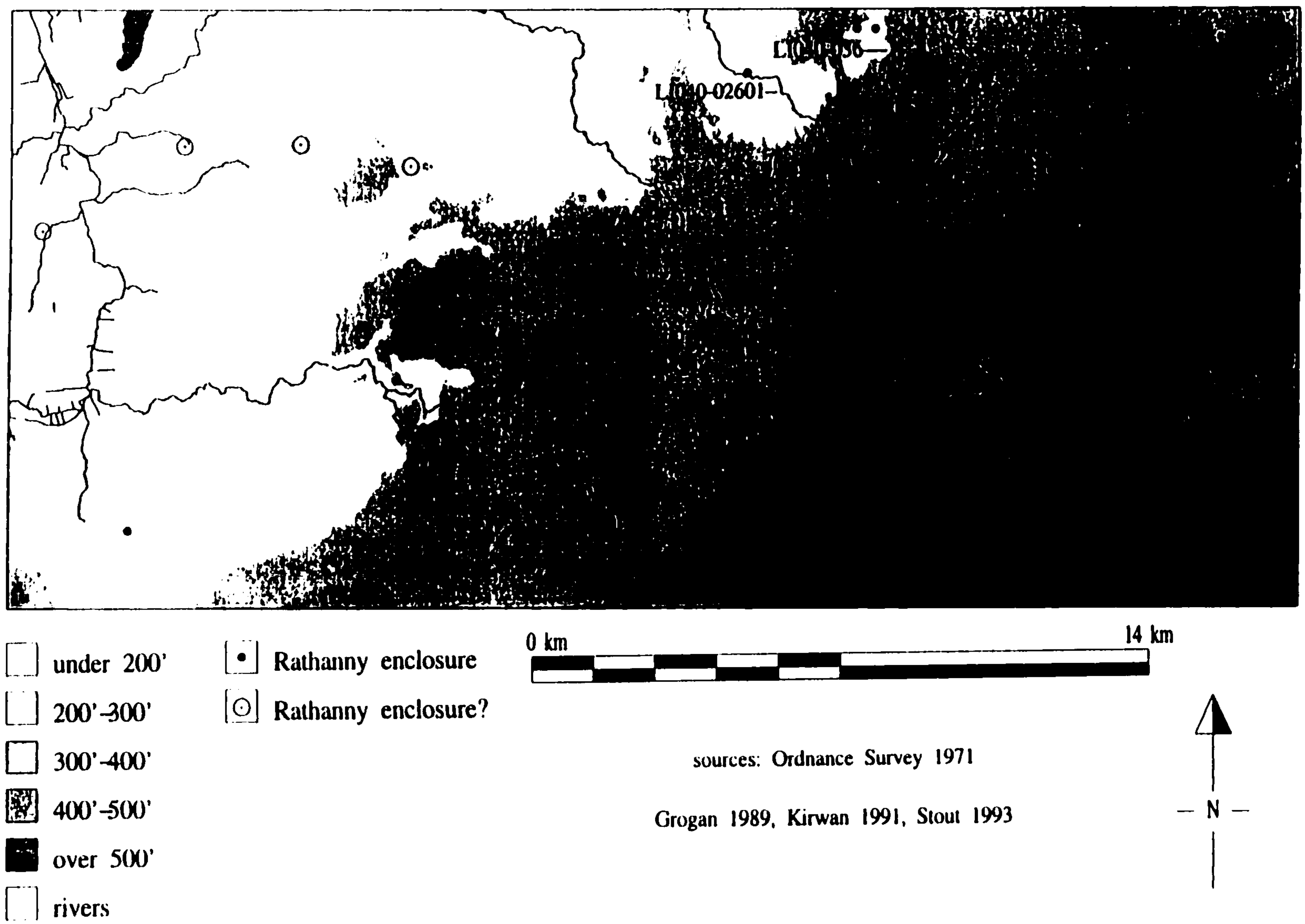


Figure 47: Rathanny Enclosures



sources: Ordnance Survey 1971

Grogan 1989, Kirwan 1991, Stout 1993

Figure 48: DTM of Coolalough (LI040-36)

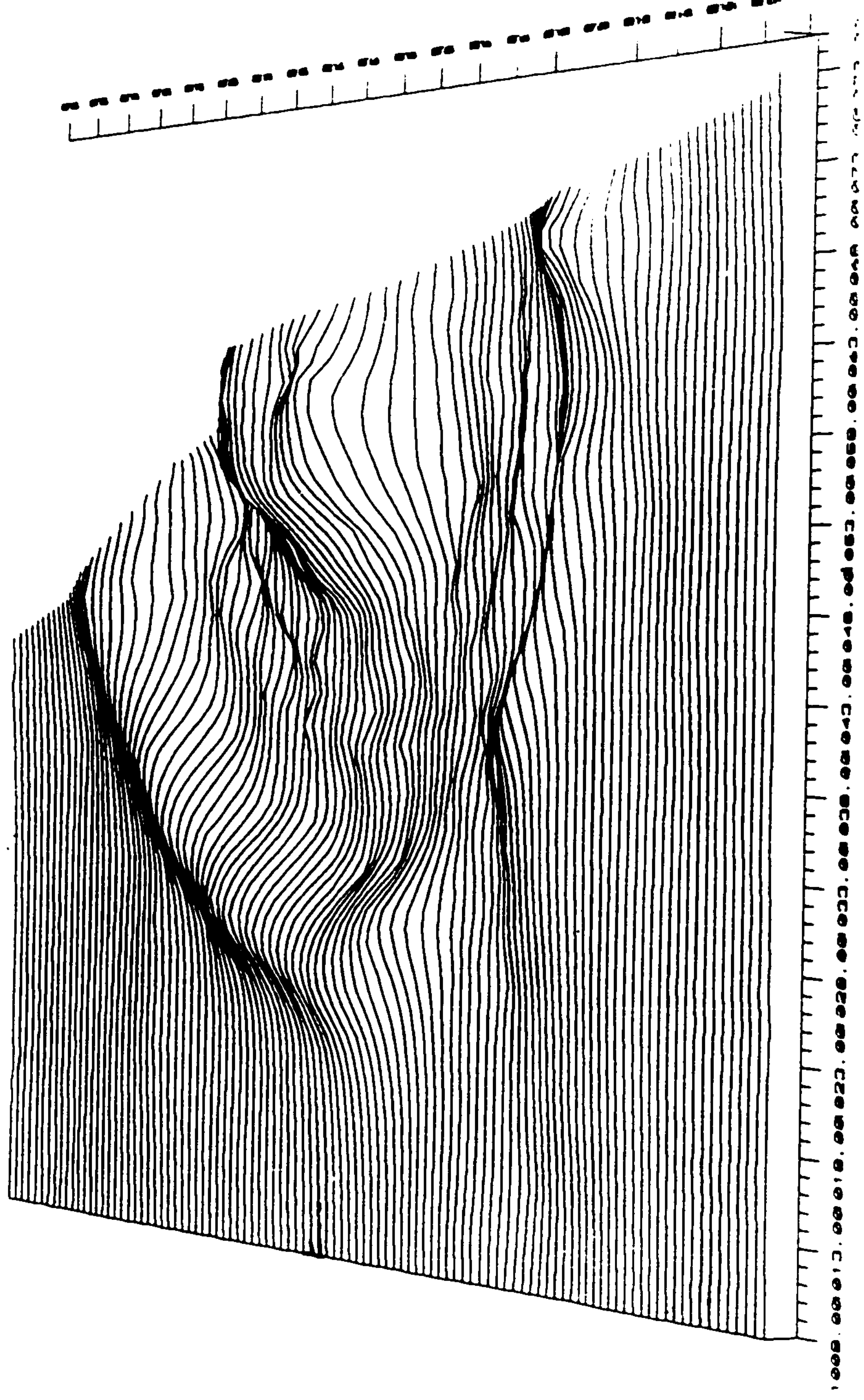
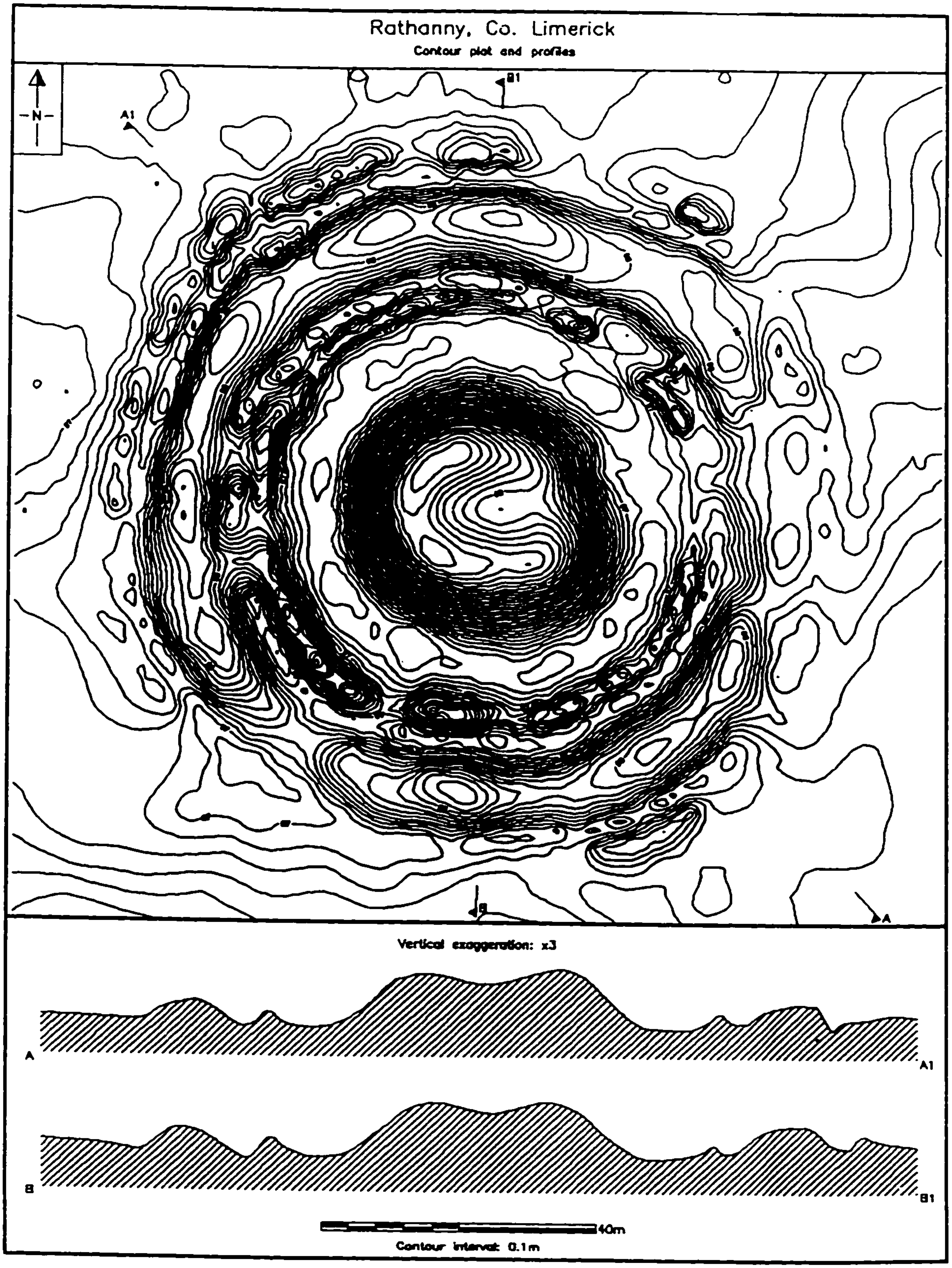


Figure 49: Contour plot of Rathanny (LI040-2601)



re-visited until 1994. Through field visits, and examination of maps and aerial photography I have identified 11 sites in the area which share similar characteristics (Figure 47).

Since there was so much more space taken up by enclosing features than enclosed space at these sites we thought it most likely they were pre-Christian ritual monuments. A field visit to three of the sites confirmed this impression. The first site visited, and the most spectacular, was at Rathanny, Co. Limerick (LI040-02601). A cremation pit was visible in the drain edge of one of the sites at Coolalough (LI040-036) (Figure 48). Investigations of that site produced a radiocarbon date of 875 BC as a *terminus post quem* for the construction of the mound. There were also indications that the site may have been a multi-period monument (Appendix D). While the good preservation of the site at Rathanny precluded any excavation, a full survey was carried out (Figure 49). This shows that the similarities between these sites carry into details such as the slight dishing of the mound.

These sites are very important for studies of the Irish Later Bronze Age because burial is rare and burial monuments are unknown from this period. They are similar in form to Ashleypark, Co Tipperary (Manning, 1985) and Fenniscourt, Co. Carlow (Condit and Gibbons 1988a). Their affinities to Later Neolithic Linkardstown burials (Wallace 1977; Manning 1983-4) and embanked enclosures (Sweetman 1976; Stout, G. 1991; Condit 1993) may be coincidental or an indication of continuity.

In the study area, these sites are interesting for their place in the Later Bronze Age landscape and their connection to preceding landscapes. The enclosures are often sited on the edge of clusters of ring ditches. At Coolalough, there was a ring ditch right up against the outer bank (LI040-186--N). In no cases, however, are there ring ditches built on top of this type of site. This is significant because sometimes ring ditches are sited within other types of enclosures (O'Kelly 1943a). There are also no cases where this type of site cuts a ring ditch. While the lack of ring ditches on these sites could point to the enclosures being later than ring ditches, there is no definite evidence for this relationship. Further spatial analysis may shed light on this problem.

Standing stones and stone circles

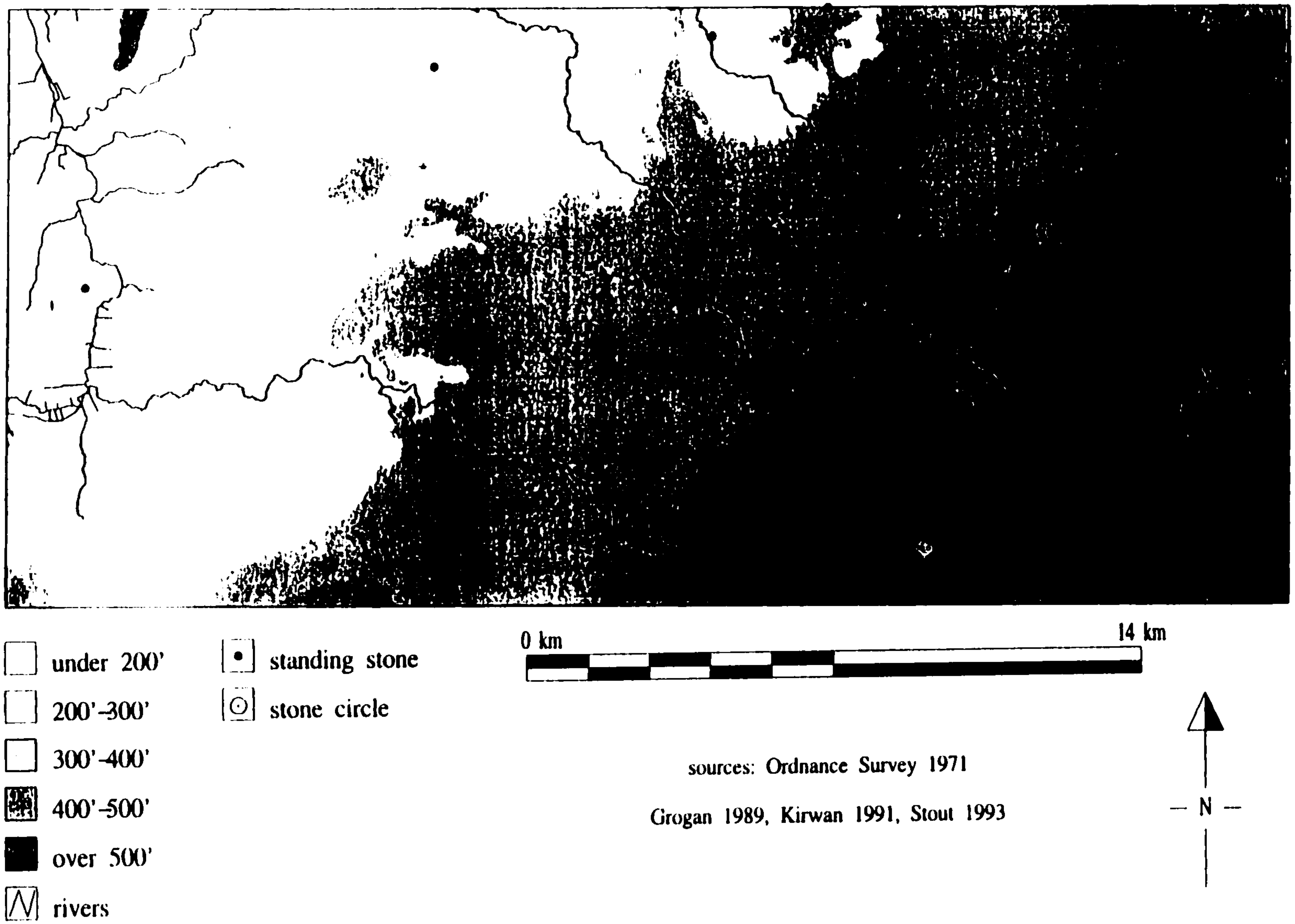
Standing stones range from approximately one metre to seven metres in height. Some excavated examples have produced evidence for burial at the base of the stone (MacAlister *et al* 1913; Leask 1937; Collins 1957). Others have produced no information about date or function (Shee and Evans 1965; Gowen 1988, 141-142). They are sometimes associated with other standing stones in alignments of three to five stones. It is difficult to date these sites and some recorded stones may even be modern scratching posts for cattle (O'Kelly 1989, 228; Gowen 1988, 142). They are however, regularly found in association with Middle and Late Bronze Age sites (Lynch 1981, 71, 73). It is generally accepted that these stones served a variety of functions from burial stones, to boundary markers; from gathering places to route markers (O'Kelly 1989, 228). There are fifteen standing stones in the study area (Figure 50).

Stone circles are found in two main concentrations, one in Ulster and one in Munster. Those in the southwest form part of a complex of sites and have a different morphology than other stone circles in the country. It was thought that their distribution related to early metal working (Ó Nuallain 1975; 1984; O'Brien 1990, 288-9). Recent radiocarbon dates, however, place them nearer to the end of the Bronze Age. As with the standing stones, some sites have produced evidence for burial. In two cases the burial has been dated to the Late Bronze Age (Lynch 1981, 237). There is only one stone circle in the study area (Figure 50).

Hillforts

There are now 59 hillforts, 51 hilltop enclosures and 13 inland promontory forts known in Ireland. These enclosures range in size from 0.5 hectares to 130 hectares (Grogan *et al* 1996; Raftery 1976, Condit 1998). They can be broken into three groups based on size and elevation. The sites in the largest group often have three ramparts (Grogan *et al* 1996). The existence of an external ditch is considered important by Raftery (1972; 1976) but the suggestion that internally ditched sites were not defensive has not been tested. The definition of this site type remains problematic as ramparts were constructed differently in different terrain. Ramparts can be made either of earth or stone (in dry stone walling or dump construction). Although these sites are thought to have fulfilled a defensive role, that is

Figure 50: Standing Stones and Stone Circles



sources: Ordnance Survey 1971

Grogan 1989, Kirwan 1991, Stout 1993

partly a matter of social display. None of the sites show evidence of violent destruction. Many excavated sites have uncovered occupation debris but it is not known if they would have housed a large, small or fluctuating population.

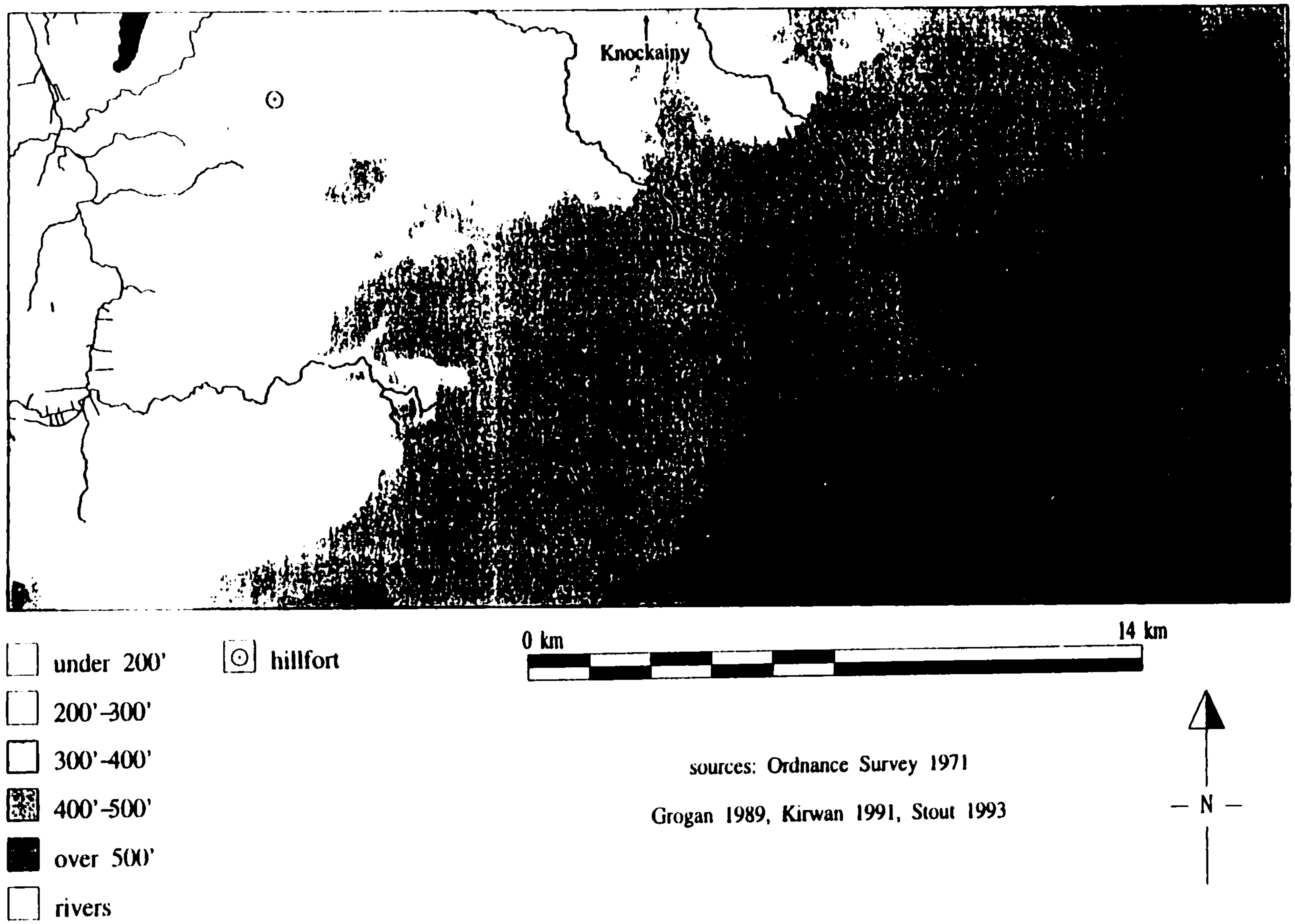
It was once thought that Irish hillforts, like those in Britain, belonged to the Iron Age. Increasing numbers of radiocarbon dates from the small number of excavated sites place them firmly in the Later Bronze Age with dates clustering around 1000BC (Mallory and Warner 1988; Weir 1987; Grogan and Condit 1994). Although hillforts have a wide distribution, there is a line of particularly large sites along the southern fringe of the midlands, running just north of the study area. Examples of all sizes were regularly sited overlooking mountain passes or fords, which implies that the coercive nature of the sites involved controlling movement. (Condit and Gibbons !988b, Nocete 1994; Condit 1995).

There are two hillforts in the study area, at Rathcannon (LI039-029) and Doonglara (LI049-098). There is another very slightly to the north at Knockainey Co. Limerick (Figure 51). All of these sites are bi-vallate and fall into the middle group in terms of size and elevation. Although they were noted as enclosures by the SMR they were identified as hillforts by Tom Condit of the North Munster Project in aerial photography as part of the present research.

Summary

Aerial photography and field survey have produced most of the archaeological knowledge of the study area. There has been comparatively little excavation. There was occupation in the area from the Mesolithic. Both domestic and funerary sites are recorded for the Neolithic. The ring ditches date largely to the Middle Bronze Age. They are regular in form but varied, and often disappointing, when excavated. Although overshadowed by the burial sites, there are a few possible Bronze Age domestic sites. All of the known sites from the Later Bronze Age, whether defensive or ritual, are high visibility sites. The position of all these sites in the landscape can now be explored.

Figure 51: Hillforts



Chapter 3: Methodology

Introduction

Landscape archaeology's theoretical focus on perception and experience has led many researchers away from quantitative methodology (e.g. Tilley 1994). Measuring perception and experience might seem contrary to these theoretical concerns. Detailed information is needed, however, in order to assess landscape in terms of the four dynamics laid out in chapter one - scale, terrain sensitivity, integration and tempo. Analysis needs to move beyond the gaze of a particular archaeologist.

I have employed a series of quantitative analyses in order to inform my assessment of the Middle Bronze Age landscape with a detailed standardised and flexible range of information. I have done this deliberately in order to fragment my vision of this landscape. This did not deny my point of view but it challenged me to see around it. This has been particularly useful in dealing with scale issues, because the scale of analysis partially determines the type of patterning perceived, and we cannot perceive several scales at once (Ebert 1992, 174). A secondary purpose in carrying out these analyses was to structure the discussion of the four dynamics around particular exercises that were designed to examine them.

Quantitative methods for spatial analysis have been used less in archaeology than in geography, and archaeology has tended to import both models and methods from the latter discipline. In both cases, their initial use was associated with the positivist focus in social science in the late sixties and early seventies (Hagget 1965; Clarke 1968). Changing theoretical concerns combined with less confidence in the archaeological data set have pushed spatial analytical techniques to the edges of archaeological research. In North America, they remained an important part of the predictive modelling common in cultural resource management (Kvamme 1988). In European research, they enjoyed resurgence as part of landscape archaeology (Bradley *et al* 1993, Crumley 1979; Crumley and Marquardt 1990; Cooney 1979).

I used two basic types of analysis: point process analysis and site catchment analysis. Both of these have been used widely by archaeologists in the seventies and were largely abandoned because they were not particularly powerful. There has been substantial research in spatial statistics since that time and point process analysis has become considerably more powerful (Bailey & Gatrell 1995; Diggle 1990; Goodchild *et al* 1992). The point process analysis described the distribution of sites, with a particular interest in distinguishing clustering within the distribution. It also tested an explanation of the results of this description. This research was the first archaeological application of these techniques.

There have been several attempts to update site catchment analysis to make use of available computing power (Schermer and Tiffany 1985; Hunt 1992). The approach I developed here differs from these in the use of a control set and in the statistical nature of the analysis. It allowed me to control scale issues much more closely. The site catchment analysis pulled outward from the sites and described their distribution in the terrain.

I am not claiming that these analyses allowed me an objective framework, nor did they give me the viewpoint of prehistoric peoples. They challenged my vantage and forced me to follow the questions in an orderly fashion. Each method was used directly to address one or more of the four dynamics. The analysis in Chapter four was based on the methods described here. The discussion in Chapter five uses understanding gained through this process in a more general archaeological discussion.

Point Process Analyses

Introduction

I used three types of analysis based around point processes: Kernel smoothing, K-functions and Raised incidence modelling. These are purely spatial analyses, based on the distance between points and not on terrain variation. They explore the presence and nature of clustering within a set of points. I used them to consider the dynamics of scale, integration and terrain sensitivity. All of the points in the chosen data set for each analysis were considered to be equivalent. I assessed clustering in the study area as a whole and within concentrations, then modelled the variations that were indicated. The three nested questions were: Is clustering present? Where is clustering present? Why is clustering present?

Each analysis brought the initial arrangement of points through a series of abstractions, which allowed the pattern to be described with greater precision mathematically. This process highlighted elements of the pattern's structure that would not have been apparent visually. All three analyses shared the first two stages of abstraction, which were based on analytical techniques developed in the sixties.

Then they each added further levels of abstraction, which allowed scale and spatial patterning to be explored in an explicit fashion. These further abstractions were the products of more recent research in spatial statistics and could not have been performed without considerable computing power. I will describe the shared abstractions in the introduction, and the details in the sections dealing with each particular analysis, below.

The Basics

Any arrangement of points can be described as a mathematical curve. This was the first level of abstraction shared by all of the analyses. Measurements of the spatial properties of the set of points are taken and plotted versus frequency. The most common measurements taken are density of points and distance between points - sometimes known as quadrat and nearest neighbour (Getis and Boots 1978; Orton 1982). The shape of the resultant curve is of more interest than its particular values because the shape can be compared to theoretical curves whose properties are known.

The most common curve for comparison is the Poisson curve, since it describes a pattern generated by complete spatial randomness. If a pattern has been formed through Poisson processes then each time a new point is added to the pattern any given area will have an equal chance of receiving that point and the position of earlier points will have no bearing on the position of the next point. Getis and Boots describe the basic assumptions of the Poisson process:

> "(1) n points are placed in a region where each possible location for a point is *equally likely* to be chosen.
>
> (2) the location of each point is *independent* of each other point." (Getis and Boots 1978, 18) (emphasis original)

These two assumptions are referred to as homogeneity and independence. Where these assumptions are true, the Poisson distribution (Getis & Boots 1978, 18) describes the probability that a defined number of quadrats will have a defined number of points. If the curve produced from the data set varies from Poisson then the process that produced the pattern violated one of the assumptions described above and the data set is either clustered or dispersed. One of the main difficulties with this model is that it is not possible to know which assumption was violated (Taylor, P. J. 1977, 144). A comparison with

Poisson can indicate that a pattern deviates from random; how far it deviates from random; and whether it is dispersed or clustered. Modelling is required to look at the sources of that deviation.

Obviously some information present in the recording of points was not taken into consideration once the arrangement was transformed into a distributional curve. The choice of measurement techniques was partially based on what information was considered to be most important - distance or density. Dealing with the pattern as a single entity simplified description, but it did not allow for explicit exploration of variation within the pattern or variation due to scale. The second shared stage of abstraction laid the groundwork for incorporating both distance and density. Both spatial and scalar variations were described more precisely by breaking the pattern into smaller units.

One of the features of the Poisson curve is that its mean is the same as its standard deviation. This figure, when describing a spatial process, is known as the intensity (Kalbfleisch 1976, 17). Consider a non-random data set. Remember that the two Poisson assumptions are homogeneity and independence. If the non-random element of the pattern is a breach of the first assumption - homogeneity - then it could be said that the whole distribution is composed of a series of smaller distributions, which conform to the Poisson assumptions but have varying intensities. If you measure them separately then each block would still produce a Poisson curve but each curve would have a different intensity - the local intensity (Berman & Diggle 1989). The plot of these local intensities versus frequency is the second level of abstraction. Varying the number and size of the smaller measurement blocks was the basis of the analyses used here.

These two levels of abstraction, and those that build on them in the rest of the analyses, require a huge number of calculations. They could not be carried out without appropriate software. The spatial analytical capabilities of ArcInfo are limited. All of the spatial statistics based on point process carried out here used Splancs - a set of software designed by researchers at Lancaster University to carry out spatial analysis within the commercial software package, S-plus (Rowlingson and Diggle 1993; 1994). This software allows for simulation, assessment and modelling with a rudimentary display function. Since sites were plotted according to National Grid Co-ordinates, no accuracy was lost in the transfer from one environment to the other.

Kernel smoothing

A point map of the data set is difficult to read because the density of sites was so high (Figure 24). Information about the distribution was lost through presentation in this manner. Kernel smoothing produced a smooth map of the distribution where variation in intensity was shown as variation in greyscale colour. The clustering within the distribution was highlighted. The confusion of overlapping point symbols was avoided. The intensity of each kernel was calculated as described above and the results were mapped as a raster image. Although originally it was designed to produce one smooth map, I have used the technique at a series of different scales because of my interest in scalar variation. Areas that seemed equally intense at one scale had discontinuities at another. This variability indicated different types of clustering at different scales.

Purpose

I used this technique to allow consideration of the whole pattern without losing information on closely spaced sites. It helped identify breaks and high spots. It was useful in considering the dynamics of scale and integration.

Assumptions

1) Each point represented a site of a similar nature and the point pattern was a reasonable representation of the distribution of sites.
2) The point pattern was considered to be an inhomogeneous Poisson point pattern. This means that variation in the distribution stems from violation of the first of the two Poisson assumptions. This may not be completely accurate, but it simplifies the measurement technique below.

Process

Information from individual points was generalised with greater precision than a simple density plot. Since the distribution was assumed to be an inhomogeneous Poisson point process it can be thought of as a set of smaller Poisson processes, each with a different intensity. For this analysis a measurement circle (kernel) was visited across the distribution on a grid and the local intensity was calculated, as described above. These intensities were mapped with different shades representing different intensities (Figure 64) (Rowlingson and Diggle 1993, 634).

Obviously the size of the kernel was key. There is an algorithm within Splancs that calculates the mean square error for any given kernel (Diggle &Rowlingson 1993, 635). This gives the bandwidth at which the curves for individual kernels most closely approximate Poisson. While the Splancs developers suggest that the lowest mean square error was the appropriate bandwidth for smoothing, it was not necessarily the effective scale. Their concern was in getting the smoothest pattern (Berman and Diggle 1989), and effective scales may highlight breaks and discontinuities. I found it most useful to vary the bandwidth in order to interrogate the pattern at many scales.

Application

This procedure was carried out on three different subsets of the data - The whole study area, and two concentrations identified at the study area scale. All the sites in Appendix B were considered since I was interested in a measure of overall activity. In each case the kernel size identified by the mean square error function was used, followed by higher and lower scales.

Weaknesses

1) The resolution of the smoothed maps depended upon the image facility in Splus. Since the purpose of the exercise was to refine visualisation, the quality of the resultant maps was disappointing. This is a good argument for the integration of analytical functions within existent GIS's like ArcInfo, which already have good map production facilities.
2) The choice of an optimal scale was a problematic concept. The use of multiple kernel sizes helped keep scale as a dynamic concept.
3) The two concentrations chosen for closer study have a small area to edge ratio. Edge effects are a common problem in spatial analysis (Pellegrini and Reader 1996). It is possible that the reason that the mean square error was less than useful for choosing kernel size related to edge effects.

Strengths

1) It was possible to see the entire distribution at once without losing information on the concentrations.
2) Visualising the changing nature of the pattern at different scales allowed insights into scale and structure that would not have been possible with a point pattern.

3) Considering the relationship between the mean square error and the patterns produced made me consider the notions of optimal scale and effective scale in a more formal fashion.

K-functions

A distribution that appears to be clustered can be, statistically speaking, random. A random distribution would conform to the Poisson assumptions: each area within the study area would be equally likely to be the location of a site; and the presence of a site would make no difference in the decision to build another. This would not be very interesting from an archaeological point of view. Because we are interested in human choice, archaeologists tend to assume that our distributions are not random, skipping an important stage in analysis. Demonstrating that the distribution is not random is a baseline for discussing siting choices in formal analysis.

This technique both demonstrated and explored clustering within the data set. The local intensity of the distribution (described above) was determined for each kernel (unit within the area) at a given scale. The mean of all the intensities at this scale was recorded for the data set and for 99 simulations of a random set. The scale of the kernel was increased. All the mean values for the data set and maxima and minima for the simulations were plotted against the scale of the kernel. The relationship between the curves indicated the nature of the distribution. If the curve for the data set lay within the envelope for the simulation then the distribution was random. If it lay above the envelope then the distribution was clustered at that scale. It is possible for a distribution to be clustered at one scale and not at another, so this technique allowed me to examine variation in clustering with changing scale.

Purpose

I used this technique to determine whether the concentrations, which are evident visually, can be defined formally as clustering and to get a sense of how substantial that clustering was. It also indicated the scales at which clustering occurs. It was useful in considering the dynamics of scale and integration.

Assumptions

1) Each point represented a site of a similar nature and the point pattern was a reasonable representation of the distribution of sites.

2) The point pattern was considered to be an inhomogeneous Poisson point pattern. This means that variation in the distribution stems from violation of the first of the two Poisson assumptions. This may not be completely accurate, but it simplified the measurement technique below.

3) The control simulations represented complete spatial randomness.

Process

The K-function is defined as the expected number of further points within a distance *s* of an arbitrary point, divided by the overall intensity of points (Ripley 1976; 1977). A kernel was visited across the study area as above. The mean of all the local intensities at that scale was calculated then the kernel size was increased (Diggle & Rowlingson 1993, 636). The mean of the local intensities was graphed versus the kernel size. The inference was based on simulation so the same procedure was followed by 99 realisations of complete spatial randomness. The simulations were plotted as an envelope with only maxima and minima showing. The curve of the data set was compared with the simulation envelope.

Application

For this analysis the study area was taken to be the area survey for the pipeline, which reduced the noise from varying survey intensity. There were 286 ring ditches in this zone (Figure 24). The initial kernel size was one metre. It was increased by one metre increments to one kilometre.

Weaknesses

1) The pipeline survey was a very odd shape which decreases the area to edge ratio. Since this was simulation technique, however, it was less prone to edge effects than techniques based on comparisons with theoretical models. Both data and control will have the same edge effects to deal with.

2) The reduced number of sites in the data set was unfortunate. It may have caused problems with understanding the role of outliers to the concentration. The pipeline survey corridor, however, did contain a wide range of concentrations. The one kilometre upper limit for kernel size was imposed

since the distances above this limit were not measurable given the pipeline survey shape. There was some indication from site catchment analysis that important changes take place above this scale.

3) The consideration of only the mean of the curve of local intensities assumes the distribution was well served by this measure. Results from the kernel smoothing and from the site catchment analysis suggest that this may not be a valid assumption.

Strengths

1) K-functions use the best characteristics of both quadrats and nearest neighbour techniques. Since intensity takes into account both density and spacing, less information was lost in the abstraction. The results did more than confirm clustering.

2) The graph plotting intensity versus kernel size was particularly useful for investigating scale issues within clustering.

3) Since only the pipeline survey area was considered, the sample was likely to be representative of the population.

Raised Incidence modelling

Once clustering has been demonstrated it is possible to look for patterns and model causes within that clustering. Simple gravity models describe clustering where the independence assumption of the Poisson distribution has been broken. The presence of one site increases the chance of other sites being constructed. This is a rather simplistic view and does not account for choice in the original location of sites. It does not examine variation within the landscape, nor does it take account of the interaction between different types of sites. This model, borrowed from environmental epidemiology, was intended to examine a more complex scenario.

The model is a mathematical statement of the proposition that the probability of building a ring ditch is increased by the presence of domestic site. The intensity measurements, described above, were related through a decay function to the distance from a domestic site for both the data set and the 99 simulation control sets. The fit between the data set and the model and the fit between the control set and the model were compared. Where the difference between the two fits was statistically significant the model was said to account for a significant amount of the clustering in the distribution. While the model was still fairly simple in terms of human choice, and made little account of terrain variation, it was a conceptual advance on gravity models.

Purpose

I wanted to test the specific proposition that domestic sites were associated with a raised incidence of ring ditches. This modelling was for description not prediction. The strong indications of clustering stemming from the above analyses prompted me to investigate the nature of that clustering. The first possibility was that certain zones were more likely to have sites, the second was that the existence of sites draws more sites. These are the assumptions of the Poisson distribution described above. The model investigated these two different assumptions separately.

The proposition could be viewed as a breach of the second assumption, independence. If it were a breach of independence, however, then all sites would exert a draw on all others. A gravity model would best describe this situation. Since domestic sites may have drawn the ring ditches, it was better to model the domestic sites as an environmental factor creating a zone that was more likely to contain ring ditches. This describes a breach of the first assumption, homogeneity. Since the heterogeneity was measured by proximity to a point source, some of the patterns produced may resemble breaches in independence. The model was intended to investigate the dynamics of scale and integration.

Assumptions

Since this was a model the assumptions are strong and may not be conformed with. I have conducted the analysis to test the assumptions:

1) The point pattern was an inhomogeneous Poisson pattern of varying intensity, as described above in the kernel smoothing (Rowlingson and Diggle 1994, 24).
2) There was a causal relationship between defined sources and the point pattern.
3) These sources raised the intensity of the pattern in their vicinity

Process

This model was designed for use in environmental epidemiolgy, to investigate raised incidence of rare illness (Diggle 1990; 1993). The independence assumption is maintained while the varying chance of an event is controlled for by parameters. The closer the postulated source of an event the higher the intensity of the Poisson curve. The model can also hold covariables that are not based on distance, but can only hold one at a time.

After the local intensities were calculated, they were plotted versus distance from the source. This curve was then described by a mathematical function containing parameters relating to distance decay. This formula was based on a decomposition of the Poisson function, since the basic model was an inhomogeneous Poisson process (Diggle 1990; 1993). The parameters were adjusted until the closest fit between the control set and the data set was reached. This was a maximum likelihood estimation. The significance of the result was determined by comparing the fit of the data set and the fit of the control set.

The fit was calculated by giving the software a data matrix containing the data set and the control set, the squared distances of each point from the source, and initial values for the parameters. This last value should not be important since the maximum likelihood should be the same regardless of the starting point for the parameters (Kalbfleisch 1976, Rowlingson *pers comm)*. A single covariate could be added along with a value for its parameter. The critical factors were the nature of the control set and the quality of the data. Size and shape of the area should not have affected the result since both control and data set were equally liable to edge effects

Application

The data set consisted of the ring ditches in the area surveyed for the gas pipeline. The control set was a simulation of complete spatial randomness. The sources were domestic sites of LN/EBA date in the same area. The potential causal relationship between source and site was the suggestion that burials form a part of an integrated landscape focussed on pre-existent domestic sites.

Many covariates were considered such as amount of Elton soil in the 1km catchment or distance from a lakeshore. Since these covariates were all spatially determined, I decided that they complicated the model in ways that confused rather than clarified understanding. No covariates were used.

Weaknesses

1) Given the limitations on sources and covariates the relationship tested was fairly simple.

2) The causal relationship between sources and sites was confused by lack of chronological control.

3) While it was easy to determine whether or not the model represented a significant improvement, it was difficult to interrogate the fit between the model and the data. Because the analysis was automated it was difficult to take apart the different components.

Strengths

1) The concepts of source and compounding influence were intuitively simple. The model incorporated variables that describe the terrain itself and variables that describe proximity. It allowed me to examine the possibility of these cemeteries being focussed on particular sites, as was postulated for many other barrow cemeteries (Barrett and Bradley 1991; Hall *et al.* 1987; Ellison and Harriss 1972)

2) Specific propositions were tested. Constructing the model required me to phrase questions about distribution in a framework that was amenable to spatial analysis - which was a beginning point for good practice. It allowed for variation within a distribution to be explained rather than simply noted.

3) The measurement technique on which the model was based made most use of the available data and matched the technique that I used to describe the distribution. It had been fully developed and tested in another research project, so the statistical and analytical concerns had already been tested. Because of this standardisation it would allow for comparison between data sets - such as other cemeteries.

Site Catchment Analysis

Introduction

The point process analyses described above were useful for examining spatial relations between sites but they could not be used to consider the sites in the terrain. I used Site Catchment Analysis to consider this set of relations in a similarly formal and statistically rigorous fashion. Site Catchment Analysis had been widely used for this purpose but had significant flaws in its application. I modified the concept to allow me to use it in this non-domestic context to explore broader issues than resource procurement. I examined more than one size of catchment and used a control set to make statistical comparisons more robust. The collection and manipulation of this volume of data required an amplification of the statistical functions within ArcInfo.

Site catchment analysis was originally introduced in archaeology thirty years ago as a scale of analysis suitable for studying site location patterns. Many modern archaeologists have overlooked its utility in this role. Until its introduction, archaeologists interested in site location often classified sites by the environmental zone in which they were located (Vita-Finzi and Higgs 1970, 1). The study of site catchment increased the scale and level of detail available and created a standardised format for analysis. The significance of this innovation often has been overshadowed by the research questions to which it has been linked.

Site catchment analysis has largely withered as an archaeological technique. This is partly because the research questions and theoretical frameworks of those who have used it have limited its potential. It has become equated with optimal foraging theory and has been largely used in order to determine the economic basis of sites (Flannery 1976). It was also limited in scope because the process of the analysis was time consuming and the useful results rarely outstripped direct observation from maps (see Renfrew 1973). Nevertheless, site location patterns continued to be actively studied (Bradley *et al* 1993). In the absence of site catchment analysis such studies were often unstandardised, and lacking focus (Groube 1981). A particular problem was the comparison of the terrain of the location of the site, a micro scale, with the terrain of the study area, a macro scale. Another problem was the presentation and comparison of locational data when the number of sites under study was large. I modified the basic process of site catchment analysis to deal with these particular problems.

The first modification was a change in purpose. Originally site catchment analysis was designed to give information about resources in the vicinity of habitation sites (Vita Finzi & Higgs 1970; Flannery 1976). Here, site catchments were defined as areas of knowledge rather than areas of use. That knowledge would have been important in the location of all types of sites, and so it could be explored for the funerary sites discussed here. This drew the analysis away from optimal foraging theory and allowed it to inform a broader range of theoretical issues.

The next modification was a change in the data collected. The first element of this was the introduction of a control set. Site catchment information was collected for a random set of points as well as for the sites under consideration. This kept comparisons of terrain between equal scales and gave a firm basis for the assessment of preference and avoidance. Originally suggested by Schermer and Tiffany (Schermer & Tiffany 1985), the use of simulation was more powerful in this analysis because of the large number of sites and because of the way in which the random set was generated.

The second element of this modification was the collection of data from three different catchment sizes in order to investigate scale questions. The same scales were used for all sites. While the different scales could represent different types of knowledge they were not chosen with use patterns already defined.

The final significant modification was the form of statistical analysis used to interpret the data collected. Firstly non-parametric tests were used to distinguish significant differences between the data set and the control group. Secondly, those significant differences were interrogated more thoroughly using curve decomposition (Tague 1995). This allowed me to see complexity in the siting patterns and to examine relationships between different aspects of locational preference.

The modifications to data collection and analysis could not have been carried out without the use of GIS and statistical software. I estimate that the data collection alone would have taken at least ten years to do by hand. I used a combination of ArcInfo, Spss for Windows, Paradox, and Microsoft Excel. Since both data collection and analysis were modified they will be discussed separately below.

Data Collection

The modifications described above required that I collect a very large body of information about the terrain of the study area in a standardised format. I chose a set of scales suited to the questions of interest. I determined quantitative measures for terrain features and collected those for the catchments of the sites and the control set. This required some programming within ArcInfo which clarified my understanding of the process as well as facilitating the data collection itself.

<u>Purpose</u>

The purpose was to gather information about the location of all sites in the study area and about a control set. The control set enabled me to assess how different the positioning of the sites is from what it would be if there was no human patterning. The information needed to be standardised across different scales.

Assumptions

1) The units of data collection represented an area whose terrain would have been known to the prehistoric inhabitants. There was no suggestion of territory, exclusivity or use.
2) The following three units represented valid scales for analysis. A circle with a radius of 5 kilometres picked up features within easy walking distance of a site. It represented the broadest area of detailed knowledge. This also coincided with the size of most terrain zones in the study area - moraine, upland, river valleys. A circle with a radius of one kilometre picked up features that would have been regularly passed during construction and use of a site. It was a tighter scale and features could have been within the same use pattern as the site. A circle with a radius of 500m picked up features intimately connected to the site - the knoll it was on the slope of, the earlier site it was cut through. I looked at complexes of sites within this zone. It was at this scale that close siting decisions were visible. With such a small area a movement of five metres could make a difference to the features picked up.
3) Modern measurement of terrain features and sites was a useful measurement of variation important to the builders of the sites. There were clearly problems with this assumption relating to soil development and hydrological change. The modern landscape was not the same as the prehistoric landscape but it did give an indication of the variation present. Consideration of landscape change, discussed in Chapter 2, will be an important feature of the interpretation in Chapter 4. There was a related assumption that the maps and GIS coverages I worked with were a reasonable representation of the modern landscape. The quality of this data has also been assessed in Chapter 2.
4) An equally sized randomly placed control set gave a reasonable measure of natural variation for the features measured.

Process

The facility for measuring features a set distance from a point already existed in ArcInfo but it could only deal with one such zone at a time if the zones overlap. I wrote a programme in AML to manage the data collection so that each site was considered in turn. The information produced was written to text files, which were processed and attached to an existing database of sites. The code for this process is reproduced in Appendix E. The following points describe the functioning of the programme.

- A site is selected and a 500m buffer zone is created.
- This buffer is intersected with coverages of soils, contours, rivers and sites.
- Summary measures are taken.
- All of the information collected is written to text files organised by scale and by which feature has been measured with a heading indicating which site has been measured.
- A new buffer of 1km is created and the process is repeated.
- The final iteration for each site creates a 5km buffer.
- The next site is then selected and the process is repeated.

While the use of ArcInfo and this AML made data collection possible, the iterative structure of the programme was slow and took up a lot of processing time. It took a week to run the 592 sites. Because of this, only one control set was measured.

The control set was generated using a random number generator in Microsoft Excel. I generated two sets of numbers within the appropriate ranges to be National Grid Co-ordinates within the study area. These were imported into ArcInfo and used to create a points coverage which was measured in the same manner as the sites.

<u>Application</u>

1) All prehistoric sites within the study area were measured at all scales. This gave information about 592 sites.
2) For soils and contours there are summary measures of the number of polygons, the total area and the total perimeter of each series or height range. The perimeter was measured in an attempt to get an

index of shape. The total length of rivers was calculated as well as the total length for each class described in Chapter 2. The total number of sites and the number of sites in each class were counted.

3) Because there is no 'natural' variation in the pattern of sites, the control set was not used for other archaeological sites in the catchment.

Weaknesses

1) The main problem was that this was still a labour and computational intensive data collection technique. A problem within ArcInfo caused the programme to crash sometimes, so supervision was required to restart it. Further refinement would require much more complex programming.

2) The most serious flaw was that the control set was represented by a single realisation of complete spatial randomness. While this was a step up from earlier approaches where catchments were compared to study areas, it left some grey areas in analysis. A proper simulation run of ninety-nine realisations of complete spatial randomness would have set the analysis on a much firmer footing. This would have taken an additional three months computation time, plus at least that much again in processing and compilation. For this more complete approach to be feasible, a programme that processes all points in a set at once is required.

3) While collected on a spatial basis, the results themselves were a-spatial. I had hoped to be able to get an index for shape so that a strip of soil could be distinguished from a block, since these may have different significance in a landscape. Similarly there was no assessment of topology - the spatial relations between different features. Well-drained soil beside a lake is different from well-drained soil beside a rock outcrop.

4) There was no control set for sites. It would not make sense because the purpose of a control set was to measure variation not related to human choice. The absence of a control set required me to analyse the sites in a different manner to the terrain, which undermined the concept of landscape as an integrated concept.

Strengths

1) It was possible to collect standardised information about this large number of sites and about a control set. Standardised collection of information about the catchments of this number of sites had not been

presented before. The largest sample for site catchment analysis in the current literature is 40 (Hunt 1992).

2) The three scales could be taken separately or together to allow flexibility in dealing with questions of scale. The analysis could still be compared with earlier studies since the largest unit is the same size as the initial size of catchment suggested by Vita-Finzi and Higgs (Vita-Finzi and Higgs 1970).

3) The organisation of the data files by scale and feature with headings for each site allowed the information to be reorganised in many different ways and the site catchment information remained connected to individual sites.

4) The data collected could be exported to many other packages making analysis more flexible and cheaper than one based solely within GIS. When imported to Paradox the locational data became part of the same data set as survey and excavation details.

Analysis

The volume of data collected by the process describe above both justified and necessitated statistical analysis. The existence of a control set allowed me to use quite powerful statistical tests. Since archaeological data are rarely normal I used non parametric tests to identify significant differences between the data set and the control set. I examine the frequency curves of significant variables to move the analysis beyond terrain features which are preferred and avoided.

Purpose

The purpose of the analysis was to assess the terrain and archaeological features of site catchments and compare it with the control set, which represented natural variation.

Specifically I wanted to identify, at each scale:

1) Which features were preferred or avoided?

2) Was the preference/avoidance general to the distribution, or were there several different siting patterns present?

3) Where there were several siting patterns present, what was their spatial distribution?

Considering the above questions across features and scales helped answer the next three questions:

1) Did preference/avoidance relate to the feature being measured or to another related feature?

2) Could the different concentrations of sites be distinguished and grouped by their terrain positions?

3) How did these things relate to the four dynamics under consideration: scale, terrain sensitivity, integration and tempo?

<u>Assumptions</u>

1) A numerical summary of the measurements was a reasonable representation of the material.

2) The sites recorded were a reasonable representation of the whole distribution and the control set was a reasonable representation of natural variation

3) People in the Middle Bronze Age had a knowledge of the terrain and of archaeological features in their catchment and this knowledge conditioned the placement of sites. The measurements related to that knowledge.

4) If the above were true then differences between cases and controls related to human behaviour and choice, amongst other factors.

<u>Process</u>

Mapping and discussion would be sufficient to describe the catchment of one site or even 10 or so sites (Vita Finzi and Higgs 1970). I was looking for statistical summaries that allowed me to generalise about all the sites or any group of sites within that. Because the distributions were markedly non-normal (see Figure 68 d)) common descriptors such as the mean and the standard deviation were not useful. Particularly at the smaller scales, there were a large number of zero values which skewed the distribution so that mean median and mode were all zero.

In order to work around these difficulties, the analysis had three basic stages. Assessing significance highlighted the features that were worth further investigation. Exploring the patterns of particular graphs identified preference and avoidance. It also identified groupings within the pattern. Comparison and interpretation were required to understand scale changes. This stage also identified which patterns were statistically significant but archaeologically unimportant.

Assessing Significance

The features that had significant differences between cases and controls were identified using the Kolmogorov - Smirnov test. This test measures the greatest difference between the two cumulative frequency curves. The significance of this measurement is tested against D (Blalock 1979, 266-269). I ran the tests on SPSS for windows. In all circumstances the null hypothesis was that there was no difference between the random distribution and the sites distribution with respect to the variable being measured. Because of the number of hypotheses being tested and because of the sample size a significance level of .005 was chosen.

I chose a non-parametric test even though the sample size was large because the curves remained markedly non-normal (Figure 68 d)) The main disadvantage in using non-parametric tests is computation time, which was not a consideration here (Daniel 1978, 16). I chose the Kolmogorov - Smirnov test because it makes use of the whole distribution - it treats departures at any point in the curve equally. It makes more use of the whole distribution than many of the other non-parametric tests such as the Mann-Whitney U which focuses again on the central tendency or the Moses test of extreme reactions, which focuses on the dispersion (Blalock, 1979 266-269). The equal consideration of all sections of the distribution is undesirable when testing some models (Kalbfleisch 1976, 23), but it is particularly useful in this circumstance.

Since there was no control set for sites I ran correlations between the different site classes using Spearman's rank correlation (Blalock 1972, 434 –436; Daniel 1978, 300-306). While this only investigates one type of relationship between sites, it gives some statistical basis to the discussion.

Exploring the Patterns

The cumulative percentage curves and frequency curves were plotted and examined. For the cumulative percentage curve the sites curve running below the random curve was taken to indicate preference while running above indicated avoidance (Figures 52, 53). In some instances the curves crossed (Figure 54) and in this situation a multiple distribution was inferred. This was more readily assessed in the frequency distribution.

Figure 52: a cumulative curve indicating avoidance

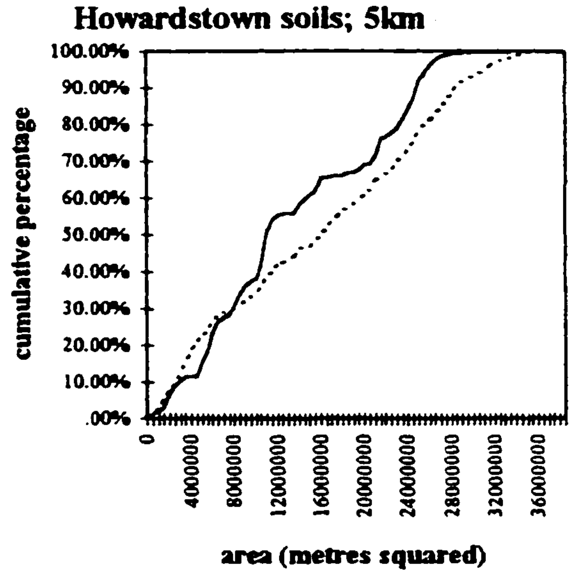


Figure 53: a cumulative curve indicating preference

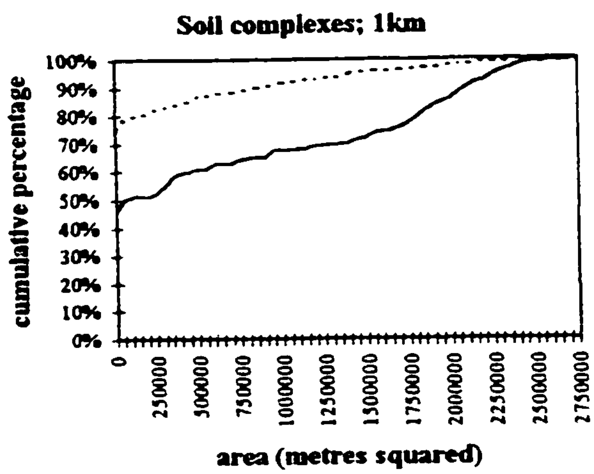
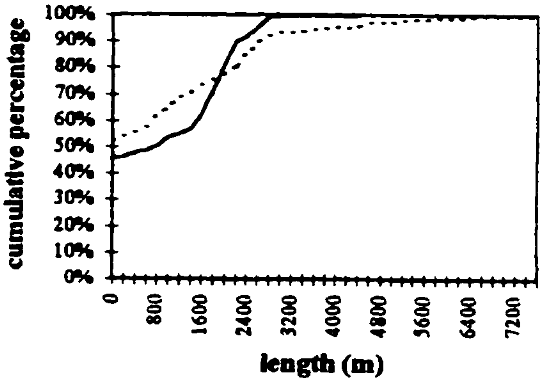


Figure 54: A cumulative curve indicating multiple distribution

Class 3 rivers; 1km



When considering the frequency graphs the shape of the curves was considered to be as important as their position. Sometimes there were simple curves and these were taken to represent a single distribution. Some had a central tendency (Fig 55). Some rose or fell fairly steadily (Fig 56). In other graphs there were clear breaks in the curves. These were taken to indicate multiple distributions, with more than one factor influencing the outcome (Tague 1995, 163). Within this the distributions could be fairly normal, rising or falling as above. These last two may have indicated that sites were placed to maximise or minimise the feature across the normal variation. This was often clear in the cumulative percentage graphs where the sites curve stepped up to meet the random curve (Fig 57).

There were basically four different ways that the sites curves could relate to the random curve. One curve could show a basic presence of the feature in the catchments while the other shows absence. Often both curves had high zero values so it was a question of which curve was more present than the other (Fig 58). The sites curve could have a similar shape to the random curve but be in a different position (Fig 59). This indicated a general preference for or avoidance of the feature being measured. The sites curve could be in the same position as the random curve but have higher or lower frequency values (Figs 60 and 61). This indicated preference or avoidance, which was constrained by the distribution of the feature. In Figure 62 the polygon of the soil was affecting both the sites and the random curve, but since the sites were preferentially located near it, their frequency values were higher.

Figure 55: a frequency curve with a central tendency

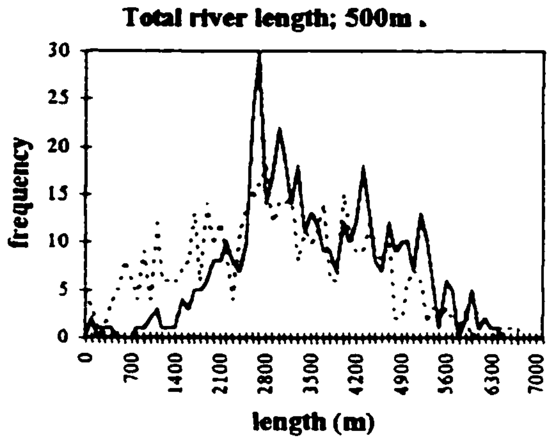


Figure 56: a frequency curve falling steadily

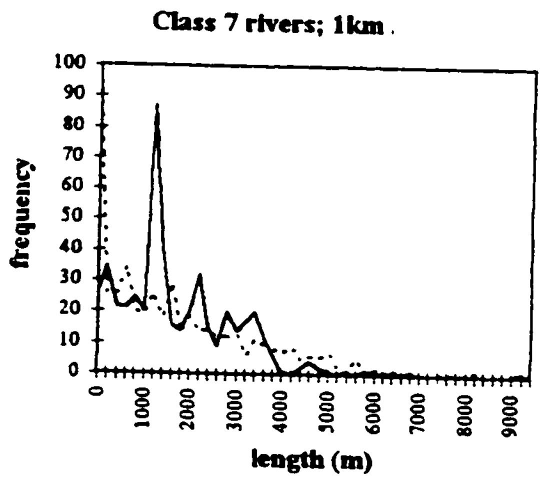


Figure 57: A cumulative curve showing maximisation

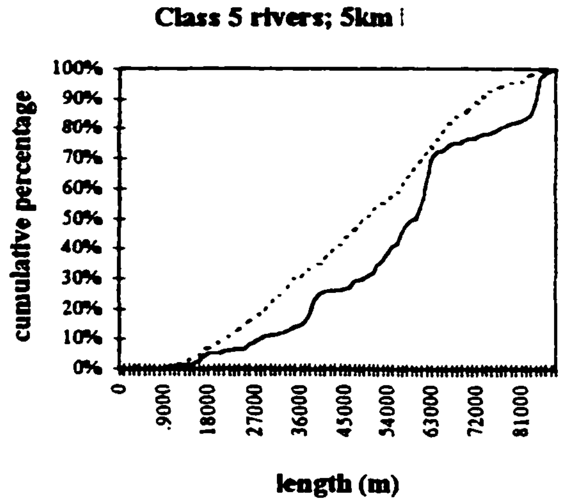


Figure 58: frequency of a rare variable – presence absence

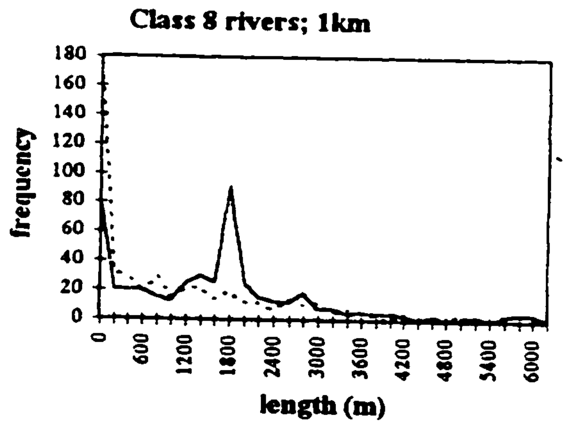


Figure 59: frequency curves with same shape but different values

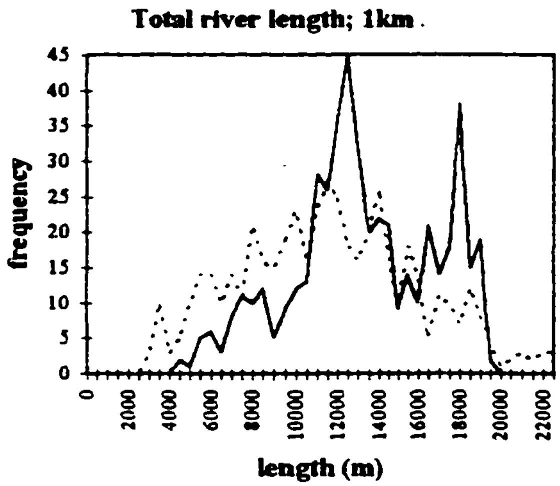


Figure 60: frequency curves with same shape but sites more common

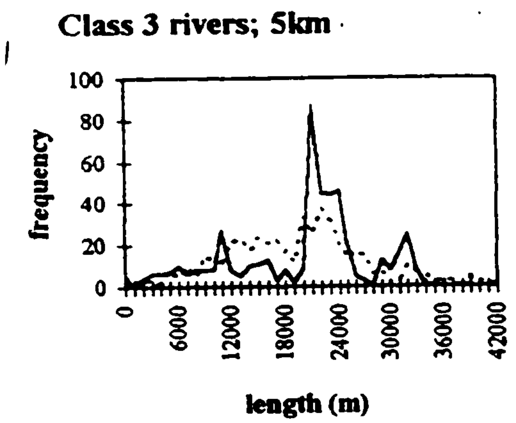


Figure 61: frequency curves with same shapes but sites less common

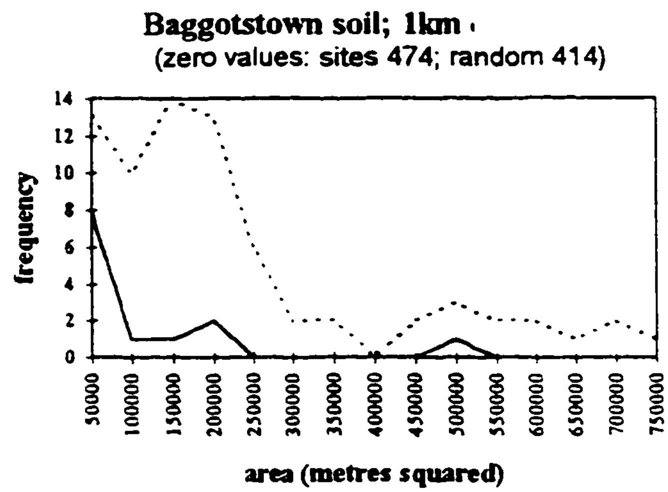
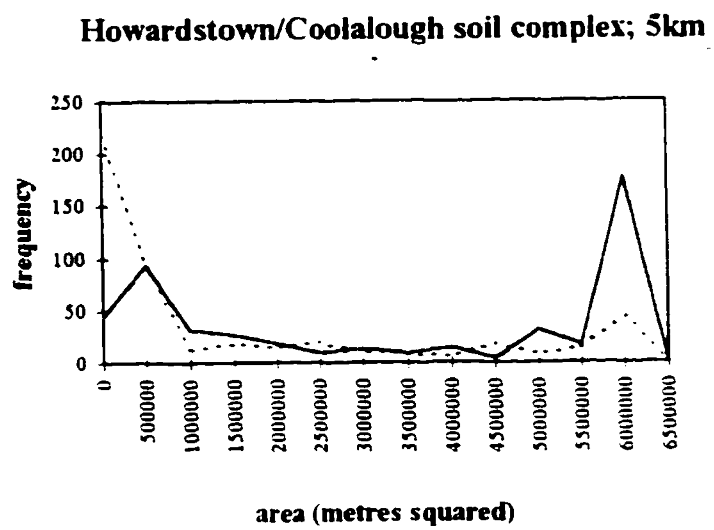


Figure 62: preferred rare soil in single polygon



The last basic pattern had a fairly simple random curve and a sites curve with several separate peaks. This indicated either several different processes effecting location (see below), or a maximisation of a certain features within different zones.

Comparison and Interpretation

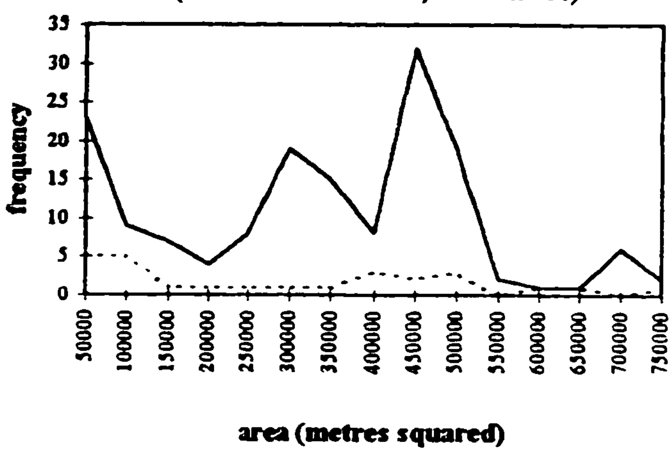
Whether or not a feature was important in a siting decision or associated with another feature involved in the decision could not be determined by statistics. Considering all significant variables, the known relationships between terrain variables and the postulated cultural relationships from other studies allowed me to distinguish between importance and significance. Essentially this was a process of archaeological argument.

Many of the graphs followed similar patterns and grouping them was helpful in identifying trends. For example there was a regular pattern for a rare soil type preferred in site location (Figure 63). Many soils occupied less $1km^2$ in the entire study area. There was, however, more than one pattern for rare soils. The effect of rare soil on the distribution of sites varied depending on how localised or dispersed that soil was. Peat for instance, occupied less than $1km^2$ of the study area and yet was found in three different locations. On the other hand, all of the $5km^2$ occupied by the Griston/Elton complex was in one place. I described the random curves in order to demonstrate this unevenness.

Figure 63: preferred rare soil

Howardstown/Elton soil complex; 1km

(zero values: sites 331; random 461)



3) The modified technique is a good controlled method for examining scale changes. Some of the results regarding scale changes could not have been predicted from earlier work. The rigorous consideration of scale led to new understanding as will be seen in the next chapter.

4) This technique can be considered as a first step for quantifying multivariate site patterns in a descriptive rather than predictive manner.

Summary

I have used quantitative methodology in order to formalise my discussion of the four dynamics landscape proposed as a framework in Chapter 1. The analytical techniques used fall into two categories; purely spatial analyses based on point process analysis; and site catchment analysis where standardised data about defined zone of the terrain are subjected to formal statistical analysis. The point process analyses were useful for considering clustering and structuring within the distribution. Site Catchment Analysis was useful for increasing the complexity of the analysis. The next chapter will consider the results of these analyses.

Chapter 4: Analysis

Introduction

There are four main analytical techniques, each of which addresses the four dynamics in different ways. In this chapter I consider the results of each analysis in some detail, focussing on the specific results of each technique. The statistical and methodological bases of the analyses are considered in the previous chapter. Here the behavioural importance of the results is discussed in relation to the four dynamics.

Kernel Smoothing

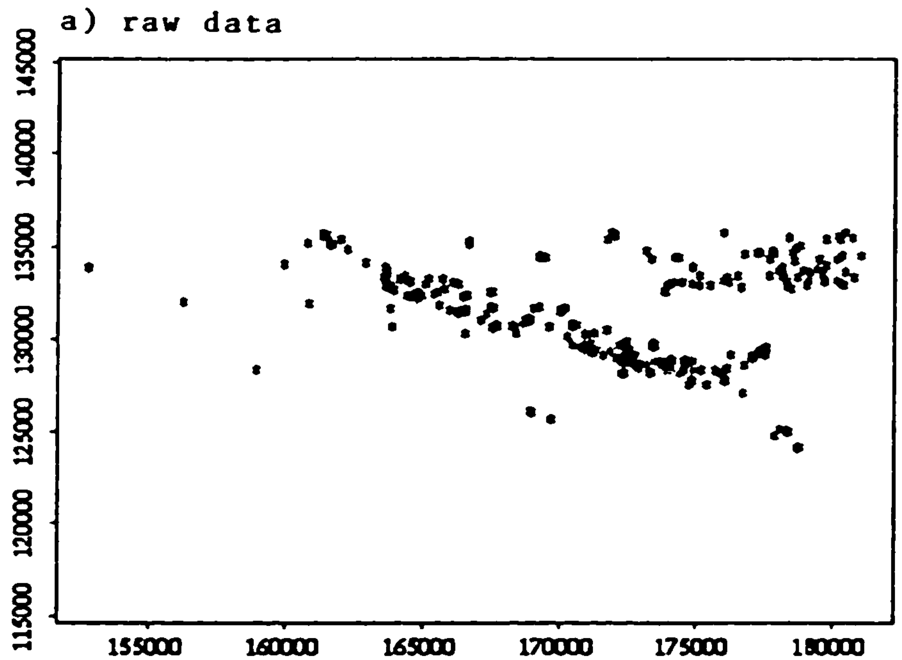
This is the most visual of the quantitative analyses. The original purpose was to view the distribution of sites without losing information on points so close together that they cannot be seen as separate points. Further extension of the method allowed me to consider more fully two of the dynamics discussed in Chapter 1.

SCALE

There is a maximisation algorithm in the software for this technique, which determines the kernel size at which the least information is lost (Diggle and Rowlingson, 1993). Using this maximisation, however, does not produce the most detailed smoothing and this questions the validity of determining a single scale at which the data is best viewed (figures 64, 65, 66). The pattern changes at different boundaries and with different choices of kernel size. Varying the scale at which smoothing was carried out made it possible to interrogate scale issues directly.

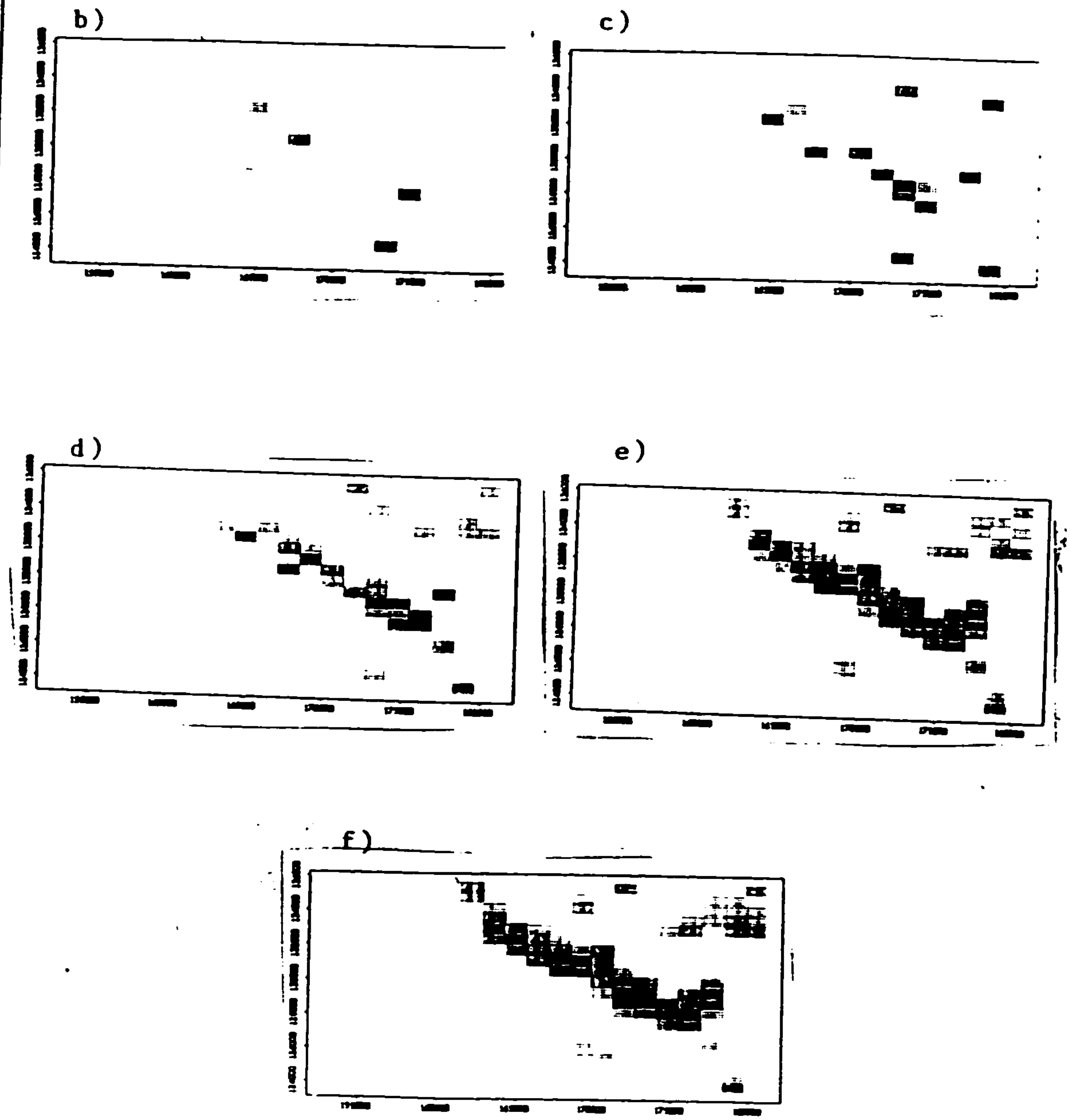
The first noticeable effect of changing kernel size is a broadening, even a blurring of the pattern. The smallest kernel sizes pick out only a few points, while the 5km kernels mask all distinctions within the distribution. This is, no doubt, the effect that the maximisation algorithm seeks to minimise. Nonetheless, it is important to consider the effects of the one part of the distribution on the rest of it. It is

Figure 64: Kernel Smoothing – all prehistoric sites (raw data)



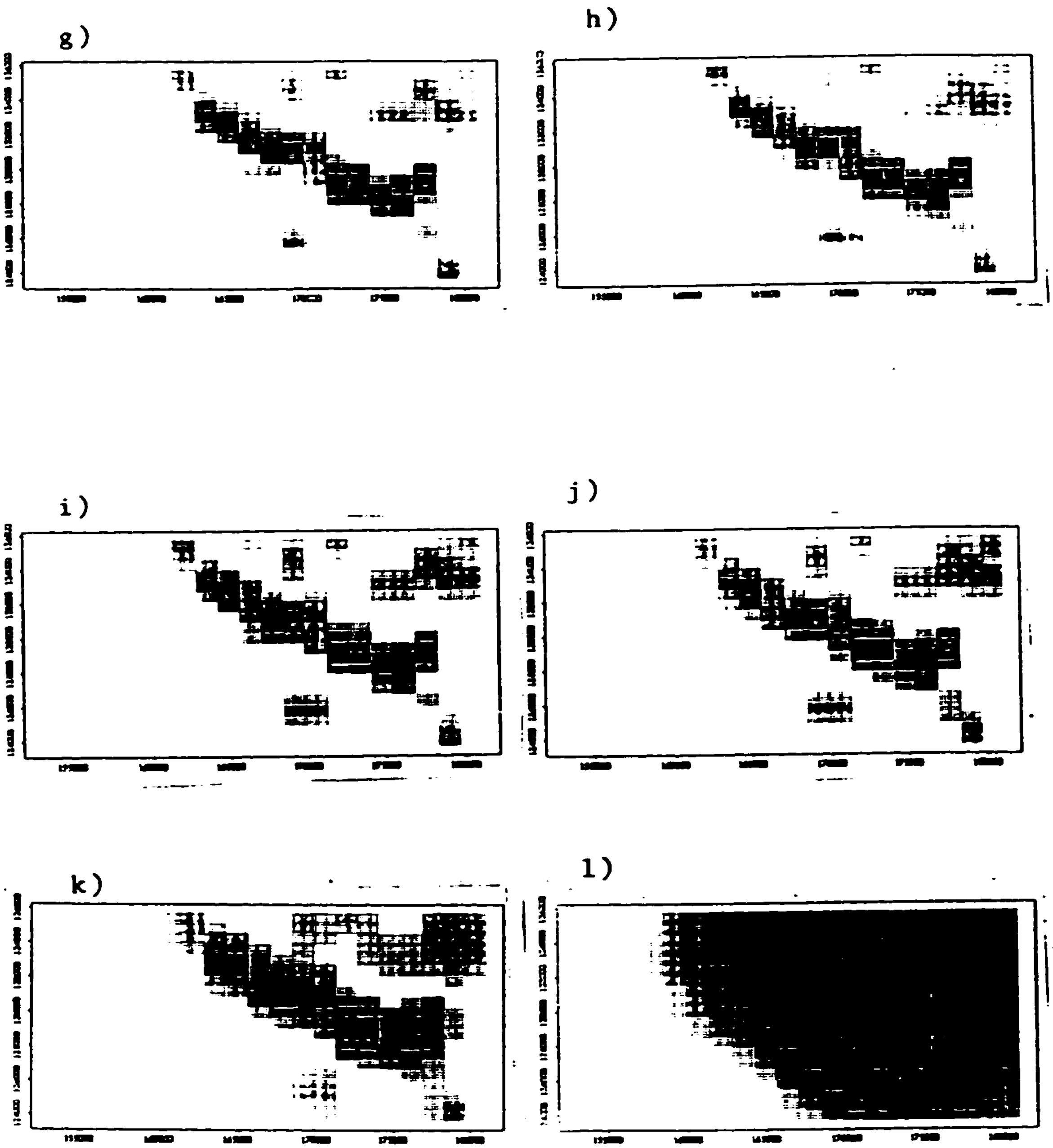
The axis markings are national grid co-ordinates.
Asterisks mark the location of sites.

Figure 64: Kernel Smoothing – all prehistoric sites (continued)



The axis markings are national grid co-ordinates.
Darker rectangles mark areas of higher intensity than lighter or white rectangles.

Figure 64: Kernel Smoothing – all prehistoric sites (continued)



The axis markings are national grid co-ordinates.
Darker rectangles mark areas of higher intensity than lighter or white rectangles.

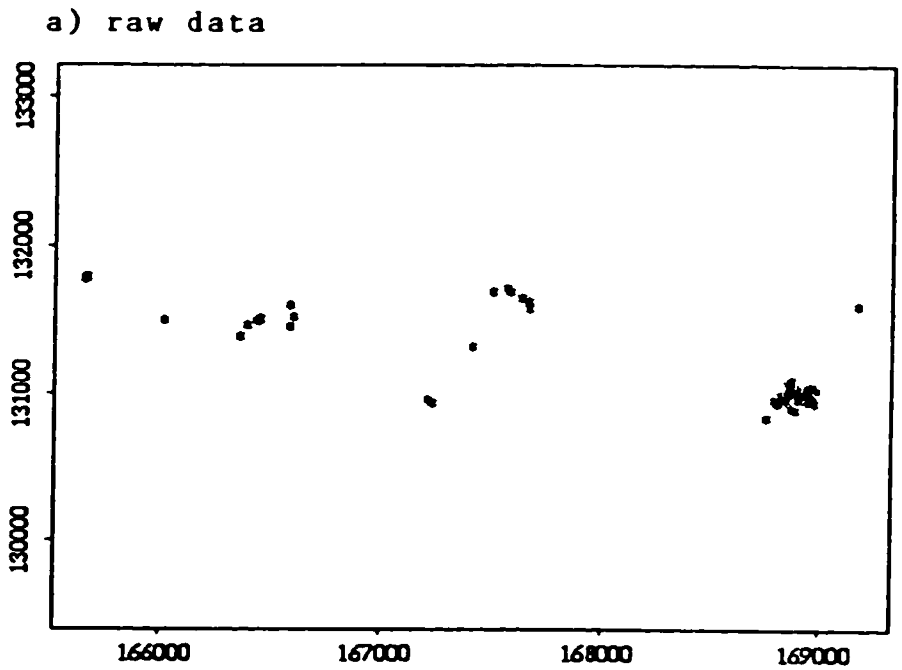
clear in figure 64 k) that the Mitchelstowndown concentration has an impact on the whole distribution (the numbers on the borders of these figures are National Grid Co-ordinates). Further, the fact that the distribution has a unity at this level and that it gets increasingly dense towards its centre is significant as well. Looking at the figures for the Elton and Mitchelstowndown areas (Figures 65 and 66) it is obvious that this is not always the case.

The next noticeable effect is that the areas of high density shift in location as the kernel size is varied. Looking at the whole distribution, the dominance of Mitchelstowndown at 5 km is not obvious from smaller kernel sizes (Figure 64). The highest intensity moves from this position (a), to Tankardstown North and Gormanstown (b), which is then surpassed by Duntryleague (c). At this kernel size Mitchelstowndown seems particularly sparse. Elton then joins Duntryleague in the highest group, while Tankardstown North maintains a middle density (d, e and f). Meanwhile Mitchelstowndown is again becoming more noticeable. At a kernel size of 800 m Mitchelstowndown, Elton and Duntryleague are equally dense (g). Then the last two move toward the medium value of Tankardstown North and the size of the Mitchelstowndown core grows (h, i and j). At 5km the distribution has a unified focus on the core (k).

This shifting emphasis stems from the different spacing *within* concentrations as well as their position in the overall distributions. There is no suggestion that the most dense concentrations at any scale are the most important but it does underline the kinds of changes that scale makes both in perception and analysis. In behavioural terms the shifting points of density suggest that effective scales in operation varied slightly between concentrations. There is some independence within the image of the unified whole at 5km.

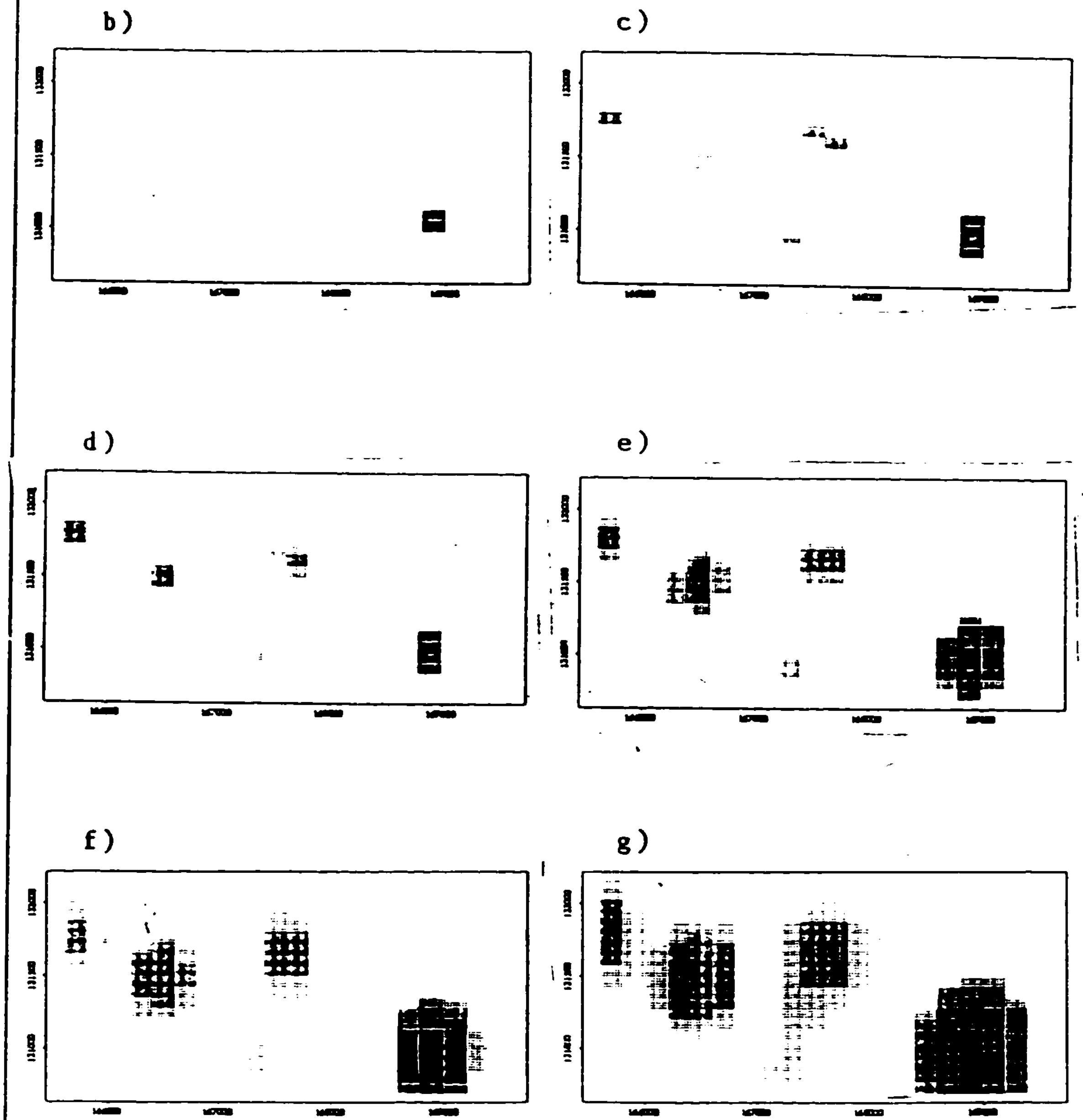
The two concentrations examined more closely have similar changes as kernel size is varied (Figures 65,66). In both cases, increase in kernel size serves to highlight the discontinuities within the concentration. I chose both the areas by bounding the zone of high density on an image of the full study area. Given this, the shared pattern of a dense core with a slightly separate scatter nearby is interesting.

Figure 65 – Kernel smoothing – Elton cemetery (raw data)



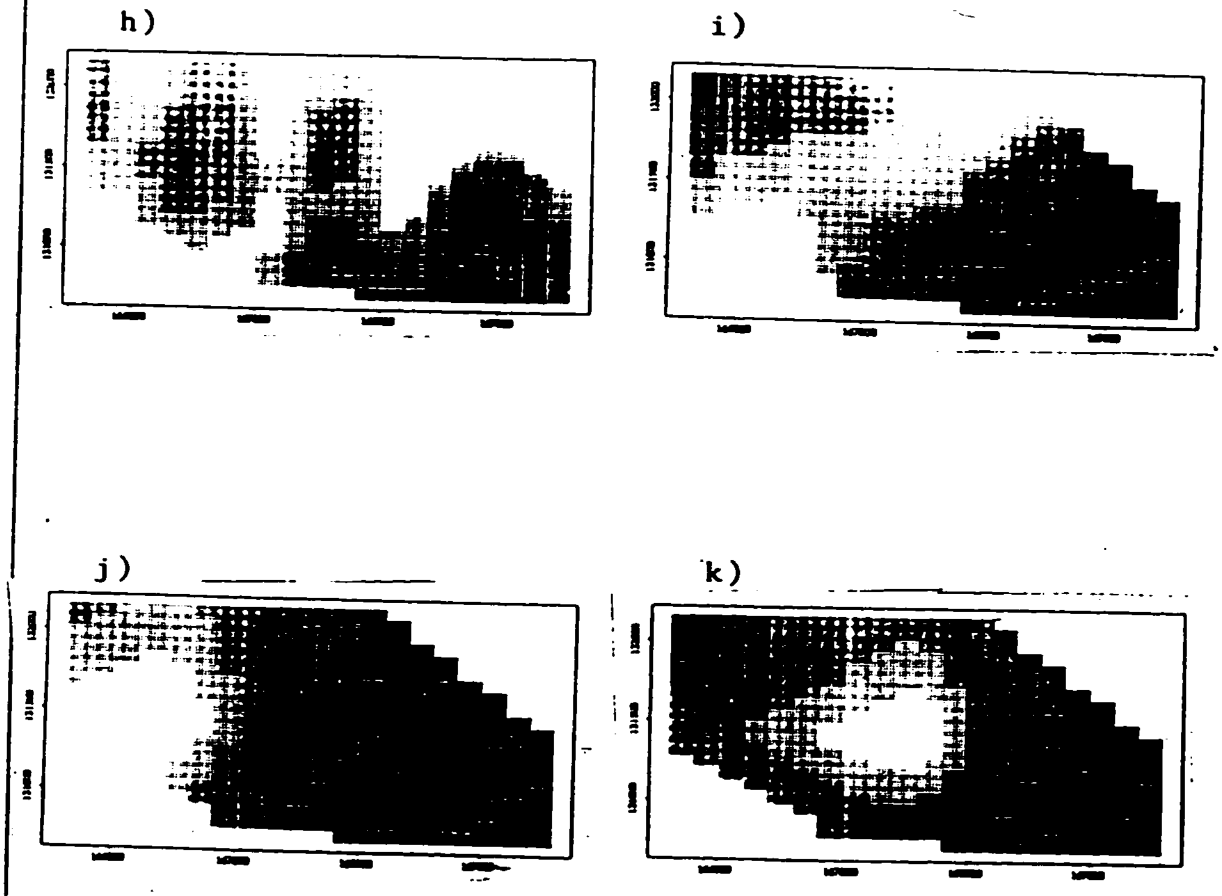
**The axis markings are national grid co-ordinates.
Asterisks mark the location of sites.**

Figure 65 – Kernel smoothing – Elton cemetery (continued)



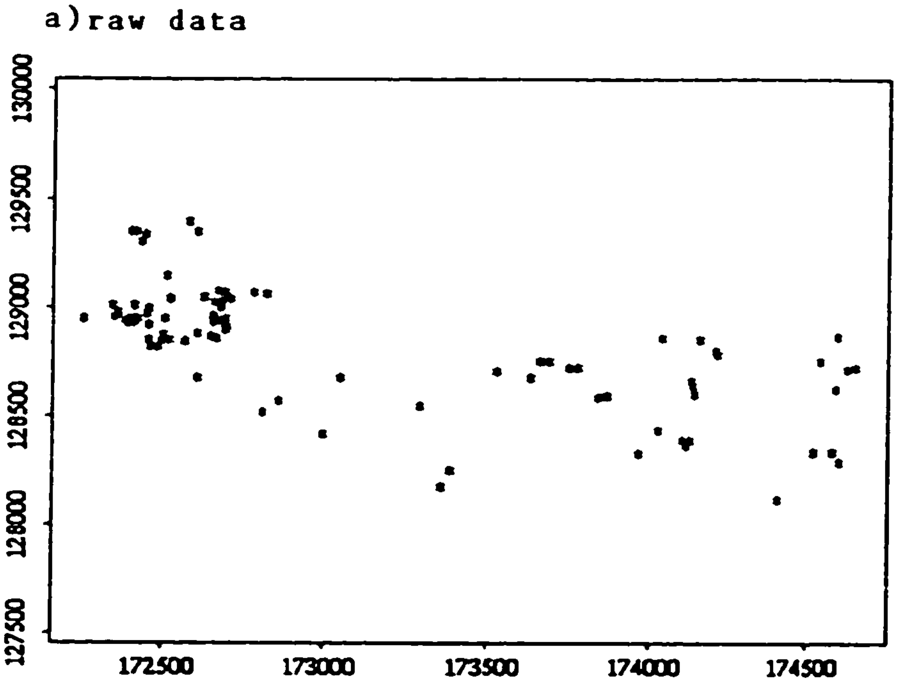
The axis markings are national grid co-ordinates.
Darker rectangles mark areas of higher intensity than lighter or white rectangles.

Figure 65 – Kernel smoothing – Elton cemetery (continued)



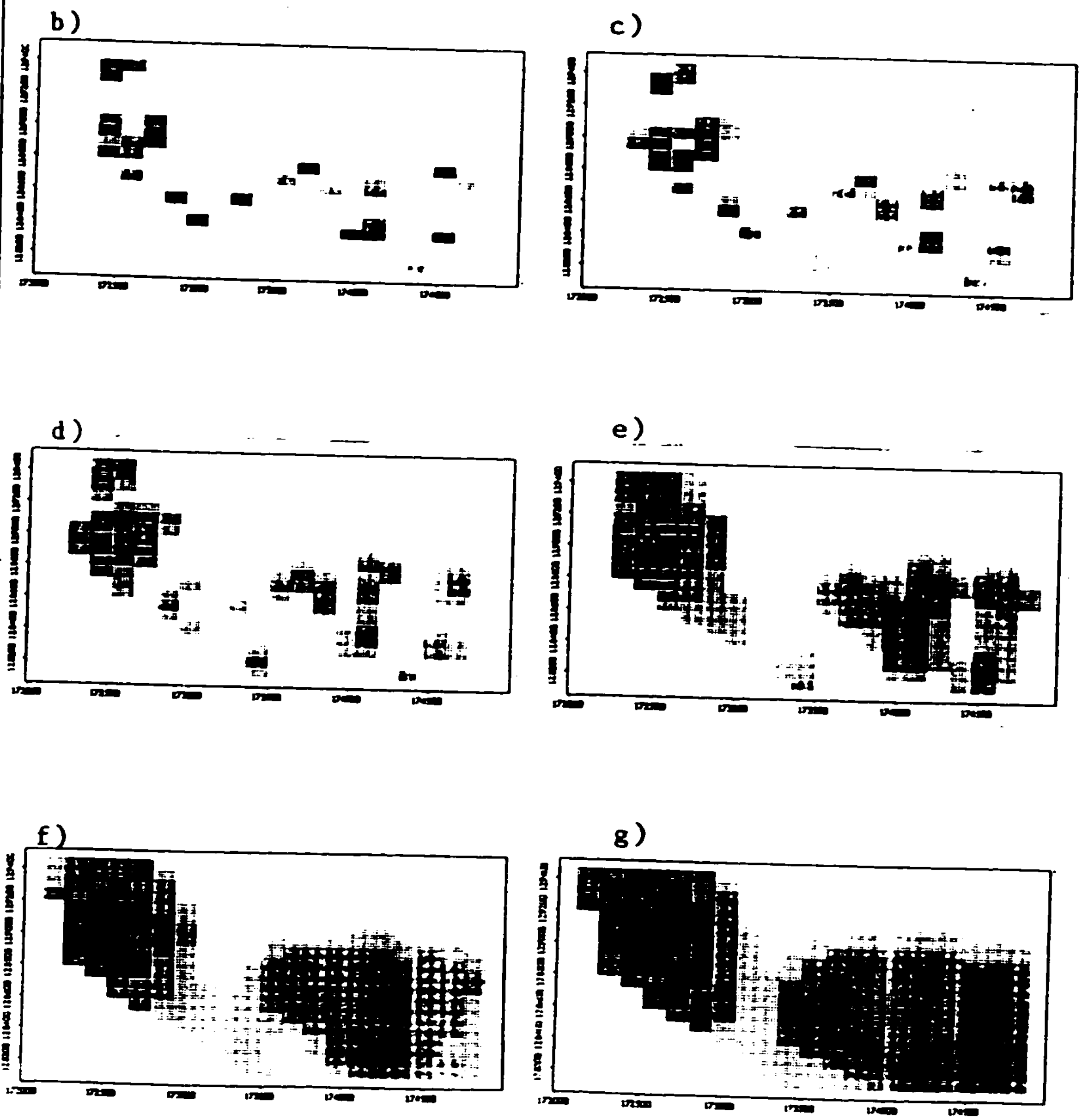
The axis markings are national grid co-ordinates.
Darker rectangles mark areas of higher intensity than lighter or white rectangles.

Figure 66 – Kernel smoothing – Mitchelstowndown cemetery (raw data)



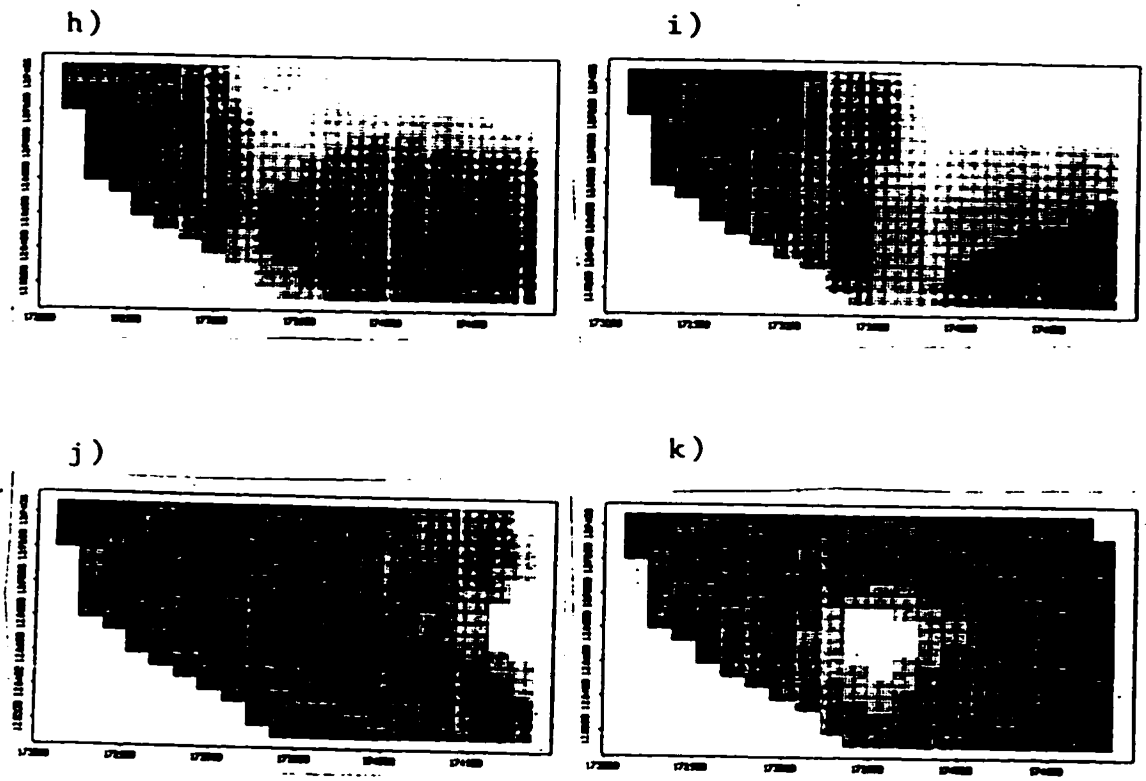
The axis markings are national grid co-ordinates.
Asterisks mark the location of sites.

Figure 66 – Kernel smoothing – Mitchelstowndown cemetery (continued)



The axis markings are national grid co-ordinates.
Darker rectangles mark areas of higher intensity than lighter or white rectangles.

Figure 66 – Kernel smoothing – Mitchelstowndown cemetery (continued)



The axis markings are national grid co-ordinates.
Darker rectangles mark areas of higher intensity than lighter or white rectangles.

The scatter is a factor in the density of the core, but these two elements do not form a single pattern the way the entire distribution does.

INTEGRATION

Without this 'smoothing' the distribution looks fairly consistent from Duntryleague to Gormanstown (Figure 64 a)). The technique highlights the intensity of the concentrations better than a point map. This is clearest at a kernel size between 900 m and 1500 m when all the major concentrations show. While the distribution shows no major gaps at this scale it is not completely integrated. This is important for the recognition of any sort of grouping and also indicates that the whole distribution is not a single pattern. There are consistent concentrations that can be distinguished from the overall distribution at Tankardstown North, Elton, Mitchelstowndown and Duntryleague Hill. While the sites at Cush and those in Tipperary are less densely spaced, they too stand out as separate clusters.

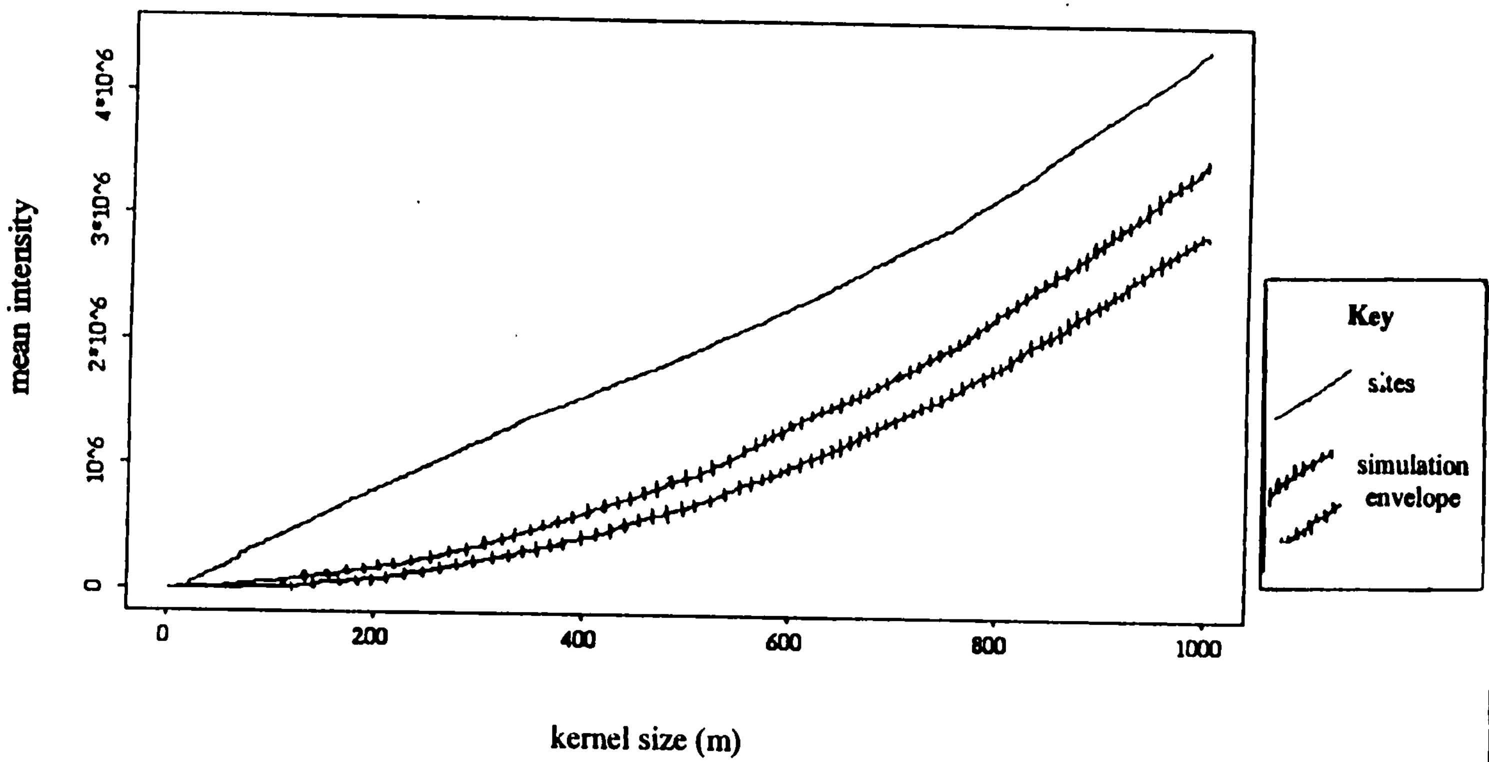
It is remarkable how evenly spaced and evenly sized these concentrations are. While each group has a different number of sites and a different internal arrangement, the spacing between groups and the overall density is strikingly regular. The zones of lower density between these groups are about 2km across in each case, which could indicate small communities with some buffer zones between them. The regularity of these discontinuities shows the importance of social relations in the placement of these sites. While the site catchment analysis has shown the importance of terrain features in the distribution, this analysis indicates that territorialism and community spacing also play a role.

K- Functions

The results of this analysis were satisfyingly straightforward. The distinction between the simulation envelope and the sites curve indicates clear and dramatic clustering at all scales up to 1km (Figure 67). There is a slight movement towards convergence in the upper reaches of the graph. It was not possible to extend the scale further because of the shape of the study area for this analysis (see chapter 3). These results indicate that the rest of the analyses have a non-random problem to explain.

Figure 67: Kernel estimation

Sites and simulation envelope
mean intensity vs. kernel size (m)



SCALE

The clustering was to be expected both from visual inspection and from the kernel smoothing. The consistency across scale, however, is unusual for this sort of analysis. It is more common to see clustering happening at a certain scale with patterns closer to random above and below it (Gattrell 1983). These curves indicate that many different effective scales are operative. The continuity across scale suggests that the clustering which produces the major concentrations is also at work in smaller groupings. It is not simply that there are major concentrations dropped into a field of random distributed sites. The clustering is happening at all scales and relates to the whole distribution.

INTEGRATION

This similarity of point process ties together the main concentrations that are shown in the kernel smoothing. A group of six sites in the middle of Mitchelstowndown could well have the same arrangement as a similar group with no other sites in the vicinity. This contrasts with the focus on discontinuity in the previous analysis. Certainly there are discontinuities but the activities in the main concentrations are different in intensity rather than in basic structure. The main concentrations represent construction happening more often than in the smaller scatters but there is no greater sense of organisation, control or bounding.

Raised incidence modelling

The complex processes implied by the first two analyses were not well modelled by the raised incidence model that was attempted here. The results of fitting the model were highly significant but were unstable. Changes in the initial parameters led to completely different results. This was surprising. Since this is a maximum likelihood model it should resolve to the same maxima regardless of the starting point. The widely varying results suggest that the likelihood surface is convoluted, which points to a more complex data structure. At one level this is hardly surprising given the results of the previous two analyses. While there may well be raised incidence of ring ditches around domestic sites, the model does not account for all the non random behaviour in the distribution.

There are three possible explanations for these results. First, it is likely that the clustering is caused by a breach of independence assumption, the existence of one site increases the chance of another close by. This fits well with the accretionary model pointed to by the Kernel estimation. Second, the model may not be picking up the main sources of heterogeneity. This is also quite likely since the site catchment analysis (see below) indicates that several terrain factors play a role in the distribution. While the model can take covariates, the spatial dependency of terrain covariates makes it difficult to consider them without circularity (see chapter 3). Third both of these factors could be exerting different influences on the distribution, creating a considerably more complex pattern than can be modelled with simple raised incidence. The consideration of these possible explanations shows the value of the modelling despite the poor fit between model and data.

Site Catchment Analysis

The data from the site catchments could be analysed in several different ways. The analysis I have done is centred on the four dynamics, scale, terrain sensitivity, integration and tempo. I am more interested in difference and similarities than in absolute values. Some terrain features take up very little space in any given catchment but were an important part of siting choices.

SCALE

Differences between results at the three scales of collection are the basis for my discussion of scale. While the three units were chosen in order to examine potential effective scales, the two concepts are not congruent. The number of significant differences between the results for the site locations and the random locations will rely to a certain extent on how closely these units approximate effective scales. Is there a scale at which there is the largest number of significant patterns? The initial data was collected at one scale and analysed at three. How does scale of analysis interact with scale of data collection? Different effective scales have different uses. What patterns stay the same and what patterns change as scales shift?

The highest number of significant differences is at the 5km scale, no feature is significant at a lower scale that it is not significant at a higher scale (Table 1). Given the results of the spatial statistics

Table 1. Kolmogorov-Smirnov differences between sites distribution and random distribution; level of significance 0.005

a) Soil series

	5km	1km	500m
Peat	0	0	0
Baggotstown	+	-	0
Ballylanders	+	0	0
Ballyvohereen	+	0	0
Ballynalacken	+	0	0
Ballybrood	-	0	0
Doonglara	+	0	0
Doonglara/Knockaceol	0	0	0
Elton	+	-	-
Elton/Coolalough	+	0	0
Elton/Howardstown	0	0	0
Rathcannon	0	0	0
Camoge	-	-	0
Coolalough	+	+	0
Coolalough/Peat	+	0	0
Drombanny	0	0	0
Gortaclareen	0	0	0
Griston	+	0	0
Griston/Elton	+	+	0
Howardstown	-	-	0
Howardstown/Peat	+	0	0
Howardstown/Elton	+	+	+
Howardstown/Coolalough	+	+	+
Lyre	-	0	0
Puckane	+	0	0
Puckane/Gortaclareen	0	0	0
Knockaceol	0	0	0
Knockastanna	0	0	0
Seefin/Peat	+	0	0
Aherlow	0	0	0
Rinneanna	+	0	0
Slievereagh	+	0	0
Unknown	+	0	0

b) River classes

	5km	1km	500m
2	-	0	0
3	+	+	+
4	+	+	0
5	+	+	0
6	+	+	0
7	+	+	0
8	+	+	+
9	+	+	+
10	+	+	+
11	+	0	0
12	+	0	0
13	+	0	0
14	0	0	0
15	+	0	0
16	0	0	0
total	+	+	+

c) contour heights

	5km	1km	500m
100'-200'	-	0	0
200'-300'	-	-	+
300'-400'	+	+	+
400'-500'	+	+	0
500'-600'	+	0	0
600'-700'	+	0	0
700'-800'	+	0	0
800'-900'	+	0	0
900'-1000'	+	0	0
1000'+	+	0	0

however, it is clear that 5km is not the only effective scale. There are three reasons for the increased statistical significance at this scale: data collection; the nature of the data; and the nature of siting.

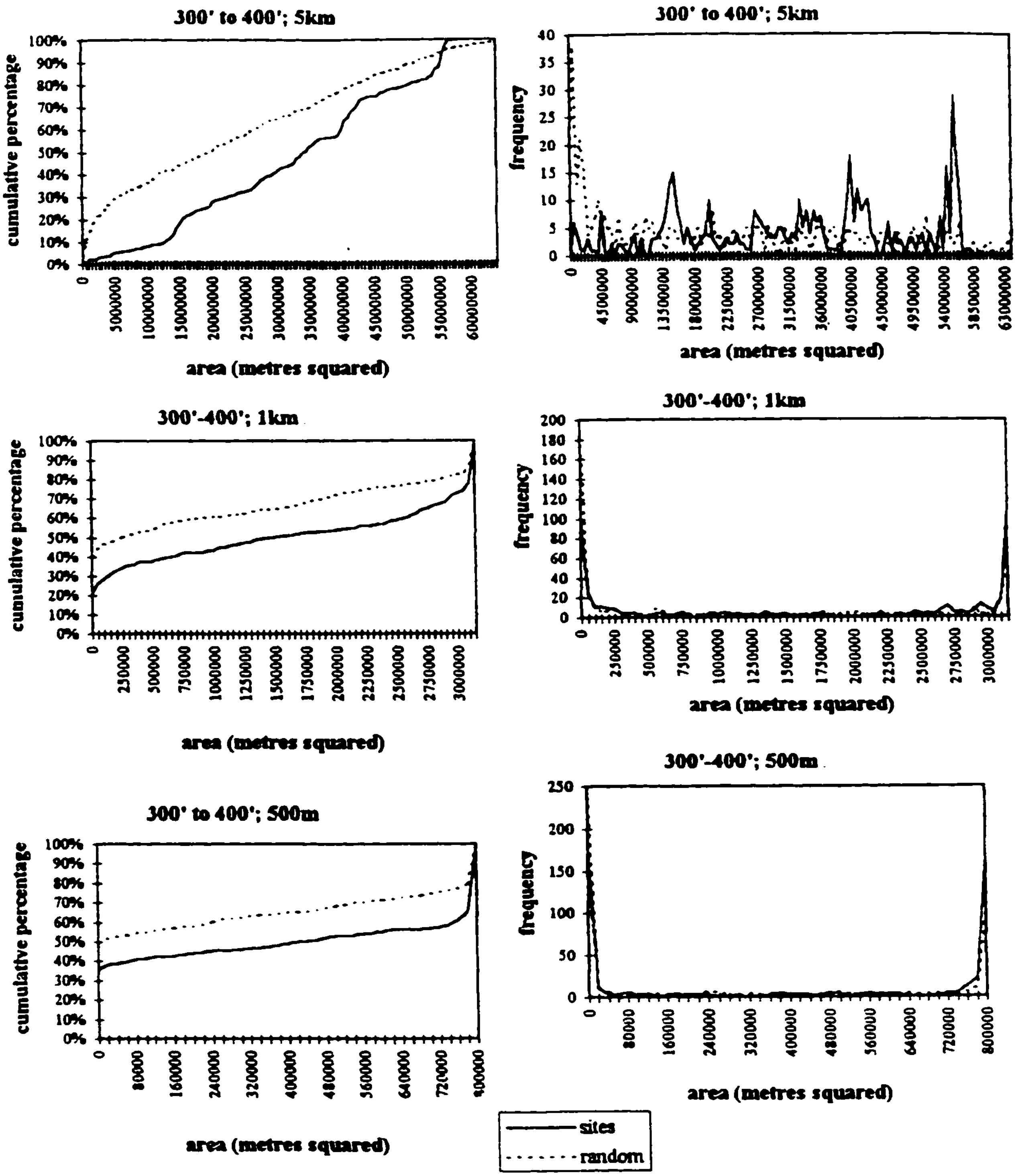
Analysis of topography, as measured by contours, is the worst affected by the data collection problems (Table 1c)). Although original measurements were taken in some detail, the published maps represent this by contour lines at 100' intervals. This creates polygons that are too large to be analysed usefully below the 5km scale (Figure 68). Either a catchment is completely within a height range or it is completely outside of it. So the frequency graphs for the 1km scale and the 500m scale are not useful. The wide spacing of the contours not only makes the polygons too large for this scale, it also gives only a very general impression of the topography of the area. There are whole hills and valleys missing and no data at all above 1000'.

The same problem of data being grouped into large polygons has some effect in the analysis of soils, particularly at the 500m scale (Table 1a)). Because the catchment is smaller than most soil polygons there is less mixture and more zero values in general. The significance of individual soil complexes at every scale indicates that some of the prominence of the 5km scale is due to data collection. Soil complexes are mapped where the intermixture of two series is too tight to draw separate polygons for each (Figures 18, and 12). The placement of sites in zones of more complex soil indicates a lower effective scale that is also operative.

The rivers are the terrain features least effected by the scale of data collection since there was no grouping together of measurements in the original mapping. Rivers are continuous and recorded as such. The only scale issue is measurement for site catchment analysis, which is fine enough to pick up most variation. The variation in significant differences across scales (Table 1b)) is a fair representation of the patterning at different scales. Only the most rare and localised tributary classes are not significant at the 1km scale and the patterns at the 500m scale relate to specific terrain issues discussed below.

The sites are not affected by the grouping together of different values, since they are recorded as points. The use of correlation to discuss their associations, however, biases the analysis towards the

Figure 68: Site catchment results: 300' – 400' contours



higher scales where there is more variation and more possible correlations (Tables 2 a) b) c)). There are very few site types which are not correlated one way or another at the 5km scale, but the lower scales have many types that are not correlated. Given the restricted statistical distributions involved (Table 3) this is not surprising.

Edge effects, which are a separate problem with data collection, are more apparent at the 5km scale than the other scales (Figure 69). Although the study area was not chosen to contain the distribution, the main concentrations are centrally placed. Since the control set is completely random, there are more points near the boundaries. The catchments for these points, and sites in similar circumstances, are truncated. This could have an effect on the results by decreasing the values for random points giving a false impression of preference, for centrally located terrain features. Most of the features significant only at the 5km scale, however, are also centrally placed. As a check on this problem, frequency graphs by percentage of catchment were compiled for the 5 km scale, the results were extremely close to the standard results.

The 5km scale is also favoured by the nature of the data. Many terrain features are rare and localised, which precludes them being within 1km or 500 m of the whole distribution, even though they may have been important. Many soil types are significant at the 5km scale but not below (Table 1a). Since the difference between the results for sites and random points for these soils at the 5 km scale is based on presence and absence (Table 4), it is difficult to know whether these soils were being chosen for at the highest scale, or whether they were associated with other favourable features. This will be discussed more under terrain sensitivity, below.

Even taking these factors into account, the prominence of the 5km scale and the small number of terrain features which are statistically significant at the 500m scale can give useful insight into siting decisions. This pattern suggests that local siting was influenced by variables not measured, such as slope, micro-topography and variables unmeasurable by archaeology like mythology and contingency. To a certain extent this points to the social end of the dynamic describing sensitivity to the terrain.

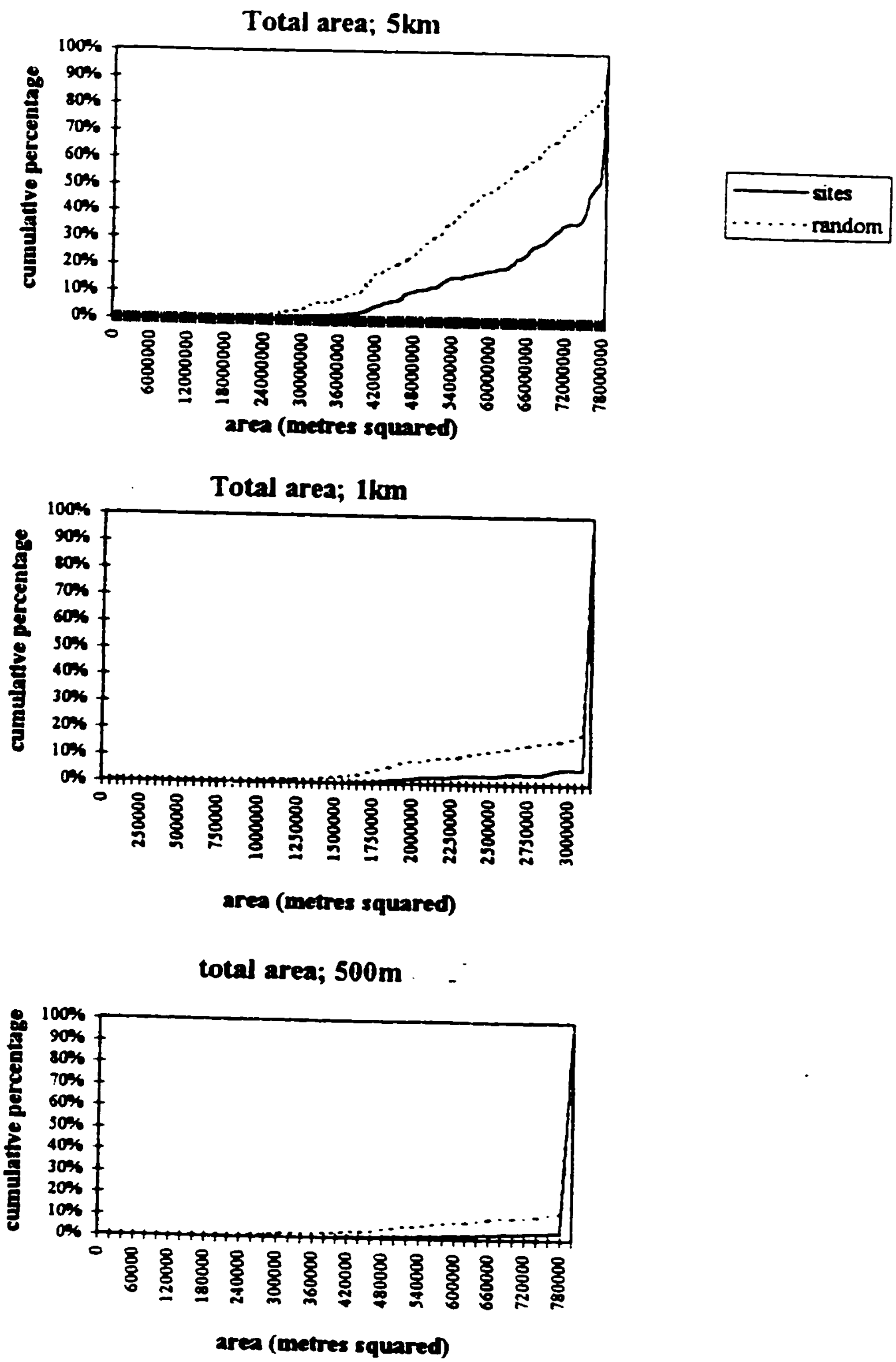
Table 3: Frequency of other site types in 500m catchments of ring ditches

	0	1	2	3	4	5	6
pit	436	23	15	6	1	1	5
eba	420	60	0	5	2		
mound	471	11	0	5			
cist	484	1	0	2			
habit	416	59	12				
field	410	72	5				
rathanny	468	14	5				
tanding ston	479	3	5				
barrow	437	50					
fullacht	442	45					
cairn	487						
circle	487						
tomb	487						

Table 4: Rare Soils: presence and absence in 500m catchments

		0	*500000*
Regosols			
	sites	420	67
	random	417	70
Lithosols			
	sites	179	308
	random	329	158
Ballyvohereen			
	sites	286	201
	random	358	129
Ballynalacken			
	sites	317	170
	random	407	80
Ballybrood			
	sites	483	4
	random	421	66
Elton/Coolalough			
	sites	200	287
	random	368	119
Coolalough/Peat			
	sites	236	251
	random	356	131
Howardstown/Peat			
	sites	225	262
	random	366	121
Rinneanna			
	sites	190	297
	random	378	109
Slievereagh			
	sites	310	177
	random	396	91

Figure 69: Site catchment results: edge effects shown in total area



The existence of any positive correlations between sites at the 500 m scale backs up the sense that such local siting decisions were influenced by many factors other than the terrain.

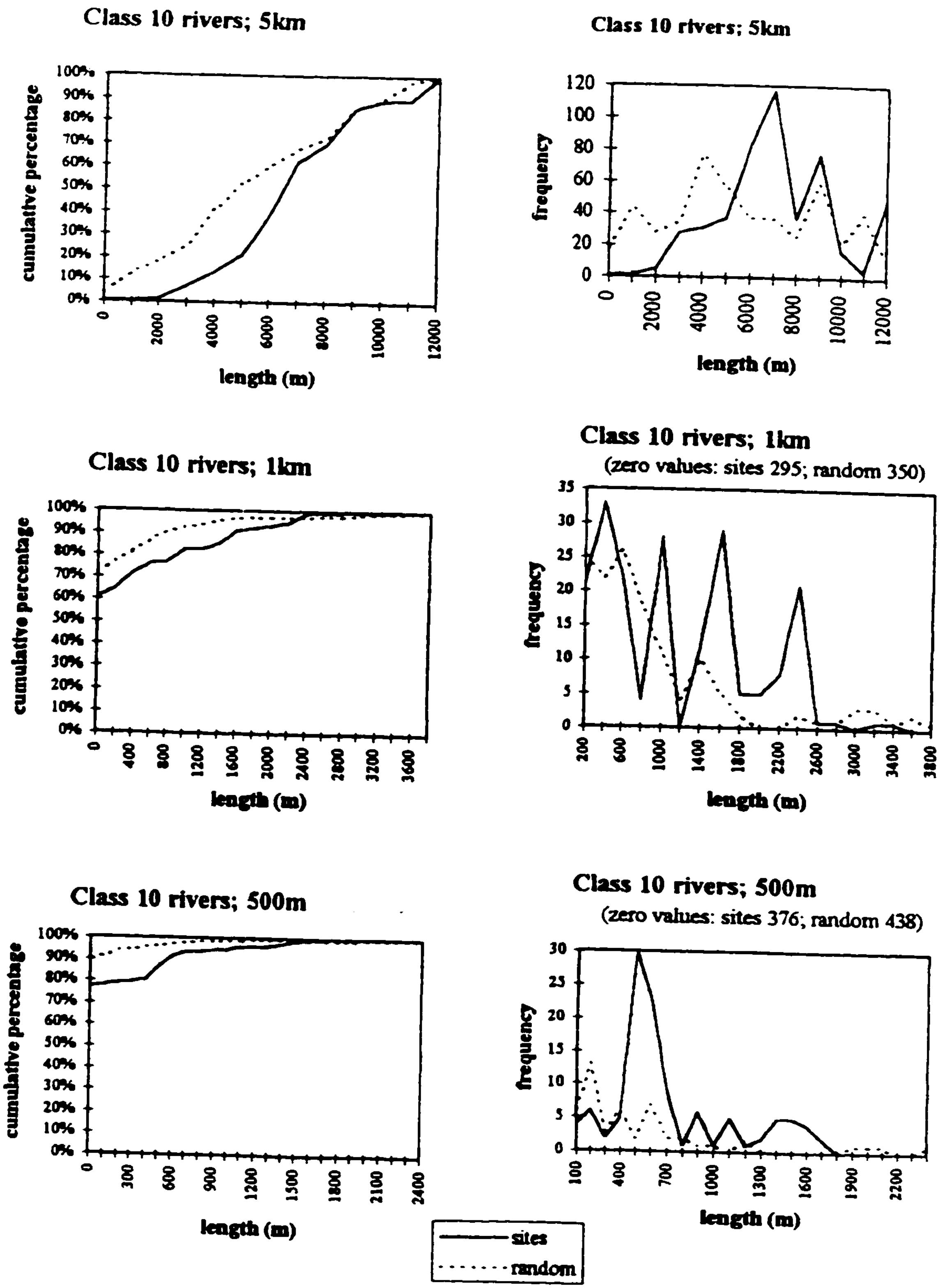
The features that are significant at all three scales are not more important than the features that are significant at only one scale. There are different considerations at different scales. Looking at the actual graphs, the relationships between the scales is more complicated than an attrition of significance. The 5km scale is obviously an important effective scale and the rare soils that turn up as significant are important in defining the nature of the zone of activity. The features important at the lower scales point to different kinds of activities, which are discussed in chapter 5.

Where a variable is significant at all three scales, the cumulative percentage graphs show less variation between scales than the frequency graphs. In most instances the sites and random curves stay fairly constant in relation to each other across the scales in the cumulative percentage graphs. In the example of Class 10 rivers, the curves come closer together, but at all three scales the separation is largely in the lower lengths (Figure 70). Looking to the frequency graphs, it is clear that the reason for the decreased distance from random is the larger number of zero values in both curves. At the 5km scale the sites curve shows essentially a single distribution with a clear mode at 7km. The random curve is much more dispersed. This pattern continues in the lower scale where it is sharp concentrated peaks which distinguish the sites curve from random, rather than the overall position. These sharp peaks represent particular concentrations of sites for which this river class is important (see below). This is the most common pattern for terrain features that are significant at three scales though the stability of the groupings is not always so clear (Table 1).

Elton soil is an interesting exception to this pattern. The most common soil in the study area, it is also the best for present agricultural practice. It is not only significant because of its ubiquity, as can be seen by comparing it to Howardstown which is nearly as common but is not significantly different from random at 500 m. The significance of Elton remains strong, but shifts in nature across the scales.

The cumulative percentage graphs show that at the 5 km scale Elton is preferred across the board; at 1km it is preferred at the upper and lower ranges, but avoided in medium values; and at 500 m it

Figure 70: Site catchment results: Class 10 rivers



is avoided across the range (Figures 71a), b), c)). This indicates that the zone of activity is heavily influenced by the distribution of Elton soil (5 km) but avoided for the specific placement of sites (500 m)

The significance of the 1km scale is less clear. The difference between the sites curve and random curve is less dramatic than at the other scales. It is in this sort of situation that the full simulation would have been particularly useful. The pattern here suggests that in areas where Elton soil is rare or dominant it is maximised, but in areas with moderate amounts it is avoided. Perhaps this indicates that in most instances a small amount of Elton soil was desirable, however, some sites were following a different locational pattern and these sites maximised the amount of Elton soil in their catchments.

This ambivalent pattern could also indicate that the overall pattern makes less sense at this scale than at the upper or the lower scale. This contrasts with the picture from the significance table (Table 1). In the transfer between preference and avoidance there must be a scale at which there is no significant difference between random and sites. These graphs suggest that that scale would be slightly above 1km.

At each scale the frequency distribution clearly breaks into several sub-distributions so that high medium and low values can be distinguished (Figures 71d), e), f)). Mapping out the spatial distribution of the three groups shows a change in their spatial distribution across the scales (Figures 72a), b), and c)). At the 5 km scale there is a target pattern. All the high values are centred on the townland of Elton, the medium values surround high and the low values surround the medium. At the 1km scale the target pattern breaks up somewhat. The low group is zero values and they are concentrated in Tipperary, which is simply a reflection of the lack of soil survey there. The high and the low groups however have a slightly different pattern than 5 km. There are sites with high values outside of the Elton 'core' in the townlands of Raheenamadra, Duntryleague and Cush. The spatial pattern is different again at the 500m scale. Not only are there sites with high value of Elton soil in all major concentrations but there are also low value sites on the edges of major concentrations. Though less clear, the 5 km scale target pattern can be seen in miniature around each concentration.

This pattern is unique to Elton soils. It illustrates the way that terrain sensitivity can change across scales. The overall distribution has high values of well-drained soil at its core and the zone of

Figure 71: Site catchment results: Elton soil

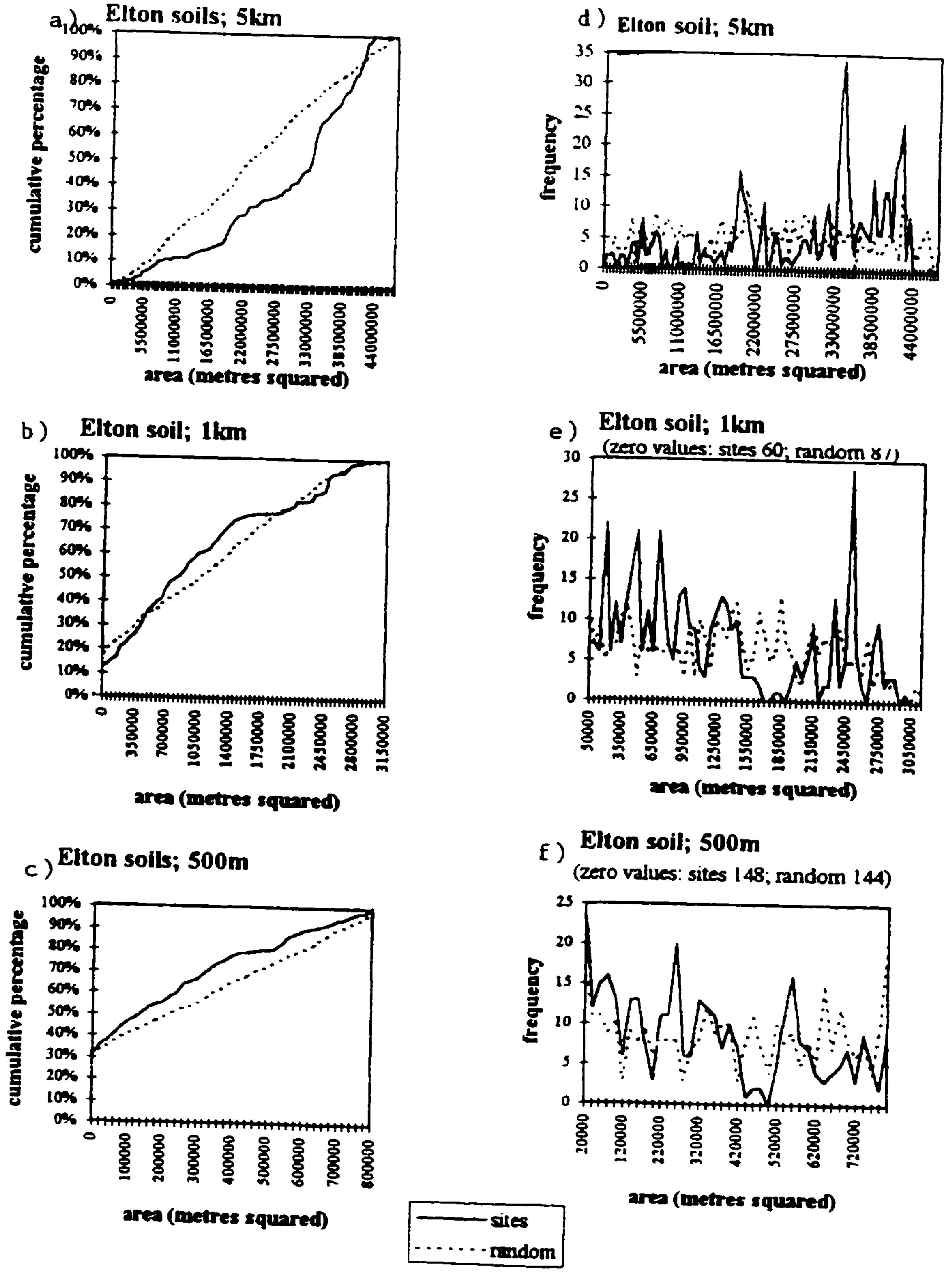
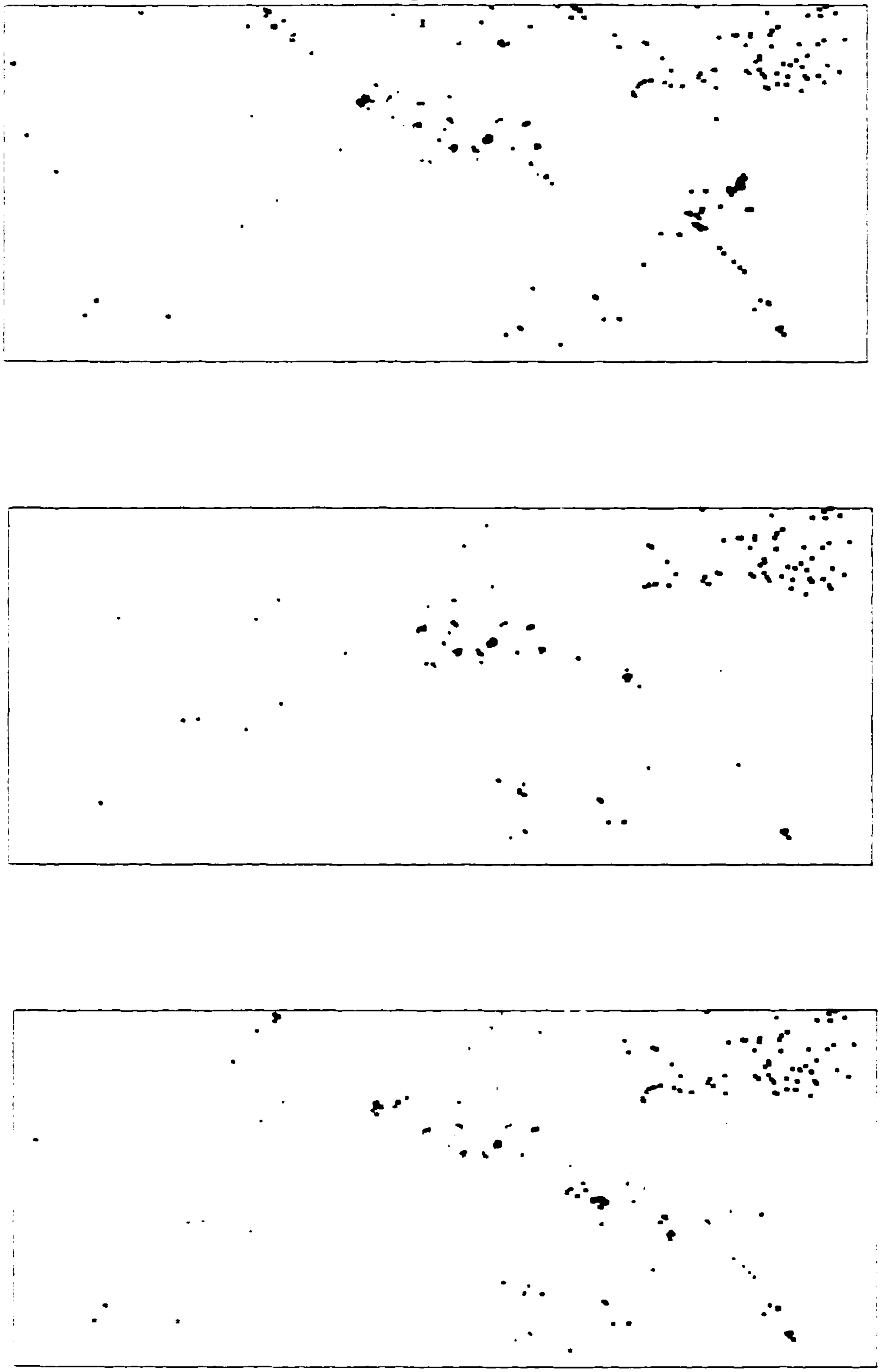


Figure 72: Elton Soil



red= high　　yellow= medium　　black = low

activity is chosen to maximise arable land. At the local scale individual concentrations also have high values of Elton soil at their core. While sites are placed to avoid good land at this scale, the peaks of activity are still marked by their arable potential.

Some features are significant at the top two scales but not at 500 m (Table 1). In all cases the cumulative percentage curves in the 1km graphs are much closer together than in the 5 km graphs so it is no surprise that they are not significant at 500 m. The landscape significance of the feature would have to change for them to move from preference to avoidance, as in the case of Elton.

There are three different ways that the sites' curve can change between different scales to become more similar to the curve for the random points. In the case of Coolalough and Camoge soils, the shape of the frequency curve remains the same but it moves to the left on the graph. As the random curves for these rare soils are heavily skewed left, this brings them closer to random (Figures 73, 74). The sites are still following a fairly unified siting pattern, but there is simply less of these soils available when looking at smaller catchments. Class 4 rivers and the height range 400' to 500' both become more dispersed, and therefore more similar to random (Figures 75, 76). Both of these features are associated with the end moraine, and I would have expected the large concentrations of sites found there to have shown up as spikes in the frequency curves. This shows that these features are less definitive of the end moraine than visual inspection would suggest. The rest of the features, which are significant only at the upper two scales all, become more concentrated. There are fewer sub-groupings and those more sharp. These peaks exert less influence in the overall distribution (Figure 76).

The correlations of the sites show some similar patterns to the terrain features (Table 2). There are correlations that remain consistent at all three scales; habitations and *Fulachta Fiadh* are always positively correlated. There are correlations that fade out; mounds and ring ditches are positively correlated at 5 km and 1km but not at 500 m. There are correlations that follow the Elton soil pattern: positive correlation, no correlation, negative correlation. Fields, pits and standing stones all follow this pattern with ring ditches. This will be important for considering integration (see below). There are

Figure 73: Site catchment results: Coolalough soil

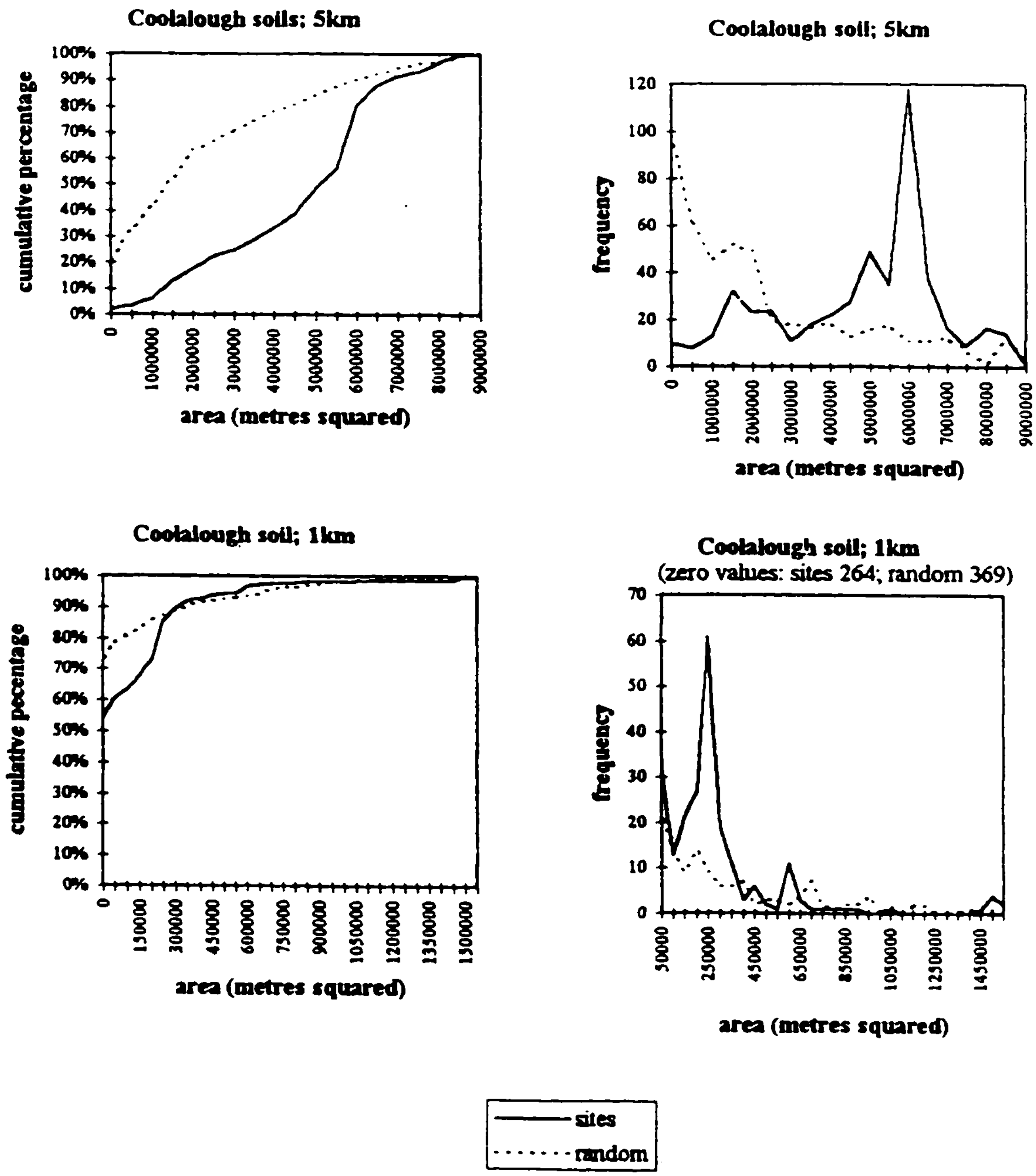


Figure 74: Site catchment results: Camoge soil

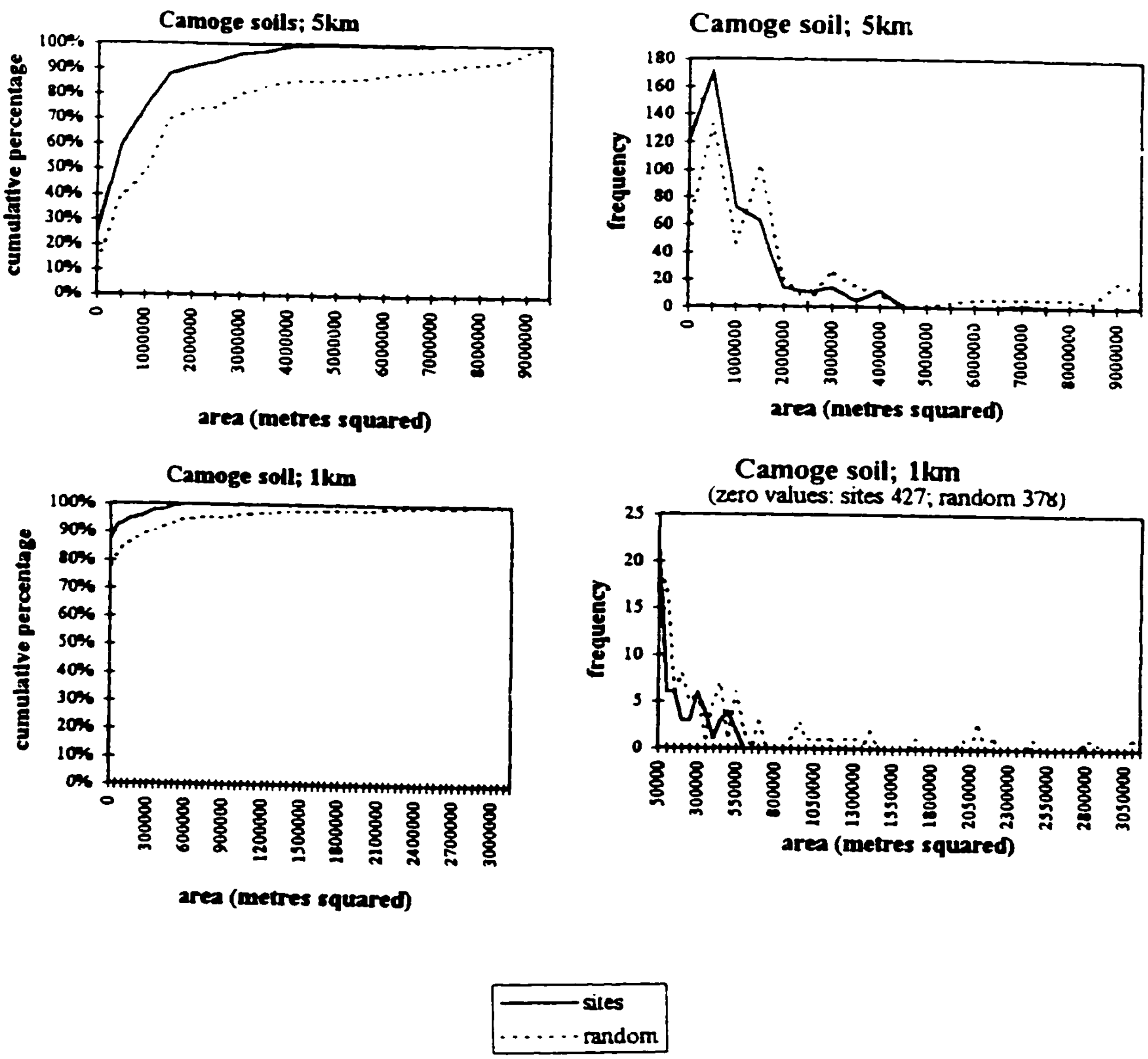


Figure 75: Site catchment results: Class 4 rivers

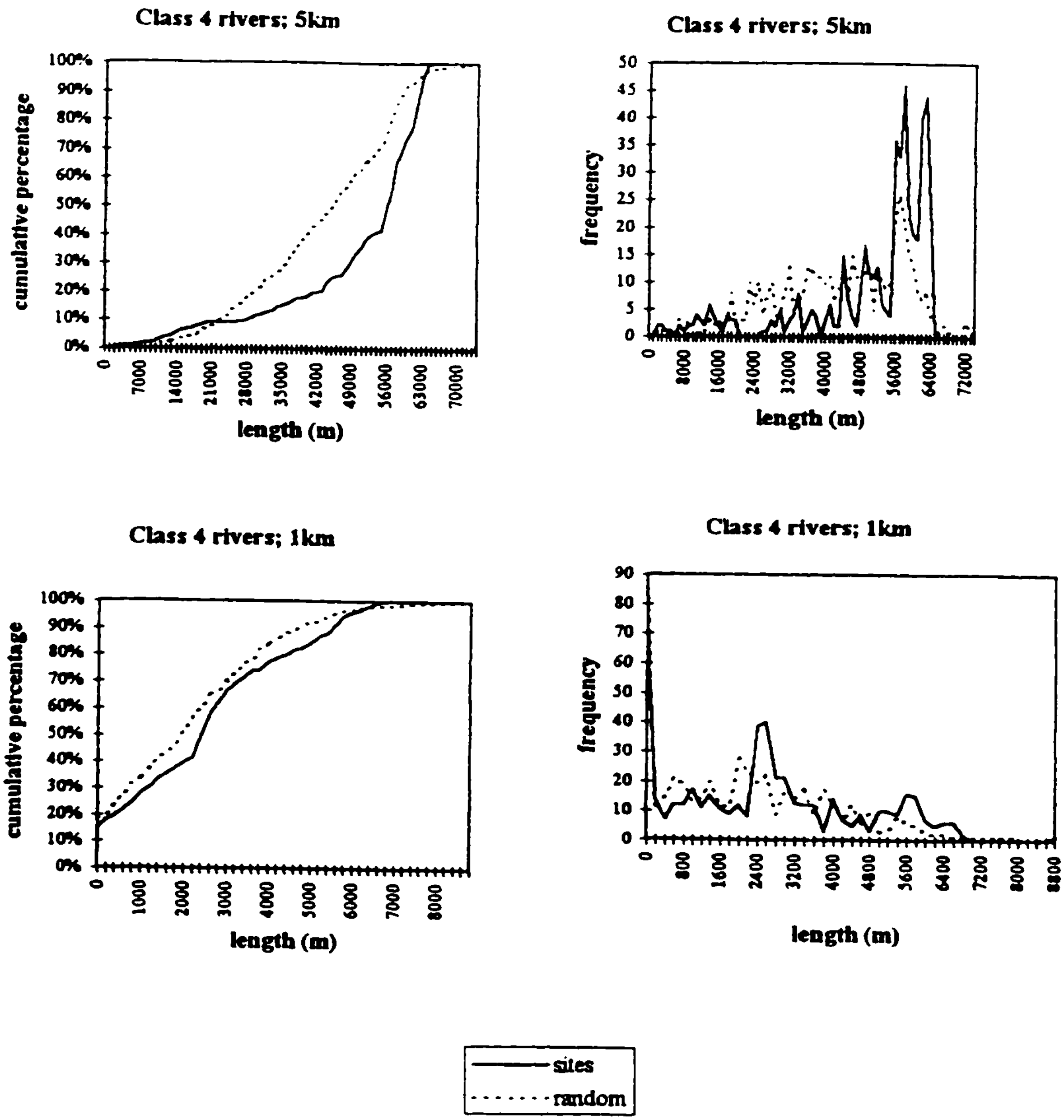
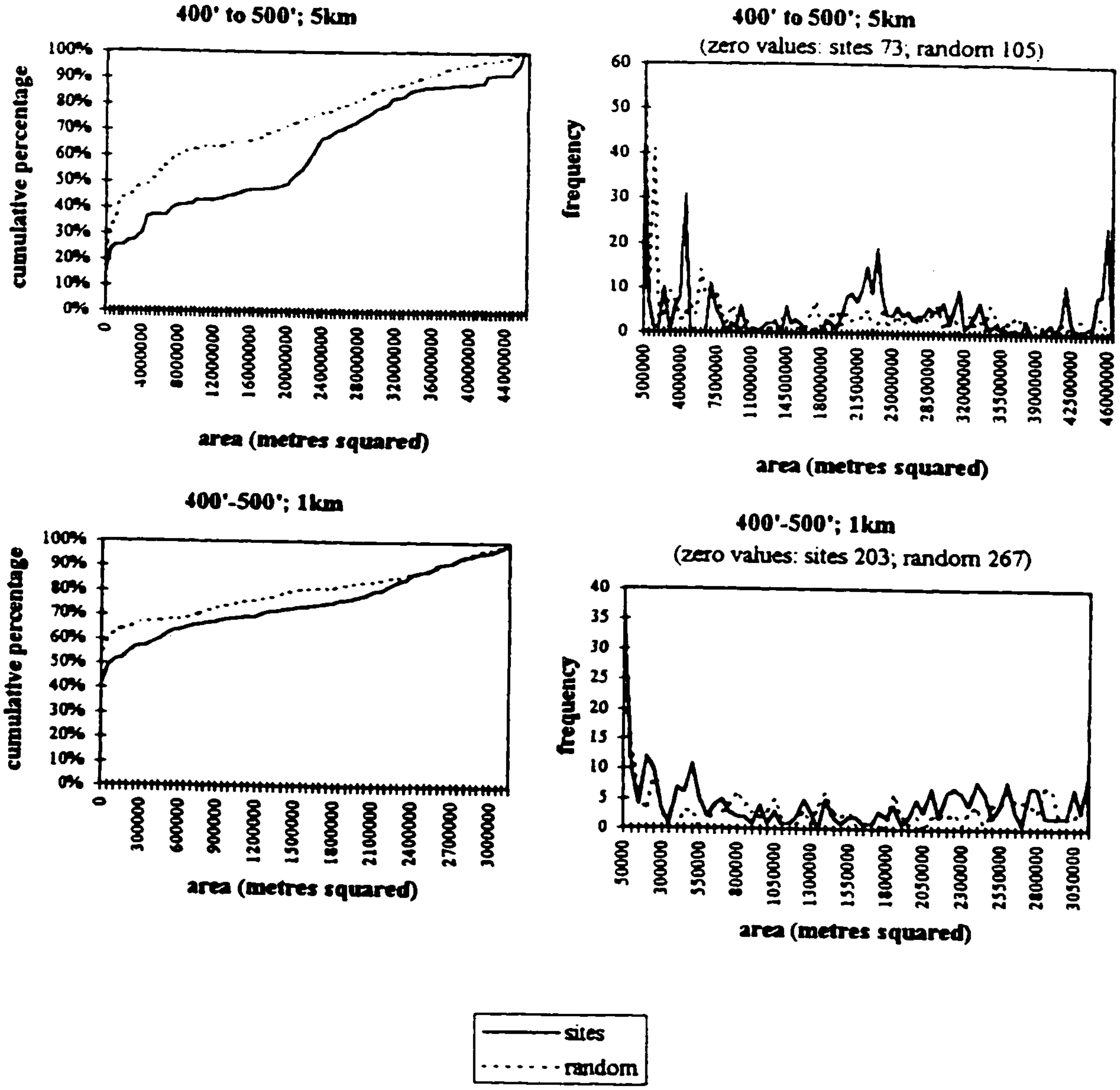


Figure 76: Site catchment results: 400' – 500'contours



correlations that flutter in and out, strengthening the argument against 1km as an effective scale. *Fulachta Fiadh* and ring ditches are positively associated at 5 km and at 500 m but not at 1km.

As the scale of analysis changes, different activities are highlighted. At the 5km scale the landscape would have been used for burial, other community rituals, habitation, agriculture, and gathering of less common resources. At the 1km scale the range of activities would depend on the degree of integration, discussed below. At the 500m scale the focus may have been more closely on burial. The relationship between the sites and the terrain features discussed here reflects these changing priorities.

TERRAIN SENSITIVITY

A terrain sensitive landscape is a balancing act. A single terrain feature does not dominate siting decisions. Not only are many terrain classes, such as soils, drainage and altitude taken into account but also many different qualities within these classes may be important. In fact, one of the strongest impressions to come out of previous landscape studies in Irish Prehistory is the preference for mixed soil types rather than large tracts of a single soil (Cooney 1979; Grogan 1989). Site catchment analysis is particularly useful for looking at this kind of problem since it looks at more than just point location. Terrain sensitivity is the dynamic most directly addressed by site catchment analysis. Are there terrain features that have regular patterns in the site catchments? Is there a class of terrain features (rivers, contours, or soil) which is particularly important for the placement of these sites? Are there types of terrain that are avoided? Is there a consistency of location with regard to any particular terrain feature?

The separation of different terrain classes, while useful, is a simplification. Soils, drainage and topography form one system. Often soil complexes represent broken ground. The terminal moraine is a feature picked up by many different measures within this assessment. This is an important pattern and will be discussed further below. A feature from one class can refer to another class. Ballybrood series soil is avoided at the 5 km scale (Table 1) and yet there is nothing else to indicate that this tiny patch of Brown Earth soil should be particularly onerous. Perhaps its proximity to the River Maigue affects its relationship with sites. The river is clearly avoided and seems to be a more important landscape feature.

The Maigue does not determine the distribution of the soil type, but it may affect the distribution of sites. So the soil is 'avoided' statistically because of its association with the river.

Nonetheless, it remains useful to consider each terrain class separately in order to bring out detail. Multivariate statistics were not suitable for these highly non-normal distributions so the results must be brought together through discussion. First I discuss the results by terrain class, particularly emphasising the considerations and limitations, then I group the main concentrations of ring ditches by terrain position, and finally I discuss terrain themes.

Terrain classes

<u>Soil</u>

The definitions of different soil groups and soils series are based on modern criteria and modern soils. While most soils within the same group have similar characteristics Gleys vary widely. Some Gleys stem from poor drainage while others relate to a high water table and the two groups have changed differently as a result of drainage. The most dramatic example of soil change in the study area is the draining (both natural and assisted) of the glacial lakes. Soil complexes are also important in the study area and clearly relate to several different terrain conditions. This points to the fact that the soil polygons in the soil coverages stand for many things. They are a model of the landscape built on individual measurements, which are in turn the result of many different types of relationships over time. I have grouped and regrouped soils series in this analysis in order to get at the most information I can.

At 5 km series from each soil group except Regosols are represented by significant variation from the control set (Table 1). At 1km Lithosols and Podzols are no longer represented. There are six Gleys, one Brown Earth and one Grey Brown Podzolic. Of the Gleys, three are complexes, one is based on lake alluvium, one on river alluvium and one on glacial drift. These last two are avoided. At 500 m there is one Grey Brown Podzolic and two complexes, one of which is lake alluvial based. Both rare and common soils play an important role in the terrain sensitivities of this landscape.

The balance of soil types was very important. Even at 5 km where the well-drained Elton soil is preferred, it is not maximised; the random curve carries on beyond the sites curve (Figure 71 d). The upper end of the range is just over half the catchment size for this scale. This pattern is less obvious at the 1km and 500 m scales where the soil series is actually avoided, but the majority of sites still have less than half of their catchments taken up by this soil. Soil complexes, while strongly preferred at the 5km scale take up only a tiny portion of the catchment (Figure 77). Being preferred at the 1km and 500 m scale also they are more likely than Elton to take up the entire catchment. Since they represent a mixture of soils this shows the importance of a mix of soils.

There are two soils that are consistently avoided, Howardstown and Camoge. Both are Gleys, neither based on lake alluvium. Both are significantly different from random only at the 5km and 1km scales. Both follow a pattern reasonably similar to the random but shifted to the left (figures 74, 78). While the river alluvium on which Camoge soil is based may mask sites (a problem with data collection), this masking could not account for the general avoidance shown in these graphs. Small amounts of these soils are acceptable, in fact there are more low than zero values in the Howardstown curve, but large tracts are avoided. This accounts for the small number of sites in the southwest leg of the gas pipeline survey. It runs through terrain dominated by large tracts of soil, already a problem for the balance, dominated by Camoge and Howardstown soils. The preference for Gleys at all three scales is really a preference for lakes and broken ground, not simply an avoidance of good farming soils.

Podzols, Lithosols and Brown Earths do not play an important role in the siting of ring ditches. These soil groups are known to be important factors in Neolithic Landscapes. Free draining brown earths and shallow lithosols are easily worked; Leached podzols can be the result of early deforestation (Edwards 1985). There are significant differences between sites and random at the 5 km scale, but they are limited in scope and may well be related to associations between these rarer soils and other more dominant patterns (Tables 1a) and 4). The Brown Earth, Baggotstown, is significantly avoided at the 1km level. This could indicate a similar pattern to Elton, but it is more likely to relate to the larger tracts of Baggotstown below the end moraine since the sites frequency curve is a left shifted version of the random curve (Figure 79). These soils are rare in the study area, altogether comprising less than 25km^2. Their

Figure 77: Site catchment results: Soil complexes

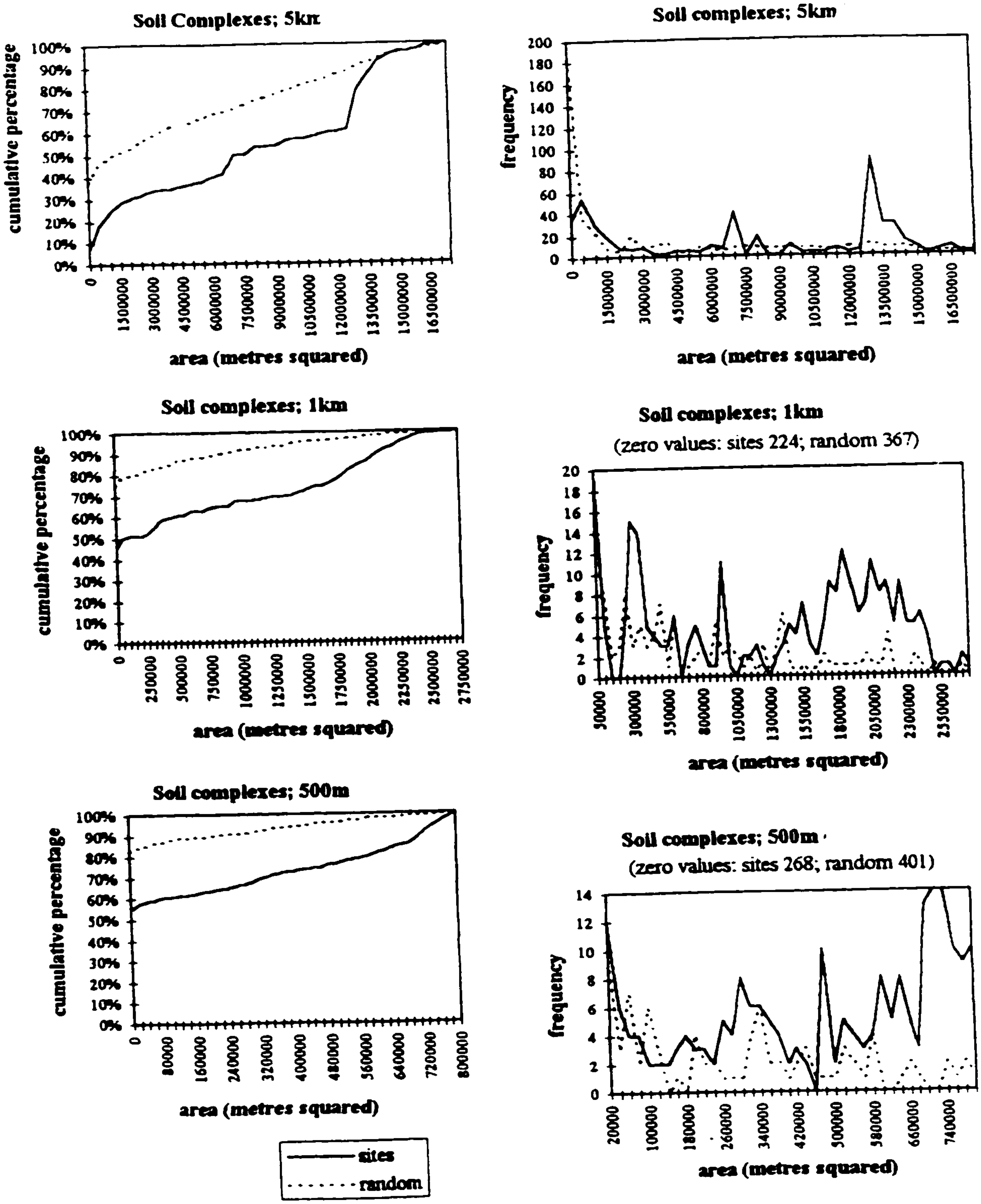
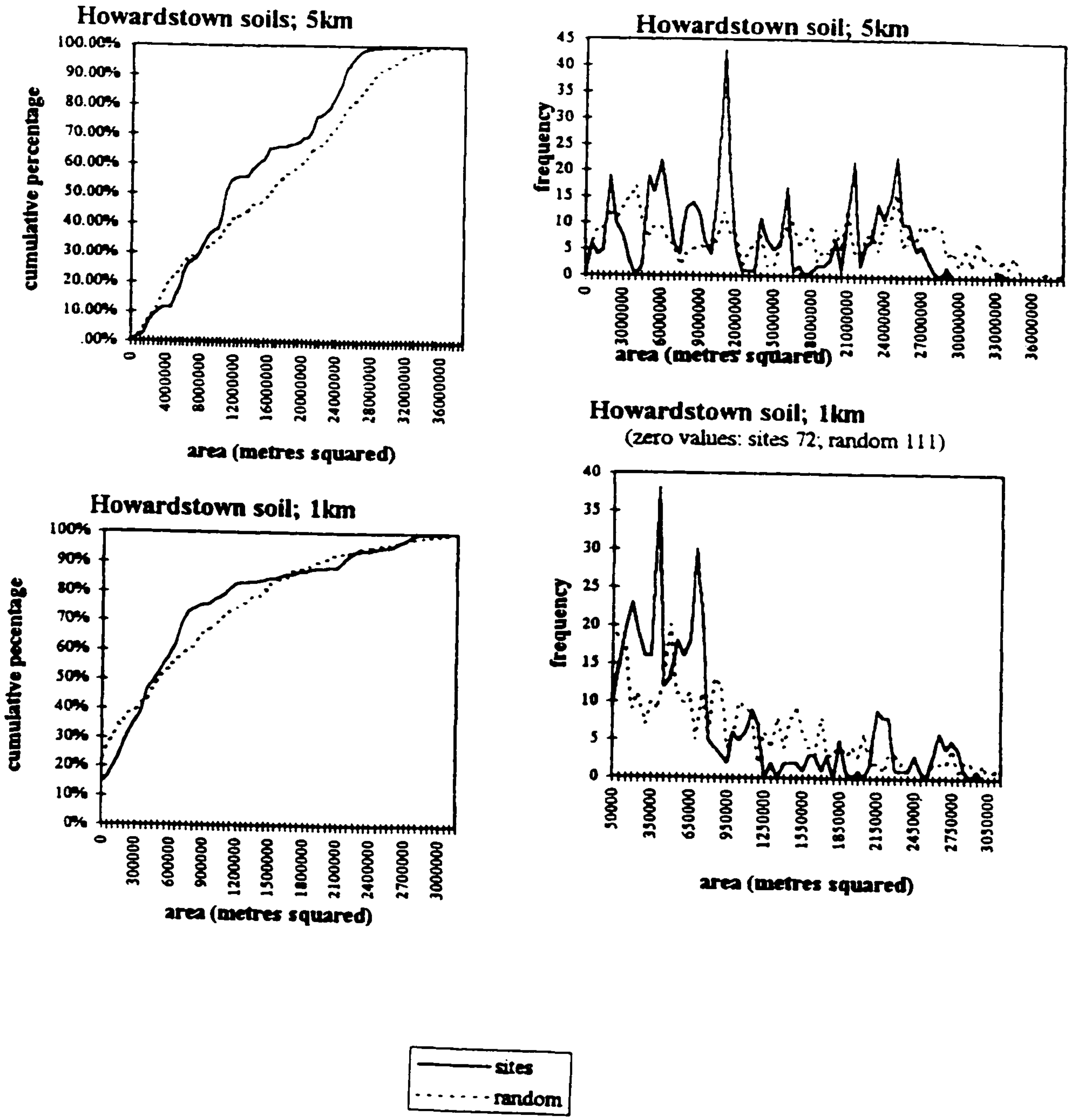
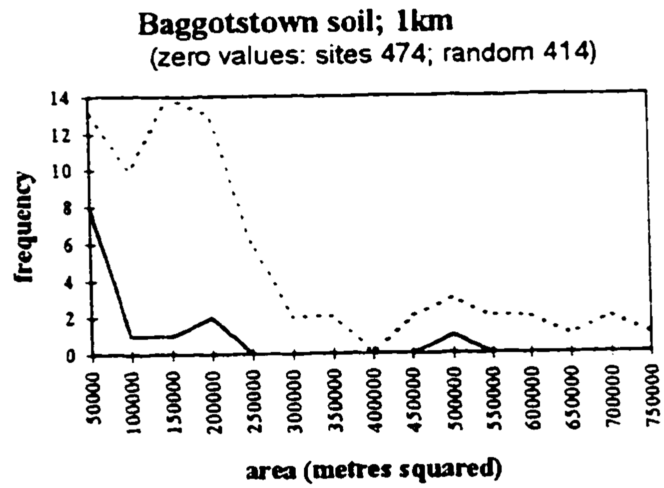


Figure 78: Site catchment results: Howardstown soil



lack of significance may be related to their rareness, but it may also indicate different priorities than those in Neolithic landscapes.

Figure 79: Baggotstown soils: frequency in 1km catchments

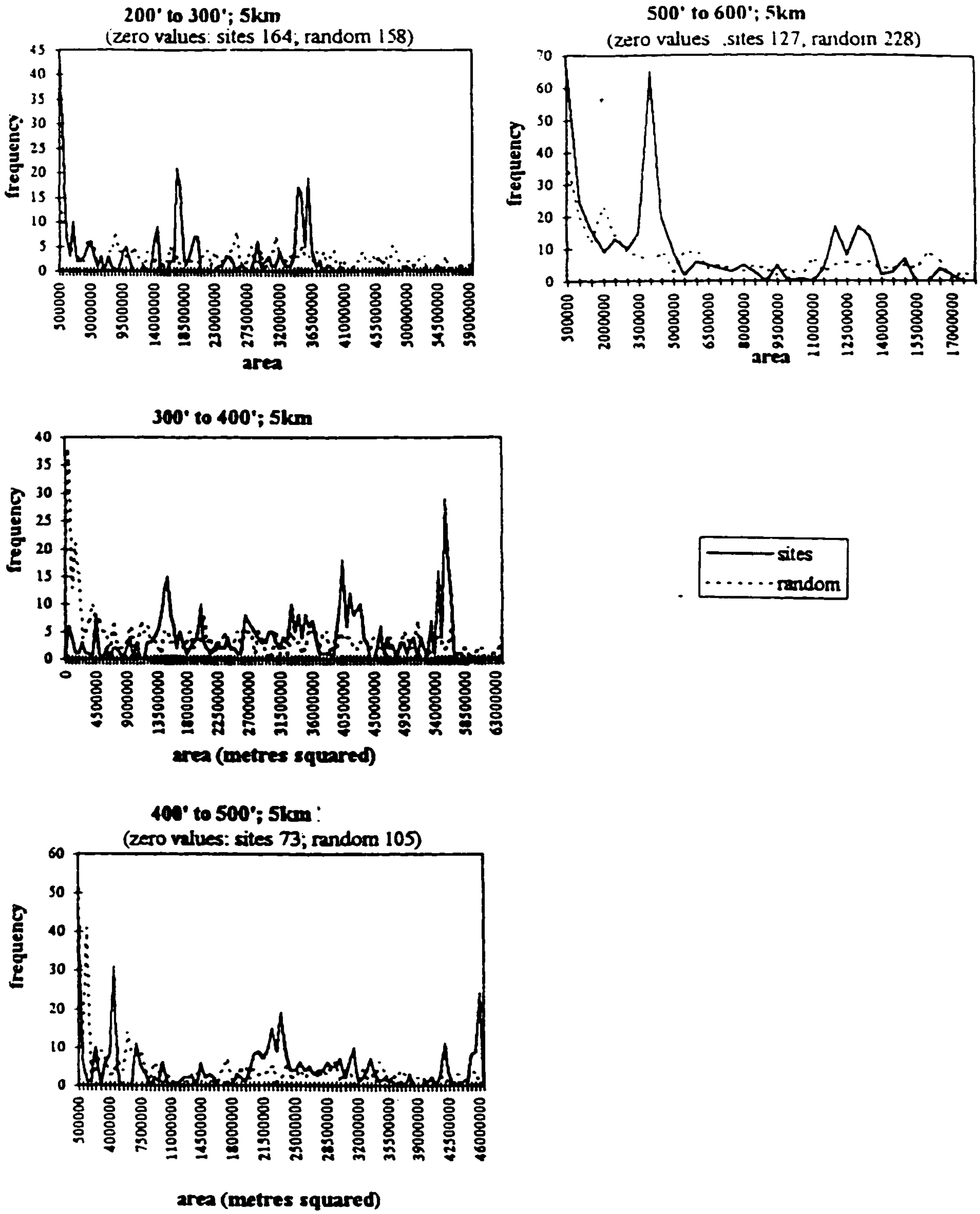


Topography

The difficulties of representing topography as contours have been discussed above. The biggest problem for this section of the analysis is that contours are spaced at 100 foot intervals and a good deal of variation is lost. For instance, there are noticeable hills between the three river valleys, which are simply not visible on the map. The mapped surface looks considerably smoother than it is. But contours do give some information on the slope of the study area as it comes out of the foothills and down onto the plain.

At the 5 km scale there is enough variation in the frequency graphs to group sites together. At each contour there is a group of sites in a peak. Elton, Coolalough, and Tipperary are in one band; Mitchelstowndown, Cush and Ballynamona in the next. So there are bands of sites, with a tight placement on the slope reflected in the sharpness of the peaks (Figure 80). At the lower scales the graphs show very little. The 200' to 300' range is avoided at the 500m scale, the values are clustered near the beginning of the range in comparison to random. The 300' to 400' range shows the opposite, with the values clustered near the end of the curve. It is this point, where the foothills first reach the plain, which is the most important place for ring ditches.

Figure 80: Site catchment results: 200' - 300' contours



<u>Rivers</u>

Overall preference for rivers is very strong at all three scales. The sites curve is usually fairly simple in the graphs of all rivers together implying a single siting rule for the whole distribution (Figure 81). The 1km curve is more complex than the other two, underlining the ambiguity of this scale. The curve breaks up substantially when the rivers are broken into their classes, which makes sense since there is a substantially less even distribution across the study area (Figure 82) (for an explanation of river classes, see Chapter 2). Some classes of rivers seem to be more important to be near than others classes 4, 5, 6 are not significant at the 500 m scale even though they are the largest part of the drainage system. It is class 3 rivers - the Morningstar, Camoge and Loobagh, and 8, 9, 10 - the tail ends of the natural drainage system which are important here.

Although the class attribute is a inherent classification, it is not clear how the difference in dendritic location affects the nature of the water course - other than the fact that the higher classes may be drainage ditches rather than streams. None of the rivers are tidal, all are liable to flooding at different stretches. Class 2 is always the River Maigue. Class 3 and 4 rivers are often named, indicating prominence, but streams as high as Class 12 are also named sometimes. Class 10 rivers are usually found in upland locations suggesting that they are part of a natural drainage scheme as most of the drainage ditches are in the lowland basins of the glacial lakes.

At both 5 km and 1km there is a change in the nature of the curves between class 7 and class 8. In Class 7 graphs the sites curves are unimodal and class 8 curves are bimodal (Figure 83). Whatever the difference in their nature, the ring ditches are placed differently with regard to these categories. The class 7 rivers have a unified siting rule, class 8 rivers have two different rules.

The rivers could be taken to be important in their own right as socially significant and important resources, they also indicate something about the extent of waterlogging of the land and its suitability for prehistoric tillage and indeed grazing. The lower tributary classes represent good drainage and the higher classes represent poor drainage and glacial lakes. It is interesting then that at the 500m scale the main

Figure 81: Site catchment results: Total river length

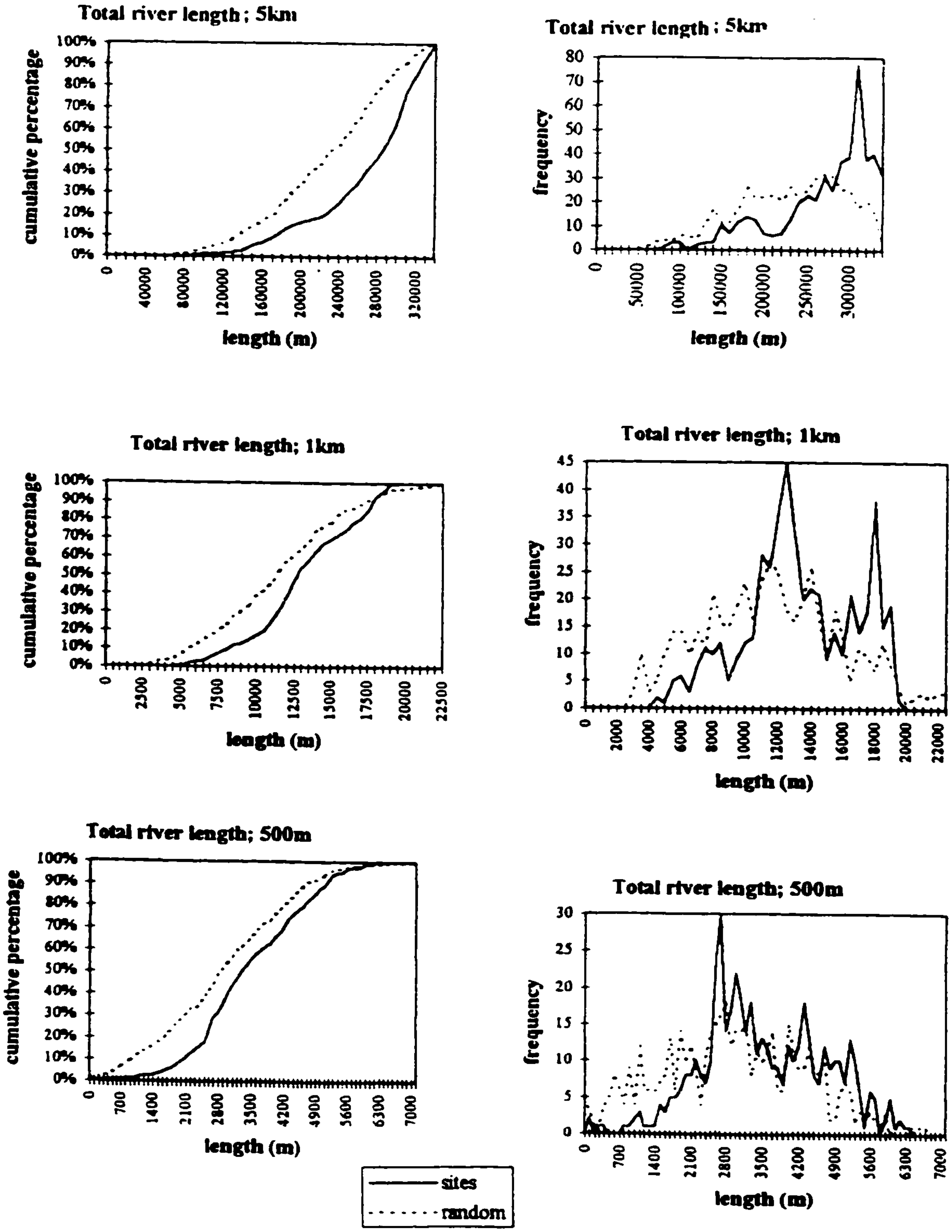


Figure 82: Site catchment results: Class 5 rivers

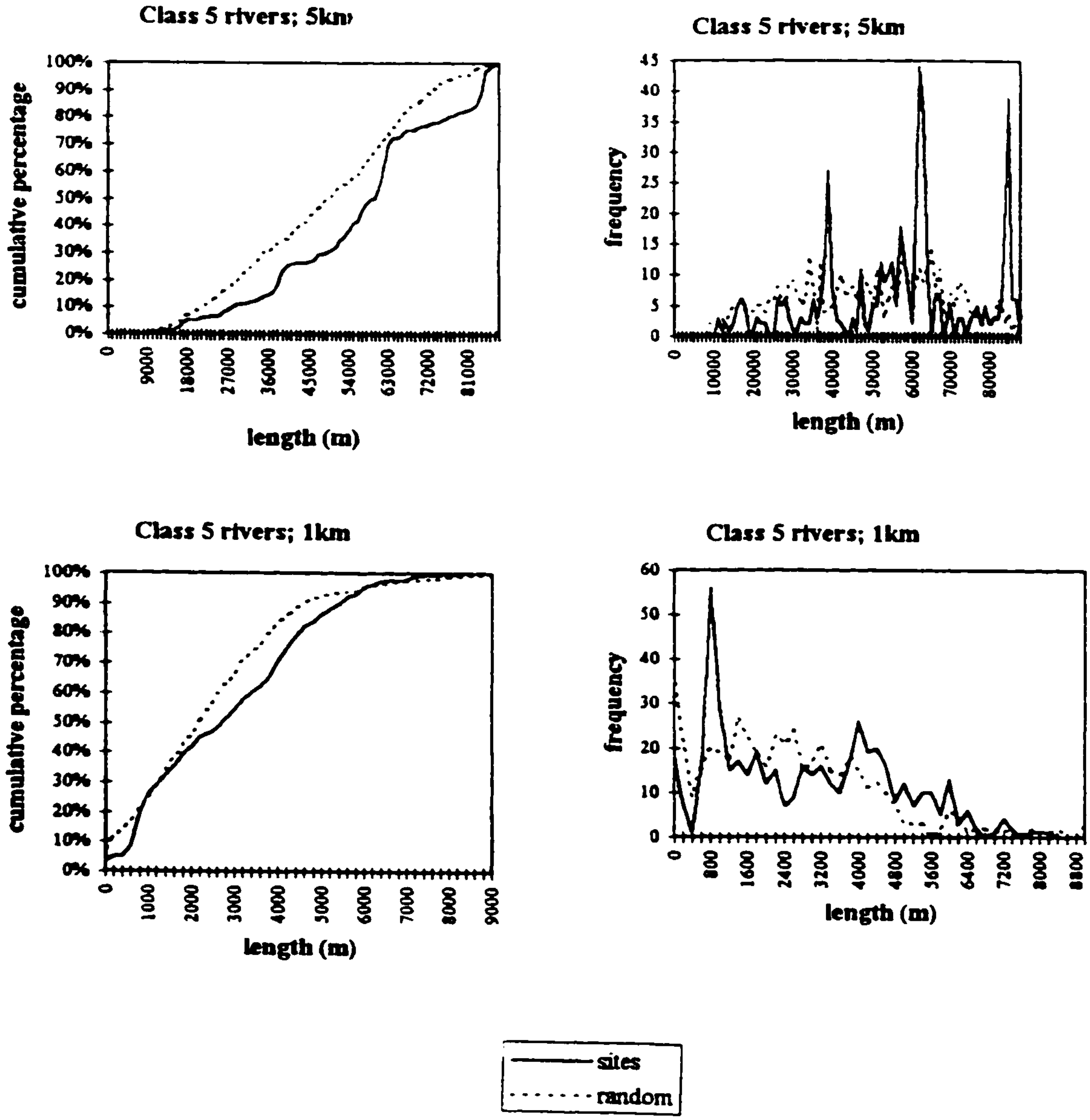
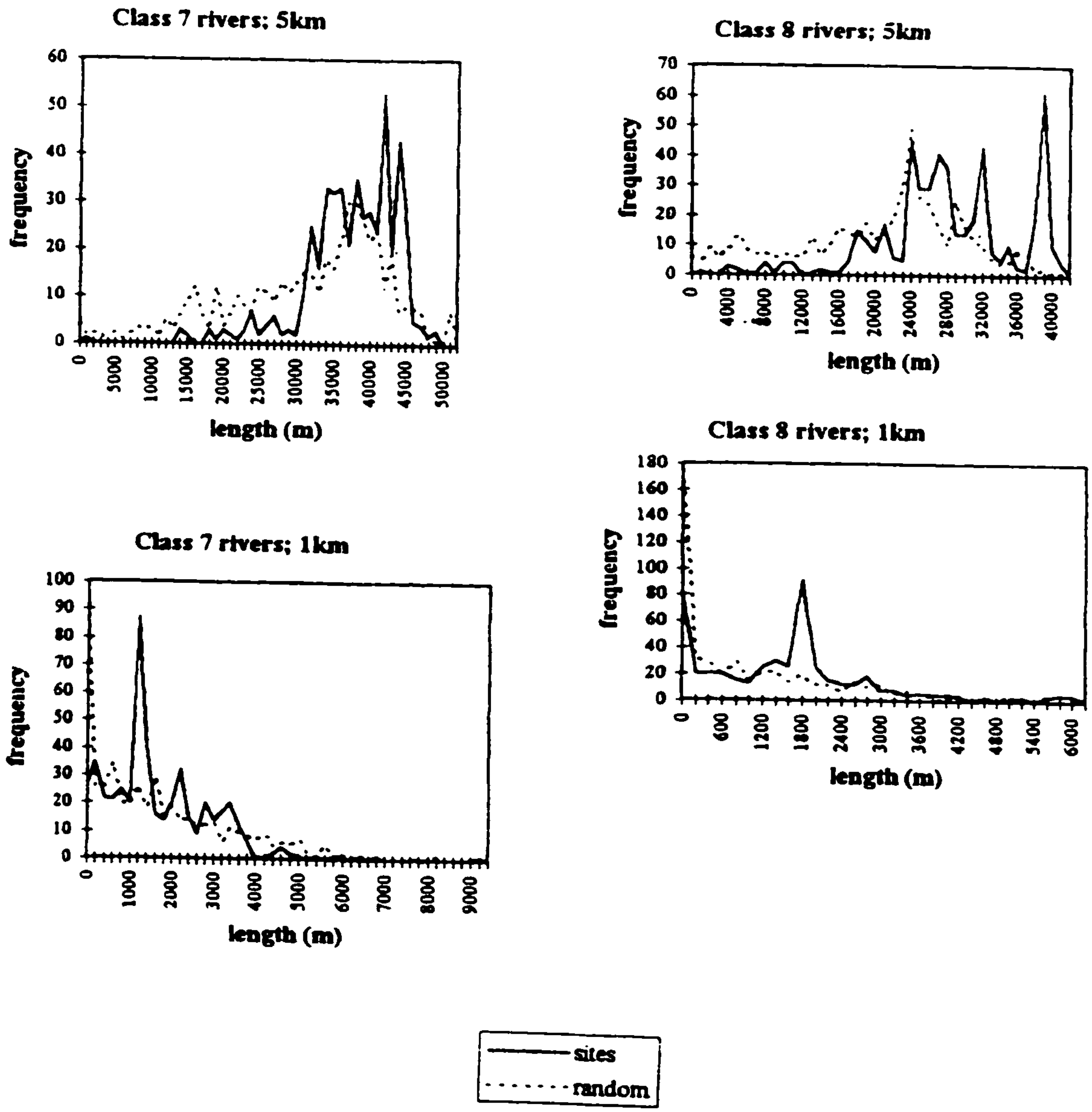


Figure 83: Site catchment results: Class 7&8 rivers



body of the natural drainage system, classes 4, 5, and 6, are not significantly different from random (Table 1a). Good natural drainage is not preferred for close siting of burial sites.

Classes 11 through 15 are only significant at the 5km scale. They show what seems to be a basic pattern for rare terrain features, the sites curve follows the random except for a sharp departure in one range. There is a preference for these rivers but the expression of that preference is constrained since the feature is found only in small amounts anywhere. These tributaries are in yet another grouping, not significant at the lower two scales. As these may be drainage ditches any relationship between them and prehistoric sites must be picking up another terrain feature, such as a glacial lake.

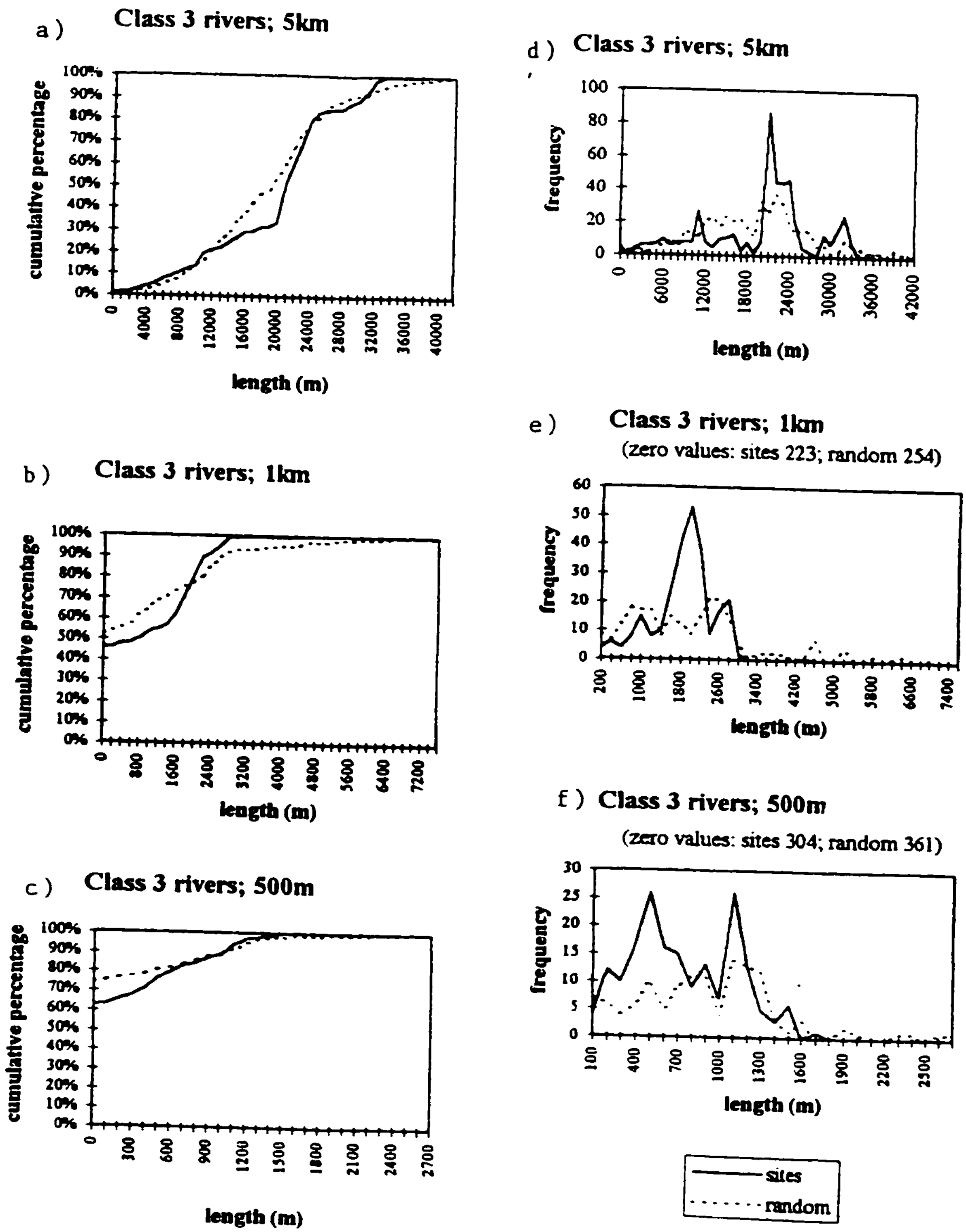
Grouping cemeteries by terrain position

The breaks in multimodal frequency graphs have been used to divide the distributions as discussed in chapter 3. Apart from indicating high medium and low groups, these breaks indicate differences in siting choice. One reason for multimodal curves is the uneven distribution of terrain features, indeed the random curves are often multimodal. But sometimes the sites curve has multiple peaks rising above a unimodal random curve (Figure 84 d). The cumulative percentage curves for these features often have stepped profile either rising up above the random curve or rising up to meet it (Figure 84 a). Given the natural range of the feature, as shown by the random curve, sites are placed to maximise or minimise the amount of that feature, while remaining in the general intended area.

Sometimes the relationship between the two curves is less clear and less regular (Figure 71). In these cases the multiple peaks may represent different siting choices. In the discussion of the Elton soil series, above, it was suggested that ring ditches in the townland of Elton were placed with more of this soil in their catchment than other area because the sites played a different role in the landscape (this is discussed further below). It is possible to group and regroup the major concentrations, or cemeteries, with regard to these similar and different terrain positions.

Ballynamona/Lissard (Figure 42) is an important concentration of sites but its position, so close to the Tipperary border, sometimes truncates the values for important soil series. In many ways it forms a group with the Tipperary sites. At 5km only this concentration and the Tipperary sites have such low

Figure 84: Site catchment results: Class 3 rivers



values for the dominant height range - 300' - 400'. At 1km it is grouped with Cush, Elton, Duntryleague, Raheenamadra, and Moanmore, Co. Tipperary in its high values for class 6 rivers. This indicates that all these concentrations have similarly good drainage. It is grouped again with Elton at 1km for high values of Grey Brown Podzolics (including those mapped in complexes). When the complexes are taken out however, it switches to the low group with Coolalough Rathanny and Mitchelstowndown. At 500 m, it is once again with Elton for low values in lake alluvial Gleys. The county border is unlikely to account for these low values since the concentration is more than 500 m from the border. This concentration has similarities with both the well-drained zones and the more complex zones.

Duntryleague while very close to Ballynamona/Lissard makes different groupings. They are together in having high values for Class 9 rivers at 5 km. But they are separate in the graphs of Coolalough soil at 1 km. In these graphs Duntryleague is in a middle group with some Mitchelstowndown sites, Gormanstown, Raheen, and Raheenamadra. Broadening this to all lake alluvials at 1km groups the Duntryleague cemetery with the high value sites of Mitchelstowndown and Rathanny. When Grey Brown Podzolics and Gleys (both without complexes) are considered at 1km it is in the high group with Elton. So this concentration is another one which has well drained soils but is near to complexes and glacial lakes.

Mitchelstowndown (Figure 41) is sited the closest to the end moraine of all the concentrations. This means that it is dominated by the rare combination of soils that are found there. It is sometimes grouped with the Cush concentration, which is in a surprisingly similar topographical position. At 5 km they are in the same low group of the 300' -400' height range, they are joined by sites in the Tankardstown North group which are on the other edge of this height range. Tankardstown North is also grouped with Mitchelstowndown in class 8 rivers at 5 km though the latter concentration dominates the group. For soil complexes at 5 km Mitchelstowndown is in the modal group with more sites near the Tankardstown North concentration. Joining them are sites in Ballynamona/Lissard, Raheen, and Duntryleague all concentrations surrounding the end moraine. The same grouping is evident for Class 7 rivers at 1km and for soil complexes at 500 m. For both Howardstown/Coolalough soil complex at 1km and lake alluvial

Gleys at 500 m it forms the highest group by itself. Mitcheltowndown's associations with the Tankardstown North sites show similarities between the two terrain positions, which would not have been obvious from looking at the maps.

The concentration at Elton (Figure 43) was uniquely placed in relation to good soil. This carries through in the 300' - 400' height range and the soil complexes at 5km. Sometimes it is joined by other concentrations such as Cush and some sites in Mitchelstowndown East, which together form the low group of the 5km graph for class 8 rivers. The similarity of terrain sometimes spreads. For example many of the sites on OS sheet 40 are in the upper group for Gleys without complexes at 5 km, showing the wide extent of unbroken glacial till. As has been discussed above the Elton cemetery is often found with the sites on Duntryleague hill, forming a group with well-drained soils.

The Tankardstown North concentration has some strange affiliations. It joins Rathanny and Coolalough in having the lowest values for soil complexes at 5 km. Yet some of these site are allied with Mitchelstowndown for this feature as described above. The connections to Mitchelstowndown continue looking at Gleys without complexes at 1km, for which it shares the lowest group with this concentration. Mostly it is similar to the sites in its immediate vicinity, dissimilar from Elton, and shares some with the wetland concentrations in Mitchelstowndown.

Terrain Themes

<u>The moraine</u>

The moraine forms the focus of the distribution as shown on the 5km kernel smoothed maps. Its combination of highly mixed soil and wetland right up against the foothills of the Ballyhoura Hills lends itself well to boundaries, both social and spiritual. While the distribution of ring ditches is in no way confined to this zone, attributes that are found here in abundance are important throughout the distribution.

Howardstown/Elton and Howardstown/Coolalough are the complexes of the end moraine. The first represents broken land and the second represents glacial till with little lakes. Soil complexes are strongly preferred at all three scales (Figure 77). The relationship between the sites and random curve is consistent. Each frequency graph shows three very distinct peaks. The spatial arrangement of the sites in these groups at all three scales is similar to the target pattern for the Elton graphs above, but this time centred on the end moraine itself. Considering how rare soil complexes are outside the moraine zone, these three tight peaks show careful site location with this feature in mind. Maximising the extent of highly mixed soils was important everywhere in the study area.

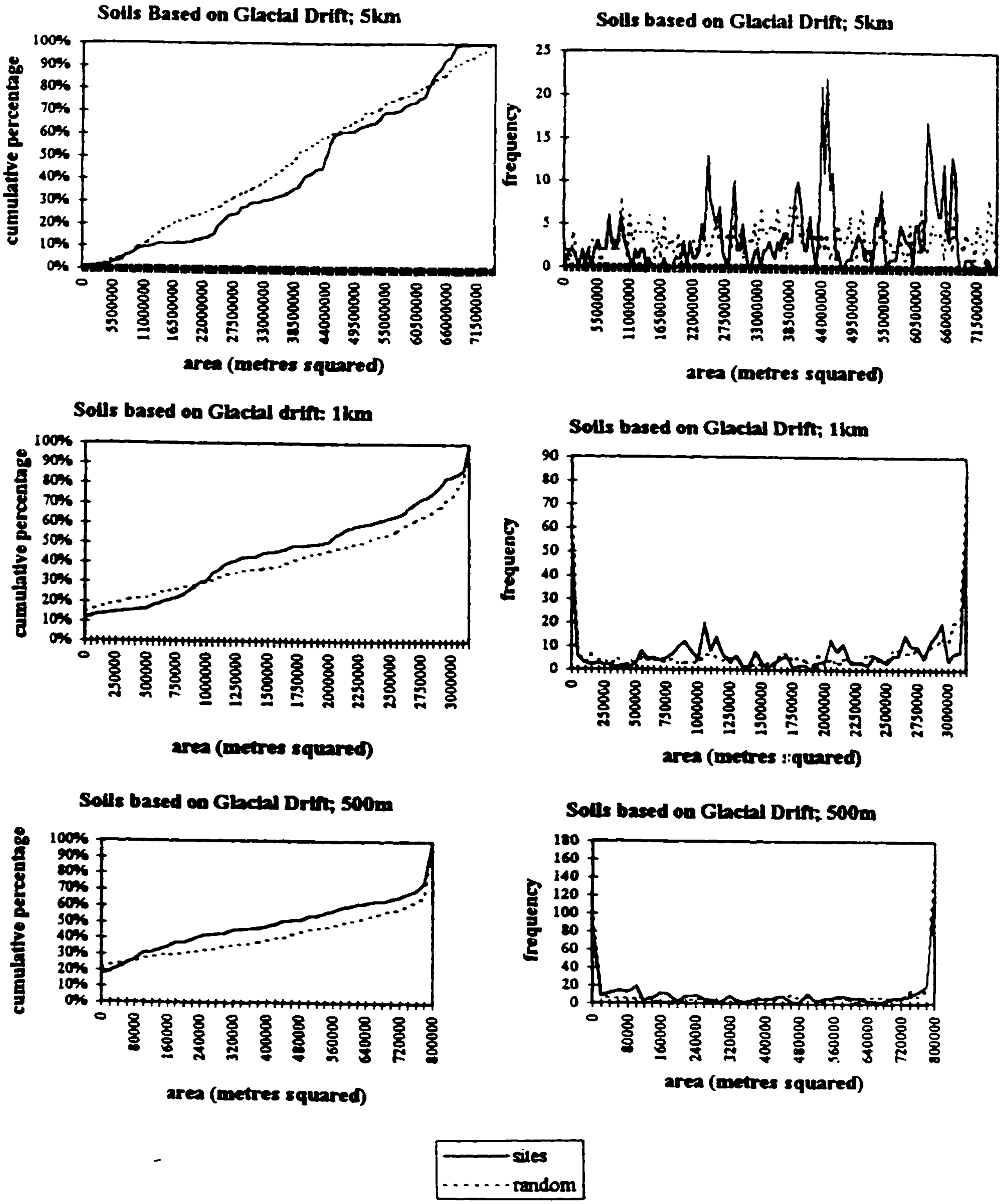
The importance of mixed soils is emphasised by the avoidance of soils based on unmixed glacial drift (Figure 85). Even at the 5km scale, where there is a marginal preference, the basic effect of the concentrations is to minimise the amount of this type of soil. While the differences between sites and random are never as pronounced as they are for soil complexes, these simple soils are avoided at the 1km and 500 m scales.

Rivers with high tributary classes are another feature of the end moraine that can be found elsewhere. There are numerous streams amongst the hummock and hollow terrain pattern and the draining reaches shown in sheet 49 NW (figure 12) are now marked by streams and drainage ditches. At 5km the importance of these features is seen in the very rare river classes 11 through 15 being preferred over random. At the 500m scale 8, 9, and 10 remain preferred for the same reason. The occurrence of these rivers outside of the moraine zone is particularly important and the peak in the 500m graph is composed of the sites that surround the Mitchesltowndown concentration. That concentration is drained by the River Morningstar (class 3).

The 400' - 500' height range has a large influence on the overall distribution even though it is almost exclusively associated with the moraine. It occupies 70.5 km^2 mostly in Tipperary. The frequency graph for 1km shows that the Tipperary sections are not the important zones. The upswing evident in the other frequency curves at this scale is not visible here since the height range is barely 1km wide where it meets the foothills at the moraine. It is the terrain position and not the overall height that is being chosen for.

The very complex set of soils on the moraine is followed closely by the distribution of ring ditches. The main concentration in Mitchelstowndown west overlooks the set of reaches and islands

Figure 85: Site catchment results: Soils based on glacial drift



produced. Down through the broken areas the ring ditches were placed on islands of dry land, either sandy glacial knolls or the foreshore of the reaches (Figure 86). The landscape is particularly sensitive to the terrain pattern of the moraine.

Wetlands

Wetlands are an important feature of any Irish landscape, but in the Bronze Age they have particular significance. In the study area the peat is blanket bog, which is generally less significant than raised bog for ritual activity since it was never open water. Seamus Caulfield describes working in the blanket bogs of Mayo. "It is not so much 'wetland archaeology' as 'you get wet'". Certainly peats and soils with peat are not substantially preferred or avoided in the study area (Table 1a). Lakes and rivers are the most important wet environments here.

While the different lake alluvial Gleys have slightly different properties and may have drained at different rates, taken together they represent lakeland which is likely to have been present for much of prehistory. The most common series, Coolalough, is based on a very fine textured marl which may indicate particularly slow drainage. This series is preferred at 5 km and 1 km (Figure 73). The lake alluvial Gleys as a group are strongly preferred at all three scales - even the distinction in zero values is substantial (Figure 87). There is no evidence yet of metalwork hoards in these lakes to match those from elsewhere, but the positioning of ring ditches shows that they had an importance in ritual.

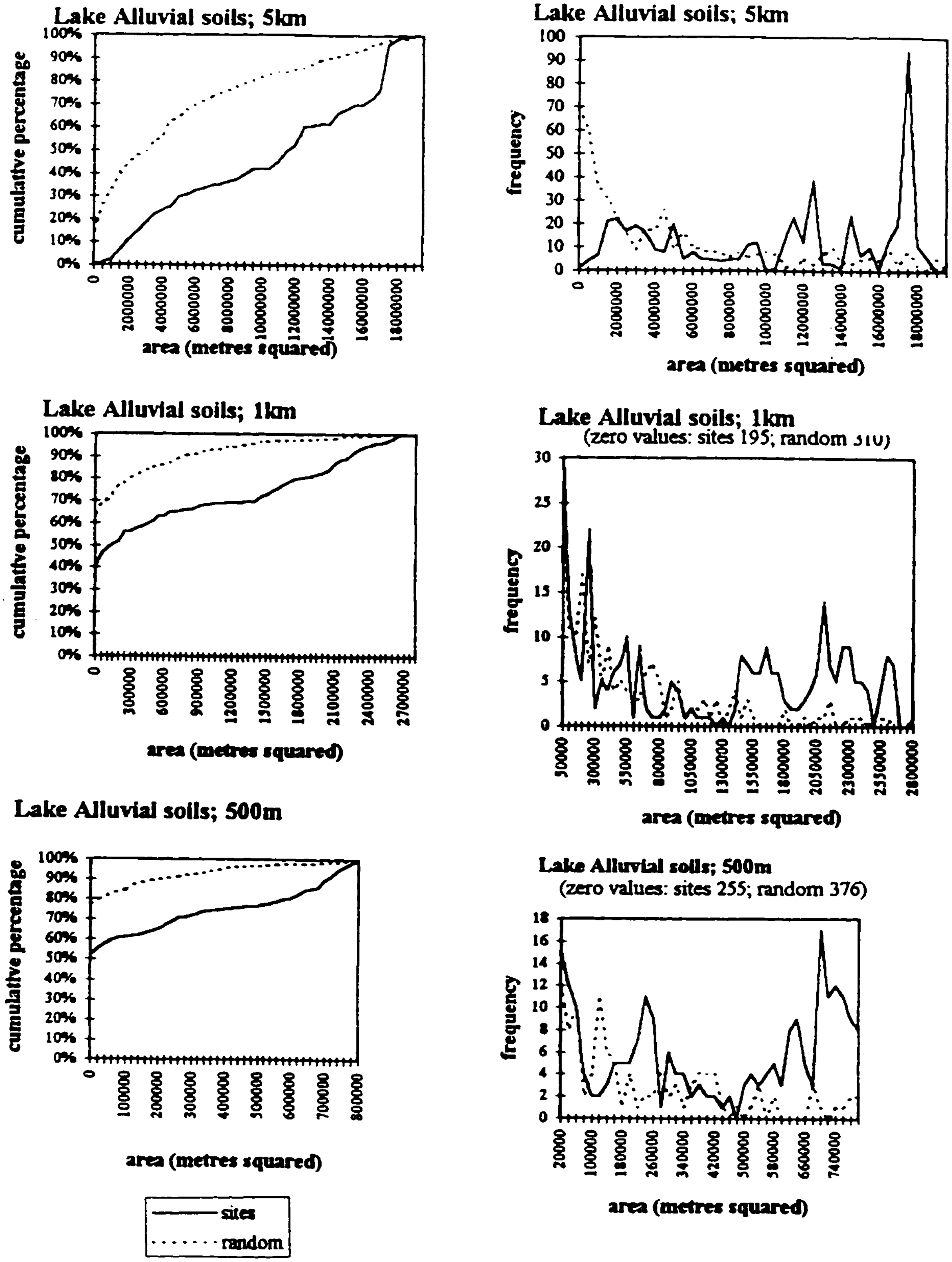
Rivers are another feature which have practical and ritual significance. The importance of rivers, especially at the 500m scale, indicates a similar situation to the lakes. The avoidance of river alluvium, in the form of Camoge soil is interesting because it shows that particular riverine environments were being chosen. River alluvium represents a once wider riverbed as well as regular flooding. While this environment may have been as wet as the draining lakes, the Middle Bronze Age inhabitants made a distinction in terms of ritual behaviour

Agricultural 'suitability'

Elton soil is the best drained and most tillable soil in the study area. It is one of the few soils which, in modern classification, can be used for more than seasonal pasture. The patterns of this soil have

Figure 86: Ring ditches and lake soils in Mitchelstowndown

Figure 87: Site catchment results: Lake Alluvial Soils



been discussed above. It moves from being preferred at a high scale to avoided at a low scale and a coherent target shaped pattern of sites breaks up as the scale becomes smaller (Figures 71 and 72). This makes sense in terms of agricultural usage. Good soil defines the activity zone but is not used for burial. There are similar patterns in other features, which support this relationship to good arable land.

Class 4, 5 and 6 rivers represent good natural drainage conditions. They form the majority of the drainage network and are close enough to major rivers to allow for good drainage. While all three are strongly preferred at the 5km scale, at the 1km scale the distinction is less substantial and class 6 rivers are avoided. There are no significant differences between sites and random at the 500m scale for any of these sites, which is particularly noteworthy given their ubiquity. The values for these rivers also form a target pattern focussed on Elton. At 5 km all three rivers have it. At 1km it has disappeared completely.

These same priorities are evident in the correlations between ring ditches and field systems (Table 2 a, b, c). The movement from preference to avoidance is clear here too. The negative correlation at the 500m scale should not be overemphasised, especially given the Moanmore complex (Figure 34). The negative correlation stems from the large concentrations in Mitchelstowndown.

Well-drained land is clearly an important part of the landscape described by the ring ditches. The overall zone of activity is well described by the distribution of good soil, good drainage and evidence of their exploitation in the form of fields. The largest concentrations of ring ditches, however, avoid these things. While each concentration has a similar range of good land nearby (Figure 72), the sites themselves tend to avoid it (Figure 71). There are concentrations where there is a greater emphasis on productive land to be discussed further below.

<u>River valleys</u>

The River Maigue is one of the most clearly avoided terrain features in the study area. This seems odd since the main concentration of sites runs from the uplands to this river. Not only is it avoided within the study area (Table 1) but also there is no substantial cluster of sites between the study area and the Shannon Estuary. Three low flying aerial photography sessions along its route recorded only three ring ditches. While sites are clustered around higher tributary classes, the Maigue is not part of this pattern. This may be connected to the Camoge soil that surrounds it and is avoided across the study area. There is a strip of this soil that runs the length of the river. It is shown on the original field maps but not reproduced in the published Soil Survey (Finch *pers comm*). The avoidance of the Maigue may also be related to the fact that this river is navigable, implying a different set of activities than the other drainage in the study area.

Class 3 rivers are the rivers that define most of the river valleys in the study area. While the sense of these valleys is stronger than contour maps show, they are not deeply cut and the rivers themselves are not prominent in the modern landscape. Nonetheless they were obviously important in the Bronze Age as shown by both the overall preference in the cumulative percentage graphs and the tight curves in the frequency graphs of all three scales (Figure 84). At the 500m scale they are one of the few river classes which is preferred even though they are much more limited in their range.

The peaks in the frequency graph at 5km do not represent a single concentration, but rather all the concentrations having a very similar siting with regard to this river class. While it is more dispersed in the lower scale graphs, the spatial mixture in the different groupings remains. It is not just that sites were regularly close to rivers, but they were regularly close to a certain amount of river. This is controlled both by the amount of twisting in the river course as well by the position of the river in the catchment. These concentrations are sited at similar points in the course of these important rivers.

While the site catchment analysis does not distinguish between the three major tributaries of the Maigue, a glance at the distribution maps shows that the Morningstar is a more important focus than the Camoge or the Loobagh (Figure 40). As with the Maigue there are two scales of explanation for this. At the regional level, the rivers lead to different places. The Camoge runs Northward to Lough Gur, another important centre. The Loobagh runs straight from the foothills of the Ballyhouras, which form a barrier to the south. The Morningstar runs southward of Duntryleague hill and comes close to the Aherlow, connecting the study area to the Southwest. So the three rivers offer different social contacts and relations. At a local level the Morningstar is associated with the end moraine and the with more complex soil patterns than either the Camoge or the Loobagh. The intersection between these two levels of concern will be discussed further in the next chapter.

Uplands

The uplands of the south-east are not an important zone for the siting of ring ditches. They are preferred at the 5km scale (Table 1c) but this is probably because of the sites on the end moraine. The highest placed cluster of ring ditches is at Cush. The Mitchelstowndown sites are often grouped with these sites in the frequency curves of the contours graphs. Ballynamona/Lissard, while higher than Mitchelstowndown, is more often grouped with lowland concentrations. While the moraine sites are lowland they are within the same activity zone as the uplands and this highlights their position on a boundary.

The soil types of the uplands have a similar pattern to the height ranges. They are preferred at the 5km scale but not significant at a lower scale. Podzols and Lithosols are not very fertile and there is little lake alluvium in this zone. But the presence of a stone circle and cairns in the uplands suggests that the same communities that dug ring ditches may have used this zone for different ceremonies. These soil types are fine for rough grazing and have important ritual significance away from wetlands in other parts of the country. They were a focus for burial in the preceding period and large-scale domestic sites in the following period. The important thing to come out of this analysis is the strong sense of separation between the foothills and the plain in the Middle Bronze Age.

Other factors

This analysis has focussed on what terrain features this landscape was sensitive to. For the 500m scale, however, there are so few significant terrain factors that unmeasured features must be considered. Variables like slope and micro-topography may play a role as well as factors like mythology and social relations and practice. While these will have had significance at all scales, they are more prominent at the smallest scale. This points to the social end of the spectrum. The role of social factors in siting will be discussed more in integration below.

INTEGRATION

All landscapes are integrated at some scale since they work as a system. But in some landscapes different activities take place in different terrain, or separated from each other for social reasons. A Southern British Middle Bronze Age complex known as Deverel Rimbury typifies an integrated landscape. Fields, houses and burial sites are intermixed. Many Bronze Age landscapes have very separate places for different activities, which leads to the identification of 'ritual landscapes' (Moore 1996). The landscape under study is fairly well integrated, but there are places which seem to be set apart as well. What activities took place together? What activities took place in the same type of terrain?

The pattern of Elton soils across the scales discussed above indicates integration since the distribution of well-drained soils is important in the siting of burial features. At the 5km scale the soil is central to the distribution. At the 500m scale the soil is avoided but is at the heart of each concentration (Figures 71 and 72). This focus on arable soil suggests that agricultural activities and burial took place reasonably close to each other and took each other into account.

Fields, pits and standing stones follow this same pattern. They are all positively correlated with ring ditches at the 5 km scale, not correlated with ring ditches at the 1km scale and negatively correlated at the 500 m scale (Table 2 a), b), c)). While this could point to differentiation, looked at more closely it is still pointing to a fairly integrated pattern.

The fields changing from preferred to avoided backs up the argument made for an integration of agricultural activity. The negative correlation with ring ditches at the 500m scale is not reflected in their relationship with the total number of sites. Given the dominance of ring ditches in the distribution, this indicates an important role for other sites in their catchments. Fields are positively correlated at the 500m scale with barrows, cists and pits, all of which are burial features. At the 1km scale there is no correlation with cists, but there is a positive correlation with standing stones. At the 5 km scale fields are positively correlated with everything except Rathanny enclosures and *fulachta fiadh*, both of these site type are heavily associated with wetland.

Correlations point to what is happening in the largest concentrations. There are certainly field systems within 500 m of some ring ditch clusters (Figure 34), but the largest concentrations, in Mitchelstowndown, are set apart. Since the other negative correlations at the 500m scale are wetland sites, perhaps Mitchelstowndown is outside of the agricultural landscape because of its position amongst the lakes of the end moraine.

The standing stones and pits, which also move from preference to avoidance, may be part of the same general ritual practice as ring ditches but performed in different place. The pits are largely a burial feature contemporary with the ring ditches. The difference in surface marking could relate to social or chronological differentiation. Standing stones have been linked to burial but they have a more substantial marking role than ring ditches and are sometimes unrelated to burial. Standing stones have nearly double the significant correlations at 500 m as they do at 1km. The relationships between these sites are tightly focused. Its hard to know whether these practices were contemporary, though certainly some pits have dates very close to the ring ditches (Appendix C). The difference in degree of marking and difference in location may both be linked to a structured integrated landscape.

Habitation sites have a complicated pattern. At 5 km they are positively correlated with everything except cairns. At the 1km scale they are only positively correlated with *fulachta fiadh*, barrows and the total number of sites. They are negatively correlated with cairns, fields, rathanny enclosures and tombs. At the 500m scale they are positively associated with barrows, cists, *fulachta fiadh*, pits and the total number of sites and have no negative correlations. It is difficult to know what to make of this, especially given the initial indications that they are associated with a raised incidence of ring ditches. While not correlated with ring ditches at the 500m scale, their positive correlation with the total number of sites indicates that they occur near ring ditches when those ring ditches have other site types nearby. This is again pointing to two different patterns for ring ditches, one integrated, one set apart.

There are several upland sites that are clearly set apart from the rest of the pattern. While megalithic tombs are from an earlier period, many studies have shown their continuing importance through the Bronze Age (Barrett and Bradley 1991, Eogan 1991, Cooney 1994). Stone circles are a

Bronze Age phenomenon and are potentially contemporary with the rest of the pattern. Cairns are a wide ranging site type, some of which are prehistoric and some of which are quite recent. It is not just their upland position, which sets these sites apart. There is a group of sites on Duntryleague hill, where the only confirmed passage tomb is found, but they are placed away from the tomb on the other slopes of the hill. The implications for tempo will be discussed below but these sites are also important social points outside the main sphere of activity.

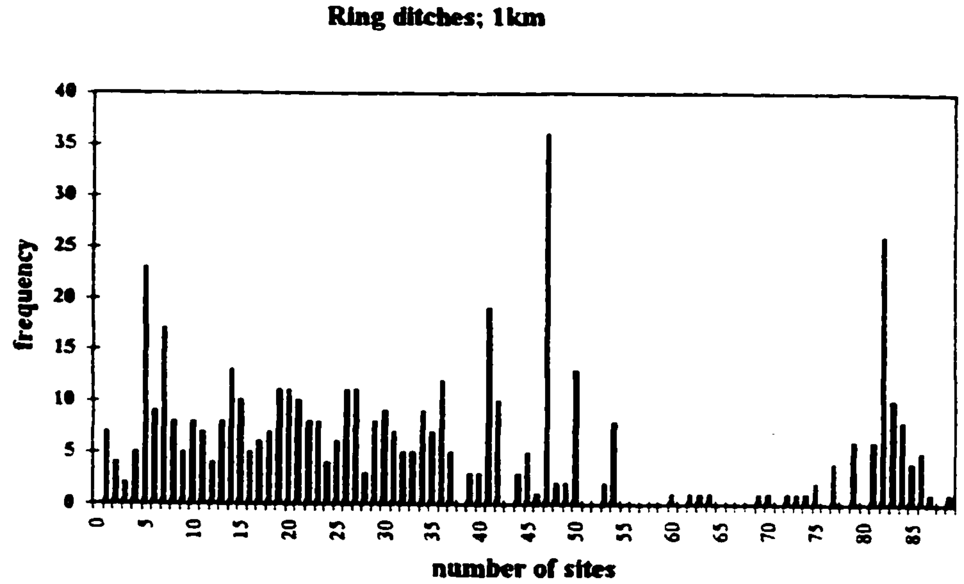
Rathanny enclosures are also set apart. While they are regularly near small concentrations of ring ditches they have the highest number of negative correlations of all sites at 5 km and 1km and are only surpassed by ring ditches at 500 m. They are found on the edges of the main zone of activity. They are also set apart by their terrain position, right on the foreshore of draining lakes. This is land that may not have been available in the main period of activity. Once again there are implications for tempo, but they also indicate the complexities of integration and differentiation.

Ring ditches themselves seem to have two different patterns. At 5km they are positively correlated with everything except cairns. At 1km they are positively correlated only with mounds and the total number of sites; while negatively correlated with cists and Rathanny enclosures. At the 500m scale they are positively associated with only *fulachta fiadh* and the total number of sites; while negatively associated with cists, fields, pits, rathanny enclosures and standing stones. The reason for this major switch as well as the counter intuitive negative correlations is in the multimodal frequency curve (Figure 88). The higher values in the frequency graphs represent the larger cemeteries, Elton and Mitchelstowndown west. The latter is in a unique terrain position and seems to be considerably more isolated than other concentrations. It is these features that the correlations are picking up.

TEMPO

Tempo is to time what scale is to space. Landscapes work at several tempos. Some places are produced and replaced quickly, others linger and take on new roles. Since this dynamic deals directly with time, the poor chronological control in this data set is a limitation. There is further consideration of

Figure 88: Frequency of ring ditches in 1km catchments of sites



both more site specific and more general information in the next chapter. In this analysis integration and tempo are connected. The integration and separation of site types from different periods reveal tempo.

For the discussion here, the chronology laid out in Chapter 2 can be reduced to three periods. The period before the construction of ring ditches is the Later Neolithic/Early Bronze Age. The period of construction and use is the Middle Bronze Age. The period coming after the construction of ring ditches is the later Bronze Age/Later Prehistoric. There are burial and habitation sites from all of these periods and their changing associations give information about the tempo of the landscape marked here by ring ditches.

The closest Later Neolithic habitation to a megalithic tomb is at Duntryleague, and there is a clear separation between the two. Tombs are positively correlated with most site types at the 5 km scale, they are in the same zone of activity. By 1km, however, they are only positively correlated with the other upland sites, cairns and stone circles. Furthermore they are negatively correlated with habitation sites, fields, and pits (some of which may be related to domestic activity). There is no correlation between tombs and ring ditches at the 1km or the 500 m scale, they are neither avoided nor preferred.

There are many more correlations between indicators of Early Bronze Age burial and habitation sites. Barrows and cists both have a consistent positive correlation with habitation sites. Barrows have a consistent positive correlation with fields. These sites are associated with some groups of ring ditches but are not in major concentrations. The negative correlations in tables 2b) and c) relate to the absence of Early Bronze Age barrows in the largest groups of ring ditches. Yet it is clear there is a connection between the two given the complex at Cush. There is also some indication that ring ditches came into use in the Early Bronze Age. One excavation recovered Early Bronze Age pottery from a central pit (Gowen 1988). The change in mortuary practice was gradual (Grogan 1989) and the ring ditches near these sites may be early in the sequence.

The indications of the raised incidence modelling suggest some spatial relationship between ring ditches and domestic sites, most of which are from the slightly earlier period. But the correlations show that the largest concentrations are apart from these sites. There is a shift in landuse then, where some

Middle Bronze Age burial sites are in Later Neolithic/Early Bronze Age domestic zones. This picture is supported by the three instances of ring ditches cut straight into earlier domestic sites (Gowen 1988).

This could be a result of increased integration and it is possible that domestic activities continued to take place in these zones. In the places where there are ring ditches near domestic sites at Duntryleague, Raheenamadra, Tankardstown south, and even Elton, there is a limited number near the domestic sites and the main concentration is slightly removed. At Ballynamona and Lissard the main concentration is on the other slope of Duntryleague hill from the complex of pits structures and ring ditches indicating an integrated settlement.

The more differentiated concentrations of ring ditches, like that at Mitchelstowndown are in wetter, more complex terrain positions. While Mitchelstowndown is the clearest example of this, the concentrations of ring ditches in Gormanstown and Ballynamona/Lissard are also nearer to lakes than the more complex groups of sites. The distinction could be chronological. Certainly the excavated sites in Mitchelstowndown and Ballynamona Lissard have different deposits than those from Elton, Cush and Duntryleague. Even the flat cemetery in Mitchelstowndown North and the *fulachta fiadh* in Mitchelstowndown east are Middle Bronze Age sites. These less integrated concentrations seem to be the most clearly Middle Bronze Age activity zones, slightly separated from earlier and later sites.

Rathanny sites show a further emphasis on wetland locations. While they are regularly surrounded by a small group of ring ditches, they are apart from the main concentrations. This indicates another shift in landuse and focus for ritual activity. While they are not included in the Site Catchment Analysis, the hillforts, located on the edges of the previous activity zone, also show this shift.

The landscape of the ring ditches bridges the landscape of megalithic tombs and that of Hillforts and Rathanny enclosures both chronologically and spatially. In the Later Neolithic, burial sites are set apart from domestic sites in upland areas. In the Early Bronze Age the landscape becomes more integrated with both burial and domestic sites in the well drained lowlands. Ring ditches are the most obvious Middle Bronze Age presence in these zones. A development of earlier burial practice, they are part of a complex including houses, fields and ritual sites. Larger concentrations of burial and ritual sites were established between communities in the broken wetlands of the end moraine. Further differentiation develops in the Later Bronze Age, ritual sites target the larger glacial lakes at the edges of the established areas and the only domestic sites known in the area are the hillforts on the hills which break the river valleys.

Summary

Each of the analyses described in Chapter 3 produced results that can be discussed according to the landscape dynamics laid out in Chapter 1. Kernel smoothing and K-functions gave results relevant to scale and integration. There were many effective scales possibly produced by an iterative processes. There are scales at which the pattern can be viewed as a cohesive whole, and others where separate concentrations are evident. These breaks within the pattern indicate separate communities. Raised incidence modelling was not a sucessful descriptor for this landscape, but the process of applying the technique gave information about the complexity of the data set.

Site Catchment Analysis produced the greatest volume of results and these results are useful for considering all four dynamics. The shifting patterns between different scales of analysis point to different effective scales for burial, habitation and agricultural use. Information on the sensitivity to terrain was detailed and complex. It is clear that the ring ditches were carefully placed with regard to a combination of terrain features, only some of which exist as separate categories in modern classifications of the landscape. All zones of the landscape were utilised, but the draining lakelands associated with the terminal moraine are the main focus of the largest concentrations of ring ditches. Correlation between different site types was the greatest aid to understanding integration, which appears to have changed over time. While most concentrations of ring ditches have other types of sites nearby, the largest seem to be associated with a more restricted range of activities. This also gives information concerning tempo. Ring ditch cemeteries are associated with both earlier sites, such as barrows and megalithic tombs, and later sites such as rathanny enclosures. But they are not associated with both together. Long term change is visible within the short term decisions concerning site placement.

This detailed discussion has investigated patterns within the distribution of sites based on statistical analyses. The discussion of these results will be explored in their wider context in the next chapter.

Chapter 5: Discussion

Introduction

In this chapter, I discuss the results of the analysis in their wider context. What does a description of the four dynamics of the Middle Bronze Age landscape mean? What is interesting here beyond an answering of the question? How does answering these questions advance our understanding of the Middle Bronze Age? Complementary and conflicting results from different analyses are considered as well as aspects of the data not covered by the analysis. I compare the patterns in the study area to contemporary landscapes elsewhere and to preceding and subsequent landscapes within the study area. These two different comparisons highlight landscape differences which come from terrain and those that come from social constraints.

Comparative material

The main difficulty in comparing my results, either synchronously or diachronously, is that comparative material has been collected in a less intensive fashion and subjected to different types of analysis. Before comparing the material on the landscape dynamics I am interested in I will do a broad assessment of the wider material as a basis for comparison.

The Irish Middle Bronze Age is known through burial sites, single finds, domestic sites and field systems (Doody 1997; O'Sullivan 1995; Grogan 1990; Ramsey 1995). As discussed in Chapter 2, this period is not well identified in the Irish literature although recent research has improved the situation. It is still difficult to move out from the excavated sites and recognise middle Bronze Age sites, other than ring ditches, by survey. Since unenclosed settlement requires intensive survey and excavation to recover, the spatial patterns of settlement are poorly defined. Ritual deposition largely defines the distribution of single artefacts and hoards (Eogan 1983; O'Carroll and Condit 1993; Cahill 1995; Ramsey 1995). The ring ditches form the best data set for landscape analysis of burial since the rest of the varied rite leaves

The Deverel Rimbury pattern is a heavily integrated settlement system identified on the chalk downlands of southern Britan in the Middle Bronze Age. Houses, trackways, fields and burials can be identified as complexes. The sense of it is that each community existed as a free standing unit or corporate group. Few interdependencies are envisaged between communities. The increasingly regional perspective shifts the scale of analysis and increases the richness of the picture (Evans 1987, Hall and Coles 1994). Ritual deposition was important here too, but the role of wetlands was different than in Ireland and lakelands such as those found in the study area were unknown.

In general the British evidence is quite different from the material studied here. There are however, similar areas - such as the Great Ouse Valley and the fenlands of the Wash (Green 1974, *Hall et al* 1987; Roberts 1998). Not only do these areas have large numbers of ring ditches as their main surviving evidence, they also occur in flooding terrain which would have been changing dramatically in the Middle Bronze Age.

Scale

An effective scale is a scale at which a spatial pattern has meaning. People made decisions at these scales. They are also the scales at which social interactions are evident. There is a relationship between the coherence of an archaeological pattern and coherence of the behaviour that formed it. In this wider discussion of effective scales, I will consider four levels of social relations - within kin groups, within communities, between communities in regular contact and between communities in intermittent contact. The different effective scales point to different scales of social organisation.

Comparisons from analysis

The ring ditches show multiple effective scales from very small to quite high. Effective scale varies slightly from one section of the distribution to another as shown by the kernel smoothing. There are breaks in the pattern, non- effective scales. Overall, the distribution is organised by a series of scales, which show no distinct break between a few metres and 1 km. Between this and 5 km, there are several breaks, but the pattern is extremely coherent at 5 km. There are effective scales beyond the study area as well. Certainly this distribution fits into at least two more scales within the region and another national scale.

The effective scales are different dependent on the measure. The kernel smoothing shows a substantially different pattern at different scales, while the k-function shows a consistent pattern of clustering. This may partly be due to different sections of the distribution clustering at different scales. Many features from the site catchment analysis point to 1km as a less effective scale than 5 km or 500 m, as the analysis of Elton soil shows. Yet there are more significant differences at the 1km scale than the 500m scale.

Site catchment analysis indicates a break in effective scale at 1km. K-functions cannot check this because of the shape of the zone of analysis (see chapter 3), but there is a slight change in the curve hinting that there could be a break here as well. Kernel smoothing on the other hand shows no break in effective scale around 1km, quite the opposite. The pattern of major concentrations suggests a reasonably regular spacing of communities through the zone of major activity. The Kernel smoothing also suggests a 2km spacing between the major concentrations.

Discussion

Because of the size of the study area, none of the analyses deals with scales above 5 km. Similarly, the scales under 100m have been poorly served. I use other studies and wider considerations to consider these questions. These smaller scales can be considered visually since the data set is not robust enough for spatial analysis. Much of the patterning below 100m relates to the structure and definition of cemeteries.

The definition of the term cemetery is largely a question of scale. General usage of the term suggests a place set aside exclusively for burial, but it is often used archaeologically to mean simply a group of burials (Waddell 1981; Flemming 1971). Sometimes the term cemetery is used for single barrows with multiple burials (Barrett and Bradley 1994, 245). It can also be used to refer to groups of monuments. Passage tombs form cemeteries (Herity 1974, Eogan 1991, Bergh 1995). Cooney has argued that megalithic cemeteries can have more than one tomb type (Cooney 1992).

The variation in the use of this term indicates a variation in effective scale. The size a group identified as cemeteries could be a useful tool for studying small effective scales diachronically. The variation also relates to modern perception. Large sites, such as passage tombs, are more likely to be perceived as a group than small ones like ring ditches or even court tombs. Since I rarely have information on the number of burials in a ring ditch, I do not refer to individual ring ditches as cemeteries. The visually defined clusters of barrows in the study area have been referred to as cemeteries because it is more evocative than referring to them as barrow clusters (Ó Ríordáin 1948; Grogan 1988b). This decision also reflects the lowest effective scale since it is the sites themselves and not the burials within them that form the lowest effective scale.

The scale of the ring ditches is very small, regularly less than 10m. However, this smallest effective scale is larger than that in an inhumation cemetery or a cemetery mound, since there is no distinguishable pattern relating to individual burial. There is very little sign of the individual in the end product of the burial ritual. More than one person was buried in any one ring ditch and once they were buried there was no distinct place for them within the site. The smallest effective scale relates to the action of corporate groups, perhaps kin groups. This is an effective scale between communal burial of the Late Neolithic and individual burial common in the Early Bronze Age and from the Late Bronze Age onward.

This trend away from the individual at the smallest effective scale should not be confused with a move back towards the communal burial of the Late Neolithic. The groups being buried in ring ditches are small. The large number of sites indicates separate groups within one community and there is no sense of many communities coming together for burial. A ring ditch is not unlike a family vault. It underscores the separate identity of the people buried there and their links to each other. The establishment of a landscape presence for a group of this size indicates a change in landholding practice.

The ancestors may still be used to legitimate social relations amongst the living but the whole community does not share the same ancestors. Some sections of the community can have more status than others.

The next effective scale relates to clusters within cemeteries. The continuous clustering shown in the k-function analysis is reflecting the fact that every large group is composed of several smaller groups. A group of three ring ditches from the largest cemetery, Mitchelstowndown, looks the same as a group of three ring ditches with no other sites in the immediate area. These clusters represent an effective scale, both by themselves and within cemeteries, represent an effective scale in the region of 30m. Such clusters could represent the burial of one kin group over a longer period of time.

A closer study of the Mitchelstowndown cemetery showed the consistency of these clusters, even within a major cemetery. This cemetery has diameter measurements for most of its sites and has been well surveyed so it was productive to examine it in detail. The concentration of sites is denser in the centre, but the distribution is still composed of clusters ranging from two to four sites. None of these clusters is consistently large. Variation in size bore no relation to position in the cemetery. The modal diameter for ring ditches in the study area is 10m (Grogan 1989). Every Cluster in the cemetery contains sites on either side of this mode. The largest sites in the cemetery are 21m in diameter. There is one of these sites in the centre of the cemetery and one on the edge.

Burial rite is also consistent through each cluster. The Discovery Programme excavated a group of sites to the south of the main concentration in Mitchelstowndown West in 1992 (Daly and Grogan 1993). This grouping contained the 21m outlier mentioned above as well as a tiny site 5m in diameter. The sites are laid out in a row, with the largest at one end and the smallest at the other. None of the sites contained any grave goods. All of the sites had the same structure. There was nothing to distinguish between the sites except their position and size. The same kinds of activities took place at small sites as at large sites. If groups of sites relate to extended kin groups, then there is little status differentiation within the group. Since the digging of a ring ditch is easy compared with the effort in the rest of the burial rite, status and scale do not go hand in hand. Larger burial sites were constructed for some groups of people.

Even within the largest cemeteries the effective scales have the same importance that they have in the smallest cemeteries. The scale of the sites themselves makes sense, the scale of a cluster makes sense, and the scale of a cemetery makes sense. These cemeteries can be composed of anywhere from one to fifteen clusters. But there is nothing about any one site that could tell you its position in a cluster, or about one cluster which could tell you its position in a cemetery.

The relationship between cemeteries is similar. The regular spacing of cemeteries shown in the kernel smoothing implies small communities with separate foci for burial. Larger cemeteries could represent larger burying communities or longer periods of use. In either case, the relationship of the burying group to the wider community is expressed in the same way – distinct but not hierarchical. Smaller cemeteries do not surround the large cemeteries any more than smaller sites surround the larger sites within cemeteries. It appears that both communities and corporate groups within them make burying decisions in a similar fashion but without reference to a central authority. The decisions lead to a complex array of burial evidence that varies from place to place (See Chapter 2). Cohesiveness is apparent in the startling uniformity of surface morphology. The exact placement of sites in the terrain (see below) and variation in burial rite express the independence of these groups.

These communities were sited in a fashion that took accounts of other groups of people at a regional scale and recognised power relations within that scale. I will argue below that the terrain positioning of the ring ditches points to a control of landscape elements connected with movement between the Blackwater valley and the Shannon Estuary. This positioning was particularly related to the role of the community at Lough Gur. The people in the study area had an active role and relationship in an effective scale of about 25 to 30 km and were part of an effective scale as large as a modern day province.

Looking at the whole of Ireland and even Europe cemeteries of ring ditches are rare. Cemeteries of larger barrows are common features of the Northern European landscape. I do not think that it is simply the low visibility of these sites which restricts their distribution. Intensive aerial surveys of large areas have identified more than were known in the 1970's but they remain uncommon. The particular circumstances that lead to this type of landscape marking form a pattern – low-lying wet areas near more dramatic concentrations of monuments (Field, D. 1999). This fairly consistent pattern indicates a wider effective scale taking in much of Northern Europe.

Synchronic Comparisons

While landscape work on the Middle Bronze Age elsewhere in Ireland is rare, there are indications of scale. There are three classes of evidence relating to different investigation patterns. By far the largest is isolated burial sites. Larger areas investigated as part of mitigation for large-scale development are an increasingly important source of information. Broader landscape studies come from the National Archaeological Survey and from individual research projects. These different classes of evidence have scales embedded in them but nonetheless they give information on a great variety in the structure of effective scales during this period in Ireland

Beginning with isolated burial sites, at Carrig, Co. Wicklow there were three cists in a circular cairn 17m in diameter. There were also burials in pits and funerary material scattered through the denuded cairn (Grogan 1990). Burial continued throughout the Bronze Age in a single cist. This indicates a smaller and better-defined scale relating to individual burying groups. It also adds another effective scale between this and the community since there is more evidence of position and place within the site due to the boundaries created by the cists (Grogan 1988b; 1990). There are multiple burials within a single Cordoned Urn. While the excavator believes that this was due to a group dying at the same time, it does not seem that the tradition of single burial continues through the Middle Bronze Age (Grogan 1990).

Moving on to larger scale projects, the Lisheen Archaeological Project has investigated an area similar in area and terrain to the Mitchelstowndown cemetery in advance of the construction of a mine about 50km northeast of the present study area (Gowen 1997, Cross *et al* in press). The glacial lakes here coalesced into fens and finally raised bogs by the end of prehistory. In the Middle Bronze Age the environments would probably have been more similar than today. There are similarities between these two Middle Bronze Age landscapes but there are significant differences also.

The greatest part of the archaeological material recorded by this project is platforms and small trackways built to utilise fen edge resources. This is a class of evidence entirely lacking in the study area, but its existence at Lisheen points to the importance of communications and relations between communities. Houses, flat cremation cemeteries and clusters of *fulachta fiadh* have also been recorded on the headland to the west of this fen (Gowen 1997, O'Niel and Stevens 1998, Cross *et al* in press).

There are no domestic or burial enclosures in this landscape. The effective scale of the community seems to be smaller than in the present study area. The space between clusters of material is around 500m. Within these clusters there is no division indicating the kind of sub-grouping evident in the present study area. The houses are found singly or in clusters, which may not be contemporary.

One of cemeteries is largest flat cremation cemetery yet to be found in Ireland. It is not yet known whether single pits in this cemetery represent individual or group burial, but early indications are that many pits contained more than one individual (Lorraine Buckley *pers. comm.).* If these burials are individual burials then there is clearly a continuance of this small effective scale through the Middle Bronze Age. A marker post found in one of the pits may account for the tight grouping of pits without enclosing elements. This may well represent a smaller scale relating to the individual, a loss of the effective scale within the community and flexibility in the scale of the community. The communities in the study area seem to be larger than at Lisheen and have a greater number of effective scales in their organisation.

Specific research projects and the National Archaeological Survey have identified three enclosed house sites and associated field systems with radiocarbon dates centring on 1700-1450BC, Belderrig, Co Mayo Cashelkeelty, and Carrownaglough. The enclosures are slightly larger and more substantial than the enclosure at Chancellorsland to the north of the study area (Doody 1995). There are no burials associated with any of these three sites. They have been interpreted as signs of expansion of settlement into uplands (Herity 1981; Lynn 1973-4; Caulfield 1988). Expansion of settlement implies increasing effective scales as groups in new areas will have wider social spheres. On the other hand, the field systems at these sites are not coaxial, like the Neolithic examples (see Chapter 2), and this may suggest organisation of the landscape by a smaller community (Cooney and Grogan 1994, 99).

In the study area, both of these trends are apparent. The activity in this area represents expansion of settlement from places such as Lough Gur, but the density is a result of in filling by several small communities (Grogan 1989). There are large effective scales, which tie these groups to distant communities. These do not overshadow small effective scales for the regular ordering of the landscape. The field systems in the study area, while not dated, have quite similar patterns to those described above.

Where houses have been identified there is usually only one house measuring less than 10m in diameter in the enclosure. These appear to be the settlements of single kinship groups, perhaps even a small extended family (Doody 1997; Eogan 1995). Once again there is no effective scale that points to relationships within a kin group. There are no clear demarcations within the house, other than a central hearth (Doody 1997). If this is the pattern that we can expect from the study area, then the ring ditch cemeteries may be the strongest expression of scale of the community in the landscape. On the other hand the settlement at Lough Gur appears to have been agglomerated (Grogan and Eogan 1987). Comparison with effective scales in other parts of Ireland underscores the variability in this dynamic. There were many different scales at which the landscape was organised and regional, even local differences are apparent.

The absence of a centralised structuring in any of the cemeteries contrasts with some of the British cemeteries where there is an ordering principle around a central burial (Ellison 1980). Sometimes the focal point is even seen as being outside the cemetery, such as a prominent chambered tomb overlooking a fenland cemetery (Evans 1987). The cemetery makes sense as a whole but its parts are parts (Barrett *et al* 1991). In the present study area taking any section of a concentration makes as much sense as taking the concentration as a whole and the boundaries of concentrations are much less marked.

Even centrally focussed cemeteries often contain clusters of cremation deposits, which are not patterned on age, sex or grave goods (Ellison 1980, 124). This is a similar situation to the pattern found in the study area, where there are clusters of monuments. Ellison's suggestion that this is either the result of an accretionary process or the result of kinship groupings has been criticised by Barrett (Barett & Bradley 1991, 216). It seems likely that the British landscape had the same variation in scale as the Irish landscape.

The classic Deverel-Rimbury settlement has the same sense of unity as the cemetery. It has houses, enclosures, fields and barrows which fit together to make a unity (Barrett and Bradley 1991, 245). Finding individual elements would only send an archaeologist looking for its complementary parts. The small scales of the individual are poorly represented in that landscape. The community also has a greater presence than it does in the Irish domestic material.

Both the fenlands of the wash and the river gravels of the Great Ouse Valley have ring ditch cemeteries (Woodward 1974; Field K. 1974; Field, D. 1999). The cemeteries of the Great Ouse Valley, while not as large as those in the study area, seem to have a similar set of effective scales. While the cemeteries make sense as a group there is no central site structuring that group (Ellison 1980, 122). It is not clear whether there are internal clusters like those in the present study area.

Middle Bronze Age landscapes in Ireland and in Britain tend to have a nested set of effective scales, focussing around social groups that could occupy a few houses. The relationships between the scales, and between the social groups represented at these scales, do not appear to be hierarchical or centralised.

Diachronic Comparisons

Since the vast majority of archaeological sites within the study area relate to the Middle Bronze Age the diachronic comparison will have to rely on wider material as well. For this comparison I will begin by discussing the scales embodied in different classes of evidence from each period and then make sense of that comparison in terms of the effective scales already discussed.

Beginning with settlement density, the Neolithic activity in the study area may represent expansion of settlement from places such as Lough Gur (Grogan 1989). The spacing of the Neolithic sites is much broader than the Middle Bronze Age pattern. While direct settlement evidence in the study area is too scant to be reliable, proxy measures such as megalithic tombs suggest a low population density. Not only are there more possible domestic sites in the Middle Bronze Age, the ring ditches themselves show an increase in population density. This density could be a result of population growth in several small communities rather than a continuing in-migration. Later Bronze Age monuments, specifically rathanny enclosures and hillforts, are less common than Middle Bronze Age sites, but there are more of these large sites than there are Neolithic sites. Their much greater size and labour input also indicates that population density need not have dropped from the preceding period.

Large scale excavations in advance of development have increased the number of known prehistoric houses in Ireland dramatically over the last fifteen years (Ó Niell and Stevens 1998; Cooney 2000, 52-85). This increase is against a backdrop of only a handful of sites being known (Grogan 1980, Grogan 1996a). When excavated the style of houses at Tankardstown was very rare (Gowen 1988). The past two years have seen the excavation of eight houses of the same type and date all across the country (Cooney 1998). This rapidly changing situation shows any discussion of the scale of houses may be overturned in a very short space of time. Nonetheless, all the recently excavated houses fall into a fairly similar size range to the previously known sites – a small house had maximum dimensions of around 5m and large house had maximum dimensions of 15m. This seems to be true for houses from both the Neolithic and the Bronze Age (Doody 1997; Grogan 1996a). There may be more of the large Tankardstown style houses in the Neolithic and more small round basket style houses in the Bronze Age (Doody 1997; Grogan 1996a) but the state of the record makes such comparisons very weak. There is variation in shape, construction technique and landscape position but no great variation in scale of houses across the three periods.

The construction of domestic enclosures does appear to be more common in the Bronze Age (Doody 1997) and this does increase the scale of space devoted to domestic activity. The construction of hillforts in the Later Bronze Age could be seen as a continuation of this increase in domestic scale (Condit and Grogan 1994). While a hillfort is clearly more than a simple domestic site, it is part of a hierarchy of enclosed sites from the later prehistoric period (Grogan *et al* 1996). Rather than a simple increase in effective scale, this trend really represents the addition of a new effective scale, in keeping with the pattern from the ring ditches. It is the manipulation of this scale, rather than the scale of a house that marks the coercive landscape presence of hillforts.

Neolithic field systems, such as the Céide fields in North Co. Mayo were laid out on co-axial plans covering whole mountainsides (Caufield 1983). This contrasts with the field systems recorded in the study area and with the other Middle Bronze Age fields discussed above. The Belderig fields are particularly important since they are very close to the Céide fields and so the difference is more likely to be chronological than spatial (Caulfield 1998). This again points to less centralised control of the landscape than in the Neolithic. This dispersed system of the Middle Bronze Age operates on smaller effective scales for day to day landscape choices. It is not possible to distinguish Middle Bronze Age fields from later Bronze Age fields in the literature (Daly 1994). Nonetheless, the scale of the organisation of the agricultural landscape may have expanded. There are indications of a heavily structured landscape surrounding the hillfort of Mooghaun in South Co. Clare. The higher status and ritual sites cluster in a core of about 5km and are surrounded by an agricultural hinterland (Grogan 1996b).

In the Neolithic, the focus on the single site for multiple burial shows a greater effective scale than the ring ditch. The burial rite in passage tombs did have a similar negation of the individual and emphasis on the burying community to the rite in the ring ditches (Cooney 1992; 1997). However, the community was much larger, as emphasised by the sparser spacing of these sites. The Later Neolithic activity at Duntryleague could be contemporary with the passage tomb further up the hill, but there were probably many other groups using the same monument for burial (Grogan 1989). This more centralised pattern with larger scale monuments seems to have reformed in the Later Bronze Age with the construction of rathanny enclosures. It is probable that there were more dispersed burial patterns contemporary with these sites (Waddell 1981, 1990), but the centralised ritual focus is reminiscent of the Neolithic pattern.

There is a greater range of effective scales in the Middle Bronze Age than in the Neolithic. The burial sites are smaller - the patterns are smaller. The high density of sites themselves decreases the scale since there is less space to work with. This higher density of population also allowed for the formation of a new effective scale. This new scale represented the actions of a group between the community and the individual, perhaps family or kin groups. The manipulation and expansion of this scale is seen in the increased enclosure of domestic space through the Bronze Age.

The large monuments of the Neolithic have been explained in terms of holding a dispersed society together and keeping information flow moving between a sparse net of people (Chapman 1981). This is not necessary in a higher density situation. People would have regular contacts with neighbouring groups, as well as maintaining less regular contacts with groups from far away.

As that population density rose, and small rank differences are enhanced, this habitual structuring of space broke down and once again large monuments appear, controlling information flow, and likely the flow of resources as well. This is an expansion and manipulation of the effective scale that was formed in the preceding period. The later prehistoric pattern is more centralised again. There are larger scale monuments, more heavily structured, greater labour input to build each one. In this case, cohesiveness is likely to be a continuation of social ties built during the previous period. Hillforts are less symbolic than Passage Tombs with more power in people's lives. The flourishing of new and regional weapons types is also testimony to the power of coercion and the increasing scale at which that was displayed.

Conclusions

It is difficult to think consciously in a multiscalar fashion. I can describe a landscape of many effective scales, but when comparing with other landscapes I tend to focus back down on one scale. Perhaps this is partly because the identification of more than one effective scale takes a more detailed analysis than is available for the comparative material.

While there are many effective scales in operation, they do not form the smooth continuum suggested by the K-function analysis. The breaks in scale are as important as the effective scales themselves. While there are terrain features that would break the study area into different units, the smaller effective scales indicate that social activities and perceptions were also important in creating patterns at different scales. Social activities created boundaries and defined units of different sizes.

The small effective scales give information about community size and structure. The first two effective scales indicate that within these communities there were smaller active groups, probably kin based, which controlled burial. There is very little sign of the individual in the end product of the burial ritual. More than one person was buried in a ring ditch and once they were buried there was not distinctive place for them within the ring ditch. The evidence from domestic sites elsewhere suggests that similar sized groups were living in small, enclosed farmsteads.

This should not present a picture of isolation however. These smaller groupings of people were burying their dead in cemeteries indicating larger group affinities. These were also small - there could be from five to eight distinct communities in the study area. This is approximately the same number that there is today. These communities also had affinities with each other, as expressed in the regularity of the patterns within these cemeteries.

This nested social structure does not appear to have had a hierarchical structure, in contrast with the Later Prehistoric landscape. Some communities had larger cemeteries, but this was a result of more burial, not more effort put into individual burials. There is nothing to indicate that any one community had greater status, power, control, and position than any other. Although there is a scale that may represent the activities of kin groups, there is no clear indicator of status differences between these groups. Different communities may have had different relations with people from further afield. The break in effective scale just above 1km may relate to this difference in positioning.

The similarity of this landscape to those of the Wash and the Great Ouse suggests some connection between these groups, and thereby a much larger effective scale. There are other indicators of contacts between Ireland, Britain and continental Europe at this point. International trade mediated some of the power relationships within the region in the later prehistoric period (Cooney and Grogan 1994, Waddell 1995; Eogan 1995). There is no evidence that the island of Ireland was an effective scale for these people. They were certainly aware of the world beyond Ireland and that knowledge conditioned their sense of place within Ireland.

Terrain sensitivity

Many different terrain features are important in siting - so terrain sensitivity is not yes or no, or lots or little, or more or less than another period. This landscape is sensitive to particular features in particular ways. These sensitivities highlight the importance of wetlands and broken land, seasonality, mosaic use and regional positioning. Since the only analysis to deal directly with terrain sensitivity is Site Catchment Analysis I will summarise and highlight the results in this section. The discussion follows a similar structure to the discussion in Chapter 4, but seeks to move beyond the analysis into a broader sense of the terrain.

Highlights from analysis

There are two separate preferences in the siting of ring ditches. One group preferred the draining lakes that now show themselves as Coolalough and Drumbanny soils and the other well-drained soils based on glacial till, such as Elton. It would seem at first that these two preferences are contradictory but in reality they point to two different siting patterns. There are cemeteries placed on the shores of glacial lakes and those on the well-drained terraces overlooking the more substantial streams.

Further, the two siting preferences represent the different scales at which terrain sensitivity takes place. Elton soils are preferred at the higher scales where the choice relates to the general zone of living. This will take in domestic, agricultural and ritual activities. At the smallest scale, the specific placement of burial sites, the choice is more often for lakeshores. This means that the well drained soil, good for agriculture is not used for burial. It also reflects the particular preference for these draining lakes in the overall ritual surrounding cremation and burial.

Terrain features are more often preferred than avoided. The River Maigue and its associated terrain is the only real example of avoidance. This may be best understood in reference to regional networks. The Maigue does not lead to the south west. This places it in a less contested corridor than the other rivers of the study area, particularly south of its confluence with the Morningstar.

The character of the river best explains its avoidance at the 500m scale. The Maigue is different from the Morningstar. It has a naturally deeper riverbed, larger flow, steeper banks and more river alluvial soils surrounding it. Substantial rivers are the focus of a completely different kind of ritual behaviour within the Irish Bronze Age, the deposition of metalwork (Cooney and Grogan 1991). They are avoided by *fulachta fiadh* ring ditches and standing stones (Grogan 1989, Feehan 1991, Condit 1990). These are locally based ritual activities and the streams that they are associated with also have a local character.

Discussion

Scale and measurement condition my understanding of terrain sensitivity. The most obvious disjunction between my measurement and the Middle Bronze Age terrain is the lack of information on vegetation. The general picture from other research (Barrett & Bradley 1991; Cooney and Grogan 1994; Molloy 1997; Weir 1987; 1993; 1995) is of a landscape composed of mixed woodland, grassland, wetland and arable crops. Placing these in a spatial framework that relates to this landscape is more difficult. Considering the landscape in terms of terrain type and place is one way of getting around this problem.

Essentially, there are four different types of terrain in the study area: moraine, draining lakelands, well-drained lowlands, river-flooded lowlands, and uplands south of the moraine. Cross cutting these are places whose terrain position is important: the Morningstar valley; the Loobagh valley; the Camoge Valley; Duntryleague Hill; Cush and Knockainy. Each of these types and places has a different resonance for economic, ritual and social concerns.

The moraine can be seen as a boundary between two worlds. The landscape to the south of it is very different from the one to the north of it. It is on the edge of the uplands, and marks the end of the Irish midlands. It has many edges within it since the erratic glacial till developed a very mixed soil pattern and a patchwork of lakes. All of these boundaries make it an appropriate place for the transition between the living and the dead. The largest cemeteries of ring ditches are found in this zone. It can stand as a liminal space in the burial ritual. The edges also have economic importance since they allow a mixed farming strategy to be practised. Flooded grasslands provide particularly rich seasonal pasture (Finch and Ryan 1966), and the newly drained shores of the lakes could have been even better in this respect. The moraine would have also been a marker to people from other areas. The maze of lakes may have created a place through which a traveller would need a guide with local knowledge in order to pass.

The broken land of the end moraine turned up as important at every scale in many different ways, as did the high end natural streams. Examination of the complex of soil and lake on this moraine suggests a pattern of sites scattered through the low islands of dryland found throughout this complex (see Figure 86). There are low terraces near the high tributary classes of the natural drainage systems. These terraces are still regularly flooded and the broken nature of the ground with small platforms surrounded by erosion gullies indicates that flooding has been prevalent in these areas over a long time. It is in these areas and on these platforms that ring ditches are most commonly found

There are indications that these naturally occurring platforms in the floodplain may have been used as a natural demarcation for ring ditches (Ó Riordain 1936; and O'Kelly; 1942). These platforms generally range in height from 30cm to 80cm and. Erosion gullies, resulting from flooding, define their edges. They have the same soil profile as the surrounding ground. They appear to have developed after the drainage of the lakes as a result of periodic flooding of delicate soil. They range in maximum dimension from 15m to 50m. Some of these platforms have been scarped around the edge, emphasising the natural feature (Grogan 1989).

The most dramatic case where ring ditches have clearly been placed on one of these platforms is in the Duntryleague cemetery where eight ring ditches were clustered together on one platform (see Figure 46). In this case, while the feature is natural, it acted as an enclosing or defining feature – marking the small cemetery out from the surrounding landscape (Ó Ríordáin 1936; 1948). Examining the relationship between these platforms and the overall distribution was beyond the scope of this study. It is possible that the use of these platforms as naturally defined areas may relate to a particular stage in the sequence of use. But this micro-siting could also be part of the detailed variation which distinguished one cemetery from another.

Most of the draining lakelands of the study area would have been fen with pools by the Middle Bronze Age (see Chapter 2). There would probably still have been substantial stretches of open water and the lime rich marl underlying Coolalough soil would have kept the acid levels in the fen low. The encroaching fen would have increased the biomass of these lakes, making them good places for wildfowl, as well as sources of herbs, berries and grasses (Feehan, 1996). Further information on the composition of these lakes would be useful since wetland is not a single terrain category. There is a distinction in prehistoric treatment between lakeland, bogs, rivers, and estuarine contexts (Cooney and Grogan 1994 , 198). Even the changes in one fen over time will provoke different human uses (Cross *et al* in press).

The importance of these lakes in the Middle Bronze Age is underlined by the Lissard log boat. This is the mark of a boat found during the excavation of one of the ring ditches in the Ballynamona/Lissard cemetery (Ó Ríordáin 1936). This was a unique find and indicates a particular connection to the glacial lake on whose shores the cemetery is placed. The rathanny enclosures were on the foreshore of lakes up to a kilometre across, which is a moderate size lake in Ireland. The earlier ring ditch cemeteries were on much smaller pools.

At Chancellorsland, immediately to the north of the Study area, the excavator has suggested that this type of landscape could have been used for seasonal pasture (Doody 1995). In other areas of Ireland, these environments were favoured for jewellery hoards (O'Carroll and Condit 1993). Field has suggested a cosmological significance for springs and wet places in this period (Field, D. 1999). In the integrated landscape studied here this spiritual significance may be in addition to the significance of these lakes for seasonal pasture and wild resources.

It is difficult to assess the use of river flooded lowlands since river alluvium may mask ephemeral archaeological remains. Nonetheless, the strong avoidance of the Maigue, and the low numbers of ring sites in the south west of the study area suggest that these types of terrain were not favoured for settlement or ritual in the Middle Bronze Age. While river floodplains can be valuable resources in arid climates, the Irish landscape has quite enough water. If these areas were avoided it shows us another aspect of the detailed variation in the response to wetlands at this time.

Well-drained lowlands could have been used for a mixed agricultural regime of both pasture and arable. In contrast with the moraine-based lakeland described above, this type of terrain is widely distributed through Ireland. While the site catchment analysis showed that these soils were important for the whole distribution, this terrain was not used in a similar fashion across the study area. The stretches of well-drained soils in the south west of the study area have Neolithic material but far fewer ring ditches than further north despite intensive fieldwork (Gowen 1988). At Elton however there was a very dense cemetery close in beside a settlement which may have been in use from the final Neolithic. More recent detailed survey of this cemetery has shown an even denser pattern of use than was available for analysis, with ring ditches overlapping one another (Masterson 1999). The importance of this location, however, was due to more than the well-drained lowlands it inhabits.

The uplands south of the moraine are also well-drained but they form a very different terrain zone, unique in the study area. With thinner glacial drift from an earlier glaciation, the foothills of the Ballyhouras are less fertile than the slopes of Duntryleague less than 5km to the north (Finch and Ryan 1966). The best advantage of this terrain its position in relation to other terrain features. These slopes have commanding views, both over the lakelands, which were clearly important, and over the pass to the Glen of Aherlow, a fertile valley with access to the south coast.

The types of site found here reflect this positioning. There is a scattering of ring ditches on the lower slopes, showing that the zone was in use during the construction of these sites. The distribution of stone circles, standing stones and hilltop cairns, however, suggests that the main ceremonies taking place were distinct from the burial tradition represented by the ring ditches. I am not suggesting a cultural or chronological distinction, rather a complementary ritual pattern which had a different landscape focus than burial. It is possible that these ceremonies were more related to relations between communities, hence the more prominent positioning with broad views. One of the two hillforts in the study area is also found in this zone. This type of site is related to increasingly centralised connections between small communities. Its position in relation to the passes to the south also fits national distribution patterns (Condit and O'Sullivan 1996).

Duntryleague is a hill that marks the entrance to two different passes into the Glen of Aherlow. This most south east corner of the study area is part of a different river catchment than the rest of the study area. More dramatically, this river, the Aherlow, flows to the south when it leaves the study area and drains into the Suir, which drains into the Atlantic in the South East of Ireland. East of Duntryleague there is another pass created by the Anaphuca River, which drains into the Funshion, this drains into the Blackwater. Looking at Figure 1, you can see that there is no similar pass to the west of the study area since the Maigue terminates. Duntryleague therefore controls the main pass to the south west. This gives Duntryleague the strategic importance of a route between the Shannon Estuary, a regional power centre important in bronze production (Grogan 1996b), and the south west, the main source of copper in Ireland (O'Brien 1994).

The Hill of Cush is an important place in the landscape of the area even today. It is the first peak in the foothills of the Ballyhouras and marks the end of the midlands. Activity and habitation spanning many periods mark this long-term importance. Across the peak of the hill are scattered markers and monuments such as stone circles and standing stones. These types of sites probably have their earliest expression in the Middle Bronze Age and continue in use as ceremonial centres and way markers through the Later Bronze Age (Ó Nuallian 1975; 1984; 1988). At the head of the river Loobagh there is a complex of sites that began in the Early Bronze Age with barrows and encisted cremations. It continued in use through the Middle Bronze Age with a small cemetery of ring ditches and is finally succeeded by a stone fort, which is probably associated with the early historic ringfort tradition (Ó Ríordáin 1940, Stout, M. 1997).

The Camoge River joins the River Maigue north of the study area and most of its length is outside the study area. It enters the study area in the northwest, near the town of Hospital, and rapidly breaks into the Drumcamoge River and many smaller tributaries. It is generally a fast flowing river with a reasonably deep bed, but in the study area it drains the former lake soils and its character changes. The valley associated with it has steeper slopes than the Morningstar River or the Loobagh River.

There are few ring ditches associated with this river, perhaps partly because of its river alluvium based soils. It is the main focus, however, for the rathanny enclosures suggesting either a change in terrain requirements for ritual or another significance for the river. Since this river leads past the settlement at Lough Gur before reaching the River Maigue, this Later Bronze Age focus on the valley may indicate a greater connection to the community at Lough Gur.

The valley of the Loobagh River is not a very substantial feature. Both shallow and broad, it floods regularly as it climbs the western slopes of the hill of Cush. The Loobagh is the shortest of the three main tributaries of the Maigue in the study area. It runs mostly though well-drained lowlands and skirts to the south of the main moraine based lakelands. While the Loobagh runs from the Ballyhoura's to the Maigue it leads to the wrong side of the hill of Cush for the passes described above. While the Loobagh was an important water source for the Early Neolithic houses at Tankardstown south, it is more marginal in the distribution of ring ditches. The ring ditch superimposed on the much earlier house at Tankardstown 2 is one of the few examples from this part of the study area. This is a clear example of changes in terrain sensitivity as will be discussed below.

The Morningstar valley is the main focus of the whole distribution. While the route of the gas pipeline artificially inflates that impression it is clear the river and its minor valley were important terrain features. This valley brings together many of the different terrain features that were important in the distribution. It drains the glacial lakeland and yet runs through well drained soils based on glacial drift. It is the most direct route from the passes to the south and the Maigue, and this route avoids the high status settlement at Lough Gur. The two largest cemeteries, at Elton and Mitchelstowndown mark the closest approaches of the Camoge. The only section of the valley which has few ring ditches is the large meander in the north of the study area, where the river floods and so Gleys based on river alluvium predominate. There are rathanny enclosures and hillforts in this area but it does not form the main focus for these types of sites. It is central to the landscape of the ring ditches, but less important for other sites.

Wider comparisons

Comparing the response to terrain synchronically is problematic since spatial variation will obviously mean terrain variation. There are, however, several themes in response to this terrain, which can be considered in other areas. The importance of wetlands for economic, social, and spiritual activities is emphasised in many research projects studying the Middle Bronze Age. Mixed soils and ecotones have been seen as significant in many different prehistoric landscapes. There are contrasts as well, such as the role of uplands and places with vistas.

Mixed soils are considered important in many studies of the Irish Prehistoric landscape (Cooney 1979, Grogan 1989). Soil complexes can be seen as extreme versions of places with mixed soils. These are zones where small-scale mixed farming can take place with great efficiency. There is no need for the infield outfield models of the British literature with their large-scale transhumance (Flemming 1971; 1985). They also indicate the importance terrain sensitivity at a scale lower than this analysis will allow (due to data limitations). They show the importance of micro-topography in the same manner as the little platforms and are part of the same moraine phenomenon.

Longstanding analysis of the distribution of Bronze Age metalwork in Ireland has shown the importance of wetland deposition (Eogan 1964; 1983; 1994; Harbison 1969a; 1969b; Kavanagh 1991). Some authors have emphasised the importance of ritual deposition in this distribution (Bradley, R. 1990, Cooney and Grogan 1994). Because most metalwork has been recovered casually we do not know where it came from, which makes understanding spatial and environmental patterning difficult but the importance of wetlands is evident (Condit and O'Carroll 1993; Cooney and Grogan 1994).

This pattern varies through the Bronze Age. Hoards, single deposition in bogs, and to a lesser extent, burial are the most common contexts for all metal in the Early Bronze Age (Cooney and Grogan 1994, 102). Some items, such as razors are found as grave goods in the early part of Middle Bronze Age (Kavanagh 1991). The most common pattern for this period, however, is single deposition in lakes and rivers (Cooney and Grogan 1994, 139). In the Later Bronze Age large-scale deposition of hoards in both wetland and dryland contexts has dominated discussions (Eogan 1983, Bradley, R. 1990). There is also a good deal of single deposition, particularly in rivers (Cooney and Grogan 1994, 178).

The Ralaghan figure, an anthropomorphic wooden figure points to the fact that not all wetland rituals were centred on the conspicuous destruction of prestige items. (Cooney and Grogan 1994, 156). Further research on votive deposition in wetlands is needed. Wetlands as a terrain entity need to be broken down into more concrete and useful concepts. First a division must be made between deposition in fen and deposition in raised bog. Are fens a version of lakes, or do fens, raised bogs and lakes all play different roles in the landscape of ritual practice? Next, the nature of particular bogs must be studied. Is there more deposition in small bogs, large open tracts, or mosaics of bogs with small 'islands' of dry land? Position in relation to other terrain features also needs to be considered. The large hoards at Mooghaun North in Clare and the Bog of Cullen in Tipperary are both overlooked by hills (Cooney and Grogan 1994 Fig 8.16). The combination of the two elements may have been important in the siting of such activities. These sites are also near contemporary high status sites and this combination needs to be studied more fully.

Recent research in Britain has highlighted the importance of wetlands in Bronze Age funerary rituals. Roberts discusses a complex of fen edge inhumations and burnt mounds as indicating a vernacular use of a fen edge in East Anglia. She sees people being buried in the fen edge as "a sign of respect to both them and their environment" (Roberts 1998, 196). The same pattern may be evident in the flat cemeteries recorded at Lisheen (Cross *et al* in press). In East Anglia, surveys of Borough Fen and Catswater Fen have shown large clusters of barrows on the fen edge.

> "This is explained as intentional locating of ritual foci at the approximate boundary between dry and wet land ... As these ritual structures all seem to relate to mortuary activities, we could suggest that the dead were being placed, or alternatively honoured, at the boundary between the 'two worlds'" (Hall *et al* 1987, 191).

The maze of rivers in the study area is one of the terrain features that must have changed substantially since prehistory but it is clear that the study area always had a plethora of small watercourses. While such a supply of fresh water is always available in Ireland, the density here is remarkable (see Figure 7). Field has argued that water and water sources may have had a particular place in Middle Bronze Age cosmography in Britain (Field, D. 1999).

The study area offers very few vistas. This is some of the flattest land in Ireland. Hills are important where they exist but they are not a prerequisite for settlement or ritual.

The scarcity of large cemeteries of ring ditches in other parts of Ireland indicates that this location is favoured for their construction. While the place is created more than its terrain, there are clearly elements that show particular terrain sensitivity. Field's analysis suggests that there are different types of burial ritual in different type of terrain. Ring ditches may have been the favoured marker for burial rituals in fen edge and dense lakeland (Roberts 1998; Field, D. 1999). Other landscapes will have had different types of burial in this period (Wadell 1981). This potential for central elements of culture, such as burial ritual, to vary in response to terrain would indicate a high degree of sensitivity in the Middle Bronze Age.

Diachronic Comparisons

Wetland was more important, or differently dealt with in the Bronze Age than in the Neolithic. There are many different indicators of ritual significance, which are not discernible in the Neolithic. There is also very little evidence for more prosaic use of wetlands in the Neolithic in Ireland.

There is a broad suggestion that Bronze Age communities expanded into heavier soils as shown in pollen diagrams and field systems (Edwards 1985, Doody 1997, Cooney and Grogan 1994). Despite the importance of modern Gley soils, in the study area the well drained soils still control the overall distribution. It has been argued above, that the availability of arable land was still important. The use of the heavier soils seems to be for pasture, for the gathering of wild resources and for ritual purposes.

Topography and aspect were more important in the Neolithic and the Late Bronze Age than they were for the bulk of the Middle Bronze Age sites. That being said, the stone circles and standing stones continue the importance of visibility and intervisibility in the landscape. The importance of passes, and routeways stays strong throughout prehistory but is marked in different ways. Movement through this landscape would have involved a lot of local contact, not messages transmitted over long distances, but by word of mouth. This fits with a down-the-line trading pattern already proposed for the Bronze Age (O'Brien 1994)

How terrain sensitive is the Neolithic landscape? Herity argues that Passage Tombs have a regular terrain position on the tops of Hills (Herity 1974). Cooney points out that siting can be much more varied (Cooney 1983). Grogan argues for a regular placement of domestic sites, which takes advantage of the best soils and prospects (Grogan 1996a). The Neolithic field systems of North Mayo are terrain oblivious. The sensitivity evident in the Neolithic is one based on economic and daily social concerns. Social factors have more effect on the placement of ritual monuments and community constructions.

The Middle Bronze Age landscape is sensitive to many terrain variables in different ways. Within the cemeteries terrain variation is less marked and less important. There are two different patterns of siting for the large cemeteries. The first, best shown in the Elton complex (Figure 43), has close clusters of ring ditches, near or within fields, on well-drained land overlooking a river. The second, best shown in the Mitchelstowndown complex (Figure 41), has ring ditches and other burial sites on floodplains near small lakes. Although there are more sites in this complex, they are less tightly clustered together. Smaller cemeteries and even outlying sites tend to fall into these two patterns as well. Compare Ballynamona/Lissard (Figure 42) and Moanmore (Figure 34) with Gormanstown (Figure 44). The site at Tankardstown South is in the first siting pattern, those at Rathanny in the second.

These two siting patterns could be contemporary or display a change in terrain sensitivities. With so few sites dated, and such a long period of cemetery development chronology remains unclear. It is possible, however, that the difference in siting stems from a change over time. Sites from earlier periods, both domestic and ritual, tend to favour the better-drained, slightly higher land preferred in the Elton pattern. Ritual sites from later periods tend to favour the draining lakeshores preferred by the Mitchelstowndown pattern. Further, all of the excavated sites with a central burial come from the first group. These are the sites of Lissard (LI049-037--)(Ó Ríordáin 1936), Adamstown (LI040-108--) (Gowen 1988); and Tankardstown South 2 (LI047-013--) (Gowen and Tarbett 1988). Since this rite is similar to the Early Bronze Age pattern of inurned cremation it may be earlier than the cominuted token burials found in ring ditches and burial sites in Mitchelstowndown (Grogan 1989; 1990; Daly and Grogan 1993).

In the Later Prehistoric period this terrain sensitivity continues with hillforts and Rathanny enclosures being sited carefully in relation to soil type, proximity to lakes and elevation. Recent research north of the Shannon estuary describes a Later Prehistoric landscape in which, all elements form a coherent whole and all are terrain sensitive. Where extensive Bronze Age field systems have been found in Ireland, they are more terrain sensitive than their earlier prototypes. Hillforts occupy the hills that were not important in the Middle Bronze Age. Rathanny sites dominate the shores of lakes that were not major ritual foci of the Middle Bronze Age.

Conclusions

The terrain sensitivities displayed by the ring ditches refer to many aspects of life. While the sites themselves are for burial, their placement constructs a landscape that reflects economic and social concerns. If they are seen as part of settlement system then it is clear that that system was based on mixed farming with both arable land and good pasturage catered for. There may have been a seasonal element to the agriculture practised, but nothing on the scale of the transhumance postulated for Bronze Age Britain.

A thorough knowledge of and sensitivity to a variety of terrain features underlies the distribution of ring ditches. There are different priorities at different scales. At the largest scale, economic concerns are related to regional social connections and probably influenced movement of people and goods through the area. The cemeteries at Duntryleague and Mitchelstowndown are the clearest expressions of these concerns but they affect the whole distribution at the highest scale. At the study area scale, concerns are for terrain that is viable for a mixed farming strategy. The central role of Elton soil is combined with a preference for soil complexes. At the local scale the concerns are more for terrain features marking boundaries, broken land, wetlands rivers. The moraine, the lakes and the small platforms are all indicators of these siting priorities, which may have cosmological significance.

Integration

All landscapes are integrated at some scale since they work as a system. But in some landscapes different activities take place in different terrain, or separated from each other for social reasons. Integration reflects how many different types of activities take place at any given scale. There is evidence for four main activities in this landscape – burial, agriculture, habitation and wider ceremonial behavior. While the burial evidence dominates the other material, all of these activities took place in very close proximity to each other. This leads me to consider this to be an integrated landscape in contrast to ritual landscapes described elsewhere (Moore 1996).

The southern British Middle Bronze Age complex known as Deverel Rimbury typifies an integrated landscape. Fields, houses and burial sites are intermixed. Many Bronze Age landscapes have very separate places for different activities, which leads to the identification of 'ritual landscapes' (Moore 1996). The landscape under study is fairly well integrated, but there are places which seem to be set apart as well. What activities took place together? What activities took place in the same type of terrain?

Integrated landscapes intermingle meanings and activities. Ritual landscapes take sections of the world and mark them off from other sections, give them stories, significance. They group together areas for one purpose and separate out other purposes – the domestic and the wild, the sacred and the secular. This is not a ritual landscape. It is a landscape permeated by domestic activity and by several different ritual activities. There was likely to be more domestic activity than is accounted for here, but it is unlikely to be in completely different zones of the landscape. Not all of the sites need have stood in the same relation to settlement.

Comparisons from analysis

The results of all of the analyses can be considered in a discussion of integration. In many ways, these results are the most complex, often seeming nearly contradictory. Correlations were used to discuss the distributions of different site types in the Site Catchment Analysis, which is a less satisfactory method than the simulation approach used for the rest of the analysis. Correlations point to what is happening in the largest concentrations, but can obscure relationships within and around smaller cemeteries. The strongest results, however, are the indications that there are at least two different siting patterns. The two siting patterns, one more integrated and one slightly set apart, relate to the two terrain siting patterns, one in well drained land and the other on lakeshores.

This multiple distribution within one type of site could have been one of the factors complicating the raised incidence modelling. It may show up also in the kernel smoothing in the sense that different concentrations cluster at different scales, an indication of their variability. On the other hand, the kernel smoothing and the K-functions also point to a coherent pattern at a range of scales. These analyses only considered the distribution of the ring ditches in spatial terms. Perhaps the spatial structure of the cemeteries is more constant than their landscape position.

Ring ditches themselves seem to have two different patterns. As with fields, cists and standing stones they move from being positively correlated with many site types at the largest scale, to being avoided at the smallest. This is partly due to the influence of the larger cemeteries, Elton and Mitchelstowndown west. The second of these two is in a unique terrain position and seems to be considerably more isolated than other concentrations. It is these features that the correlations are picking up. The concentration of sites in Mitchelstowndown, are set apart. Since the other negative correlations at the 500m scale are sites associated with wetland, such as rathanny enclosures and *fulacht fiadh*, perhaps Mitchelstowndown is outside of the agricultural landscape because of its position in amongst the lakes of the end moraine.

Many different results point to the integration of agricultural and ritual activities. The importance of the well-drained soil, Elton, has already been discussed above. The relationship between ring ditches and fields, pits and standing stones follows the same pattern (Figures 71 and 72; Table 2 a), b), c)). The negative correlation with ring ditches at the 500m scale does not reflect a general separation of burial sites and agricultural activity, even at this small scale. Fields are positively correlated with barrows, cists and pits, all of which are burial features. The positive correlation of fields and all site types except Rathanny enclosures and *fulachta fiadh*, shows the same overall concern with agriculture as the Elton pattern.

Habitation sites have a similarly changeable pattern. Although the specifics are different, notably in the positive correlation between habitation sites and *fulachta fiadh* at the 500m scale, they once again show the integration of domestic and ritual activity. While not correlated with ring ditches at the 500m scale, their positive correlation with the total number of sites indicates that they occur near ring ditches when those ring ditches have other site types nearby. This is again pointing to two different patterns for ring ditches, one integrated, one set apart.

Standing stones, cairns, stone circles and megalithic tombs are upland sites that are clearly set apart from the rest of the pattern. They are more visible from a distance than the other site types, both by location and structure. The difference in degree of marking and difference in location may both be linked to a structured integrated landscape. These sites were important social points outside the main sphere of activity. They were designed to be seen from the areas where people lived, slightly apart but still part of the same landscape.

Rathanny enclosures are also set apart but they are considerably less visible than these sites because of their lowland position. They are found on the edges of the main zone of activity and have many more negative correlations than positive ones. The foreshores of draining lakes where these sites were constructed would have been underwater for most of the Middle Bronze Age. While this separate location pattern probably relates to changes over time (see below), it provides an example of lowland ceremonial sites that are not as clearly integrated with the domestic landscape as the ring ditches.

Kernel smoothing at kernel sizes in the region of 1km highlighted the intensity of the concentrations against the background scatter of sites. While the distribution shows no major gaps at this scale, it is not completely integrated. These concentrations are remarkably evenly spaced and sized. The zones of lower density between these groups are about 2 km in each case, which could indicate small communities with some buffer zones between. There are consistent concentrations that can be distinguished from the overall distribution at Tankardstown North, Elton, Mitchelstowndown and Duntryleague Hill. While the sites at Cush and in Tipperary are less densely spaced, they too stand out as separate clusters.

Discussion

The different terrain positions and concentrations discussed in the section on terrain sensitivity also vary in terms of integration. There are concentrations with many different activities and others with only burial and ritual sites. There are concentrations that have earlier sites at their core and others that are dominated by the Middle Bronze Age sites.

Both Duntryleague and Cush have similar terrain positions in the foothills. Both are on the westward crests of hills. Both have earlier activity: at Duntryleague a Passage tomb; at Cush an Early Bronze Age cemetery. The ring ditches at these sites are more tightly placed than those in other concentrations. While not all the sites are as closely spaced as the group in figure 46 the distinction is still noticeable. While the domestic activity at Cush is considerably later than the ring ditches the sites at Duntryleague are slightly earlier or potentially contemporary (Appendix C). The Duntryleague domestic site also has a similar form to the ring ditches and was originally interpreted as a ritual site with some domestic activity. This highlights the close connection between these two activities.

At Elton domestic activity, both previous and possibly contemporary is also evident. There are also field systems near the concentrations of ring ditches. The high values of Elton soil, which are so prominent in the 5 km scale maps (figure 72) point to the importance of agricultural activity here. The main concentration of ring ditches is about 100m north of the domestic site and there is a further tightly placed concentration to the north east. The main concentration of sites overlooks a terrace on the Morningstar, while the smaller concentration is on a tributary of the Camoge. This is an important connection point between the different river values, its soils and proximity to lakes make it suitable for a wide range of activities.

The concentration of ring ditches at Mitchelstowndown is unique both in the study area and in Ireland. There is nowhere else with this density of sites. Within the study area the terrain position is regularly separated out from other groups (see above). The moraine has produced a particularly complex pattern of soils to the south and east of the main concentration, which the sites stretch out into - on dry land through the maze of lakes. This unique position sets it apart and there is no evidence for domestic or agricultural activity in the main concentration. There is a domestic site in Raheenamadra slightly to the north but the ditch of a ring ditch has cut it. This concentration represents a different pattern for ring ditches than the other concentrations. Outside of the main sphere of activity it is the closest this landscape comes to a 'ritual landscape'. Its position nearly midway between Duntryleague and Elton is important in this and it may represent a boundary zone between two communities.

The broken, wet lands of the end moraine are not all marginal. There is a strong association between field systems and the medium size groups of ring ditches. Further, several sites in these areas may be denuded domestic sites, or at the very least represent everyday activities taking place very close to the mortuary sites. One of the largest cemeteries, Elton, is built next to the site of a beaker kiln, and there are cultivation systems intermingled with the ring ditches themselves. There is also an outlying ring ditch cut into the foundations of the Early Neolithic house at Tankardstown. Not all the cemeteries show this pattern, but enough to indicate that some of them were part of an integrated habitual pattern rather than a separate space in which wide community narratives are acted out.

A habitual pattern of construction and use could have formed this pattern. These sites were a part of life and the patterns of distribution are interwoven with other activities of life. They can be contrasted with 'ritual landscapes' of large-scale monuments which "represent the peak of cohesion for a dispersed community". These sites certainly do not represent the peak of cohesion. Each individual site probably represents the efforts and concerns of an individual corporate group, the choices for specific placement of these sites shows no sign of being controlled by a central design. Where sites form clusters within cemeteries it could be because of kinship, chronology or desire for alliance. In contrast with many other traditions of burial, there is not a central control.

Within this framework of small-scale choices of individual corporate groups, there is evidence that the overall cohesion of the groups constructing these sites was high. Firstly, the form of the sites themselves is uniform. The repetition of similar choices across this area shows several different social groups making similar ritual choices without a central focus for that activity.

Enclosure, of burial, habitation and agricultural activity all point to a increased concern with differentiation, marking out the landscape in a physical fashion rather than relying on local knowledge. It could also point to a more exclusive use of the landscape by different groups. Even if the cemeteries represent the burials of several different social groups, both the barrows and the platforms emphasise a distinctive zone set aside for the activity.

Wider Comparisons

There are no definite habitation sites from the same period known within the study area, but there are indications that the ring ditches were an active part of the living landscape. At Chancellorsland, Co. Tipperary, Doody is excavating domestic enclosures and ring ditches as a functional unit (Doody 1995; 1997). The large number of rebuilding episodes suggests that the domestic use of the enclosure may have been seasonal which fits well with suggestions of ring ditches being used to mark seasonal pasture territories (Barfield and Hodder 1988).

There is increasing evidence that wetlands were a focus of domestic activity in contemporary landscapes elsewhere in Ireland. At Cullyhanna Lough, Co. Armagh a large, round, post built house and a semicircular out building were surrounded by a stockade on the foreshore of the lake (Hodges 1958). Posts from the stockade have been dated dendro-chronologically to 1526BC (Mallory & McNeill, 1991, 108). There are also the recently discovered estuarine sites at Carrigdirty, Co Limerick where again there are two large round post built structures dating to the Middle Bronze Age (1678-1521 BC). The structures are associated with habitation debris such as basketry. While they are now situated on the tidal mudflats of the Shannon estuary in the Middle Bronze Age the area would have been periodically flooding fen or carr woodland (O'Sullivan, 1995, 9). Both of these sites may have been seasonally occupied but were substantial sites nonetheless.

The complex at Moanmore, Co. Tipperary, (figure 34) may be comparable to the nearby group of fields, domestic sites and burial sites at Chancellorsland Co. Tipperary (Daly 1994, Doody 1995; 1997). Perhaps Deverel-Rimbury sites like Itford Hill are less remarkable than was once thought (Holden 1972). For Cranbourne Chase, Bradley argues that the Middle Bronze Age barrows are contemporary with integrated field systems. There too lynchets form small systems while the barrows cover broader areas (Barrett and Bradley, R. 1991, 148).

The tight integration of burials, and *fulachta fiadh* has parallels both at Lisheen, Co Tipperary and in the fens of the Wash in Britain (Ó Néill and Stevens 1998; Cross *et al* forthcoming, Roberts 1998). While it can be argued that *fulachta fiadh* were used for rituals (Barfield and Hodder 1988) such interpretations are becoming less common as more sites are excavated with no evidence for either feasting or structures for steam baths (Ó Drisceoil 1988). Roberts suggests that an integrated landscape stands in contrast to ritual landscapes proposed for other parts of the same fen (Roberts 1998, 197).

Ritual landscapes are a common feature of Bronze Age landscape research (Flemming 1982; Bradley and Hart 1983; Barrett and Bradley, R. 1991; Field, D. 1999; Moore 1995). The recognition that cosmological concerns condition people's relations with the landscape need not imply a separation between sacred and secular realms. The evidence from the study area suggests that there are two patterns, one integrated and one less so. It is possible that 'ritual landscapes' are the focus of regional ceremonial activities where more integrated ones are formed by local patterns. There could be a status differentiation involved as well, with high status settlements separated from lower status groups by ritual space (Grogan *et al* 1996).

Diachronic Comparisons

This habitual use and daily cohesion can be related to population density and settlement pattern. The habitation in this area in the Neolithic was sparse, with a major focus for habitation and ritual 20km to the north at Lough Gur. The passage tomb at Duntryleague, and perhaps some of the other megalithic tombs and even cairns, indicate that people were using this area but these appear to be small groups. There are two houses at Tankardstown south, but it does not seem that they were contemporary with each other (Gowen & Tarbett, 1988).

Landscapes that were once integrated, can become ritual foci for later landscapes. "In some circumstances ritual "sites tend to be found in proximity to ancestral villages and settlements most of which have been recorded as archaeological sites. ...Elders often refer to these sites as 'stone people'"(Mohs 1994, 192-93). Cooney remarks, "It appears the landscape was being remodelled and transformed through the addition of new monuments and layers of cultural activity" in reference to the Boyne Valley as a sacred landscape (Cooney 1994, 37). In this circumstance, the remodelling is likely to have used the monuments but the changes certainly affected the secular use of the area.

In the Middle Bronze Age, the population had grown, and people had been using the area for similar purposes for some time. It is a process of in-fill. It is difficult to tell whether the ambiguous domestic evidence in the Duntryleague cemetery is an indication of a continuing integrated landscape, or a new ritual focus for an existing domestic landscape. The main Late Neolithic ritual focus, the passage tomb, is a little distance up slope, so perhaps there was in fact a little less integration in that landscape.

It is difficult to make comment on the integration of the Later Prehistoric sites since we only have the highest end of the settlement hierarchy. Rathanny enclosures and hillforts only reflect the landscapes of public display and very little of day to day life. The fact that these two site types, potentially reflecting sacred and secular displays of power respectively, are sited in very different zones of the landscape underscores the rise of secular power shown in other landscapes (Nocete 1994). Devotion of whole areas of the landscape to ritual practice implies the kind of centralised control which is characteristic of the Later Bronze Age. The small-scale integrated landscape represented by the Middle Bronze Age material may represent more independent communities. An integrated vernacular landscape may have underpinned the Later Bronze Age pattern in the study area, as is suggested for southeast Clare (Condit and O'Sullivan 1996).

Conclusions

This is a tightly integrated landscape. It is at least as tightly integrated as the Deverel-Rimbury settlements, or the landscapes of the ring ditches in the Great Ouse Valley (Barrett and Bradley 1991; Woodward 1978; Green 1979). It is more integrated than the preceding landscape or the one following. It is possible that differentiation showing as two patterns of siting has a chronological basis, smaller cemeteries that are more integrated overlook the large cemeteries. The unique position of the Mitchelstowndown cemetery may reflect a chronological distinction between it and the other cemeteries. Generally speaking, the breaks in the pattern are not functional breaks but scale breaks - breaks between communities. The similarity between the different cemeteries shows the integration between these communities, as does the unity that the distribution shows when smoothed at a 5km scale. This integration is a matter of contact and not on one community controlling others.

Tempo

Tempo refers to the rate of change within a landscape. This can be studied by examining remodeling at particular sites, but since landscape change take place at many scale, so does its rate or tempo. Braudel has proposed three useful time scales, the *Long Duree*, the process and the event (Braudel 1969). Comparisons between different periods refer to the *Long Duree*. The process is a time scale that may encompass a lifetime. While some large scale building projects may reflect change as a process, most are shorter again and reflect change as an event. While the tempo of a landscape may be fast when considered in terms of one time scale it may be slower considered of the others.

This is the landscape dynamic least well served by the data available for this study. The small number of excavated sites and even smaller number of radiocarbon dates leaves room for doubt over the most basic sequences. In the analysis tempo was considered at the scale of the *Long Duree* by considering the integration of sites from different periods. Further consideration and comparison with other landscapes is used here to explore the other two scales.

Highlights from analysis

There is only one major concentration of ring ditches that has no Early Bronze Age burial sites in the 1km catchments of its sites - Elton. Many of the others, including Mitchelstowndown and Ballynamona/Lissard, have some sites with Early Bronze Age sites in their catchments others not. The sites with Rathanny enclosures do not have any Early Bronze Age sites in their catchments. This suggests a shifting through the landscape of ritual sites. Elton has early habitation sites, as well as contemporary and later domestic sites, but ring ditches are the only ritual sites. Ring ditches are part of a more integrated landscape. As it differentiates out again in the Later Bronze Age not only does the focus shift from the major concentrations of ring ditches but also from earlier Bronze Age sites. This is not a re-colonisation of established places but a continuation an overlap with the immediately preceding period.

Discussion

The ring ditches are quickly built and clearly mark a regular occurrence. There is some reference back to earlier landscapes, but the expansion also means that the extent to which this happens is limited, certainly the major activity is away from earlier foci. Previous domestic zones are reconstructed by ritual activities. This produces substantial change over the course of construction

Although a ring ditch could be dug in an afternoon, the processes leading to its construction would have taken much longer. Not only is cremation on an open pyre a process which takes many days, but there were clearly other steps in the disposal of the remains. The burnt bones were ground and in most cases only token amounts were deposited (Grogan 1989). Other times and places for deposition probably existed within the rite. The fact some sites have the remains of many individuals interred at the same time also stretches the length of time associated with each site. Primary burial by cremation may have taken place over a period of time. Ring ditches were constructed less often, perhaps on a cycles, perhaps after the death of a particular group member. The landscape could be altered with the passing of the seasons or with the passing of a key member in the social structure.

The nature of the monuments and the nature of the terrain render that the idea of orientation and siting in terms of astronomical events close to meaningless. I only saw views of any sort after a long time working in the area. Therefore, the cycles represented in siting, which have been used in other instances to understand the temporal structure of a landscape (Keller 1994, 95, Ingold 1993), are mute in this system.

As usual, setbacks in understanding can be a source of information. There are hills and valleys in this terrain, many more than the maps show, and many more than ring ditches use. If the marking of the astronomical passing of the seasons were an important function of ring ditches then they would have made use of the terrain variations that could be mark that cycle

They embody a yearly cycle less steady than the stars - flooding. Areas liable to flooding are prime sites for ring ditches and flooding is certainly cyclical. In this area, however, flooding can happen at most times of the year and would render these places. Some of this is due to a change in the hydrological regime of the area. Perhaps, since these would have been lakeshores, it was not the periodic flooding but the periodic draining which made these places so special. Particularly since this was the beginning of the process of drainage in these glacial lakes. This would be good for seasonal pasturage because particularly rich grass species occupy seasonally flooded areas. Whether flooding or draining the sites are placed to emphasise seasonal fluctuations.

Small-scale monuments indicate slow tempo. The impact of each site is slight. Place is created gradually by the repetition of choice. Chronological problems may be indicators of continuity. This type of marker for a burial was constructed for at least a millennium. This long chronological range indicates long gaps between the choices of burial placement and rite. The low visibility of the sites indicates that there was a good deal of continuity of community through this period. The contact with previously buried individuals, however, is less in this rite than in earlier periods where graves and cists were re-opened after a period of time . There are many sites where the dates have been a surprise to the excavators and many sites with numerous widespread dates (see Chapter 2 and Appendix C). All of these factors point to very little landscape change in the course of a lifetime.

The existence of field systems has implications for tempo. A set of fixed boundaries indicates that the same area of land was being used for agricultural purposes over many years, rather than a shifting system (Barrett & Bradley 1991, 225). This is not to say that different fields were not used in different years but there was some stability in the area defined for agriculture.

There is a shift in placement between the Later Neolithic and the Early Bronze Age. Early Bronze Age burial and habitation have many correlations with each other and few with Neolithic sites.

The Middle Bronze Age cemeteries cluster around places with material from both periods. Small and medium cemeteries of ring ditches are found in places with Neolithic and Early Bronze Age activity. There are also small clusters on the lake edges where the rathanny enclosures were built in the Later Bronze Age. Ring ditches were built at earlier and later ritual spaces, but the largest concentrations were isolated amongst the lakes at the foot of the end moraine. While rathanny enclosures were built on the edges of the ring ditch distribution, they are set apart from the Neolithic and Early Bronze sites, indicating a large landscape change, a lot of change over the *Long Duree*.

Wider Comparisons

There are several important sites in Ireland with continuity of occupation from the Neolithic to the Bronze Age. Lough Gur continued to be a focus of settlement right through the Bronze Age (Grogan and Eogan 1987; Cleary 1993). Since there was little change in architecture and the stratigraphy is shallow, it is difficult to distinguish separate periods. Belderrig, Co. Mayo, a site with Neolithic occupation, was reoccupied, and slightly different field systems were built. Radiocarbon dates for the later occupation are 1700-1310 BC (Caulfield 1988) Moynagh Lough Co Meath has occupation from the Mesolithic to the Early Christian. It is situated on enhanced mudbanks in the shallows of the lake and there are numerous cycles of inundation and reoccupation (J. Bradley 1982; 1991). Clearly these sites do not necessarily represent continuity of population but they do show that there is a similarity in siting choices as well as architectural styles in the case of Lough Gur.

The complex of Chancellorsland, to the north of the study area, seems to fit this picture of long term intermittent use. It appears to be a complex of activity including agricultural activity, domestic activity and burial activity. Yet evidence of rebuilding and its landscape positioning suggest that it was used discontinuously. There are two different tempo implications for this. The first is the possibility that occupation was seasonal and it was part of a seasonal grazing round as suggested for the group of ring ditches in the fenlands of the Wash in England (Evans 1987). The second is that it was part of a less regular pattern of settlement where existent sites were re-established after some period of abandonment. As research on this site progresses the situation may become clearer (Doody 1995; 1997).

Diachronic Comparisons

This existence of widespread domestic evidence, including low enclosures and field systems, is an indication of landscape change at the end of a sequence of landscape development, since if domestic activity continued it would have altered the existing evidence (Barrett and Bradley 1991, 224). The change or abandonment need not have been permanent. Moving a field wall or a house in a current settlement is a different activity than slighting features which were there when the settlement was established. Later destruction obviously takes place but for such evidence to survive there must have been a period of change or abandonment fairly soon after the last period of construction.

> "It would be misleading to distinguish too sharply between the 'ritual' landscape that formed in earlier prehistory and the agricultural landscape that seems to have taken its place, for even the most practical activities, such as building a house or enclosing a settlement drew on a symbolic code of considerable antiquity. It was the fact these changes were expressed through modifications of an established cosmology that made it possible to contemplate new developments in the pattern of settlement. It was precisely because the successive landscapes of Cranbourne Chase were organised according to similar principles of order that changes could be accomplished so rapidly." (Bradley, R. 1998, 158)

In the study area there is some evidence for this kind of change in the form of the field systems, which may have been associated with the ring ditches. The absence of domestic evidence from across the study area, however, would point to widespread landscape change at the end of the Middle Bronze Age.

Diachronic patterns at a regional scale.

In the Neolithic this area was still less densely populated than Lough Gur, 20km to the north. This is a landscape of expansion, which implies a lot of landscape change in a short time. The construction of the Passage Tomb would have been labour intensive but could have been accomplished in a short period of time. The Passage Tomb at Duntryleague is constructed at one of the few points in the study area from which Lough Gur can be seen. Although there was substantial settlement through the Neolithic, the focus of this landscape remained outside of the study area.

In the Early Bronze ritual activity spread out from Duntryleague into Cush, Raheenamdra and Elton. These are similar terrain positions to Duntryleague but they are not visible from Lough Gur. The construction of barrows would have been less labour intensive than the passage tomb, but their landscape impact would have still been fairly substantial quite quickly.

In the Middle Bronze Age the Morningstar valley became the main focus of activity. The slow accretion of ring ditch cemeteries would have marked the valley as a significant place for a substantial local community. This would underscore local control of a regional route-way. This corridor led directly from the pass at Duntryleague to the Maigue, bypassing the Camoge as it led to Lough Gur. So the positioning of a cemetery at a juncture between two rivers, such as that at Mitchelstowndown, changed the nature of that place. It made a statement about landuse and ownership, and possibly changed movement through that place. This could have changed patterns of trade at a regional level.

Later Prehistoric activity was mostly at the borders of the Middle Bronze Age corridor. The focus of the landscape had moved northward again, possibly indicating an increased role for the settlement at Lough Gur. This was particularly emphasised by the concentrations of Rathanny enclosures along the Camoge Valley and the absence of these sites west of Knockainy. The Hillforts marked passes and vantage points while the rathanny enclosures marked the valley routes (Figures 47 and 51). Both of these site types would have been much slower to build than the earlier smaller sites, but their landscape impact would have much greater. Since there are so few rathanny enclosures in comparison to ring ditches, the cycle of their construction must have been considerably slower. Perhaps they were associated with the passing of more powerful members of the community.

Conclusions

The ring ditches, as a group, were used over a period of up to one thousand years but most of the construction probably took place within a few centuries. Prior to their use the landscape was based on a dispersed settlement pattern focussed on a restricted set of well drained soils. The landscape they created indicates a dense pattern of local communities imbuing a larger range of landforms with significance. The foci of activity move through the study area. Early concentrations reused pre-existent places of Later Neolithic domestic activity. Larger cemeteries came to be constructed on the shores of draining lakes in the Morningstar valley. Later much larger burial monuments reused smaller cemeteries on the northern reaches of this lakeland which stand between the southern passes and the important settlement and ceremonial centre at Lough Gur. Although each site is small their use reflects a significant restructuring of the local landscape in the wider community.

The entire course of this set of changes represents the *long duree*. There is a quick change at the end of the Neolithic, followed by a slow accretion through the Middle Bronze Age and another quick change at the Beginning of the Later Bronze Age. Over the three periods there is an increase in the rate of change. The reuse of earlier places by first ring ditches then rathanny enclosures could be part of a conscious effort to link new ritual practices to established places as has been suggested in other landscapes (Condit and O'Sullivan 1994, Cooney 1994, Cross 1991).

Conclusions

This chapter has discussed of the broader implications of this analysis in understanding the Middle Bronze Age landscape of south east Limerick. Several themes run through the discussion. There is more than one pattern represented by the ring ditches. There are two terrain positions, two sets of associations with other sites. This could indicate a chronological differentiation between the small to medium cemeteries and the larger cemeteries. Given that the spatial structure of the cemeteries is so similar this change may well have taken place slowly. Most of the results coming from this study have parallels elsewhere despite the unique concentration of sites and unusual terrain of the end moraine.

Chapter 6: Conclusions

Introduction

In this dissertation I have modelled a Middle Bronze Age landscape by studying the distribution of a group of mortuary sites. I designed a set of dynamics by which I can describe this landscape in a clear and comparable manner. I collected a set of relevant data and established a GIS to interrogate them. I devised a set of analytical techniques to explore relations (particularly spatial relations) between different elements of this data set. I conducted these analyses and considered their results in relation to the dynamics of landscape mentioned above. Finally I set these results in the context of current research on the Middle Bronze Age. This allowed me to examine patterns within the distribution of sites that bear on social and environmental relations.

A dynamic framework

The landscape model presented in this dissertation is based on a framework of four dynamics: scale, sensitivity to terrain, integration, and tempo. This framework is one of the contributions of the thesis. Its application to the current problem demonstrates its utility in increasing the power of landscape analysis. It was particularly useful for producing results that can be compared to results from other landscapes. The framework is powerful because it sees landscape as a cultural product with an environmental context. This attaches landscape concerns to the wider concerns of the constituent disciplines. Each dynamic has had its own challenges and offered its own contributions to my understanding.

Effective scale was probably the most powerful dynamic for this set of problems. It helped me discuss relations within and between communities in a structured fashion. It also established a link between individual sites, small clusters, large cemeteries and the whole distribution of sites. The identification of scales at which the pattern made less sense was particularly illuminating. The switching of patterns from one scale to another underlined the value of a multi-scalar analysis. This switching between scales is central to an understanding of landscape.

The dynamic of *terrain sensitivity* offered different insights. The identification of the later prehistoric pattern of lakes in the study area stemmed from an analytical highlighting of the soil complexes on the terminal moraine. The links between agricultural and ritual concerns demonstrated in the relationship of the distribution to well-drained soils was one of the most pleasant surprises of the research. Connecting this dynamic to scale forced me to think about the kinds of constraints and requirements which different activities would have with regard to the terrain. The equation of well-drained soils and arable agriculture is reasonably well established, as is a prehistoric preference for mixed soils (Cooney 1979; Grogan 1996b; Doody 1997). The connection of these preferences and a seasonal flooding regime to mixed agricultural regime with little mobility is a new perspective.

Integration was a difficult dynamic to come to grips with but it was rewarding in the end. It was heavily underpinned by my understanding of scale. The ways in which the agricultural and domestic landscape was intermingled with the landscape of the ring ditches allowed me to view the concerns of the community as a whole. The role of standing stones and stone circles slightly outside this landscape was important in considering the continuance of inter-community relations. These places created strong links, which allowed for coherence in a pattern created at so many different scales.

While the importance of wetlands in prehistoric cosmology has been invoked to explain ring ditch distributions in Britain (Field, D. 1999) there was no indication of a 'ritual landscape' at play here. This does not mean that symbolic and spiritual concerns were not important in site location, simply that such conceptual views of landscape are an integral part of living and not confined to burial activities (see Bradley, R. 1998).

Given the poor chronological control in the data set, the dynamic of *tempo* was the least well served by this research. Yet there were still insights it could offer. The changing places, reuse of earlier foci, expansion into landscapes and re-working once again of the world thus transformed is the dominant narrative of many prehistoric landscapes (Barrett and Bradley 1991, Eogan 1991, Bradley, R. 1998). In this case, the subtle marking of annual patterns with strategic use of flooding lands contrasts with dramatic celestial marking in other landscapes (Moore 1996). This highlights the local, intimate focus that runs through the whole analysis.

The construction of a ring ditch was a short event at the end of a long burial rite. The individual impact of each site was fairly small but the slow cumulative effect was transformative. It is the constant revisiting of existing places that created this landscape. Quick events form a slow process, which is revolutionary in the long dureé. The extent of the change effected required a formal process of re-visiting earlier places in the landscape created by this process. This is shown in other places through the relationship between passage tombs and hillforts (Grogan *et al* 1996).

A complex data set integrated

When I began this research a significant cluster of sites had been identified and preliminary work on their distribution had indicated that they played an important role in structuring the Middle Bronze Age landscape (Gowen 1988, Grogan 1988b; 1989). In Chapter 2 I describe these sites in their environmental and archaeological context. This preliminary assessment was made possible by the establishment of a GIS, which held all data in a standardised format. While most data collection had already taken place, the establishment of this GIS required me to assess data quality and reclassify material.

The rathanny enclosures are a newly identified element of the Later Bronze Age landscape. My investigation of the site at Coolalough, described in Appendix D, and the radiocarbon dates it produced (Appendix C) significantly alter the picture of Later Bronze Age ritual practice in Ireland. I hope to pursue a more formal consideration of this site type in Ireland as a whole with my colleagues Tom Condit and Eoin Grogan, of the Discovery Programme.

Analytical methodology

The terrain of the study area is not unique. The Middle Bronze Age landscape created there was. This unique landscape was compared with other interfaces of humans and the environments they inhabit through an analytical process. The fragmentation of the dense and complex remains of this landscape by the use of quantitative methods allowed me to consider the material outside of the framework of the modern unique landscape which has been formed in similar terrain.

Working with quantitative abstractions presented its own challenges and rewards. There is a trend within landscape archaeology that has moved almost entirely away from quantitative analysis (Mithen 1991; Thomas 1991; 1990; 1993; Tilley 1994). I wanted to understand the landscape as a lived in cultural product – neither as a set of spatial equations, nor as a statement of cosmological belief. Quantitative methodology allowed me to describe the enormously complex landscape in a detailed fashion. It also allowed me to see patterns within that landscape. The methods are described in Chapter 3 and the results in Chapter 4.

The descriptive point process analyses were particularly useful for considering the whole pattern without losing sight of its constituent parts. The K-functions helped me understand the processes of clustering at work. The kernel smoothing allowed me to visualise those processes and their variation with different scales of analysis. Using these descriptions for discussion of the archaeological landscape required a conscious acknowledgement of my own role in the analysis. Keeping the work grounded was a challenge.

The use of point processes for modelling was less productive. The simple model that I tested did not describe the complexity of the landscape. At one level this should not be surprising. Nonetheless, the process was designed to model rare epidemiology, which is also a complex problem (Diggle and Rowlingson 1993). The instability in the model led me to thinking about the distribution as a pattern that had developed over a long period of time. The priorities and requirements of a millennium of landscape change would need a very sophisticated model.

The Site Catchment Analysis brought me back to descriptive techniques. With the modifications I made in purpose, data collection and statistical analysis it was a powerful tool. The three scales of data collection gave me a firm footing for considering scale issues highlighted by the other analyses. The use of a random control set allowed for useful statistical tests to be carried out. I was able to bring this analysis further with the use of curve decomposition. The consideration of other sites within the site catchments was surprisingly helpful in exploring the volume of inter-site relationships embodied in tempo and integration.

I had always expected Site Catchment Analysis to be most useful for describing terrain sensitivity. It was certainly very good for laying patterns out in an explicit fashion. The difficulty I had not anticipated was in the double abstraction of modern measurement and prehistoric choices. Translating soil areas and river lengths into meaningful locations within the terrain was a long process. The grouping, regrouping and comparison underlined for me the compromise of landscape.

Results considered

The analysis described above produced an intricate model of the structure of the landscape. The significance of this model for addressing the theoretical concerns laid out in Chapter 1 and for understanding the Middle Bronze Age in Ireland was assessed in Chapter 5. The discussion was organised according to the four dynamics, and integrated the results of all analyses as well as comparing these results with the wider archaeological context

The main challenge here was identifying an appropriate set of contextual material for synchronic and diachronic comparison because of the variable standard of recording and analysis in the literature. Comparisons were made between landscapes with similar terrain, such as fenland in Ireland and Britain, and also dissimilar terrain, such as the chalk downlands of southern Britain and the limestone lowlands of Southeast Co. Clare. In the discussion I also considered aspects not accounted for in formal analysis, such as the detailed variation between different sites, arguments concerning dating, and my experience of the modern landscape. Some of the important conclusions are discussed above, under the headings of each dynamic. The conclusions with wider implications for the Middle Bronze Age and for the theoretical position of landscape archaeology are discussed below.

Understanding the Middle Bronze Age

The Middle Bronze Age was period of expansion in south-west Ireland. Population, settlement, trade networks and social complexity all increased. In the study area this expansion was marked by an increase in the number of communities and in the ritual monuments with which they structured their landscape. From three to four Late Neolithic communities with one major ritual focus came six or seven Middle Bronze Age communities each with their own ritual focus and perhaps sharing some others. There was no dominant or central community within the study area. Each group behaved in a similar fashion with variation indicating independence.

The very slight visibility of the structures remaining from the burial rite indicates the intimacy of this landscape – messages required local knowledge to decode. The terrain favoured this intricate pattern. A lacework of small lakes on the terminal moraine led to myriad streams and rivers marking direct and circuitous routes to the Shannon estuary. Seasonal flooding favoured a mixed agricultural regime, which required little mobility to make use of both arable and pastoral resources. The complex mix of well-drained soil and seasonal wetland provided a focus for both agricultural and ritual structuring of the landscape.

While the pattern of sites demonstrated the existence of separate communities it also showed the importance of a smaller group, perhaps a kinship group. While Neolithic burial rites emphasised the community and Early Bronze Age rites brought forward the individual, the burial rite of ring ditches created a place for kin groups within the community as important social entities. Perhaps it is inequality between these groups that is being expressed in the construction of the rathanny enclosures in the following period.

The pattern of sites in the landscape also suggests some ways that this social change was mediated. Some of the ritual foci of the new burial rite re-used places that were constructed for Early Bronze Age and even Neolithic burial. The largest concentrations, however, were placed away from these earlier foci, in the newly formed land on the edge of draining glacial lakes. Here the same processes of burial rite and site location led to a new phenomenon. These large dense cemeteries were constructed alongside, and at times intermingled with, settlements and fields. At the end of the Middle Bronze Age new monumental burial structures were built on the edges of the distribution, using the glacial lakes even more explicitly.

While these new burial monuments, the rathanny enclosures, were linked by their distribution to Middle Bronze Age ritual patterns, hillforts, as the secular expression of increased inequality, mirrored the upland location of Late Neolithic and Early Bronze Age ceremonial sites. These places may have continued their importance through ceremonies and gatherings at sites such as standing stones and stone circles throughout the millennium in which ring ditches were the main burial focus. Perhaps these longstanding upland places continued the ceremonial expression of cohesion between several communities while the lakelands contained the foci of separate kin groups. The dispersion and lack of apparent hierarchy in the distribution of ring ditches was the context in which the Later Bronze Age incipient state was formed.

The manipulation of regional power networks was central to that process. The exchange of bronze and gold used for both weaponry and display marked relations between powerful groups across Europe (Eogan 1995; Rowlands 1980). The study area is located on the only inland route from the bronze production centres of Cork and Kerry and the emerging regional centre on the Shannon estuary.

This placement gave communities in the study area a role in the trade networks of more powerful communities. The dense marking of the moraine at the main passes dividing the two groups may demonstrate the role of local communities in a down the line trading pattern. The concentration of ring ditches indicates communities along the Morningstar River marking territory for traders making their way to the navigable River Maigue. The subsequent pattern formed by the Rathanny enclosures shows a shift in that route to the valley of the Camoge River and the settlement and ritual centre at Lough Gur.

Theoretical Implications

The first theoretical concern identified in Chapter 1 was the debate over environmental determinism. It is clear that neither social nor environmental forces are determinative in the formation of this landscape. Each society created new places from the same locations. Those places gain their nature from the combination of social and environmental processes involved. So each ring ditch marks a unique place because the event of construction is conditioned by the circumstances. Nevertheless, ring ditches appear to be a particularly popular burial rite in broken, wet terrain.

The study area was, however, one of the few places in Europe which was becoming less wet through this period. As the glacial lakeland drained through later prehistory new land was revealed. The responses to and use of this new marginal land by prehistoric communities illuminates the roles of individuals, kin groups and communities in the construction of new social hierarchies which characterise the end of prehistory.

The rate and nature of long term change was the second theoretical concern identified in Chapter 1. The role of environmental change in the development of coercive inequality in later prehistory has received a good deal of attention in the last ten years. Dramatic and disastrous volcanic dust veils have also been given considerable explanatory power. (Burgess 1989 Baillie 1995; Baillie and Munro 1988; Weir 1993). The present research provides a long term assessment of landscape in which to consider these events. Nothing in the transition from the Middle Bronze Age to the Later Bronze Age suggests catastrophic change in this landscape. The dramatic change in monumental form and centralisation is offset by a continuity of siting patterns suggesting a change resulting from internal social processes.

The third element of theoretical concern identified in Chapter 1 is scales of social interaction. I have argued here that the dispersed pattern of ring ditches indicates an infilling of the landscape, which was a necessary precursor to the dominant and centralising force of hillforts and rathanny enclosures. The establishment of a landscape presence for kin groups may well be more important than individual burial in the development of social hierarchy since real coercive power takes many generations to become entrenched. Events such as the construction of a hillfort or the abandonment of marginal pasture can be identified more easily than the processes of change that lead up to them. Particularly dramatic changes can be perversely underpinned by a strong sense of continuity and a powerful sense of the past (Bradley, R. 1998, 158).

Conclusion

This dissertation has been a contribution to understanding the Middle Bronze Age landscape as an interface between the changing environment and the changing communities that inhabited it. "As interpreters of the past we have a responsibility to strive to reach beyond what is immediately observable" (Bergh 1995, 19). With this research I have used a formal structure and quantitative methodology to help me in this endeavour. Nonetheless, the landscape between Knockainy and Cush, following the winding course of the Morningstar, composed of the intricate complexes of Elton and Coolalough soils, formed on the terminal moraine, and marked by the ephemeral ring ditches has always been at its heart.

Many prehistoric landscapes were created for display (Bergh 1995, Barret and Bradley, R. 1991, Eogan 1991). Most of the messages in this landscape were more about the everyday than about eternity. I have attempted to understand an intimate landscape. The attempt has been rewarding.

Appendix A: Soils

Series name	Group	Modern Limitations	% area	Distribution	Drainage	Parent material
Blanket peat	Peat	Peat is not really a soil	0.22	Mixed with Seefin on Slievereagh, covering Griston on the Griston	Unclassified	Varied (Seefin and Griston)
Baggotstown	Brown Earth	Coarse texture, liable to periodic drought	0.94	5 patches right up against the fault line, at the leading edge of the end moraine. 3 more closer to the Maigue	Excessively drained, rapid permeability	Outwash of fluvioglacial materials of predominantly limestone composition (with some sandstone shale and volcanics) and of Weichsel
Ballylanders	Brown Earth	No serious limitations	2.7	The predominant well drained soil below the fault	Well drained, moderate permeability	Glacial drift, soliflucted drift and colluvium of predominantly silurian shale with some Old Red Sandstone, of mixed Saale Weichsel Age. Ocassionally the soil overlies
Ballyvoherreen	Brown Earth	Coarse texture, liable to periodic drought	0.12	One patch, bridging the mottled area near Mitchelstowndown and	Excessively drained, rapid permeability	Coarse Textured glacial and fluvioglacial materials, mostly of Old Red Sandstone and Silurian shale composition with some Limestone influence of Weichsel Age.
Ballynalacken	Brown Earth	No serious limitations	0.12	One patch on the lower southeast slopes of Slievereagh, just above	Well drained, moderate permeability, deep water	Glacial drift, soliflucted drift and colluvium of predominantly silurian shale with some Old Red Sandstone, of mixed Saale Weichsel Age. Ocassionally the soil overlies
Ballybrood	Brown Podzolic	No serious limitations	0.06	One patch, right by the Maigue	Well drained, moderate permeability	Old Red Sandstone and Colluvium of Old Red sandstone composition
Doonglara	Brown Podzolic	Somewhat high elevation and steep	0.45	On slopes of Slievereagh and Duntryleague	Well drained, moderate permeability	Old Red Sandstone and Colluvium of Old Red sandstone composition

Series name	Group	Modern Limitations	% area	Distribution	Drainage	Parent material
Doonglara / Knockaceol	Podzol	Doonglara is essentially reclaimed Knockaceol, when they occur together its mixed	0 14	One patch on the east side of the Aherlow, accross from Duntryleague	Well drained, moderate permeability, deep water	Colluvium of Sandsone and conglomerate origin
Elton	Grey Brown Podzolic	No serious limitations	36 78	The predominant soil north of the fault line. especially on slight knolls.	Well drained, moderate permeability	Glacial drift composed of limestone with a proportion of sandstone shale and volcanics, of Weichsel Age
Elton / Coolalough	Composite	Being mapped together none of the Elton patches would be large enough for consistent	0 1	One patch, just north of the moraine, northeast of Garryspillane	Very poorly drained, Slow permeability. Seasonal very high water-table	Composite
Elton / Howardstown	Composite	Mapped together the ground is fairly broken and patches would not be big enough for	0 03	Small patch, south east of Duntryleague, right up against the fault line	Well drained, moderate permeability, deep water	Glacial drift composed of limestone with a proportion of sandstone shale and volcanics, of Weichsel Age
Rathcannon	Grey Brown Podzolic	Adverse soil physical conditions, basically a stickier version of Elton, more clay in the B	0 33	2 patches between the Morningstar river alluvium and its Elton. Said to be intricate in its patterning and mapped more at the detailed scale An edge	Well drained, moderate permeability, deep water	Glacial drift composed of limestone with a proportion of sandstone shale and volcanics, of Weichsel Age
Camoge	Gley	Drainage very poor, hazard of periodic flooding	3 9	Strips following the course of the Morningstar and the Loobagh, though not constant. Two larger floodplains, at the confluence of the Loobagh and the Maigue, and somewhat to the east of the Morningstar and the Maigue	Poorly drained, seasonally high water table	River Alluvium, varying in texture and base content
Coolalough	Gley	Very serious drainage problems, high water table	3 11	Largely in the east of the study area, in moderate size patches, often in pairs. Also in tiny patches mixed in with Howardstown	Very poorly drained, slow permeability, seasonally very high water table - a	Lake alluvium, base rich but varying in texture, more clay than sand

Series name	Group	Modern Limitations	% area	Distribution	Drainage	Parent material
Coolalough / Peat	Composite	Varied	0 05	Largely in the east of the study area, in moderate size patches, often in pairs. Also in tiny patches mixed in with Howardstown	Very poorly drained, slow permeability, seasonally very high water table - a	Lake alluvium, base rich but varying in texture, more clay than sand
Drombanny	Gley	Very serious drainage problem, high water	0 45	One patch, in Gormanston	Poorly drained, variable permeability (slow to moderate) seasonally high water table	Lake Alluvium, base rich but varying in texture, sandier
Gortaclareen	Gley	Drainage poor to very poor, adverse soil physical conditions	0 03	Two tiny patches in Griston, otherwise admixed with Puckane. A Border effect of Ballylanders with a gley?	Poorly drained, very slow permeability, deep water	Fine textured Glacial drift of Old Red Sandstone composition with Silurian shale and some limestone, of mixed Saale Weichsel age
Griston	Gley	Serious drainage problem, high water	0 25	One major lake bed to the southwest of Slievereagh, a mixture of tiny patches and Elton just south of Mitchelstowndown	Very poorly drained, slow permeability, seasonally very high water table - a	Lake Aluvium, base rick but varying in texture - sandy
Griston / Elton	Composite	Varied	1 34	Small area just south of Mitchelstown	Very poorly drained, Rapid permeability. Seasonal very high water-table	Composite
Howardstown	Gley	Drainage poor to very poor, adverse soil physical conditions	27 05	The most common gley in the study area, intermixed with Elton on the lower slopes	Poorly drained, very slow permeability, seasonally high water table	Glacial drift composed of limestone with a proportion of sandstone shale and volcanics, of Weichsel Age
Howardstown / Peat	Composite	Varied	0 03	Small patch on the Tipperary border in the middle of the Coolalough lakeland	Poorly drained, Very slow permeability. Seasonal very high water-table	Glacial drift composed of limestone with a proportion of sandstone shale and volcanics, of Weichsel Age
Howardstown / Elton	Composite	Mapped together the ground is fairly broken and patches would not be big enough for	0 43	Moderate sized patch west of Elton townland	Poorly drained, Very slow permeability. Seasonal very high water-table	Glacial drift composed of limestone with a proportion of sandstone shale and volcanics, of Weichsel Age

Series name	Group	Modern Limitations	% area	Distribution	Drainage	Parent material
Howardstown / Coolalough	Composite	Varied	1.67	Large lake bed to the northwest of the Mitchelstowndown composite, probably	Poorly drained, Very slow permeability. Seasonal very high water-table	Composite
Lyre	Gley	Drainage imperfect to poor, moderate to weak structure	0.87	All in the extreme southwest, part of the pattern below the fault relating to the spread of the	Poorly drained, variable permeability (slow to moderate), seasonal high water table	River alluvium varying in texture and base content
Puckane	Gley	Drainage poor to very poor, adverse soil physical conditions	1.7	The predominant gley south of the fault line, intermixed with Ballylanders	Poorly drained, very slow permeability, deep water	Fine textured Glacial drift of Old Red Sandstone composition with Silurian shale and some limestone, of mixed Saale Weichsel age
Puckane / Gortaclareen	Gley	Drainage poor to very poor, adverse soil physical conditions	2.42	Moderate patch in extreme south east of study area	Poorly drained, Very slow permeability. Deep	Fine textured Glacial drift of Old Red Sandstone composition with Silurian shale and some limestone, of mixed Saale Weichsel age
Knockaceol	Podzol	Shallow soils, pan formations, steep slopes high altitudes	0.45	On the south slope of Slievereagh and on the north slope of Duntryleague	Well drained, moderate permeability, deep water	Old Red Sandstone and Colluvium of Old Red sandstone composition
Knockastanna	Podzol	Shallow soils, pan formations, steep slopes high altitudes	0.07	Tiny bit in the extreme south, associated with the foothills of the Galty's	Variable drainage, complex of moderate-slow permeability, deep water	Glacial drift, soliflucted drift and colluvium of predominantly silurian shale with some Old Red Sandstone, of mixed Saale Weichsel Age. Ocassionally the soil overlies
Seefin	Podzol	Shallow soils, pan formations, steep slopes high altitudes	0	Only in combination with blanket peat, covering the top of Slievereagh	Unclassified	Old Red Sandstone and Colluvium of Old Red sandstone composition
Seefin / Peat	Composite	Shallow soils, pan formations, steep slopes high altitudes	1.84	Most of Slievereagh Hill is covered by this mixture		Old Red Sandstone and Colluvium of Old Red sandstone composition

Series name	Group	Modern Limitations	% area	Distribution	Drainage	Parent material
Aherlow	Regosol	Hazard of periodic flooding	0.1	A tiny strip right along the Aherlow	Excessively drained, rapid permeability, deep water	River alluvium, varying in texture and base content
Rinneana	Lithosol	Shallow soils frequent bedrock outcrops, borderline E	0.02	Tiny patch to the west of Knocklong, main body just off the estuary, by	Moderately well drained, slow permeability, deep	Carboniferous Limestone bedrock
Slievereagh	Lithosol	Very shallow soils, frequent rock outcrops, steep slopes, high	0.1	Three small patches on the east slope of Slievereagh	Excessively drained, rapid permeability, deep water	Old Red Sandstone and Colluvium of Old Red sandstone composition
Not surveyed to series	Unknown	Unknown	12.5	Mostly North East of the study area - Co Tipperary	unclassified	

Appendix B: List of Sites

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI039-002---	HARDING GROVE	ring ditch	152900	133820
LI039-017---	RATHCANNON	possible rathanny type	156530	133010
LI039-022---	RATHCANNON	barrow	157230	135650
LI039-031---	RAYMONDSTOWN	possible rathanny type	159140	133020
LI039-034---	BALLINLEE SOUTH	ring ditch possible	159990	134000
LI039-040---	GARBALLY	ring ditch	161420	135480
LI039-041---	GARBALLY	ring ditch	161420	135710
LI039-042---	GARBALLY	ring ditch	161450	135650
LI039-043---	GARBALLY	ring ditch	161550	135620
LI039-04401-	BALLINLEE NORTH	ring ditch	161660	135100
LI039-04402-	BALLINLEE NORTH	ring ditch	161680	135080
LI039-04403-	BALLINLEE NORTH	ring ditch	161690	135100
LI039-04404-	BALLINLEE NORTH	ring ditch	161700	135120
LI039-04405-	BALLINLEE NORTH	ring ditch	161720	135060
LI039-04406-	BALLINLEE NORTH	ring ditch	161720	135080
LI039-04407-	BALLINLEE NORTH	ring ditch	161730	135120
LI039-045---	BRACKVOAN	ring ditch	162020	135290
LI039-050---	BALLYGRENNAN	standing stone	162330	134600
LI039-062---	CLOGHER WEST	ring ditch, possible	156290	131940
LI039-086---	SCOUL	ring ditch	160900	131870
LI039-088---	BALLINSTONA NORTH	possible rathanny type	161650	132540
LI039-091---	BALLYFOOKEEN	possible rathanny type	153310	131250
LI039-09902-	BALLYNOE	standing stone	154330	129950
LI039-116---	BALLYGRENNAN	ring ditch	162342	134793
LI039-133--N	BALLINREA	ring ditch	160812	135114
LI040-004---	BALLYGRENNAN	ring ditch possible	162960	134120
LI040-005---	BALLYGRENNAN	pits	163120	133990
LI040-010---	BAGGOTSTOWN	barrow	165740	135480
LI040-014---	BAGGOTSTOWN	ring ditch	166730	135250
LI040-015---	BAGGOTSTOWN	ring ditch	166720	135080
LI040-016---	RATHANNY	barrow	167930	134430
LI040-022---	RATHANNY	standing stone	168700	135170
LI040-023---	RATHANNY	barrow	168880	132980
LI040-024---	KNOCKAINY WEST	long cist cemetery	169060	135690

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI040-02601-	RATHANNY	rathanny type	169310	134410
LI040-02602-	RATHANNY	ring ditch	169350	134460
LI040-02604-	RATHANNY	ring ditch	169410	134450
LI040-02605-	RATHANNY	ring ditch	169370	134390
LI040-02606N	RATHANNY	ring ditch	169369	134388
LI040-02607N	RATHANNY	ring ditch	169421	134330
LI040-02608N	RATHANNY	ring ditch	169369	134388
LI040-031—	GOTOON	standing stone	170380	135010
LI040-033—	COOLALOUGH	standing stone	171330	135740
LI040-036—	COOLALOUGH	rathanny type	171799	135312
LI040-03701-	COOLALOUGH	ring ditch	171860	135730
LI040-03702-	COOLALOUGH	ring ditch	171920	135650
LI040-03703-	COOLALOUGH	ring ditch	172080	135590
LI040-03704-	COOLALOUGH	ring ditch	172090	135540
LI040-046—	GOAT ISLAND	fulacht fiadh	163320	133780
LI040-04701-	TANKARDSTOWN	field system	163500	133100
LI040-04801-	TANKARDSTOWN	ring ditch	163600	133272
LI040-04802-	TANKARDSTOWN	ring ditch	163604	133348
LI040-04803-	TANKARDSTOWN	ring ditch	163670	133226
LI040-04804-	TANKARDSTOWN	ring ditch	163677	133333
LI040-04805-	TANKARDSTOWN	ring ditch	163710	133286
LI040-04806-	TANKARDSTOWN	ring ditch	163719	133490
LI040-04901-	TANKARDSTOWN	ring ditch	163662	132844
LI040-04902-	TANKARDSTOWN	ring ditch	163727	132740
LI040-04903-	TANKARDSTOWN	ring ditch	163734	132914
LI040-04904-	TANKARDSTOWN	ring ditch	163729	132881
LI040-04905-	TANKARDSTOWN	ring ditch	163747	132949
LI040-04906-	TANKARDSTOWN	ring ditch	163792	132832
LI040-04907-	TANKARDSTOWN	ring ditch	163840	132620
LI040-04908-	TANKARDSTOWN	ring ditch	163825	132958
LI040-04909-	TANKARDSTOWN	ring ditch	163861	132931
LI040-04910-	TANKARDSTOWN	ring ditch	163871	132913
LI040-04911-	TANKARDSTOWN	ring ditch	163950	132700
LI040-05002-	GOAT ISLAND	ring ditch possible	163680	133870
LI040-05003-	TANKARDSTOWN	ring ditch possible	163720	133650
LI040-053—	TANKARDSTOWN	ring ditch possible	163950	132580

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI040-05502-	TANKARDSTOWN	ring ditch	164211	133174
LI040-05503-	TANKARDSTOWN	ring ditch	164263	133245
LI040-05504-	TANKARDSTOWN	ring ditch	164263	133179
LI040-05505-	TANKARDSTOWN	ring ditch	164290	133131
LI040-060—	BALLINCOLLOO	ring ditch	164563	133150
LI040-06101-	BALLIN COLLOO	field system	164710	132570
LI040-06102-	BALLYNAMONA	ring ditch	164440	132300
LI040-06103-	BALLYNAMONA	ring ditch	164443	132339
LI040-06104-	BALLYNAMONA	ring ditch	164560	132198
LI040-06105-	BALLYNAMONA	ring ditch	164535	132357
LI040-06106-	BALLYNAMONA	ring ditch	164550	132326
LI040-06107-	BALLYNAMONA	ring ditch	164585	132278
LI040-06108-	BALLYNAMONA	ring ditch	164601	132262
LI040-06109-	BALLYNAMONA	ring ditch	164606	132284
LI040-06110-	BALLINCOLLOO	barrow	164607	132474
LI040-06111-	BALLYNAMONA	ring ditch	164617	132340
LI040-06112-	BALLYNAMONA	ring ditch	164612	132321
LI040-06113-	BALLYNAMONA	ring ditch	164702	132221
LI040-06115-	GORMANSTOWN	ring ditch	164800	132340
LI040-06116-	GORMANSTOWN	ring ditch	164833	132509
LI040-06117-	GORMANSTOWN	ring ditch	164830	132408
LI040-06118-	GORMANSTOWN	ring ditch	164850	132407
LI040-06119-	GORMANSTOWN	ring ditch	164853	132450
LI040-06120-	GORMANSTOWN	ring ditch	164842	132075
LI040-06121-	GORMANSTOWN	ring ditch possible	165020	132340
LI040-06122-	BALLINCOLLOO	ring ditch	165100	132940
LI040-06123-	BALLINCOLLOO	ring ditch	165129	132920
LI040-06124N	GORMANSTOWN	ring ditch	164788	132473
LI040-06125N	GORMANSTOWN	ring ditch	164829	132480
LI040-06126N	GORMANSTOWN	ring ditch	164859	132497
LI040-06302-	GORMANSTOWN (PHILLIPS)	ring ditch	165476	132378
LI040-06303-	GORMANSTOWN (PHILLIPS)	ring ditch possible	165580	132520
LI040-06304-	GORMANSTOWN (PHILLIPS)	ring ditch possible	165590	132490
LI040-06501-	GORMANSTOWN (PHILLIPS)	ring ditch	165660	131770
LI040-06502-	GORMANSTOWN (PHILLIPS)	ring ditch	165670	131780
LI040-06503-	GORMANSTOWN (PHILLIPS)	ring ditch	165670	131770

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI040-067---	BALLINE	ring ditch	166020	131500
LI040-07001-	GORMANSTOWN (GRADY)	ring ditch possible	166370	131380
LI040-07002-	GORMANSTOWN (GRADY)	ring ditch	166400	131460
LI040-07004-	GORMANSTOWN (GRADY)	ring ditch	166440	131490
LI040-07005-	GORMANSTOWN (GRADY)	ring ditch	166449	131503
LI040-07006-	GORMANSTOWN (GRADY)	ring ditch	166599	131589
LI040-07007-	GORMANSTOWN (GRADY)	ring ditch	166600	131450
LI040-07008-	GORMANSTOWN (GRADY)	ring ditch	166451	131491
LI040-07009-	GORMANSTOWN (GRADY)	ring ditch	166615	131511
LI040-07101-	GORMANSTOWN (GRADY)	ring ditch	166567	132238
LI040-07102-	GORMANSTOWN (GRADY)	ring ditch	166543	132248
LI040-07103-	GORMANSTOWN (GRADY)	ring ditch	166578	132282
LI040-07104-	GORMANSTOWN (GRADY)	ring ditch	166698	132252
LI040-076---	ADAMSTOWN	ring ditch complex	167418	131317
LI040-07701-	ADAMSTOWN	ring ditch	167510	131680
LI040-07702-	NEWTOWN	ring ditch	167580	131700
LI040-07703-	NEWTOWN	ring ditch	167590	131690
LI040-07704-	NEWTOWN	ring ditch possible	167640	131640
LI040-07705-	NEWTOWN	ring ditch	167668	131570
LI040-07706-	ADAMSTOWN	ring ditch	167670	131620
LI040-07801-	ELTON	habitation	168690	130918
LI040-07802-	ELTON	ring ditch	168772	130839
LI040-07803-	ELTON	ring ditch	168800	130963
LI040-07804-	ELTON	ring ditch	168815	130941
LI040-07805-	ELTON	ring ditch	168853	130982
LI040-07806-	ELTON	ring ditch	168830	130990
LI040-07807-	ELTON	ring ditch	168837	130964
LI040-07808-	ELTON	ring ditch	168877	130908
LI040-07809-	ELTON	ring ditch	168899	130893
LI040-07810-	ELTON	ring ditch	168860	131070
LI040-07811-	ELTON	ring ditch	168858	130958
LI040-07812-	ELTON	ring ditch	168888	131021
LI040-07813-	ELTON	ring ditch	168879	131089
LI040-07814-	ELTON	ring ditch	168876	131046
LI040-07815-	ELTON	ring ditch	168910	130970
LI040-07816-	ELTON	ring ditch	168889	131000

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI040-07817-	ELTON	ring ditch	168924	131003
LI040-07818-	ELTON	ring ditch	168930	130970
LI040-07819-	ELTON	ring ditch	168940	130990
LI040-07820-	ELTON	ring ditch	168914	131038
LI040-07821-	ELTON	ring ditch	168864	131008
LI040-07822-	ELTON	ring ditch	168855	131018
LI040-07823-	ELTON	ring ditch	168953	130948
LI040-07824-	ELTON	ring ditch	168947	131020
LI040-07825-	ELTON	ring ditch	168960	130962
LI040-07826-	ELTON	ring ditch	168973	130964
LI040-07827-	ELTON	ring ditch	168954	130997
LI040-07828-	ELTON	ring ditch	168960	131030
LI040-07829-	ELTON	ring ditch	168970	131050
LI040-07830-	ELTON	ring ditch	168970	131040
LI040-07831-	ELTON	ring ditch	168975	130981
LI040-07832-	ELTON	ring ditch	168918	130953
LI040-07833-	ELTON	ring ditch	168990	131020
LI040-07834-	ELTON	ring ditch	168990	131030
LI040-07835-	ELTON	ring ditch	168983	130943
LI040-07836N	ELTON	fulacht fiadh	168753	130969
LI040-092—	BALLYGRENNAN	ring ditch possible	163900	130620
LI040-096—	BALLINSCAULA	rathanny type	166890	130210
LI040-097—	BALLINSCAULA	rathanny type	166930	130120
LI040-098—	STEPHENSTOWN	ring ditch	167225	130959
LI040-099—	STEPHENSTOWN	ring ditch	167246	130935
LI040-10002-	STEPHENSTOWN	ring ditch	167566	130665
LI040-10003-	STEPHENSTOWN	ring ditch	167644	130654
LI040-10004-	BALLINVANA	ring ditch	167679	130545
LI040-10005-	STEPHENSTOWN	ring ditch	167721	130700
LI040-10006-	STEPHENSTOWN	ring ditch	167730	130724
LI040-10007-	BALLINVANA	ring ditch	167772	130600
LI040-10008-	STEPHENSTOWN	ring ditch	167751	130706
LI040-10009-	STEPHENSTOWN	ring ditch	167803	130704
LI040-10010-	STEPHENSTOWN	ring ditch	167750	130725
LI040-10011-	STEPHENSTOWN	ring ditch	167780	130694
LI040-10012-	STEPHENSTOWN	ring ditch	167780	130723

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI040-10602-	BALLINVANA	ring ditch	168363	130683
LI040-10603-	BALLINVANA	ring ditch	168373	130662
LI040-10604-	BALLINVANA	ring ditch	168506	130543
LI040-10605-	BALLINVANA	ring ditch	168387	130677
LI040-10606-	BALLINVANA	ring ditch	168430	130577
LI040-10607-	BALLINVANA	ring ditch	168486	130539
LI040-10608N	BALLINVANA	ring ditch	168393	130649
LI040-10609N	BALLINVANA	ring ditch	168411	130634
LI040-108---	DOONMOON	ring ditch	169723	130591
LI040-116---	BALLYNAHINCH	ring ditch	170349	130088
LI040-117---	BALLYNAHINCH	ring ditch	170371	130052
LI040-118---	BALLYNAHINCH	ring ditch	170578	129686
LI040-119---	BALLYNAHINCH	ring ditch	170817	129569
LI040-120---	KNOCKLONG EAST	ring ditch	170975	130181
LI040-121---	BALLYNAHINCH	ring ditch	170916	129587
LI040-122---	KNOCKLONG EAST	ring ditch	171009	130194
LI040-124---	KNOCKLONG EAST	ring ditch possible	171065	130200
LI040-126---	BALLYNAHINCH	ring ditch	171059	129350
LI040-12701-	BALLYNAHINCH	ring ditch	171117	129598
LI040-12702-	BALLYNAHINCH	ring ditch	171141	129582
LI040-12703N	BALLYNAHINCH	ring ditch possible	171183	129522
LI040-128---	HAMMONDSTOWN	ring ditch possible	171220	129730
LI040-129---	BALLYNAHINCH	Field system	171330	129620
LI040-131---	KNOCKLONG EAST	ring ditch possible	171351	130193
LI040-132---	ISLAND DROMAGH	ring ditch	171400	129360
LI040-135---	ISLAND DROMAGH	possible rathanny type	171540	129770
LI040-136---	HAMMONDSTOWN	field system	171710	129880
LI040-13701-	KNOCKLONG EAST	field system	171820	130360
LI040-13702-	KNOCKLONG EAST	ring ditch possible	171790	130410
LI040-138---	MITCHELSTOWNDOWN NORTH	pit burials	171810	129550
LI040-140---	BALLINCOLLOO	ring ditch	164394	133383
LI040-141---	BALLINVANA	ring ditch	168490	130250
LI040-142---	RATHANNY	ring ditch	169600	134400
LI040-14501-	KNOCKLONG WEST	ring ditch	170540	130750
LI040-14502-	KNOCKLONG WEST	ring ditch	170550	130730
LI040-146---	KNOCKLONG WEST	ring ditch possible	170540	130620

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI040-14701-	KNOCKLONG WEST	ring ditch	170660	130720
LI040-14702-	KNOCKLONG WEST	ring ditch	170660	130700
LI040-156---	BALLINCOLLOO	ring ditch possible	165320	133210
LI040-157---	BALLINCOLLOO	ring ditch possible	164560	133020
LI040-158---	GORMANSTOWN (PHILLIPS)	ring ditch	165860	132660
LI040-160---	BAGGOTSTOWN WEST	ring ditch	165760	133180
LI040-162---	BAGGOTSTOWN WEST	ring ditch	166220	133080
LI040-163---	BAGGOTSTOWN WEST	ring ditch	166360	132970
LI040-16401-	BOTTOMSTOWN	ring ditch	167550	132490
LI040-16402-	BOTTOMSTOWN	ring ditch	167620	132480
LI040-16601-	ELTON	ring ditch	169180	131590
LI040-16602-	ELTON	ring ditch	169180	131610
LI040-16603-	ELTON	ring ditch	169320	131680
LI040-178--N	BALLYNAHINCH	ring ditch possible	170905	129651
LI040-17901N	DOONMOON	pit	169731	130612
LI040-17902N	DOONMOON	possible kiln	169747	130602
LI040-180--N	BAUNNAGEERAGH	ring ditch	163856	131600
LI040-182--N	BALLINSCAULA	ring ditch	166621	130228
LI040-183--N	BALLINSCAULA	Fulacht Fiadh	166656	130213
LI040-18501N	ELTON	ring ditch	170114	131461
LI040-18502N	ELTON	ring ditch	170167	131534
LI040-18503N	ELTON	ring ditch	170126	131509
LI040-18504N	ELTON	ring ditch	170143	131482
LI040-18505N	ELTON	ring ditch	170153	131489
LI040-18506N	ELTON	ring ditch	170165	131493
LI040-18507N	ELTON	ring ditch	170153	131474
LI040-18508N	ELTON	ring ditch	170169	131476
LI040-18509N	ELTON	ring ditch	170178	131473
LI040-18510N	ELTON	ring ditch	170186	131469
LI040-18511N	ELTON	ring ditch	170188	131484
LI040-18512N	ELTON	ring ditch	170281	131543
LI040-18513N	ELTON	ring ditch	170297	131532
LI040-18514N	ELTON	ring ditch	170281	131526
LI040-186--N	COOLALOUGH	ring ditch	171759	135325
LI041-00203-	MITCHELSTOWNDOWN NORTH	ring ditch	172250	129654
LI041-00204-	MITCHELSTOWNDOWN NORTH	ring ditch	172227	129641

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI041-003---	COOLALOUGH	rathanny type	172220	135310
LI041-005---	MITCHELSTOWNDOWN NORTH	ring ditch	172425	129347
LI041-006---	MITCHELSTOWNDOWN NORTH	ring ditch possible	172510	129780
LI041-01301-	RAHEENNAMADRA	earthwork	173580	129730
LI041-01302-	RAHEENNAMADRA	mound	173277	129528
LI041-01303-	RAHEENNAMADRA	mound	173279	129508
LI041-01309-	RAHEENNAMADRA	standing stone	173310	129700
LI041-01312-	RAHEENNAMADRA	standing stone	173430	129950
LI041-01314-	RAHEENNAMADRA	mound	173497	129614
LI041-01315-	RAHEENNAMADRA	ring ditch	173452	129601
LI041-01319N	RAHEENNAMADRA	ring ditch	173467	129645
LI041-01320N	RAHEENNAMADRA	ring ditch possible	173451	129764
LI041-01321N	RAHEENNAMADRA	ring ditch possible	173515	129682
LI041-01322N	RAHEENNAMADRA	ring ditch possible	173453	129571
LI041-026---	BALLYLOOBY	cairn	176680	131620
LI041-03201-	LISSARD	ring ditch	177493	129377
LI041-03202-	LISSARD	ring ditch	177463	129381
LI041-03203-	LISSARD	ring ditch	177420	129371
LI041-03204-	LISSARD	ring ditch	177468	129350
LI041-03205-	LISSARD	ring ditch	177549	129393
LI041-03206-	LISSARD	ring ditch	177441	129460
LI041-03207-	LISSARD	ring ditch	177458	129480
LI041-03208-	LISSARD	ring ditch	177542	129495
LI041-03209-	LISSARD	ring ditch	177572	129491
LI041-03210-	LISSARD	ring ditch	177588	129485
LI041-03211-	LISSARD	ring ditch	177640	129470
LI041-03212-	LISSARD	ring ditch	177570	129530
LI041-03213-	LISSARD	ring ditch	177595	129565
LI041-03214-	LISSARD	ring ditch	177576	129553
LI041-033---	LISSARD	ring ditch	177503	129313
LI041-041---	MITCHELSTOWNDOWN NORTH	ring ditch	172352	129705
LI041-042---	MITCHELSTOWNDOWN NORTH	ring ditch	172420	129737
LI041-043---	MITCHELSTOWNDOWN NORTH	ring ditch	172582	129390
LI041-044---	MITCHELSTOWNDOWN NORTH	ring ditch	172610	129347
LI041-052--N	MITCHELSTOWNDOWN NORTH	ring ditch	172406	129348
LI041-053--N	LISSARD	ring ditch	177357	129295

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI047-01201-	TANKARDSTOWN SOUTH	habitation	158400	128260
LI047-01202-	TANKARDSTOWN SOUTH	habitation site	158420	128250
LI047-013—	TANKARDSTOWN SOUTH	ring ditch	158920	128290
LI047-025—	ARDKILMARTIN	standing stone	161710	128820
LI047-046—	THOMASTOWN	mound	158040	124700
LI047-059—	GARRYNDERK NORTH	rathanny type	155250	124760
LI047-06201-	GARRYNDERK NORTH	fulacht fiadh	155630	125290
LI047-089--N	ASH HILL	megalithic tomb	160526	127911
LI048-021—	ISLAND DROMAGH	ring ditch	171290	129270
LI048-022—	ISLAND DROMAGH	ring ditch	171619	129095
LI048-024—	MITCHELSTOWNDOWN NORTH	ring ditch	171891	129291
LI048-025—	MITCHELSTOWNDOWN NORTH	ring ditch	171908	129315
LI048-03301-	CUSH	ring ditch	168990	126020
LI048-03302-	CUSH	ring ditch	169040	125982
LI048-03303N	CUSH	ring ditch	169063	125996
LI048-03401-	CUSH	field system	169900	125870
LI048-03410-	CUSH	barrow	169783	125628
LI048-03411-	CUSH	ring ditch	169777	125652
LI048-03412-	CUSH	ring ditch	169760	125632
LI048-03415-	CUSH	cist	169750	125600
LI048-03417-	CUSH	pit burial	169908	125504
LI048-03418-	CUSH	cist	169752	125600
LI048-03419-	CUSH	cist	169908	125504
LI048-03420-	CUSH	lined pit	169909	125503
LI048-03421-	CUSH	lined pit	169750	125606
LI048-03422-	CUSH	habitation site	169750	125581
LI048-03424-	CUSH	standing stone	169960	125490
LI048-039—	CUSH	standing stone	170387	125600
LI048-041—	BALLINVREENA	standing stone	171030	126470
LI048-061—	MOORESTOWN	standing stone	169440	123940
LI048-06502-	KILLEEN	standing stone	169920	124210
LI048-06503-	KILLEEN	standing stone	169970	124150
LI048-068—	BALLINTOBER	cairn	171310	123570
LI048-070—	ISLAND DROMAGH	ring ditch possible	171270	129200
LI049-00101-	MITCHELSTOWNDOWN WEST	ring ditch	172114	128979
LI049-00102-	MITCHELSTOWNDOWN WEST	ring ditch	172124	128959

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI049-00103-	MITCHELSTOWNDOWN WEST	ring ditch	172147	128979
LI049-00104-	MITCHELSTOWNDOWN WEST	ring ditch	172146	128957
LI049-00105-	MITCHELSTOWNDOWN WEST	ring ditch	172134	128897
LI049-00106-	MITCHELSTOWNDOWN WEST	ring ditch	172169	128958
LI049-00107-	MITCHELSTOWNDOWN WEST	ring ditch	172169	128939
LI049-00108-	MITCHELSTOWNDOWN WEST	ring ditch	172351	129008
LI049-00109-	MITCHELSTOWNDOWN WEST	ring ditch	172366	128978
LI049-00110-	MITCHELSTOWNDOWN WEST	ring ditch	172389	128938
LI049-00111-	MITCHELSTOWNDOWN WEST	ring ditch	172357	128952
LI049-00112-	MITCHELSTOWNDOWN WEST	ring ditch	172420	129010
LI049-00113-	MITCHELSTOWNDOWN WEST	ring ditch	172369	128961
LI049-00114-	MITCHELSTOWNDOWN WEST	ring ditch	172400	128949
LI049-00115-	MITCHELSTOWNDOWN WEST	ring ditch	172419	128949
LI049-00116-	MITCHELSTOWNDOWN WEST	ring ditch	172399	128924
LI049-00117-	MITCHELSTOWNDOWN WEST	ring ditch	172460	128990
LI049-00118-	MITCHELSTOWNDOWN WEST	ring ditch	172460	128914
LI049-00119-	MITCHELSTOWNDOWN WEST	ring ditch	172460	128842
LI049-00120-	MITCHELSTOWNDOWN WEST	ring ditch	172457	128967
LI049-00121-	MITCHELSTOWNDOWN WEST	ring ditch	172419	128930
LI049-00122-	MITCHELSTOWNDOWN WEST	ring ditch	172466	128814
LI049-00123-	MITCHELSTOWNDOWN WEST	ring ditch	172510	128943
LI049-00124-	MITCHELSTOWNDOWN WEST	ring ditch	172528	129034
LI049-00125-	MITCHELSTOWNDOWN WEST	ring ditch	172509	128869
LI049-00126-	MITCHELSTOWNDOWN WEST	ring ditch	172432	128940
LI049-00127-	MITCHELSTOWNDOWN WEST	ring ditch	172520	128849
LI049-00128-	MITCHELSTOWNDOWN WEST	ring ditch	172629	129039
LI049-00129-	MITCHELSTOWNDOWN WEST	ring ditch	172662	128931
LI049-00130-	MITCHELSTOWNDOWN WEST	ring ditch	172679	129075
LI049-00131-	MITCHELSTOWNDOWN WEST	ring ditch	172664	129019
LI049-00132-	MITCHELSTOWNDOWN WEST	ring ditch	172660	128962
LI049-00133-	MITCHELSTOWNDOWN WEST	ring ditch	172702	128906
LI049-00134-	MITCHELSTOWNDOWN WEST	ring ditch	172696	129064
LI049-00135-	MITCHELSTOWNDOWN WEST	ring ditch	172713	129035
LI049-00136-	MITCHELSTOWNDOWN WEST	ring ditch	172685	128927
LI049-00137-	MITCHELSTOWNDOWN WEST	ring ditch	172671	128943
LI049-00138-	MITCHELSTOWNDOWN WEST	ring ditch	172686	129011

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI049-00139-	MITCHELSTOWNDOWN WEST	ring ditch	172683	128998
LI049-00140-	MITCHELSTOWNDOWN WEST	ring ditch	172685	129027
LI049-00141-	MITCHELSTOWNDOWN WEST	ring ditch	172696	128947
LI049-00143-	MITCHELSTOWNDOWN WEST	ring ditch	172787	129064
LI049-00144-	MITCHELSTOWNDOWN WEST	ring ditch	172826	129060
LI049-00146N	MITCHELSTOWNDOWN WEST	ring ditch	172157	128916
LI049-00147N	MITCHELSTOWNDOWN WEST	ring ditch	172175	128910
LI049-00148N	MITCHELSTOWNDOWN WEST	ring ditch	172191	128926
LI049-00149N	MITCHELSTOWNDOWN WEST	ring ditch	172265	128948
LI049-00150N	MITCHELSTOWNDOWN WEST	ring ditch	172486	128816
LI049-00151N	MITCHELSTOWNDOWN WEST	ring ditch	172504	128839
LI049-00152N	MITCHELSTOWNDOWN WEST	ring ditch	172569	128838
LI049-00153N	MITCHELSTOWNDOWN WEST	ring ditch	172610	128882
LI049-00154N	MITCHELSTOWNDOWN WEST	ring ditch	172698	128889
LI049-00155N	MITCHELSTOWNDOWN WEST	ring ditch	172656	128857
LI049-00156N	MITCHELSTOWNDOWN WEST	ring ditch	172672	128857
LI049-003—	MITCHELSTOWNDOWN NORTH	ring ditch	172450	129332
LI049-004—	MITCHELSTOWNDOWN NORTH	ring ditch	172442	129304
LI049-005—	MITCHELSTOWNDOWN WEST	fulacht fiadh	172918	128999
LI049-006—	MITCHELSTOWNDOWN WEST	ring ditch	172610	128673
LI049-011—	MITCHELSTOWNDOWN WEST	mound	173340	128710
LI049-012—	MITCHELSTOWNDOWN WEST	ring ditch	173295	128546
LI049-01401-	RAHEENAMADRA	pit burial	173508	128884
LI049-01402-	RAHEENAMADRA	pit burial	173489	128879
LI049-015—	MITCHELSTOWNDOWN EAST	ring ditch	173870	128585
LI049-016—	MITCHELSTOWNDOWN EAST	ring ditch	173532	128703
LI049-018—	RAHEENAMADRA	field system	173870	129370
LI049-020—	MITCHELSTOWNDOWN EAST	ring ditch	173752	128714
LI049-021—	MITCHELSTOWNDOWN EAST	ring ditch	173778	128722
LI049-024—	MITCHELSTOWNDOWN EAST	ring ditch	173844	128584
LI049-025—	MITCHELSTOWNDOWN EAST	ring ditch	173975	128322
LI049-02701-	MITCHELSTOWNDOWN EAST	ring ditch	174211	128793
LI049-02702-	MITCHELSTOWNDOWN EAST	ring ditch	174041	128854
LI049-02703-	MITCHELSTOWNDOWN EAST	hearth and pit with pot	174212	128696
LI049-02705-	MITCHELSTOWNDOWN EAST	ring ditch	174135	128655
LI049-02706-	MITCHELSTOWNDOWN EAST	ring ditch	174144	128635

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI049-02708-	MITCHELSTOWNDOWN EAST	ring ditch	174164	128851
LI049-02709-	MITCHELSTOWNDOWN EAST	ring ditch	174214	128778
LI049-02710N	MITCHELSTOWNDOWN EAST	ring ditch possible	174147	128599
LI049-02902-	MITCHELSTOWNDOWN EAST	ring ditch	174106	128381
LI049-02903-	MITCHELSTOWNDOWN EAST	ring ditch	174129	128386
LI049-02904-	MITCHELSTOWNDOWN EAST	ring ditch	174119	128367
LI049-031---	MITCHELSTOWNDOWN EAST	pit burial	174232	128692
LI049-03302-	RAHEEN	ring ditch	174552	128753
LI049-03303-	RAHEEN	ring ditch	174601	128859
LI049-03304-	RAHEEN	ring ditch	174639	128711
LI049-03305-	RAHEEN	ring ditch	174663	128713
LI049-034---	RAHEEN	barrow possible	174577	128592
LI049-035---	RAHEEN	ring ditch	174587	128328
LI049-036---	RAHEEN	pit burial	174649	128596
LI049-037---	RAHEEN	ring ditch	174599	128625
LI049-041---	RAHEEN	fulacht fiadh	174887	128505
LI049-04801-	NEWTOWN	field system	175610	128270
LI049-04804-	NEWTOWN	ring ditch	175720	128270
LI049-04901-	DUNTRYLEAGUE	field system	175810	129040
LI049-051---	NEWTOWN	ring ditch	175767	128257
LI049-052---	NEWTOWN	ring ditch	175785	128222
LI049-055---	DUNTRYLEAGUE	pit	175890	127880
LI049-056---	DUNTRYLEAGUE	pits	175928	127819
LI049-057---	DUNTRYLEAGUE	fulacht fiadh	176000	127840
LI049-058---	DUNTRYLEAGUE	hearth pit	176026	127794
LI049-059---	DUNTRYLEAGUE	ring ditch	176127	127775
LI049-06001-	DUNTRYLEAGUE	field system	176070	128080
LI049-06002-	DUNTRYLEAGUE	ring ditch	175992	128173
LI049-061---	DUNTRYLEAGUE	pits	176290	127722
LI049-06201N	DUNTRYLEAGUE	ring ditch	176305	129065
LI049-06202N	DUNTRYLEAGUE	ring ditch	176299	129063
LI049-06203N	DUNTRYLEAGUE	ring ditch	176293	129056
LI049-06204N	DUNTRYLEAGUE	ring ditch	176301	129055
LI049-06205N	DUNTRYLEAGUE	ring ditch	176307	129060
LI049-06206N	DUNTRYLEAGUE	ring ditch	176311	129055
LI049-06207N	DUNTRYLEAGUE	ring ditch	176301	129049

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI049-06208N	DUNTRYLEAGUE	ring ditch	176285	129056
LI049-07201-	BALLYNAMONA	ring ditch	177063	129114
LI049-07202-	BALLYNAMONA	ring ditch	177071	129132
LI049-07203-	BALLYNAMONA	ring ditch	177073	129077
LI049-07204-	BALLYNAMONA	ring ditch	177086	129055
LI049-07205-	BALLYNAMONA	ring ditch	177083	129116
LI049-07206-	BALLYNAMONA	ring ditch	177090	129100
LI049-07207-	BALLYNAMONA	ring ditch	177102	129031
LI049-07208-	BALLYNAMONA	ring ditch	177156	128910
LI049-07209-	BALLYNAMONA	ring ditch	177159	128983
LI049-07210-	BALLYNAMONA	ring ditch	177185	129113
LI049-07211-	BALLYNAMONA	ring ditch	177264	129092
LI049-07212-	BALLYNAMONA	ring ditch	177258	129046
LI049-07213-	BALLYNAMONA	ring ditch	177297	129135
LI049-07214-	BALLYNAMONA	ring ditch	177293	129068
LI049-07215-	BALLYNAMONA	ring ditch	177297	129090
LI049-07217-	LISSARD	ring ditch	177390	129194
LI049-07218-	LISSARD	ring ditch	177390	129270
LI049-07219-	LISSARD	ring ditch	177390	129231
LI049-07220-	LISSARD	ring ditch	177417	129224
LI049-07221-	LISSARD	ring ditch	177476	129213
LI049-07222-	LISSARD	ring ditch	177513	129163
LI049-07223-	LISSARD	ring ditch	177518	129110
LI049-07224-	LISSARD	ring ditch	177545	129255
LI049-07225-	LISSARD	ring ditch	177559	129278
LI049-07226-	BALLYNAMONA	ring ditch	177594	129161
LI049-076—	DEERPARK	cairn	177714	128346
LI049-077—	DEERPARK	passage tomb	177717	128389
LI049-078—	DEERPARK	cairn	177861	128362
LI049-093—	GLENLARY	megalthic tomb	172458	125293
LI049-095—	CLOGHAST	stone circle	172530	125250
LI049-103—	BALLYFROOTA	megalithic tomb	174150	126420
LI049-120—	SPITTLE	pit burial?	176901	126800
LI049-122—	SPITTLE	pit burial, possible	177222	126492
LI049-123—	SPITTLE	cremation pit possible	177439	126286
LI049-127—	BALLYNATONA	pit burial	177600	126130

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI049-133---	SPITTLE	ring ditch	178120	125105
LI049-166---	BALLINTOBER	mound	172780	124490
LI049-18901-	BALLYFAUSKEEN	ring ditch	178696	124082
LI049-18902-	BALLYFAUSKEEN	ring ditch	178755	124104
LI049-191---	BALLYFAUSKEEN	ring ditch	178850	124120
LI049-19201-	BALLYFAUSKEEN	ring ditch	178787	124037
LI049-19202-	BALLYFAUSKEEN	ring ditch	178813.98	123990
LI049-196---	BALLYFAUSKEEN	fulacht fiadh	178930	123870
LI049-212---	BALLYFROOTA	ring ditch	174412	128113
LI049-213---	BALLYFROOTA	barrow	174699	127671
LI049-214---	BALLYFROOTA	ring ditch	174741	127529
LI049-215---	BALLYFROOTA	ring ditch	174768	127779
LI049-216---	BALLYFROOTA	ring ditch	174839	127696
LI049-217---	CLOGHAST	ring ditch	173360	128177
LI049-218---	CLOGHAST	ring ditch	173388	128248
LI049-219---	DUNTRYLEAGUE	ring ditch	176086	127728
LI049-220---	DUNTRYLEAGUE	ring ditch	176123	127680
LI049-221---	DUNTRYLEAGUE	ring ditch	176156	128307
LI049-222---	DUNTRYLEAGUE	ring ditch	176180	128427
LI049-223---	DUNTRYLEAGUE	ring ditch	176747	127003
LI049-224---	DUNTRYLEAGUE	ring ditch	176788	128499
LI049-22501-	GLENLARY	ring ditch	172321	128165
LI049-22502-	GLENLARY	ring ditch	172361	128112
LI049-22503-	GLENLARY	ring ditch	172403	128082
LI049-226---	MITCHELSTOWNDOWN EAST	ring ditch	174032	128427
LI049-227---	RAHEEN	ring ditch	174522	128328
LI049-228---	RAHEEN	ring ditch	174607	128283
LI049-229---	RAHEEN	ring ditch	174905	128715
LI049-230---	MITCHELSTOWNDOWN WEST	ring ditch	172354	128683
LI049-231---	MITCHELSTOWNDOWN WEST	ring ditch	172378	128683
LI049-232---	MITCHELSTOWNDOWN WEST	ring ditch	172420	128677
LI049-233---	MITCHELSTOWNDOWN WEST	ring ditch	172812	128511
LI049-234---	MITCHELSTOWNDOWN WEST	ring ditch	173054	128670
LI049-235---	NEWTOWN	ring ditch	174930	128334
LI049-23601-	NEWTOWN	ring ditch	175373	127488
LI049-23602-	NEWTOWN	ring ditch	175390	127484

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
LI049-23603-	NEWTOWN	ring ditch	175408	127474
LI049-237---	RAHEEN	ring ditch	175223	128336
LI049-238---	SPITTLE	ring ditch	178388	125020
LI049-239---	SPITTLE	ring ditch	178450	124990
LI049-240---	MITCHELSTOWNDOWN EAST	ring ditch	173636	128676
LI049-24101-	MITCHELSTOWNDOWN EAST	ring ditch	173664	128746
LI049-24102-	MITCHELSTOWNDOWN EAST	ring ditch	173690	128750
LI049-245---	SPITTLE	ring ditch	177920	124790
LI049-246---	SPITTLE	ring ditch	178393	124974
LI049-265--N	MITCHELSTOWNDOWN NORTH	ring ditch	172518	129145
LI049-266--N	DUNTRYLEAGUE	pit	176012	127782
LI049-267--N	DUNTRYLEAGUE	three pits	175959	127807
LI049-268--N	DUNTRYLEAGUE	pit burial	176045	127787
LI049-269--N	DUNTRYLEAGUE	ring ditch and enclosure	176097	127773
LI049-270--N	MITCHELSTOWNDOWN WEST	ring ditch	172397	128678
LI049-271--N	MITCHELSTOWNDOWN WEST	ring ditch possible	172864	128564
LI049-272--N	MITCHELSTOWNDOWN WEST	ring ditch possible	173003	128409
LI049-273--N	RAHEEN	habitation site, enclosure	174620	128624
TI065-006---	GORTVUNATRIME	ring ditch	176090	135680
TI065-007---	BALLYNAVEEN	ring ditch	173240	134670
TI065-009---	BALLYNAVEEN	ring ditch	173380	134250
TI065-010---	BALLYNAVEEN	ring ditch	174220	134420
TI065-011---	BALLYNAVEEN	ring ditch	174350	134350
TI065-017---	EMLY	ring ditch	176800	134560
TI065-019---	TULLA (EMLY PR)	ring ditch	177280	134650
TI065-020---	TULLA (EMLY PR)	ring ditch	177410	134630
TI065-021---	BALLYHOLAHAN EAST	ring ditch	175160	133380
TI065-024---	BALLYHOLAHAN WEST	ring ditch	173840	132590
TI065-025---	BALLYHOLAHAN WEST	ring ditch	173890	132480
TI065-026---	BALLYHOLAHAN WEST	ring ditch	173980	132820
TI065-027---	BALLYHOLAHAN EAST	ring ditch	174080	132930
TI065-028---	BALLYHOLAHAN EAST	ring ditch	174240	132990
TI065-029---	BALLYHOLAHAN EAST	ring ditch	174470	133040
TI065-030---	BALLYHOLAHAN EAST	ring ditch	174930	132960
TI065-031---	BALLYHOLAHAN EAST	ring ditch	175130	132840
TI065-032---	MOANMORE (EMLY PR)	ring ditch	176090	133140

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
TI065-033---	MOANMORE (EMLY PR)	ring ditch	176160	133270
TI065-034---	MOANMORE (EMLY PR)	polygonal cist	176660	133380
TI065-03401-	MOANMORE (EMLY PR)	ring ditch	176564	133396
TI065-036---	MOANMORE (EMLY PR)	ring ditch	175530	132800
TI065-03901-	MOANMORE (EMLY PR)	ring ditch	176270	133000
TI065-040---	MOANMORE (EMLY PR)	ring ditch	176680	132740
TI065-044---	BALLYHOLAHAN EAST	ring ditch	174850	133810
TI066-014---	LATTIN NORTH	ring ditch	180230	135560
TI066-015---	LATTIN NORTH	ring ditch	180450	135660
TI066-025---	CLASHDRUMSMITH	ring ditch	178450	135440
TI066-026---	BREANSHA	ring ditch	178620	134790
TI066-027---	BREANSHA	ring ditch	178820	134940
TI066-031---	NICKERES	ring ditch	179820	135340
TI066-034---	TULLA (EMLY PR)	ring ditch	177880	134710
TI066-035---	TULLA (EMLY PR)	ring ditch	177860	134580
TI066-036---	TULLA (EMLY PR)	ring ditch	177700	134270
TI066-038---	LISSOBIHANE	ring ditch	178540	134650
TI066-03901-	LISSOBIHANE	ring ditch	178590	134240
TI066-04101-	LISSOBIHANE	ring ditch	179520	134290
TI066-042---	LATTIN NORTH	ring ditch	180270	135320
TI066-043---	LATTIN NORTH	ring ditch	180760	135420
TI066-04702-	LISDUFF (LATTIN PR)	ring ditch	180160	134280
TI066-048---	LISDUFF (LATTIN PR)	ring ditch	180380	134440
TI066-05001-	LATTIN WEST	ring ditch	181080	134450
TI066-072---	BALLYNAGRANA (EMLY PR)	ring ditch	178030	133680
TI066-073---	LISSOBIHANE	ring ditch	178170	133870
TI066-074---	LISSOBIHANE	ring ditch	178190	133760
TI066-075---	BALLYNAGRANA (EMLY PR)	field system	177820	133260
TI066-07501-	MOANMORE (EMLY PR)	ring ditch	177703	133343
TI066-076---	BALLYNAGRANA (EMLY PR)	ring ditch	178170	133380
TI066-077---	BALLYNAGRANA (EMLY PR)	ring ditch	178260	133220
TI066-078---	LISSOBIHANE	ring ditch	178990	133590
TI066-080---	LISSOBIHANE	ring ditch	179230	133550
TI066-081---	MOORESFORT	ring ditch	179420	133710
TI066-082---	LISDUFF (LATTIN PR)	ring ditch	179800	133890
TI066-08301-	MOORESFORT	ring ditch	179630	133470

MON #	TOWNLAND	CLASSIFICATION	NGR N	NGR E
TI066-085---	BALLYNAGRANA (EMLY PR)	ring ditch	178350	133110
TI066-088---	MOANMORE (EMLY PR)	ring ditch	178360	132750
TI066-089---	BALLYNAGRANA (EMLY PR)	ring ditch	178470	132700
TI066-092---	BALLYNAGRANA (EMLY PR)	ring ditch	178770	133250
TI066-093---	BALLYNAGRANA (EMLY PR)	ring ditch	179140	133140
TI066-094---	BALLYNAGRANA (EMLY PR)	ring barrow	178780	132860
TI066-095---	BALLYNAGRANA (EMLY PR)	ring ditch	179080	132830
TI066-097---	MOORESFORT	ring ditch	179730	133150
TI066-098---	MOORESFORT	ring ditch	179780	133050
TI066-09901-	MOORESFORT	ring barrow	179590	132620
TI066-10101-	MOORESFORT	ring ditch	180480	133530
TI066-102---	MOORESFORT	ring ditch	180870	133280
TI066-104---	MOORESFORT	ring ditch	180170	133150
TI066-10501-	MOORESFORT	ring ditch	180370	132920
TI066-10502-	MOORESFORT	ring ditch	180440	132800

Appendix C: Radiocarbon Dates

Site	SMR	Context	Lab Number	Determination	Calibrated dates
Coolalough 1	LI040-0036---	Peat from base of mound	GrN-21355	2510±50 BP	800 - 410 BC
Mitchelstowndown North	LI049-00145-	Wood from platform	GrN-14902	6585±30 BP	5567 - 5549 BC
					5524 - 5440 BC
Tankardstown 1	LI047-01201-	Oak plank from wall slot	GrN-14713	5105±45 BP	3978 – 3892 BC
					3890 – 3796 BC
Tankardstown 1	LI047-01201-	Oak plank from wall slot	GrN-15386	5005±25 BP	3926 – 3916 BC
					3914 – 3876 BC
					3808 – 3710 BC
Tankardstown 1	LI047-01201-	Oak plank from wall slot	GrN-15387	4880±110 BP	3940 – 3840 BC
					3820 – 3500 BC
					3460 – 3370 BC
Tankardstown 1	LI047-01201-	Oak plank from wall slot	GrN-16643	5085±25 BP	3950 – 3902 BC
					3882 – 3800 BC
Tankardstown 1	LI047-01201-	Grain from internal pit	OxA-1476	4890±80 BP	3932 – 3874 BC
					3810 – 3508 BC
					3408 – 3384 BC
Tankardstown 1	LI047-01201-	Grain from internal pit	OxA-1477	4840±80 BP	3784 – 3500 BC
					3458 – 3378 BC
Duntryleague	LI049-269--N	Charcoal from hearth	GrN-15400	4030±100 BP	2880 – 2290 BC
Doonmoon	LI040-108---	Charcoal from pit	GrN-15395	3870±100 BP	2580 – 2030 BC
					2000 – 1990 BC
Doonmoon	LI040-108---	Charcoal from pit	GrN-15396	3875±35 BP	2458 – 2276 BC
					2248 – 2204 BC
Raheen 2	LI041-01319N	Charcoal from cremation	GrN-15390	3290±35 BP	1674 – 1652 BC
					1638 – 1506 BC
					1482 – 1454 BC
Raheen 2	LI041-01319N	Charcoal from ditch	GrN-15391	3020±90 BP	1442 – 994 BC
Mitchelstowndown North	LI040-138---	Charcoal from cremation	GrN-15394	3080±35 BP	1412 – 1262 BC
					1230 – 1226 BC
Mitchelstowndown North	LI040-138---	Charcoal from cremation	GrN-15379	3105±35 BP	1426 – 1298 BC
					1290 – 1266 BC

Site	SMR	Context	Lab Number	Determination	Calibrated dates
Doonmoon	L1040-108---	Charcoal from burial pit	GrN-15397	3000±210 BP	1740 – 1710 BC
					1700 – 790 BC
Raheenamadra	L1041-01319N	Charcoal from cremation	GrN-15402	2785±35 BP	996 – 838 BC
Adamstown	L1040-076---	Charcoal from ditch	GrN-15398	2655±35 BP	896 – 876 BC
					850 – 790 BC
Adamstown	L1040-076---	Charcoal from pit	GrN-15399	2500±120 BP	900 – 870 BC
					850 – 370 BC
					270 – 260 BC
Raheen	L1049-041	Wood from trough	GrN-13686	3605±40 BP	2116 – 2088 BC
					2038 – 1876 BC
					1838 – 1818 BC
					1800 – 1784 BC
Raheen	L1049-041	Wood from trough	GrN-13692	3555±50 BP	2026 – 2004 BC
					1980 – 1744 BC

Appendix D: Report on the investigation of a rathanny enclosure at Coolalough, Co. Limerick

Location

Coolalough 1 (OS 6" sheet 40 plan 4, trace 3, National Grid co-ordinates 17181 13532, SMR 40:36) is a mound surrounded by three banks on the floodplain of the Mahore river in Co. Limerick, just outside the village of Hospital, near the border of Co. Tipperary. O'Kelly (1943, 238) describes the Coolalough site, one of his type A sites (raised platform earthworks), as being surrounded by three fosses, a series of causeways and a number of gaps through the banks.

It is situated on Coolalough series soil, a gley with lake alluvium as parent material. This soil is extraordinarily wet all year round and even after extensive modern drainage it is only suitable for limited summer pasture. Southward the site looks across the floodplains of the Mahore, the Camoge, the Drumcamoge and the Morningstar rivers before the land rises up into the Ballyhoura Hills. To the north is a line of lower hills including Knockainy and the hill just north of Hospital (Fig.47).

Description

The site is composed of three banks, three internal ditches and a central mound.(Fig.48). Before the destruction described below the site was circular in plan with a dished appearance. The outer bank has a profile of material thrown outward, steeper on the outside than on the inside. This suggests that it was constructed from material derived from the interior of the site. The interior banks are not immediately apparent on visiting the site since they are less substantial than the outer banks and have suffered more erosion. While O'Kelly mentions causeways between the banks (1943, 238), there are none apparent. The top of the mound is slightly dished, its slopes slightly concave, and in appearance it is similar to a bowl barrow.

The overall diameter of the site is 78m. The outer enclosing bank ranges in width between 8.7m and 11.8m. There is a gap 9.4m wide in this bank in the Southeast quadrant which also shows slightly in banks 2 and 3. The ditch inside this bank ranges from 3.3m to 3.8m The height of bank 1 above the surrounding land is 0.4m, its height above the ditch is .85m. The middle bank ranges in width from 1.8m to 2.5m and the ditch inside this bank is 2m wide. The innermost bank is 2m - 2.3m wide and the ditch inside this ranges in width between 2.5m and 3.4m. The mound stands 1.64m high with a diameter of 14m on top and a basal diameter of c. 28.5m

The site was visited in late May at which time the entire site was bisected by a modern field fence with a ditch on either side running approximately NE-SW. Part of the north section of the site had been used as a dumping ground for waste building material in recent times. The outer bank was slightly better preserved on the north side than the south but the interior banks were less well preserved. The vast majority of the mound was on the south side of the ditches or in the field fence between the ditches. On the north side there was only a very slight rise. The gap recorded in the outer bank is unlikely to be an original feature, an entrance, and is more likely to result from disturbance. It is most likely that this is damage from a later field drain which can be seen running up to the site.

When we arrived at the site on the 8th of November the portion of the site north of the drainage ditch had been entirely levelled. Many of the drains in the surrounding fields had been re-cut and levelling the site probably took place at the same time. The site must have been deliberately levelled, because the disturbed soil had the same borders as had the site. The disturbed soil was very fresh with no vegetation , suggesting that destruction had taken place within the past few weeks. The portion of the site south of the drainage ditch was undamaged.

Investigation of levelled portion of site

The levelled portion of the site was photographed and examined in detail. The surface of the disturbed area was walked and two pieces of lithic debitage were collected. In addition, a large quantity of animal bone was collected from the eastern side of the site. The new cut drain edge was examined but since it had been cut with a bucket scoop features were not completely clear. The basic soil sequence was lake marl covered by peat on which the modern soil had developed. Where the outer bank had been it was possible to see the vestige of its profile. This was underlain by peat, but the peat was cut inside the bank, presumably by the interior ditch. Unfortunately, the high level of water in the drain did not allow us to determine the depth of the interior ditch. The outer bank appears to have been constructed partly of redeposited lake marl. A piece of bone was recovered from the drain edge immediately above the peat over the lake marl where the outer bank had been.

A previously unrecorded ring-ditch was also noted immediately beside the levelled site. It is located 20m north of the drain edge. It measures 7m NS and 6m EW. The mound is 3.6m in diameter. The mound was approximately 20-30cm high.

A cleaned section of the drain face

Although on the south side the drain face is mostly overgrown there was some collapse near the centre of the site near the middle of the mound. This showed signs of burning when examined during the previous visit. 2m of this face were cleaned and recorded as a section (Fig.8.9). Although the drain cuts below the level of lake marl, the section was only cleaned a few centimetres into this natural material.

Context 1 is sod. Context 2 is brown grey with mottled with a large amount of clay. Context 3 is medium brown with a finer texture than context 2. It is relatively stone free and quite homogeneous. It has small amounts of cremated bone visible in it. Context 4 is bright red, fine textured, soft and dry. Context 4a has substantial quantities of cremated bone and some burnt but not cremated bone. There is a substantial amount of charcoal rich soil at the bottom of this feature. Context 4b differs from 4a in that it has no bone and much less charcoal. Context 5 is mottled grey and reddish brown, sticky, but fairly loose and comes away in clumps. Context 6 is similar in colour to context 5 but it is much more compacted and has less organic component. Context 7 is a dark red grey brown, with quite a high organic content, context 7b is slightly paler than context 7a. Context 8 is similar in colour to context 5 but is slightly more compact. Context 9 is a medium red grey brown with an organic component but more homogeneous and less crumbly than context 7. Context 10 is compacted grey clay, only slightly mottled. Context 11 is similar in colour and consistency to context 8. Context 12 is compacted fen peat. Context 13 is mottled grey lake marl.

Our understanding is that the mound was constructed by scooping up the surrounding lake marl which by this point had been covered by fen peat. The different contexts with varying amounts of organic and clay content reflect the mixing of these two materials in varying amounts. The lower levels have higher quantities of peat because the scooping started from the surface. The very compact sections of lake marl are lumps which did not mix with the peat. We don't know why context 5 is so much looser than the other contexts. Context 4 is the result of in situ burning. 4a appears to be a pit where cremation took place while 4b is the site of associated surface burning. Context 3 is a capping which was placed over the cremation pit before any soil development took place. It seems that context 2 is more redeposited lake marl, the final construction of the mound. This is the only place in the section where we can see definite evidence of soil development.

The mound may have been constructed as a single sequence with the burning in the pit as part of this sequence since there is no definite soil development before this point. On the other hand since the lower levels show varying levels of organic content it is possible that the burning relates to a subsequent use of the mound and context 7 could be an old sod line. If this were so then it is still the case that the burning took place soon after the construction of the main height of the mound (contexts 5 and 6) since there is clearly no soil development here.

Samples taken

Samples were taken of a mixture of charcoal, burnt and cremated bone from context 4a as soon as it was exposed since we did not know its extent and it was possible that it had been nearly completely eroded. Since it survived as a substantial feature, it was possible to take separate, larger samples of these three components in the course of cleaning the section. One sample contains burnt earth and cremated bone, it is hoped that the species that the bone came from can be identified. The next sample contains possibly burnt but not cremated bone much of which came from the areas with charcoal. This was taken both for identification and with the hope of a radiocarbon date. The sample of charcoal rich soil was taken as a back up for a radiocarbon date, it is not as suitable since it shows no structure and we cannot be certain whether the wood was substantial or twiggy.

A sample for a radiocarbon date was also taken of the compacted fen peat from the base of the mound. A date from this sample could tell us two things. Firstly it will date environmental change associated with the lake becoming a fen. Secondly it could give us a fairly tight *terminus post quem* for the construction of the mound since there is no soil development above the peat. Clearly there is no reason to assume that these two different events were close to one another and one sample cannot date two events. Since the peat is compacted it could represent many centuries growth even though it is only about 10cm thick. Nonetheless a date may be useful because it would give us a ballpark range for these two events that we have little chronological control on right now. Even the fact of the lack of soil formation gives us a better sense of the sequence since it implies the mound was built on a surface of peat rather than a developed soil. The other possible benefit of a radiocarbon date from the fen peat is that if the date is significantly earlier than the date from the burning then we can be more confident in the model of a two phase mound.

Discussion

Construction and purpose of the mound The mound appears to have been constructed by scooping up the surrounding material. It is most likely to have been constructed in two phases first as a low mound which after soil development was considerably raised. Both the fact that context 7 appears to be a buried sod, and the fact that context 5 is considerably looser than the lower deposits support this interpretation. The cremation which took place in the pit seems to have been a significant part of the use of the site as a mound, though it is unlikely to be associated with the construction of the mound. There is no evidence of subsequent human activity on the mound.

Other similar sites in the area There are four sites in the general vicinity which share similar characteristics in the general vicinity of the town of Hospital: another site in Coolalough, one at Rathanny, at Ballinscaula, and at Ballinstona.. These sites, which are located in marshland and riverine environments, consis of a large central mound surrounded by a series of circular banks and ditches with diameters of over 100m. Some of these sites were described by O'Kelly in his survey of the field monuments in the barony of Small

County as type C enclosures (1943).

Architectural affinities of the site As was mentioned above the mound itself is similar in shape to bowl barrows (O Ríordáin 1979, 137-138). Since the enclosure must be taken with it however the affinities are wider. The overall form of the monument, particularly the dished scooped appearance and wide banks, has much in common with embanked enclosures such as the site excavated at Monknewtown, Co. Meath (Sweetman 1976). The lowland position of the sites would also have parallels in the similar location of the embanked enclosures in the Boyne Valley (Stout 1991). The internal ditches may be elaborations of this. O'Kelly's suggestion of a motte (1943, 238) is undermined by the fact that there are no causeways across the ditches, enclosure is complete and there is no evidence of occupation on the top of the mound. In addition the mound is really too low to be a seriously defensive feature.

At Ardcroney, Co. Tipperary, a large mound surrounded by a series of banks and ditches was found tc contain a Linkardstown-type burial, a single inhumation burial of the Late Neolithic period (Wallace 1977; Manning 1983-4). A closer parallel may be found at the site of Ashleypark, Co. Tipperary (Manning, 1985) / similar site, Fenniscourt, close to the River Barrow in Co. Carlow was also suggested to belong to the same tradition (Condit and Gibbons 1988). It too is surrounded by three enclosing elements which seem to have bee laid out prior to the construction of the mound.

Relationship of the mound to the enclosure Whether the site is a single or multi phase monument and t' implications of that for its architectural affinities rests on the relationship between the various components of tl site. Since we have no direct stratigraphy , this relationship could not be confirmed by our investigation but there are a number of lines of evidence relating to it. Firstly the drain section on the destroyed side of the site shows peat underlying both the outer bank and the mound. The internal banks and ditches were not visible in this section, but that could be due to conditions. Secondly both the outer bank and the mound are constructed from redeposited lake marl. Thirdly the mound may be a two phase monument. The things suggest that it is possible but not necessary that the initial construction of the mound was contemporary with the construction of the outer bank. They also suggest that there was more than one phase of construction at the site.

Could the outer bank have been constructed from material from the inside of the site (as indicated by its profile) if the mound was already standing? Yes. The area of the interior of the site was approximately 2286m^2 and the height discrepancy between the exterior of the site and the interior of the site is 45cm. The volume represented by this discrepancy is in the region of 1200m^3 and the volume of the bank is in the region of 1000m^3 so there would be enough soil to form the bank and some to spare. The outer bank could have been constructed with material scarped from the inside without disturbing the centre of the site. This accounts for the fact that both the mound and the outer bank are underlain by peat while the inner ditch of the bank cuts that deposit of peat.

The mound, however, has a volume of approximately 500m^3 so the entire monument could not have been constructed from the soil scarped inside of it, some material must have been imported from elsewhere. Since this is the case it is possible that the mound was built after the enclosure was constructed.

Clearly the relationship of the mound to the enclosure needs further investigation.. The spacing of all of the features suggests a coherent plan - is most likely that the construction and use of both elements were associated if not contemporary. While there are these separate elements, the construction of a mound within an existing enclosure would cause practical difficulties. The evidence suggests that the mound could be older than contemporary with, or more recent than the outer enclosure. If the mound is a two phase structure we know that enough time must have elapsed between the two stages for a sod to develop. Unfortunately if the entire site is a multi phase monument we do not know what the time lapse was between these stages . Further investigation is required to resolve these questions.

Landscape setting The siting on an extremely waterlogged part of the floodplain is one of the most striking features of the site. Even today the area is of marginal agricultural use and it is difficult to imagine intensive farming of this area in prehistory. In addition the heavily waterlogged nature of the surrounding area would have made access to the site extremely laborious. This is interesting as embanked enclosures are seen as monuments relating to large gatherings. There is a considerable amount of evidence for habitation in the Neolithic and Bronze Age in the wider area, such as at Lough Gur to the north (Grogan and Eogan 1987) and along the line of the Gas Pipeline to the south west (Gowen 1988). Further, there is evidence that settlement expanded in the Early to Middle Bronze Age to take in these areas of lower more waterlogged soils (Grogan 1989, 146-148). While the position is striking, it forms part of a pattern of use which is amenable to wider study.

Relationship of the site to ring-ditches One of the main site types to be found on these floodplains of tributaries to the Maigue River are ring-ditches. There are over 500 examples of this type of barrow on the SE Limerick plain. They are morphologically very similar and the example found right beside this site is typical. They range in size from 6 to 20m and usually consist of a low mound surrounded by a u-shaped ditch, with either no bank or a very low bank. Excavated and dated examples tend to cluster in the Middle Bronze Age. They occur in cemeteries and favour the floodplains in their siting (Grogan 1989, 149-151).

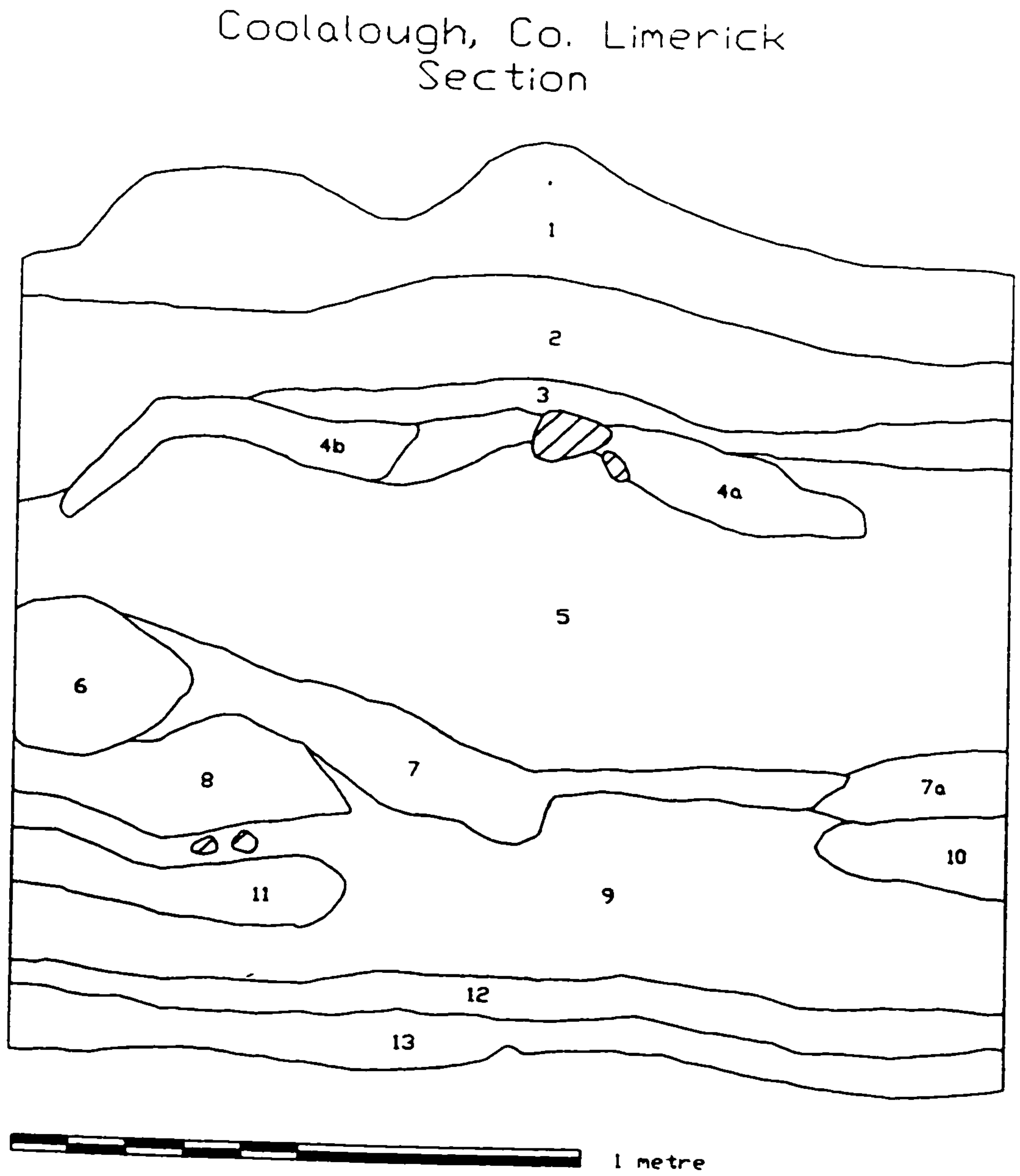
The recording of a ring-ditch right beside this site highlights the possible associations between the two type of monument. There is also a group of 4 other barrows in the field next to the site (Tarbett 1987). Other examples of this monument type that we have identified are also sited on the edge of clusters of barrows. In no cases are there ring-ditches built on top of this type of site. This is significant because there are a number of cases where ring-ditches are sited within other types of enclosures (O'Kelly 1943). There are also no cases where this type of site cuts a ring-ditch.

The regular spatial association of these two types of sites is interesting and suggests that there may be other associations. While the lack of ring-ditches on these sites could point to sites like Coolalough being later than ring-ditches, there is no definite evidence for this relationship. Further spatial analysis may shed light on this problem.

Possible Dating There are three different sources of information about possible dating for this type of site. Associations with other monuments, architectural affinities, and absolute dates. The associations with other monuments are not clear, but they may point to a date later than the Middle Bronze Age. The architectural affinities are mixed and bring up the possibility that it is a two phase site. The affinities with embanked enclosures points to the Later Neolithic while the Bell barrow affinities, including cremation in a pit would point to a Bronze Age date. If the site is a single phase monument it may represent a synthesis of two monument types, coming at the end of the series of both. Alternatively the affinities with the Linkardstown type burial may suggest a single phase site dating to the Later Neolithic. Clearly the possibility of radiocarbon dates coming from the collected samples from the mound may help clarify the picture.

Threat to the site At present we are unsure whether the same landowner owns both parts of the site, from the pattern of reclamation so far it seems unlikely. The portion of the site north of the drain has already been levelled and is unlikely to be damaged further. If the southern section of the site is owned by a different person it may not be under any further threat. There are, however, at least 5 ring-ditches on the same land as the levelled section and while they have not been affected so far they may be under threat. The fact that these sites are so slight is an advantage as they are less obtrusive, but they are noticeable when driven over in a tractor and serious land reclamation may affect them. A preservation order on the other sites on the land would be a sensible precaution.

Figure 89


Coolalough, Co. Limerick
Section
1
2
3
4b
4a
5
6
7
8
7a
10
11
9
12
13
1 metre

Appendix E: AML code for automating Site Catchment Analysis in ArcInfo

Introduction

This text explains sca.aml and related files

The purpose of the aml is to allow the processing of a large number of sites for site catchment analysis, allowing overlap of catchments and requiring minimum input from the user. As I have written it, it takes about 2-3 minutes per site to calculate and store all required stats on three different catchment sizes. This means that when dealing with the large numbers of sites that I wrote it for, it takes quite a while to run. Its still faster than processing sites individually.

To run this aml you will need

```
AMLS
sca.aml
select.aml
buff.aml
stat.aml
kill.aml

COVERAGES
rivers - built as arcs and including the attribute Trib (3, 3, I)
soil- built as polys and including the attribute series (6, 6, C)
sites - built as points and including the attribute  mon_no (12, 12, C)
        (this is a subset of the smrpts coverage including all the sites you
        are interested in)
cntrs - built as polys and including the attribute height_od (7, 7, C)


INFO FILES
in round brackets you must have, in twirly ones is your own business
SITES.EXT - (MON_NO, CLASS { ANY OTHER INFORMATION YOU WANT TO SELECT SITES (
        you can have sites in your coverage which are not in this file but e'
        site in this file must be in the coverage, otherwise it will
        return an error, trying to buffer a non-existant site
SOILSER1.LUT - (SERIES {SYMBOL, NAME ETC}) I made this table for map
        compositions hence the stange name.
HEIGHT.LUT - (HEIGHT {SYMBOL ETC})
SITESCLASS.LUT (CLASS {SYMBOL ETC}) the class should be related to the class
        SITES.EXT  in my tables I've made them more general, so my
        SITES.EXT table has a class 'ring ditch possible', this CLASS select:
        those by 'ring' but it depends on how much grouping you've done befo
        bringing the sites in. The class selection is a contains selection.

RELATES
sites.rel - sites.ext, info, mon_no, mon_no, ordered, rw


This aml will produce the following text files:

for each catchment size:

one text file listing the total area of each catchment
one text for all rivers listing the total number of rivers arcs and
        their total length within each catchment
one text file for each value of Trib listing the total length of all rivers
        and the total number of rivers arcs within each catchment
one text file for each soil series listing the total number of polygons of tl
        specified soil type, their total perimeter and their total area
one text file listing the total number of all sites in each catchment
one text file for each site class listing the total number of sites
```

one text file for each height range listing the total number of polygons
        at this height, their total area and total perimeter

this adds up to over 200 text files so they are stored in a directory called /scafiles, you will need to set this up before you run the aml.

Each of the files will have the same number of entries as your sites.ext fil These text files contain irelavent text (headers from the stats program etc) and will need editing before they can be converted to info files. They don' have mon_no's attached, which is one of the reasons you need to process each site for each class even when the value is 0. (The other reason is that its importnat to record the 0 values as well) They are in the identical ord to sites.ext so when converting to info you can move the mon_no from that file for the mon_no item in your new info file (should you want such an item)

I haven't set the program up to calculate percentages indivually, if you want percentages you can divide the various areas by the values in area.txt. You can calculate them all at once in an info report which is a quicker way of working.

sca.aml

```
/* automates site catchment analysis
/* selects sites, buffers them, performs statistical analysis
/* writes stats to text file, deletes buffers and cycles again

/* this aml controls the site being processed and directs the other amls
/* associated amls: select, buff, stat, kill

/* declares and opens cursor on sites.ext
cursor select declare sites.ext info
cursor select open

/* selects current site and runs selection aml
&do &while %:select.AML$NEXT%
&sv .site = %:select.mon_no%
&r select.aml


/* sets buffer size and runs the buffering aml
&do .buffer &list 500 1000 5000
&r buff.aml

/* runs the aml which compiles statistics
&r stat.aml

/* kills coverages ready for next buffer size
&r kill.aml

/* cycles to next buffer size
&end

/* moves on to next site
cursor select next

&end
```

select.aml

```
/* selects specified site and puts it in a coverage to be buffered

ae
ec sites
ef labels
select mon_no = [quote %.site%]

/* creates new coverage with only specified site in it
put focus
q
```

buff.aml

```
/* creates buffer of a specified size around specified site

buffer focus sca # # %.buffer% # point

/* cuts specific covers for comparison

intersect rivers sca riversca line
intersect soil sca soilsca poly
intersect sites sca sitessca point
intersect cntrs sca cntrssca poly
```

stat.aml

```
/* computes stats for different covreages and writes them to text files


ap

/* runs through the different coverages
&do cover &list riverssca soilsca sitessca cntrssca

&select %cover%
        &when riverssca
                &call rivers
        &when soilsca
                &call soil
        &when sitessca
                &call sites
        &when cntrssca
                &call cntrs
&end


&end

/*resets defaults
listoutput screen
q

/* satisfies the &call usage
&return

/* statistical routines for each coverage

/* RIVERS
&routine rivers
/* specifies text file to write to
listoutput %.buffer%rivers.txt

/* computes statistics
statistics riverssca arcs
sum length
end


&do number := 2 &to 16 &by 1
aselect riverssca arcs
reselect riverssca arcs trib = %number%

/* specifies text file to write to
listoutput %.buffer%rivers%number%.txt

/* computes statistics
statistics riverssca arcs
sum length
end
&end
```

```
&return

/* SOIL
&routine soil

/* specifies text file to write to
listoutput %.buffer%area.txt

/* computes statistics
statistics soilsca poly
sum area
end

/* declares and opens cursor on soilser1.lut
cursor soil declare soilser1.lut info
cursor soil open

/* selects current series

&do &while %:soil.AML$NEXT%
&sv series = %:soil.series%

aselect soilsca polys
reselect soilsca polys series = [quote %series%]

/* specifies text file to write to
listoutput %.buffer%soil%series%.txt

/* computes statistics
statistics soilsca polys
sum area
sum perimeter
end

/* moves to next series
cursor soil next

&end
/* clears cursor so it can be reestablished next cycle
cursor soil remove
&return

/* SITES
&routine sites

/* counts all sites
/* specifies text file to write to
listoutput %.buffer%sites.txt

/* computes statistics
statistic sitessca points
sum area
end

/* counts sites by class
/* declares and opens cursor on sitesclass.lut
cursor sites declare sitesclass.lut info
cursor sites open

/* selects current class

&do &while %:sites.AML$NEXT%
&sv class = %:sites.class%

aselect sitessca points
```

```
reselect sitessca points sites.rel//class cn [quote %class%]

/* specifies text file to write to
listoutput %.buffer%%class%.txt

/* computes statistics
statistic sitessca points
sum area
end

/* moves on to next class
cursor sites next

&end
/* clears cursor so it can be restablished in next cycle
cursor sites remove
&return

/* CNTRS
&routine cntrs

/* declares and opens cursor on height.lut
cursor height declare height.lut info
cursor height open

/* selects current height

&do &while %:height.AML$NEXT%
&sv height = %:height.height%

aselect cntrssca polys
reselect cntrssca polys height_od = [quote %height%]

/* specifies text file to write to
listoutput %.buffer%cntrs%height%.txt

/* computes statistics
statistics cntrssca polys
sum area
sum perimeter
end

/* moves on to next height
cursor height next

&end
/* clear cursor so it can be reestablished next cycle
cursor height remove
&return
```

kill.aml

```
/* Kills coverages created so that new catchment sizes can be drawn

&do cover &list sca riverssca soilsca sitessca cntrssca
kill %cover% all
&end

/* after all buffer sizes
/* kills coverage containing site so new site can be processed

&if %.buffer% = 5000 &then
kill focus all
```

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