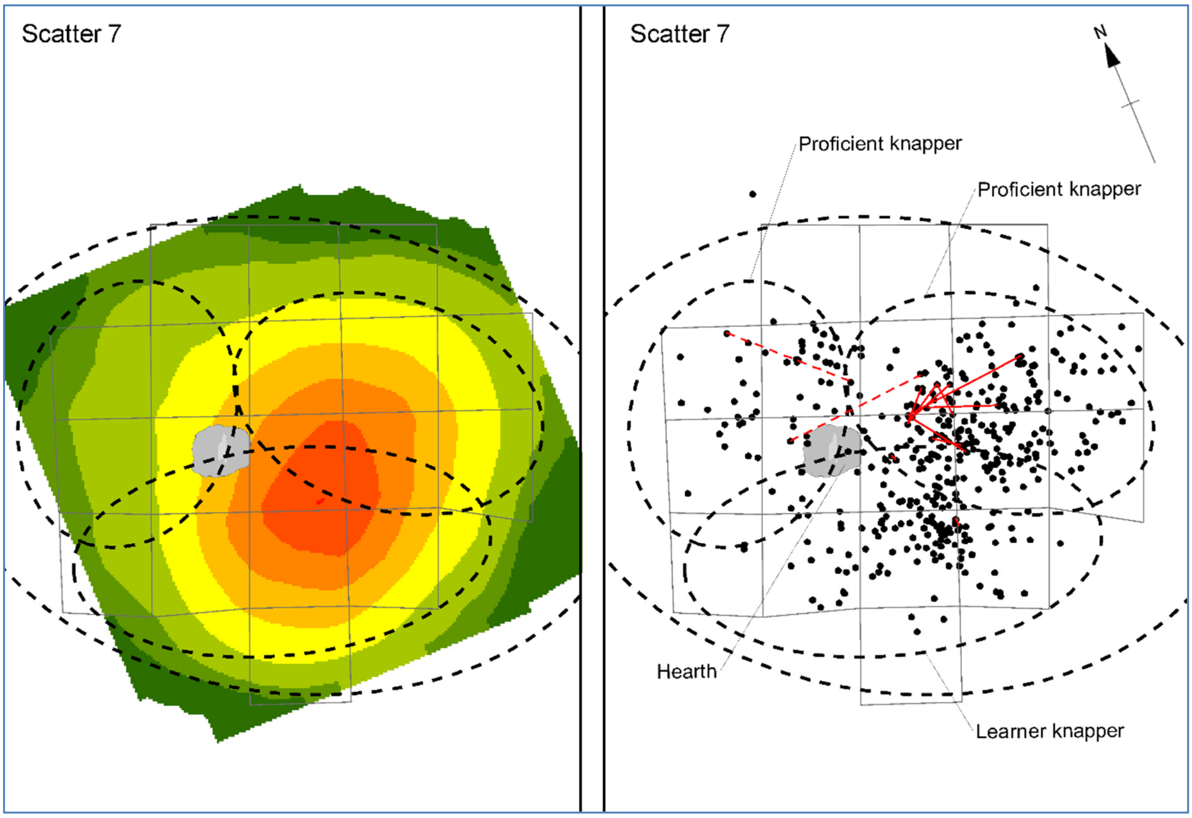
Historic England

Managing Lithic Scatters

Lithic Scatters Case Studies



Case Study 1: Lithics Scatters and the Planning Process

Ed Blinkhorn (Archaeology South-East UCL)

Introduction

Analysis of 1280 PPG16 era (1990-2010) interventions which identified Late Upper Palaeolithic or Mesolithic archaeology in England (Blinkhorn 2012; Figure 1) underpins this case study, which aims to explore the value, potential and opportunities that lithic scatters present. The historical approach to lithics at all stages of the planning process will also be discussed. The durability of lithics cements their importance as indicators of prehistoric occupation, especially applicable where impoverished preservation conditions prevail, and they constitute the most reliable distribution of human occupation for earlier prehistory. It is unsurprising, therefore, that lithics overwhelmingly dominate the archaeological record for these periods, and are the most frequently encountered earlier prehistoric evidence class in the commercial sector.

Opportunities

The planning process delivers widespread opportunities and unparalleled access to hitherto unexplored sites and landscapes at scales rarely achievable by the academic or voluntary sectors, notably through large housing developments, quarrying, and infrastructure projects. Spatial bias generated by planning conditions provides a nationwide archaeological distribution which derives more from economics and less from academic research priorities, perhaps pointing to a more representative picture of settlement/mobility in prehistory. Larger scale interventions should not, however, overshadow the value of discrete, high-resolution, and high-impact deposits where they can be identified.

Out of the ordinary discoveries such as the pit burial of eight Horsham microliths from Saltwood Tunnel (Devaney 2009; Figure 2) or the Final Palaeolithic finds from Nea Farm (Barton *et al*. 2009) demonstrate the capacity of development-led projects to make valuable contributions to knowledge. However, with ~3% of interventions returning 1000+ piece early prehistoric lithics assemblages, the value of lithics recovered from any single site is less likely to be as significant as the aggregate value of data generated in any given landscape, or planning authority. In areas such as Greater London and the East Midlands lithic scatter distributions have been substantially augmented, leading to riverine-focused datasets. Such progress emphasises the prospection capacity of development-led projects which penetrate superficial geologies and urban land-use (Figure 3).

Nevertheless, the cumulative value of opportunities in landscapes of known significance should not be ignored. Interventions at Wykeham Quarry (NAA 2004; Fraser *et al*. 2009), Scarborough (Tabor 2007) and Ling Lane (NAA 1996) broaden both the spatial and temporal scope of the internationally important eastern Vale of Pickering Late Glacial and Early Holocene landscape around Star Carr, and a similar effect is noted around Newbury in the Thatcham and Wawcott landscapes. It is notable that in both examples, due early consideration and emphasis is placed on the potential context of discovery with focus on the geoarchaeological understanding of significant horizons.

Value/Potential

Commercially derived lithics assemblages have the same potential as those generated by other sectors, and rely upon specialist involvement at the point of discovery to generate value. Frequently, earlier prehistoric lithics which are reported lack secure stratigraphic provenance due to recovery from non-feature deposits, and the scarcity of geoarchaeological assessment compounds the problem of ascertaining the potential and value of a lithic scatter. The risk is that without an adequately understood context of discovery, lithics recovered from multi-period focused works are reduced to 'residual' status. Additionally, decisions made early on in projects frame the recovery and understanding of a lithic scatter. Feature-focused approaches, used to budget time, scope and costs of excavations, distract from understanding site formation processes and the degree of post-depositional disturbance affecting lithics.

Scientific dating was irregularly applied within the dataset, commissioned on ~7% of interventions, although 11 of the 38 1000+ assemblages were associated with dates. Difficulties in assigning assemblages to periods and sub-periods might be ameliorated with schemes of dating, including luminescence techniques, increasing the value of the assemblage and contributing to a corpus of dated material for refining typochronologies.

Landscape scale approaches beyond the development site, and broader synthetic works which could enhance understanding at local and regional scales, are essential components of realising the value of excavated lithic scatters. Publication rates diminish with the size of the assemblage: 60% for 1000+ pieces, 56% for 500+, 52% for 250+, and ~20% for all projects recovering lithics. Excepting larger projects like the Channel Tunnel Rail Link which can have the scope and budget to synthesise data beyond the development impact, mechanisms which draw together diverse data generated by the planning process are few. The state of dissemination is better than might be expected, but synthetic overviews are lacking.

The Planning Process

DBAs

Desk-based assessments (DBAs) form the first stage of the majority of development-led projects, yet are poorly suited to identifying lithic scatter potential. Limited by a short search radius, DBAs can only coarsely map prehistoric discoveries held by the HER, and pre-PPG16 era records are dominated by references to imperfect sources such as Wymer's 1977 gazetteer. Crucially, the radial search does not identify contexts of preservation or concealment (e.g. alluvium), and emphasises standing archaeological features or remains which can be identified from remote mapping. The density of sites within any given area held by the HER ultimately influences fieldwork aims and methods. Where more visible ploughzone scatters are identified, some degree of truncation can be presumed, though sealed lithic scatters of much greater value are identifiable only through isolation of the preserving context(s), be they features, buried land surfaces, or bodies of sediment. Greater awareness of regional-scale densities, preferred geologies and landforms guided by the Regional Research Frameworks, and of bias generated by flint collectors and the HER dataset, would enhance the scope of DBAs to recognise areas of potential without immediately adjacent lithic scatters.

Evaluation and Mitigation

During the 1990s, evaluation of Upper Palaeolithic and Mesolithic sites for lithic scatters saw a move away from wide-interval fieldwalking and test-pitting schemes, increasingly replaced by machine-excavated trial trenching, already dominant as the chief method. The shift may reflect waning interest in determining presence/absence on the basis of the ploughzone and the widespread frequency of multi-period-focus projects.

Hey and Lacey's (2001) study suggests that a 10% trenching sample (of the site surface area) would provide adequate coverage for the Neolithic and Bronze Ages, much more commonly associated with feature-based archaeology. Sampling rates on sites recovering earlier prehistoric archaeology from trial trenching show a marginal increase in the (mean) average, from 3.2% in 1990-1999 to 3.6% in 2000-2009. Test-pitting schemes were undertaken at an average coverage of 3.1%, although known deposits were more likely to be targeted. With trial trenching remaining a dominant field method today, earlier prehistoric archaeology cannot be adequately accounted for at the evaluation stage with such low sample interventions. Given the highly localised nature of high-resolution lithic scatters, those discovered during later phases are likely to incur unexpected financial costs and delays to the development scheme.

Geoarchaeological approaches, primarily palaeoenvironmental exercises on deeper riparian deposits in London, successfully identified 300% more Late Pleistocene/Early Holocene capture points in the period 2000-2009 than in 1990-1999, though the number of interventions is small and the methods used were not designed to recover lithics. The aims and output of palaeoenvironmental interventions conceal the potential to apply geoarchaeological methods to archaeological evaluation, predominantly closer reading of geological and geophysical data, and deposit modelling, where appropriate.

While methods can be better tailored for lithic scatters at sites within and adjacent to known areas of archaeologically prolific densities, unanticipated discoveries at the evaluation stage are trickier to manage. It is of high importance to define the limit of Quaternary deposits within interventions across the evaluation area (Pope *et al*. 2016) – the limit of archaeological potential. In this respect the term 'natural' is deceiving and would be best replaced with a geological descriptor. Emphasis must be placed on understanding the scatter, especially its stratigraphic integrity, as typological assessment by context can be of very limited use in determining spatial potential within an assemblage and across a site. Opportunities to enhance lithic datasets need to be recognised early on in the field both to benefit efficient progress at a site, and contribute to tailored priorities in Written Schemes of Investigation. As such, lithic scatters can require specialist advice from the outset.

By underestimating the potential contribution of lithic scatters to understanding prehistory, opportunities generated by the planning process can be diminished at every stage of the discovery, assessment and analysis cycle. Critical 3D data - which highlight degrees of disturbance, in addition to forming the architecture of technological analysis - have been infrequently collected in commercial work at both evaluation and mitigation stages; orientation and dip data were not collected. Microscopic analysis was carried out on two assemblages from the dataset, recommended but not undertaken on many more, and no residue analysis was commissioned. On well executed projects, and given favourable preservation conditions, one might expect much higher figures for specialist analyses.

Conclusion

While the majority of the PPG16 era sites within the dataset did not overturn the *status quo* generated by academia, at the least each project contributes to the understanding of local lithic distributions across diverse landscapes and geologies. Equally, the majority of sites were not anticipated to have an earlier prehistoric component. Many, however, generated nuanced interpretations of assemblages deriving from features and buried landsurfaces, capturing the changing Late Upper Palaeolithic and Mesolithic worlds across England and developing new windows into technological diversity and adaptation nationwide. Key to successful projects were clearly defined site-specific aims which addressed contemporary priorities – and methods appropriate to the geology and anticipated resolution of the lithic scatter. A geoarchaeological approach is preferable, with input into projects from the outset.

References

Barton, R N E, Ford, S, Collcutt, S N, Crowther, J, Macphail, R I, Rhodes, E and Van Gijn, A, 2009 A Final Upper Palaeolithic site at Nea Farm, Somerley, Hampshire and some reflections on the occupation of Britain in the Late Glacial Interstadial, *Quartär* **56**, 7-35

Blinkhorn, E H, 2012 The Mesolithic and the Planning Process in England. University of York: Unpublished PhD thesis

Devaney, R, 2009 The worked flint from Saltwood Tunnel, Saltwood, Kent, in S Foreman, *Channel Tunnel Rail Link Section 1*, York, Archaeology Data Service. doi.org/10.5284/1000230

Fraser, M, Cloutman, E W, Mitchell, W A and Chambers, F M, 2009 Wykeham Quarry Eastern Extension, Vale of Pickering, North Yorkshire. NAA 09/43. Barnard Castle: Northern Archaeological Associates Ltd

NAA, 1996 Seamer Carr landfill extension: archaeological evaluation, NAA 96/53a. Barnard Castle: Northern Archaeological Associates Ltd

NAA, 2004 Wykeham Quarry, Vale of Pickering, Proposed Eastern Extension: Survey of Deposits in Quarry Section Q1 and Phase 1 Development Area WK04, NAA 04/83. Barnard Castle: Northern Archaeological Associates

Pope, M, Bates, M, Blinkhorn, E, Conneller, C, Scott, B and Shaw, A, 2016 *Excavation and Recording of Lithic Scatters*. http://doi.org/10.13140/RG.2.1.2481.3847

Tabor, J, 2007 Scarborough Integrated Transport Scheme, Fieldwork Area A [Cayton Bay], Interim Report. 07/68. Northern Archaeological Associates. Barnard Castle

Wymer, J J, 1977 *A Gazetteer of Mesolithic Sites in England and Wales,* Council for British Archaeology Research Report **20**, London

Case study 1 Figures

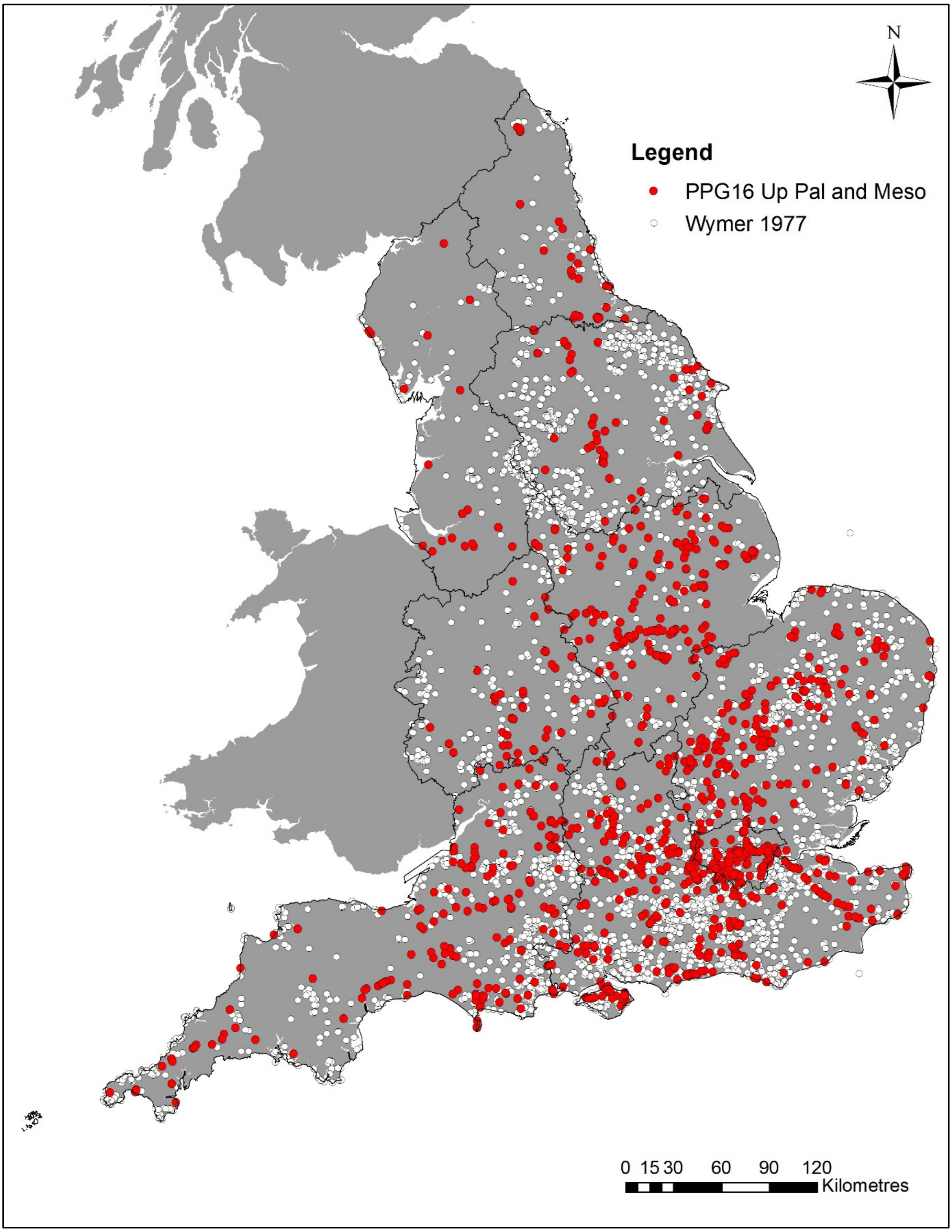


Figure 1: Distribution of Late Upper Palaeolithic and Mesolithic sites: PPG16-era and Wymer 1977

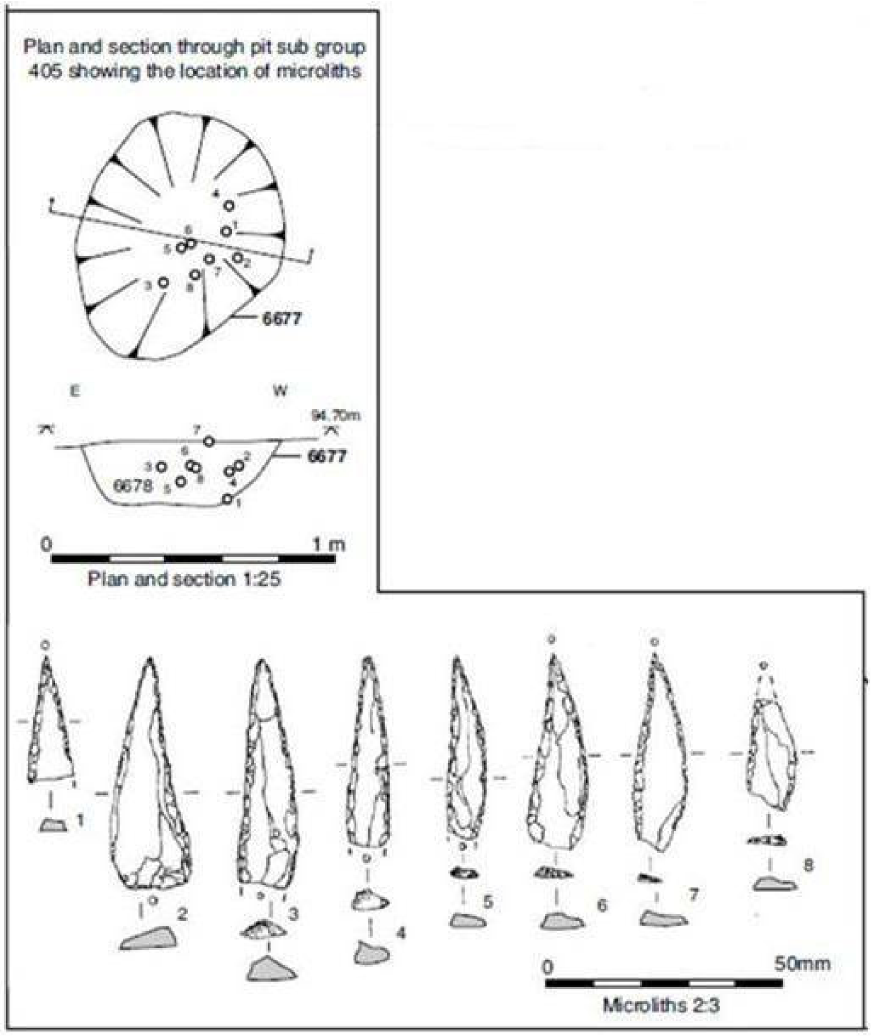


Figure 2: Saltwood Tunnel: Pit sub group 405

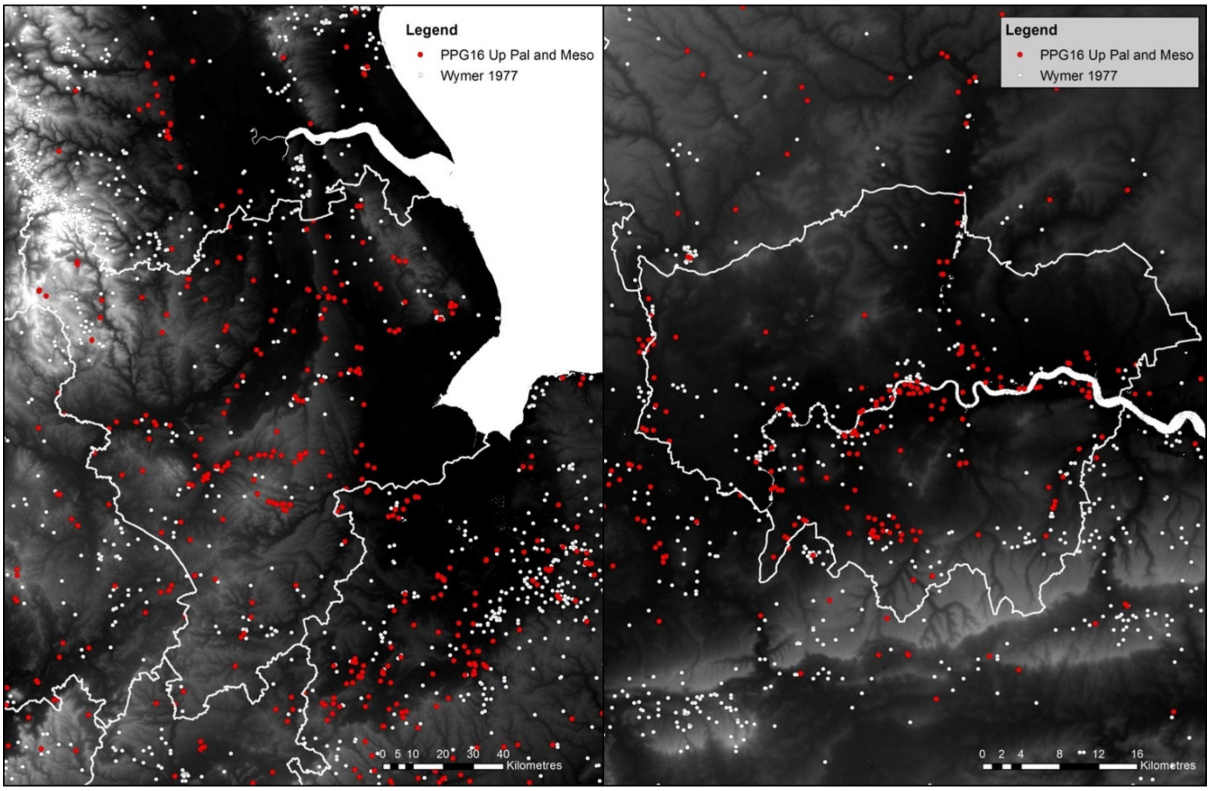


Figure 3: Late Upper Palaeolithic and Mesolithic distributions in (a) East Midlands (b) London

Case Study 2: Assessing the Potential of Ploughsoil Scatters: Fieldwork at Oily Hall, Lode, Cambridgeshire

Lawrence Billington (Oxford Archaeology East)

Introduction

This case study sets out the results of fieldwork undertaken at a ploughzone lithic scatter site at Oily Hall, Lode, in the Cambridgeshire fens. Ploughzone scatters such as this represent the most abundant evidence of prehistoric activity across most of lowland Britain, but they are generally seen, with some justification, as having low interpretative potential (see Bond 2011). The following suggests that significant information can be recovered from ploughzone sites, providing that appropriate methodologies and approaches are employed in their investigation and interpretation.

Background

The fieldwork was undertaken as part of doctoral research concerned with assessing the interpretative potential of ploughzone lithic scatters of Late Upper Palaeolithic (LUP) and Mesolithic date (Billington 2016). A major part of this research entailed the collation of information on LUP and Mesolithic finds across a large part of Eastern England (Fig. 1), which identified almost one thousand accurately located Mesolithic findspots, and a large number of poorly-provenanced assemblages. The vast majority, probably over 80%, of these findspots derived from ploughzone contexts — and in many parts of the study area these disturbed scatters and stray finds provide the only evidence of Mesolithic activity.

Whilst this record of ploughzone sites is valuable in allowing the regional and landscape scale distribution of findspots to be examined, in most cases the interpretative value of their lithic assemblages was limited. This was partly attributable to the inherent limitation of ploughzone archaeology, including a lack of stratified or dateable contexts, high degrees of spatial disturbance and the frequent superimposition of numerous episodes of activity, creating complex palimpsests. However, other issues surrounding the interpretation of these sites related to the circumstances under which they were sampled and recorded, particularly in terms of the small size of most assemblages and the suspicion that many are biased towards certain classes of artefact. It was in light of such problems that a programme of fieldwork and analysis was carried out to explicitly examine the effects of collection methods on the interpretation of ploughzone sites, and to inform future investigations of such sites.

Fieldwork at Oily Hall

Oily Hall is located in the south-eastern Cambridgeshire fens, in the lower Cam valley. The area was subject to extensive fieldwalking during the Fenland Project which identified a series of lithic scatters strung out along a spread of terrace gravels adjacent to the River Cam (Fig. 2; Hall 1996). The flintwork from these scatters included a high proportion of Mesolithic material, alongside some later flintwork, but they produced few chronologically sensitive pieces such as microliths, and remain difficult to characterise in any detail.

In 2008 an opportunity arose to reinvestigate the area, when the National Trust acquired a parcel of land at Oily Hall, Lode. The Trust intended to take the land out of cultivation but, conscious of the archaeological significance of the area, first invited a local archaeological society, the Cambridge Archaeological Field Group, to fieldwalk the site. Work began with extensive fieldwalking carried out along transects spaced at 10m intervals, which revealed a distinct scatter of flintwork, running along the terrace edge (Fig. 2). This was followed up by gridded collection over a selected part of the scatter, with total collection of finds from 253 10m^2 squares. Finally, in 2015, small-scale excavation was undertaken in one of the densest areas of the lithic scatter, with the excavation of sixteen 1m^2 test pits and the dry-sieving (5mm mesh) of all excavated deposits.

Results

The fieldwork provides a valuable opportunity to assess the results of each phase of work. The initial, transect, fieldwalking of the site recovered a small assemblage of 151 worked flints but was important in establishing the location and extent of the scatter in the north-western part of the area and, in the wider landscape context, demonstrating the continuation of what appears to be a semi-continuous swathe of lithic scatters along the fen-edge in this area (Fig. 2).

This initial work also allowed the second phase of surface collection to be carefully targeted on an area with high densities of flintwork. A total of 1,285 worked flints were recovered from the 253 10m^2 collection units, a mean of 5 pieces per 10m^2, ranging from 0-34 pieces (Fig. 3). The assemblage is chronologically mixed, with diagnostic forms dating from the Mesolithic to the Early Bronze Age, but typological and technological analyses and differential recortication ('patination') indicate that *c* 70% of the assemblage is of Mesolithic date.

The test pitting recovered an assemblage of 573 worked flints, 493 of which came from the ploughsoil, with the remainder coming from remnant buried soil horizons. From the ploughsoil alone, the 16 test pits produced a mean of around 30 worked flints each, ranging from 10-68. Calculations comparing the average test pit density to the highest density recovered from the 10m^2 surface collection units (34 pieces), suggest that around 1% of the total population of ploughsoil artefacts was collected from the surface, a figure far lower than those cited from experimental ploughsoil sampling, which typically suggest that between 3% and 7% of the total artefact population is collected (e.g. Clark and Schofield 1991; Boismier 1997; Ammerman 1985). Variation in the proportion of surface collected material can be attributed to many factors, including ground conditions and fieldworker experience/aptitude but, in the case of Oily Hall, the compositions of the surface and excavated assemblages suggest that a major factor was the difficulty in recognising and collecting smaller artefacts during surface collection. Thus, whilst almost 40% of the test pit assemblage was made up of small pieces less than 20mm in size, only 11% of the surface collected material fell into this category.

This clear bias towards the recovery of larger and more obvious pieces has implications for comparing assemblages derived from surface collection with those from excavations. This is of special importance for Mesolithic sites, where many of the chronologically sensitive and informative pieces, especially microliths, are diminutive, easily overlooked pieces. The effects of this are well-illustrated by the data from Oily Hall (Figs 4 and 5). The assemblage derived from surface collection included a roughly equal (and small) number of 'Early' and 'Later' Mesolithic microliths, alongside a range of tools suggestive of a 'balanced', domestic-type assemblage (cf Mellars 1976; Myers 1987).

In contrast, the retouched tools from the test pits were overwhelmingly dominated by microliths, which were almost exclusively Later Mesolithic ‘narrow-blade forms’, more diminutive than their Early Mesolithic, ‘broad-blade’ counterparts.

These differences have major implications for interpreting the Mesolithic activity at the site – not only does the excavated assemblage suggest that a far greater proportion of the material is likely to relate to activity during the later Mesolithic, it also indicates that the tool assemblage is less balanced than the surface collection would suggest, with consequences for interpreting the character and duration of occupation at the site. In the wider regional context, it is significant that later Mesolithic microliths are likely to be underrepresented in surface collected material – a trend which may at least partly explain the smaller number of demonstrably Later, as opposed to Early, Mesolithic findspots across much of East Anglia (Jacobi 1996; Billington 2016).

Conclusions

Although the results of the fieldwork at Oily Hall indicate that caution must be exercised when interpreting assemblages derived from surface collection, it is important to emphasise that each of the stages of fieldwork summarised here played a complementary role in charactering the scatter at Oily Hall. The initial fieldwalking effectively defined the extent of the main lithic scatter, and allowed it to be very clearly related to its local topographic/landscape context, whilst gridded collection allowed intra-site distributions to be examined in detail and recovered a substantial assemblage which allowed the basic chronology and character of the scatter to be established. Finally, the small-scale excavation of the scatter provided an unbiased assemblage which allowed the composition of surface collected material to be critically assessed and provided important, reliable, evidence for the chronology and character of activity at the site. More widely, the results provide some indication of what might be expected from more intensive investigation of ostensibly similar scatters in the wider landscape.

The work summarised here suggests that at least some of the interpretative problems presented by ploughsoil scatters can be addressed by deploying appropriate methodologies, and by recognising differences in the kinds of questions we can reasonably ask of assemblages recovered using different sampling methods. The complementary nature of different methods of ploughsoil sampling highlights the potential for examining lithic scatters at varying spatial scales and intensities; integrating detailed, site-specific investigations into broader landscape and regional-scale studies. In this context, the inherent problems of ploughsoil scatters must be balanced against their virtues, especially in terms of their high archaeological visibility and the comparative ease with which they can be investigated and sampled, whilst in favourable circumstances the intensive excavation of ploughsoil scatters can be expected to yield important results no less significant than those from some ostensibly well-preserved sites.

Acknowledgements

The work described here was undertaken whilst in receipt of a doctoral studentship, funded by the Arts and Humanities Research Council and set up, supervised and resourced by Historic England and the University of Manchester. The impetus for the work at Oily Hall came from Angus Wainwright of the National Trust and was carried out by dedicated member of the Cambridge Archaeological Field

Group, to whom, special thanks are extended, especially to Mike Coles and Terry Dymott, for allowing me to draw so extensively on the results of their work.

Bibliography

Ammerman, A J, 1985 Plow-Zone Experiments in Cantabria, Italy, *Journal of Field Archaeology* **12**, 33-40

Billington, L P, 2016 Lithic Scatters and Landscape Occupation in the Late Upper Palaeolithic and Mesolithic: A Case Study from Eastern England. Unpublished PhD thesis, University of Manchester. https://www.escholar.manchester.ac.uk/item/?pid=uk-ac-man-scw:307798

Boismier, W, 1997 *Modelling the effects of tillage processes on artefact distribution in the ploughzone - a simulation study of tillage-induced pattern formation*, Oxford, British Archaeological Reports (British Series) 259

Bond, C J, 2011 The value, meaning and protection of lithic scatters, *Lithics* **32**, 29-39

Clark, R H and Schofield, A J, 1991 By Experiment and Calibration: an integrated Approach to Archaeology of the Ploughsoil, in A J Schofield (ed.), *Interpreting Artefact Scatters: contributions to ploughzone archaeology*, Oxford, Oxbow Books, 93-105

Hall, D, 1996 *The Fenland Project No. 10: Cambridgeshire Survey, Isle of Ely and Wisbech*, East Anglian Archaeology **79**, Cambridge, Fenland Research Committee

Hall, D and Coles, J, 1994 *Fenland Survey: An Essay in Landscape and Persistence*, London, English Heritage

Jacobi, R M, 1996 The Late Upper Palaeolithic and Mesolithic in Essex, In O Bedwin (ed.), *The Archaeology of Essex: Proceedings of the Writtle Conference*, Chelmsford, Essex County Council

Mellars, P A, 1976 Settlement patterns and industrial variability in the British Mesolithic. In G de G Sieveking, I H Longworth and K E Wilson (eds), *Problems in Social and Economic Archaeology*, London, Duckworth, 375-99

Myers, A M, 1987 All Shot to Pieces? Inter-Assemblage Variability, Lithic Analysis and Mesolithic Assemblage 'Types'; Some Preliminary Observations, in A G Brown and M R Edmonds (eds), *Lithic Analysis and Later British Prehistory: some problems and approaches*, Oxford, British Archaeological Reports (British Series) **162**, 137–153.

Case Study 2 figures

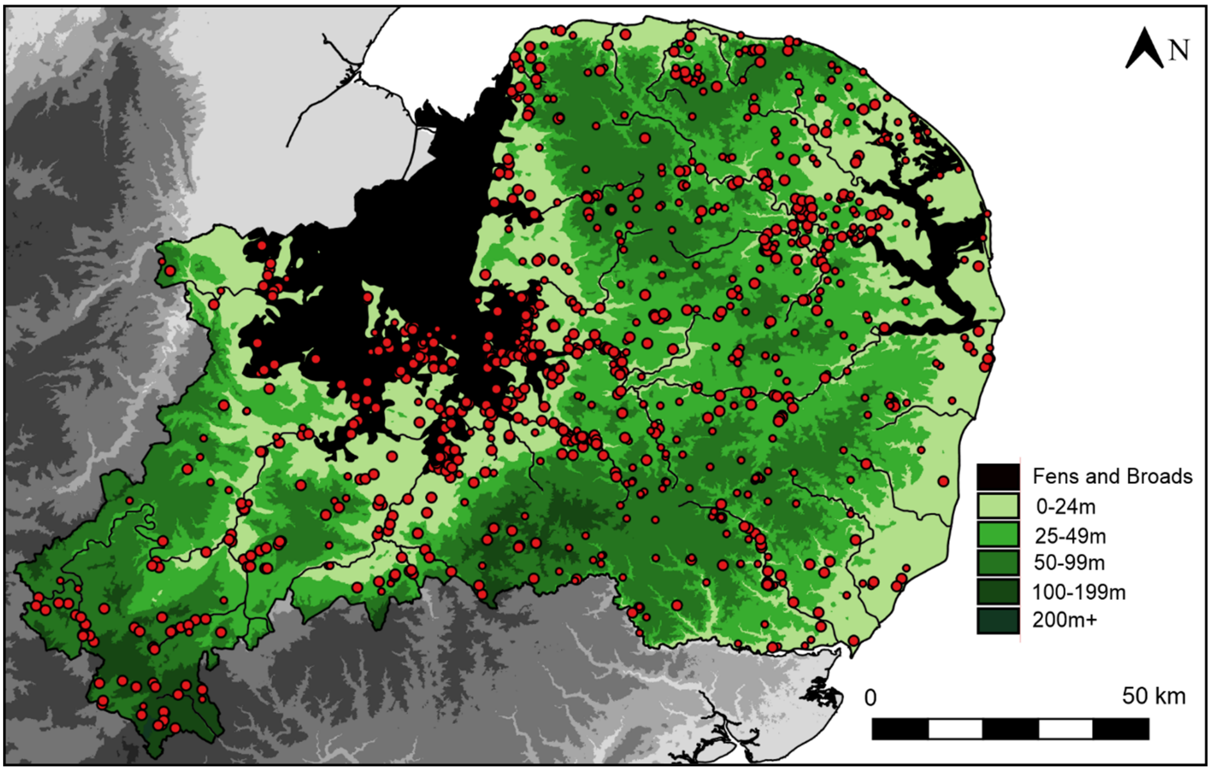


Figure 1. Distribution of accurately located findspots of Mesolithic flintwork from a study area in Eastern England.

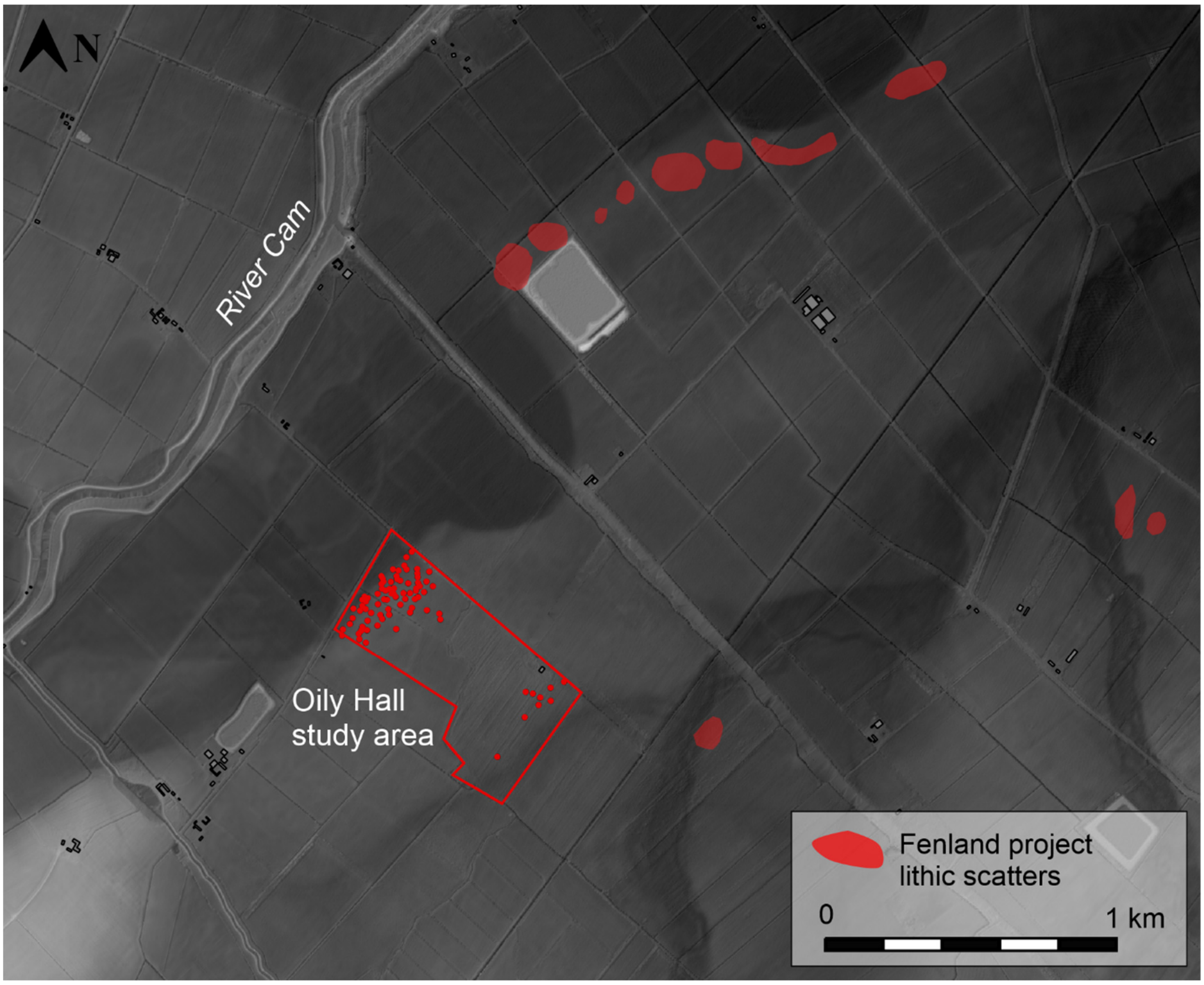


Figure 2. Location of the investigated area at Oily Hall, with the distribution of worked flints recovered from the initial phase of fieldwalking and the location of lithic scatters identified during the Fenland Project (after Hall 1996) (Background mapping derived from Environment Agency composite lidar data (2m resolution) licensed under the Open Government Licence v3.0).

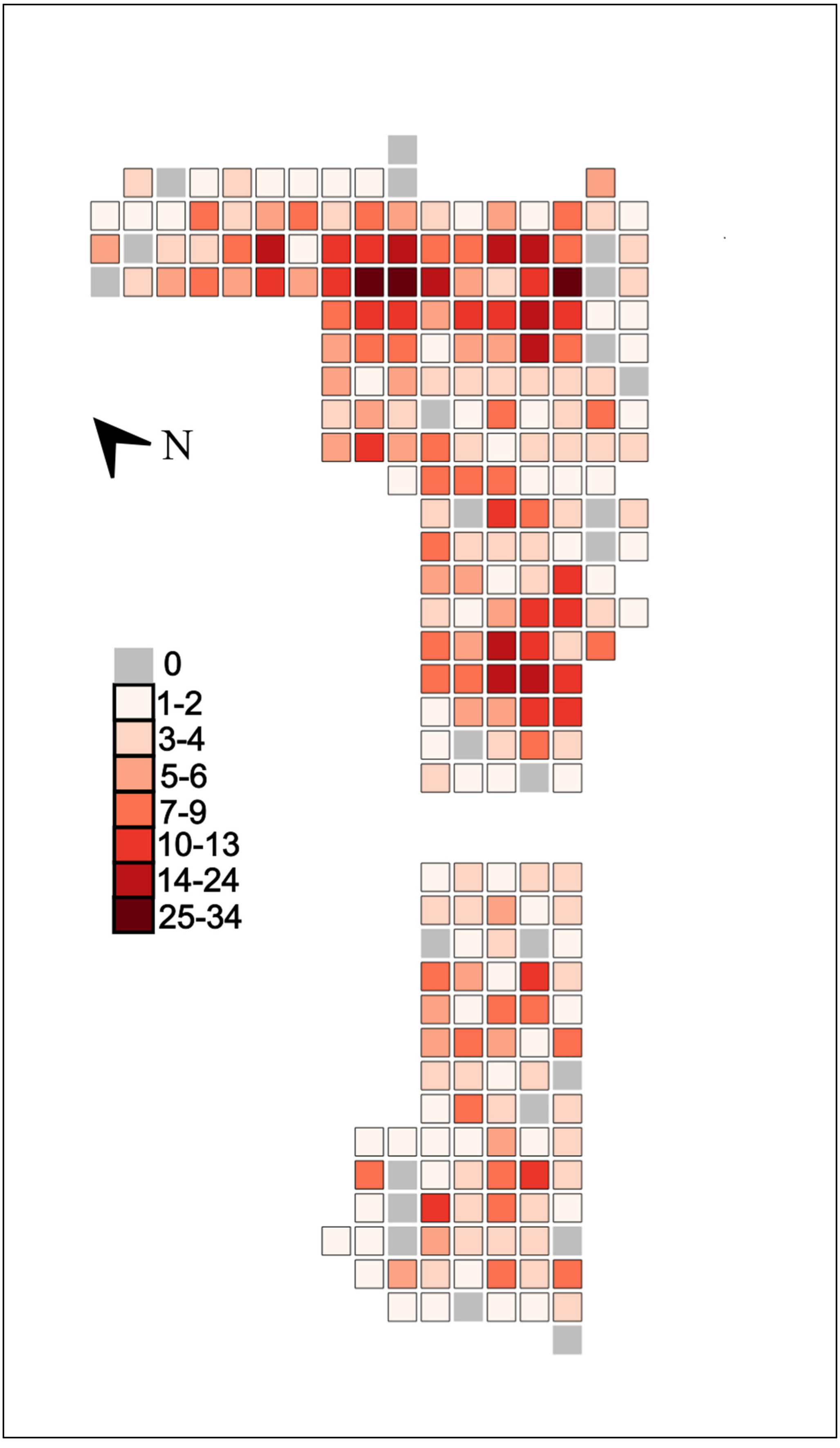


Figure 3. Distribution of worked flint recovered during gridded surface collection at Oily Hall, showing density of flint per 10m2 collection unit.

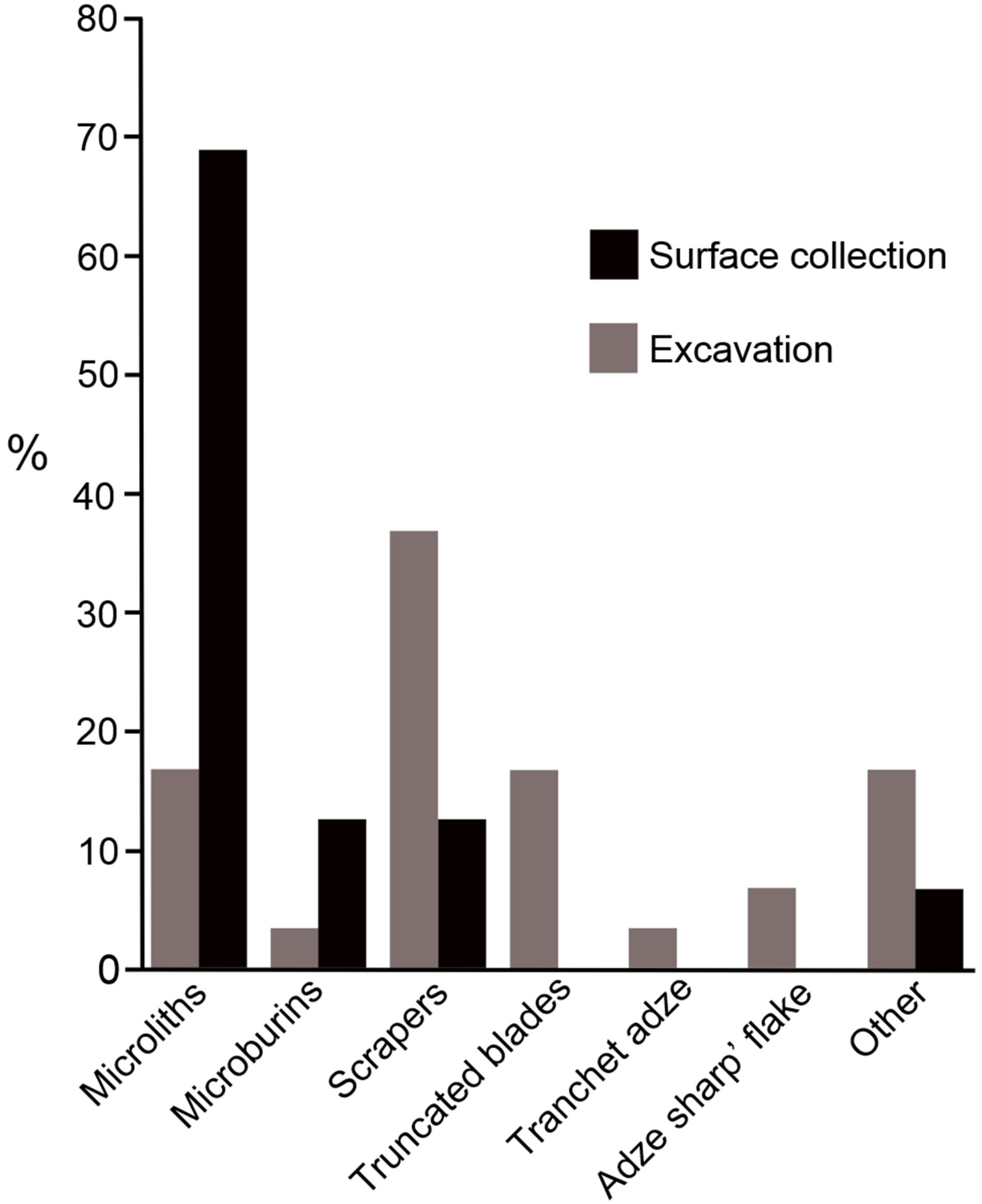


Figure 4. Percentages of retouched tool classes recovered during the surface collection and excavation at Oily Hall (Mesolithic element of the assemblages only).

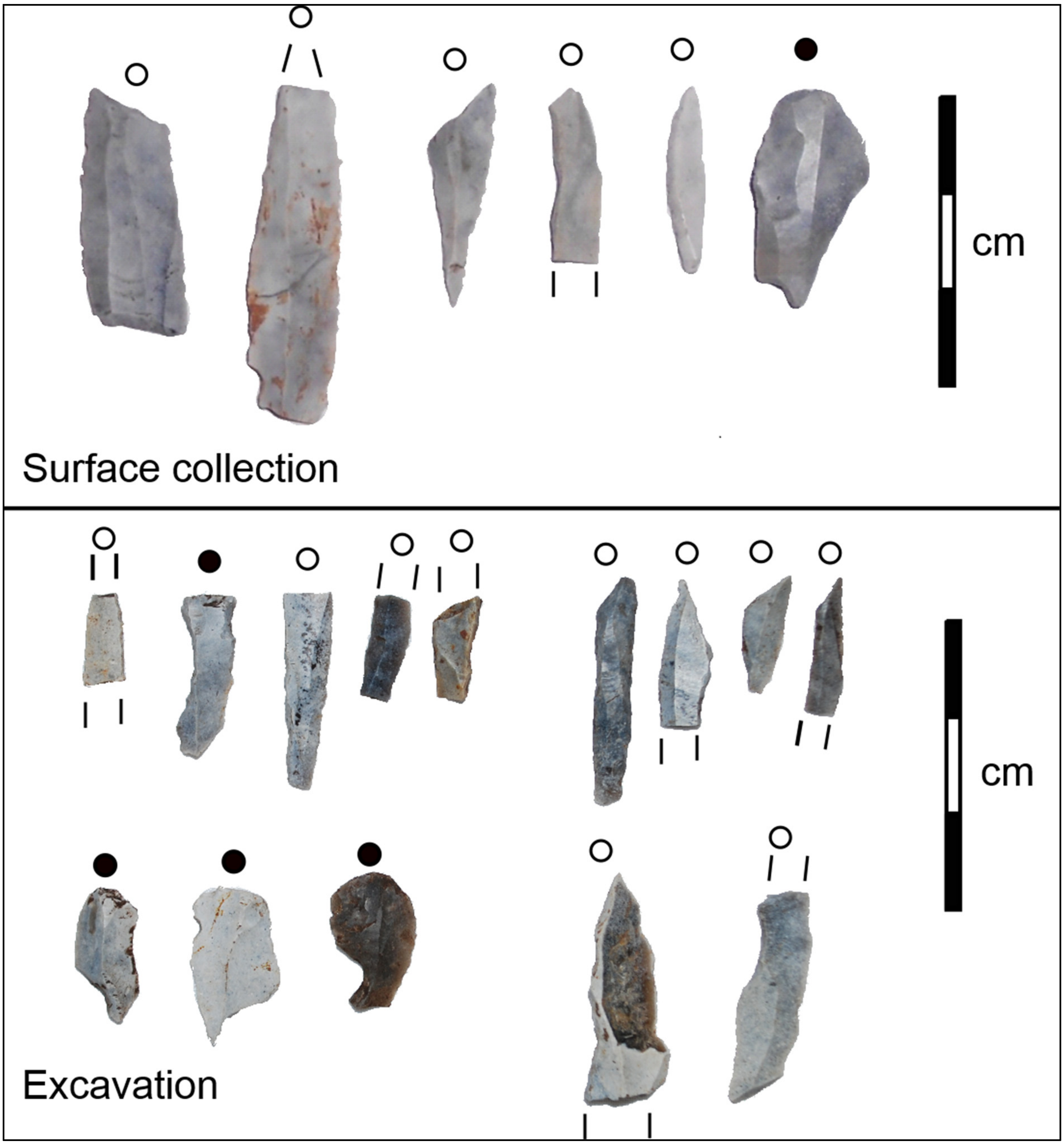


Figure 5. Microliths and microburins recovered during the surface collection (upper) and excavation (lower).

Case Study 4: Investigating prehistoric landscapes with lithic scatters in the Lower Exe Valley

Olaf Bayer (Historic England)

Introduction

This study used a number of multi-period surface lithic assemblages from a museum collection to investigate the changing character of prehistoric inhabitation in a landscape-scale study area. Key to this was engaging with both the contents (the stone tools of which they are comprised) and contexts (the topographic and cultural locations in which they are found) of lithic scatters. In addition to lithic analysis research also included visits to scatter locations to understand their landscape setting, and the use of aerial photographs and geophysical survey to elucidate the nature of monuments in close proximity to scatters. The project was guided by four broad and overlapping research questions (see Table 1).

The project study area was a 4km by 4km block of lowland mid-Devon surrounding the lower Exe basin (see Figure 1). The location was selected as it combined a large well-recorded surface lithic collection with an area of intensively studied archaeological cropmarks (Griffith 1990; 2001), and a recently examined late glacial to Bronze Age palaeoenvironmental sequence (Fyfe *et al* 2003). The extent was determined by the core of the Uglow lithic collection. Chiefly collected by amateur archaeologist John Uglow between the 1930s and late 1990s the collection contains assemblages spanning the Mesolithic to the Bronze Age.

Results

A two-stage approach was taken to lithic analysis. An initial assessment was carried out on the entire collection (19,137 pieces) and its associated paper archive. The assessment quantified and roughly characterised each of the collection's assemblages. This enabled informed decisions to be taken about the size (16,577 pieces) and geographic extent, of the sub-sample of the collection to be examined in greater depth. A relatively pragmatic approach was taken to selecting lithic artefact attributes examined as part of the fuller analysis. Priority was given to analyses (see Table 2) which it was hoped would provide answers to the research questions. All data were recorded and analysed in Excel spread sheets which were then exported to ArcGIS for plotting as maps. The basic unit of analysis was the individual lithic artefact, enabling maximum flexibility when interrogating the dataset.

In addition to the complexities inherent to working with surface lithic assemblages, historic amateur collections can introduce a number of uncertainties and variables whose influence needs to be understood prior to analysis. The Uglow collection is the result of over 60 years of fieldwork, conducted by a changing roll call of fieldworkers, driven by evolving research questions, and using different collection methodologies (from casual collection in the 1930s, to systematic collection in 10m grids by the 1980s). Table 3 summarises some of the issues that the collection presented and the actions taken to accommodate them.

The distribution of lithic artefacts within the study area is very variable. Particular concentrations occur in areas of the valley floor, and on the hilltops on its immediate western edge. The southern slopes of the Raddon Ridge produced a lesser quantity of lithic material, and even less is present on the Exe/Culm interfluve, the south-west and the western edges of the study area. The identification of chronologically distinctive lithic artefacts and a characterisation of the collection's debitage indicates occupation in the study area spanning the Mesolithic (potentially the Early Mesolithic) through until at least the Early Bronze Age. This sequence begins in the Mesolithic with a small number of foci of activity mainly on the valley floor and its western edge. During the Neolithic and Early Bronze Age the intensity of this occupation greatly increases, and extends beyond the valley floor into the wider hinterland.

Against this picture there is a recurring trend suggesting the long-term or repeated use of particular places. Put simply, places with evidence of Mesolithic inhabitation often have evidence for Neolithic and Early Bronze Age inhabitation. This occurs at small scales and low intensities throughout the study area. However, it is most apparent amongst the larger scatters on the valley floor and its western flank, and particularly at scatters N1 and N12 (see Figure 1). Both scatters appear to have been a focus of inhabitation spanning millennia, from the Mesolithic and recurring throughout the Neolithic into the Early Bronze Age. It Is suggested that the sustained inhabitation of locales such as these would have necessitated an engagement with both the physical traces, and cultural legacies of past inhabitation. It is amongst these 'persistent places', that the study area's first monuments are built in the late 4th millennium BC (see Figure 2).

The study area's lithic assemblages are chiefly comprised of two raw materials, nodular flint and Greensand chert, with much smaller quantities of pebble flint, Haldon chert/flint and Portland chert. There is some evidence that trends in raw material use changed over time. Nodular flint seems to have been used throughout the entire lithic using sequence whilst Greensand chert appears to have been particularly associated with Mesolithic activity. Portland chert is particularly associated with Neolithic artefacts.

None of the collection's raw materials occur naturally in the study area, all have been imported. Notwithstanding the possibility that a minority component of the Greensand chert and pebble flint may have come from river terraces relatively close to the study area, most of the raw materials have been transported over distances of between 15 and 40km, and in the case of Portland chert up to 80km. With the exception of Portland chert it is difficult to pin the collection's raw materials to particular sources, but linking them to generalised source areas does give an idea of the direction and scale of routine movement or contact. A further observation is that although spatially distant, some of the potential raw material sources (Haldon Ridge and the western edge of the Blackdown Hills) are visible from parts of the study area.

Raw materials arrived in the study area in differing states of modification. Nodular flint and Greensand chert both arrived in a partially modified state, the flint more so than the chert, with the earliest stages in their reduction having occurred elsewhere in the landscape. The situation with pebble flint and Haldon chert/flint is different, as it seems to have arrived in an almost unmodified state. Portland chert differs again in that it seems to have arrived in a very modified state, either as ready-made cores or finished artefacts, principally mid-Neolithic transverse arrowheads.

Analysis of raw material reduction sequences and the relative proportions of retouched or utilised material indicates that the manufacture and maintenance of stone tools and their subsequent use was widely distributed across the study area. Similarly, the incidence of artefact burning is relatively constant amongst the collection's assemblages. In the majority of instances there is little to suggest that specific tasks or activities were concentrated in specific places. However, some anomalous trends hint at a degree of separation and difference in Mesolithic taskscapes. Both the low incidence of artefact utilisation/retouch, and imbalances in the Greensand chert reduction sequence indicate that whilst the initial stages of the chert working process took place on the valley floor (particularly at scatters N1 and N12), the products of this working were 'consumed' elsewhere in the study area and probably beyond.

Conclusion

The study has shown that it is possible to use what many would class as a 'poor' data set (historic collections derived from surface lithic assemblages) to further our understanding of prehistoric landscape inhabitation. The analysis of surface lithic assemblages has successfully helped to address questions relating to the character and composition of inhabitation, biographies of place, and scales of mobility and contact. It has proved much harder to break apart large scatters into anything approaching the constituent events that created them, and to address questions about the temporality of occupation. This is in part due to the necessary aggregation of scatters with multiple collection units into single assemblages for the purposes of the current analysis. It is considered that should the original detailed resolution be reintroduced to an analysis of these scatters a much more nuanced understanding of their spatial configuration would emerge. However, it is anticipated that a fine grained understanding of the temporal aspects of these scatters (e.g. continuous vs episodic occupation) might remain elusive.

Acknowledgements

This project formed the basis of a PhD started at the University of Bristol (2006-8) and completed at the University of Central Lancashire (2008-11). Research was supported by a scholarship from the University of Central Lancashire, and by grants for the initial assessment of the lithic assemblages and for aspects of fieldwork from Devon County Council. The Uglow collection is held by the Royal Albert Memorial Museum, Exeter.

References

Bayer, O J, 2011 Lithic scatters and landscape: the Mesolithic, Neolithic and Early Bronze Age inhabitation of the lower Exe valley, Devon. Unpublished doctoral thesis, University of Central Lancashire. Available online at http://clok.uclan.ac.uk/3149/

Fyfe, R M, Brown, A G and Coles, B J, 2003 Mesolithic to Bronze Age vegetation and human activity in the Exe Valley, Devon, *Proceedings of the Prehistoric Society* **69**, 161–181

Griffith, F M, 1990 Aerial reconnaissance in mainland Britain in the summer of 1989, *Antiquity* **64**, 14-33

Griffith, F M, 2001 Recent work on Neolithic enclosures in Devon, in T Darvill and J Thomas (eds), *Neolithic enclosures in Atlantic north-west Europe*, Oxford: Oxbow Books, 66-77

Case study 4 figures

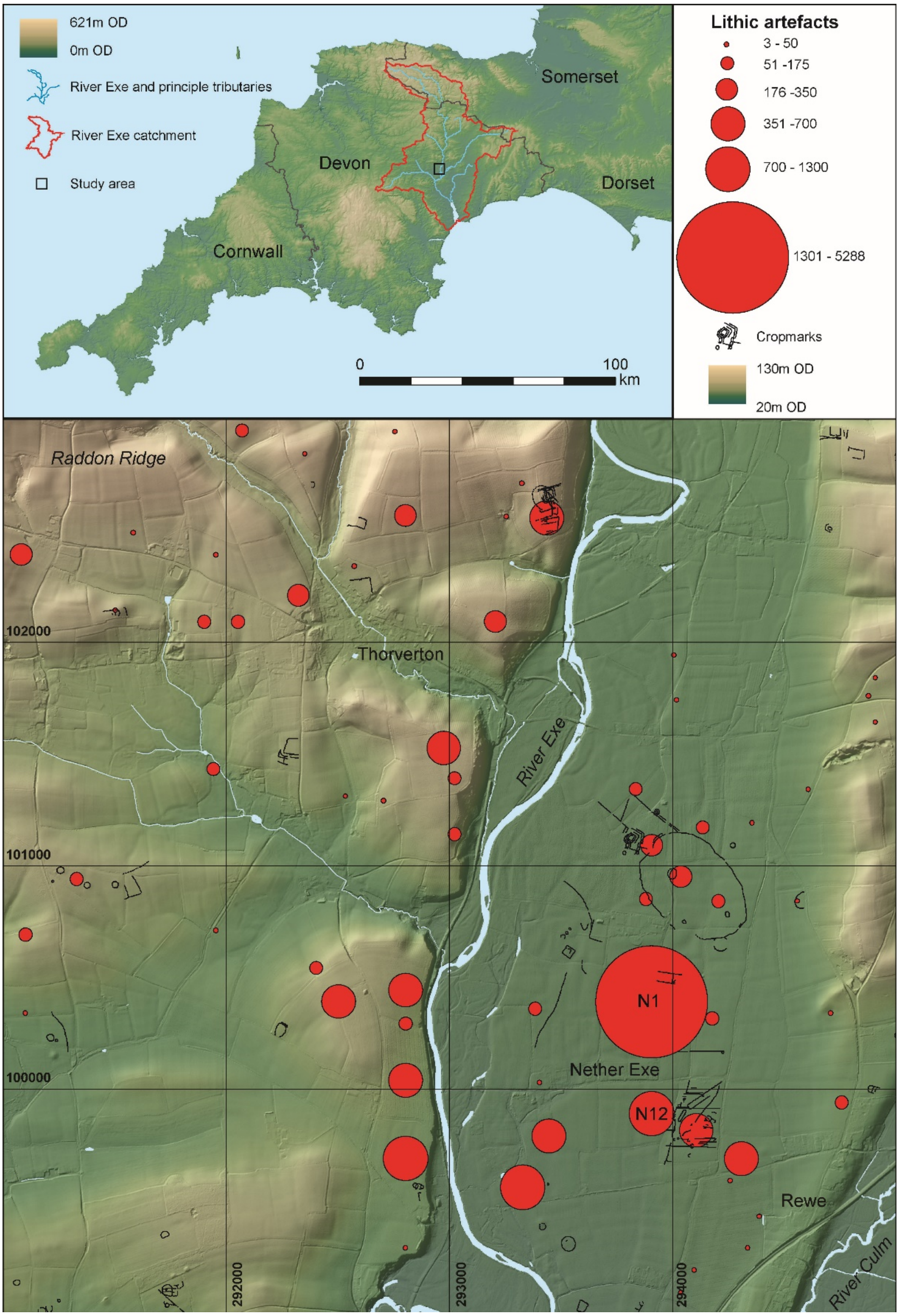


Figure 1. Location of the lower Exe valley. Topography derived from 90m SRTM topography data courtesy of CGIAR http://srtm.csi.cgiar.org, and 1m lidar digital terrain model © Environment Agency copyright/or database right 2015. Rivers data derived from OS data© Crown copyright and database right (2018) and © Crown Copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100024900. Cropmark data supplied by Devon County Council.

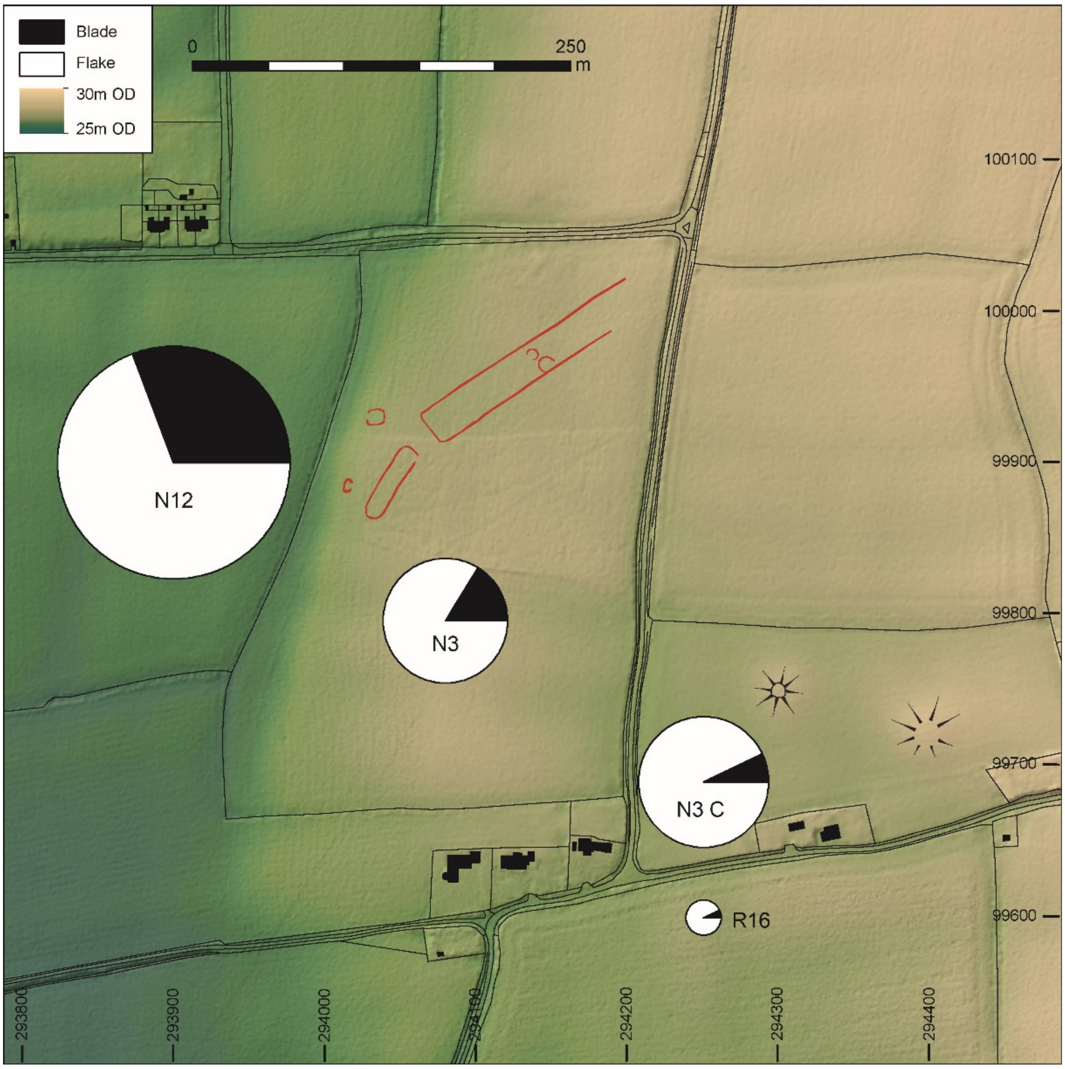


Figure 2. Mid-Neolithic oblong-ditched enclosure and cursus monument, and Early Bronze Age barrows on the western edge of the third terrace. These monuments are located within an extensive spread of later Neolithic and Early Bronze Age lithic scatters. The exception is scatter N12 which contains a significant proportion of Mesolithic material evidenced by microliths and high proportions of Greensand chert and blade-based technology. Topography derived from 1m lidar digital terrain model © Environment Agency copyright/or database right 2015. Mapping © Crown Copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100024900.

	Research Question	**Related questions**
1	How can lithic scatters be used to understand the character and composition of inhabitation?	• what types of activity created the scatter? • how intense is occupation? • nucleated/dispersed? • dense/low-level? • focus of activity/background noise?
2	How can lithic scatters be used to understand the temporality of inhabitation?	• When does occupation occur? • What is the duration of occupation? • Is it sustained or episodic? • A single event/ or an accretion of multiple events?
3	How can lithic scatters contribute to biographies of place?	• What is there before, during and after a scatter? • What do scatters tell us about the prehistory, use and afterlife of monuments/locales? • How do scatters relate to monuments or topographic features?
4	What can lithic scatters tell us about scales of mobility/contact?	• Where do raw materials come from? • What state do raw materials arrive/leave in? • Is the scatter balanced? • What is there and what is missing? • How do the scatters in the study area relate to each other/other places within the study area? • How do the scatters in the study area relate to places outside the study area?

Table 1. Research questions

Attribute recorded	**Rationale**
Collection unit/grid reference	The most detailed available grid reference for each artefact was recorded. This ranged between a centre point for an entire field to the centre of a 10x10m grid square. This primary location was then degraded to a secondary 'field level' location to enable all lithic assemblages of different sizes and from derived from different collection methodologies to be analysed on something approaching an equal basis.
Artefact type	Typological analysis was used to indicate a date and function for each artefact. A small range of chronologically distinctive artefacts were easily assigned to specific periods (e.g. late Mesolithic or Early Bronze Age). These artefacts accounted for approximately 3% of the total collection. Dating was much less specific for the majority of retouched artefacts and debitage.
Dorsal scar type (presence /absence of blade-based working)	The proportion of artefacts displaying evidence of a blade-based reduction sequence was used as a crude technological index of assemblage date. Underlying this analysis is an assumption that blade-based working is indicative of Mesolithic, and to a lesser extent Early Neolithic, activity.
Raw material	Raw material type (e.g. nodular flint or greensand chert), colour (e.g. black or brown) and tone (e.g. dark, mid or light) was recorded. This identified the different types of raw material present; linked particular raw materials to certain sources, enabling a discussion of scales and directions of contact outside the study area; enabled a discussion of whether particular types/colours of raw materials were used for particular tasks, or in particular periods.
Reduction sequence (percentage dorsal cortex)	The percentage of cortex retained on the dorsal face of each artefact was assigned to one of 6 classes. This enabled a discussion of which stages of the stone working process (from initial preparation of raw materials, to the use and maintenance of finished tools) are present at each scatter, and which are missing and by implication happened elsewhere in the landscape.
Retouch	The presence/absence of artefact retouch was used (in combination with reduction sequence) to identify the stages of the stone working and tool use process represented in a scatter.
Presence/absence of burning	Burning was used as a crude indicator of domestic activity, the underlying assumption being that it reflects the accidental burning of artefacts in hearths.
Artefact weight	Artefact weight was used alongside artefact count to quantify scatter size and relative proportions of raw material.

Table 2. Lithic recording methodology

Issue	Action taken
Were all lithic artefacts (not just diagnostic pieces) collected and retained?	• Examine notes and correspondence in the collection archive, and published accounts. • Interviews with surviving fieldworkers • Wherever possible compare the composition of multiple episodes of collection from the same area.
Is the location and extent of non-systematically collected scatters accurately recorded?	• Carry out new systematic surface collection in areas of existing assemblages
To what extent is assemblage size determined by collection methodology?	• Examine notes and maps in the collection archive to identify collection methodology used for each assemblage • Examine relationship between collection methodology and assemblage size.
Is it possible to analyse assemblages derived from different collection methodologies on a like for like basis?	• Over 1000 'sub-field' collection units merged into 63 larger 'field-level' collection units to enable their analysis on something approaching a like for like basis • During analysis an emphasis placed on the composition of whole assemblages (i.e. proportion of artefact types/traits rather than absolute counts).
To what extent do blank areas reflect the absence of prehistoric activity or of fieldwork?	• Interviews with surviving fieldworkers • Rapid walkover survey in blank areas • Consideration of the impact of landscape scale taphanomic processes (colluviation/alluviation) and of twentieth century agricultural practice on scatter visibility/availability • Take an underlying assumption that blank areas generally reflect a lack of data. • Existing scatters seen as positive data and a qualified approach taken when extrapolating from them into blank areas

Table 3. Working with lithic assemblages from museum collections

Case Study 5: Beyond the Fence: Lithic Scatters and the Grime's Graves Environs

Barry Bishop (Pre-Construct Archaeology and University of Buckingham)

Introduction

This report highlights the considerable potential that lithic scatters can have in helping to re-populate a landscape that, due to past and present land-use, has generally been seen as inhospitable to archaeological inquiry. Grime's Graves, one of Britain's largest, best known and intensively explored flintmine complexes, lies in an area dominated by forest. Its investigation required the formulation of a suite of approaches that commenced with 'opportunistic' field-walking, was enhanced using Ground Penetrating Radar and culminated with a test-pitting programme. It succeeded in significantly extending knowledge of the monument and its surrounds. In particular, it has demonstrated that the scheduled site is only part of a much more extensive 'landscape of extraction'.

Background

The flintmine complex at Grime's Graves, near Brandon in Norfolk has been the subject of intensive archaeological explorations for over 150 years, although investigations have been almost entirely confined to the scheduled site itself (e.g. Armstrong 1926; Barber *et al*. 1999; Clarke 1915; Greenwell 1870; Longworth and Varndell 1996; Longworth *et al*. 2012; Mercer 1981). The limitations of this have long been recognized; "One of the most intractable problems remains the relationship of the flint mines to the patterns of settlement and exploitation of the surrounding landscape" (Barber *et al*. 1999, 73). Consequently, a collaborative doctoral research programme was instigated, run jointly by English Heritage (now Historic England) and the University of York and funded through an Arts and Humanities Research Council studentship (Bishop 2012). One of the key aims of the project was to 'restore' the scheduled site to its broader landscape setting.

Archaeological prospection within the area immediately surrounding Grime's Graves (*c* 1 km radius: 'the environs'), is beset with difficulties (Fig. 1). It lies in the Breckland, an area of low population density dominated by Forestry Commission and Ministry of Defence activities, and generally heavily forested. Traditional archaeological methods, such as aerial photography or systematic fieldwalking, are impractical, and commercial development that might be subject to archaeological mitigation is virtually non-existent. As a result, almost nothing is known of the archaeology of the environs, limiting our understandings of how Grime's Graves operated within its wider material and social world, or of its longer term historical trajectory.

Methodology

In order to redress this, it was necessary to explore how past activities had been structured across the environs, and how this may have related to the geological and topographical qualities of the landscape. As established procedures for investigating the archaeology can be only of limited effect, it was imperative to formulate novel, multi-facetted and reflexive approaches to exploring the environs (Fig 2).

Surface monitoring

The first task was to map the distribution of archaeological material, which principally comprised struck flint, across the environs. Although heavily forested, patches of disturbed ground are present. These have been caused by a variety of processes, including the felling and destumping of forestry stands, erosion of trackways, disturbance caused by wind-felled trees, and episodes of soil scarification undertaken by Natural England for ecological purposes. Particularly useful were localised disturbances caused by the considerable number of moles and rabbits.

The environs were continually monitored over the three-year duration of the project and every instance of soil disturbance recorded. Most exposures were small and isolated and these were recorded as separate entities. Only in two locations, a 'destumped' forestry stand to the south of the scheduled site and a furrowed pathway to its north, was it was possible to apply a more systematic approach and these were fieldwalked with artefacts recorded according to 5m² grids. The location and area of each exposure was recorded and in order to assess changes in the density of flintwork across the environs, the number of 'pieces of struck flint per m^{2}' calculated. All flintwork was quantified and assessed according to its raw material and typo-technological attributes.

GPR

Given the nature of Grime's Graves, it was considered important to relate the distribution and density of struck flint across to the environs' sub-surface conditions. Previous work employing Ground Penetrating Radar (GPR) at Grime's Graves has shown the technique to be particularly suitable for identifying both archaeological and geological sub-surface features and deposits, and can supplement the basic geological mapping as produced by the BGS (Bartlett nd; Linford *et al*. 2009). Accordingly, a GPR survey was undertaken where ground conditions permitted; mostly limited to grassy paths, but extending as far as practical beyond the scheduled site's boundaries

Test-pitting

The surface survey had provided insights into the spatial structuring and the range and chronology of flintworking at a landscape scale, and the GPR had identified quarry-like features extending beyond the scheduled area. In order to 'ground truth' the GPR and to provide 'complete' assemblages of struck flint for detailed analysis, a programme of test-pitting was instigated utilising the help of volunteers from the local community.

Two areas were selected. Firstly, the surface monitoring had identified significant quantities of primary flint working waste within Compartment 3235, a newly-felled forestry stand to the southwest of the scheduled site, *c* 700m from the visible earthworks. GPR survey was not possible here due to thick deposits of felling debris, but was conducted on grass trackways that lined three of its sides. This revealed significant numbers of circular sub-soil anomalies comparable to GPR images of confirmed flint mining shafts and pits at the scheduled site. However, the underlying chalk is susceptible to peri-glacial weathering which can include the formation of circular solution hollows; these results therefore required ground truthing.

The second area selected for test-pitting was along the side of the trackway that runs along the western side of Compartment 3204. Here the surface survey had identified low but persistent levels of worked flint while GPR survey had revealed a number of sub-surface anomalies. Its position, running up the northern side of the dry valley from the scheduled site's boundary fence, provided for a suitable contrast to Compartment 3235 and an opportunity to investigate an important element of the topography. Additionally, the geological strata underlying Compartment 3204 consists of solid chalk, whereas Compartment 3235 lies on glacial deposits, allowing a comparison to be made between flint use and localised geological conditions.

Results

Taken together, these methods provided insights into the changing ways in which the landscape around Grime's Graves has been used over the long term. The opportunistic surface monitoring of ground disturbance revealed a persistent spread of flintwork extending way beyond the scheduled site, the nature, chronological range and composition of which is highly variable and provided insights into the patterning of different activities across the landscape scale and over long periods of time. It enabled the environs to be seen as an ever-evolving 'taskscape', with the material conditions of the landscape shaping how people could encounter and experience the area (cf Conneller 2008; Edmonds 1997; Gibson 1979; Ingold 1993). Particular concentrations were identified to the south and west of the scheduled site, areas where glacial deposits coincide with outcropping seams of the high knapping-quality flints from the Brandon Flint Series. Of particular importance is the identification through surface monitoring, GPR survey and test-pitting of intensive quarrying and initial dressing of flint in Compartment 3235, with the GPR indicating that quarrying may have continued over a much wide area, at least 1km beyond Grime's Graves' scheduled boundaries. Away from these deposits, as in Compartment 3204, flintworking occurred but at a much reduced scale, even if closer to the scheduled site (Figs 3 and 4).

The surveys have shown that spatial patterning of activity in the environs is complicated, but closely tied to variations in the geological and topographical character of the area. It is clear that the flintworkers had an acute sense of areas' physical characteristics, not least the distribution of flint resources, both as seams within the chalk and also within glacial tills containing flint eroded from the chalk below.

Conclusions

By being adaptable, recognizing the limitations of what the landscape had to offer and employing a suite of differing but mutually reinforcing methodologies, considerable insight into the prehistory of the area was gained.

The durability of flint means that it has long been and continues to be regularly encountered wherever the soil is broken, and his project took the approach that such scatters are indicators of spatially defined points of activity. In order to appreciate their potential, we need to get away from thinking about them as sites or tightly defined patterns of settlement and see them more as residues of technological action that can be related to the specific qualities of the landscape. In other words, it can be just as productive to see past activity as framed on a landscape scale, rather than as a series of isolated points within it. Examining and plotting the distribution of surface derived material combined with a detailed appreciation of the physical characteristics of the landscape therefore gives an opportunity to investigate the changing ways in which it could be inhabited.

This paper summarizes a project that was designed as part of a research programme with the fieldwork specifically formulated for an area that presents difficulties for standard methods of archaeological inquiry. Similar methodologies can easily be adapted and enhanced for use elsewhere, according to the potentials and limitations of any given landscape. During the three years that the project lasted considerable help was sought and freely given by local archaeological groups and volunteers (Fig. 5). Such interest means that the project can be extended into the future, with the local community monitoring new ground disturbance over the long term, refining the mapping, and our understanding, of past activity within this difficult terrain.

References

Armstrong, A L, 1926 The Grime's Graves Problem in the Light of Recent Researches. Presidential Address. London, Nov, 1926, *Proceedings of the Prehistoric Society of East Anglia* **5(2)**, 91–136

Barber, M, Field, D and Topping, P, 1999 *The Neolithic Flint Mines of England*, English Heritage, Swindon

Bartlett, A D H, nd Grimes Graves, Norfolk. Report on Archaeogeophysical Survey 2006. Unpublished English Heritage Report by Bartlett-Cark Consultancy

Bishop, B J, 2012 The Grime's Graves Environs Survey: exploring the social landscapes of a flint source. Unpublished PhD Thesis, University of York

Clarke, W G (ed.), 1915 *Report on the Excavations at Grime's Graves, Weeting, Norfolk, March – May, 1914*, Prehistoric Society of East Anglia, London

Conneller, C, 2008 Lithic Technology and the Chaine Operatoire, in J Pollard (ed.), *Prehistoric Britain*, Blackwell, Oxford, 160-176

Edmonds, M, 1997 Taskscape, Technology and Tradition, *Analecta Praehistorica Leidensia* **29**, 99–110

Gibson, J J, 1979 *The Ecological Approach to Visual Perception*, Houghton Mifflin, Boston

Greenwell, W, 1870 Grime's Graves: a paper read at the Blackmore Museum, Salisbury, at the seventeenth annual meeting of the Wiltshire Archaeological and Natural History Society. Privately published, Salisbury

Ingold, T, 1993 The Temporality of the Landscape, *World Archaeology: Conceptions of Time and Ancient Society* **25(2)**, 152–174

Linford, N, Martin, L and Holmes, J, 2009 Grimes Graves Norfolk, Report on Geophysical Survey, October 2007. Unpublished English Heritage Research Department Report 64-2009

Longworth, I and Varndell, G, 1996 *Excavations at Grimes Graves Norfolk 1972–1976, Fascicule 5: Mining in the Deeper Mines*, British Museum, London

Longworth, I, Varndell, G and Lech, J, 2012 *Excavations at Grime's Graves Norfolk 1972–1976: Fascicule 6: Exploration and Excavation Beyond the Deep Mines*, British Museum, London

Case Study 5 figures

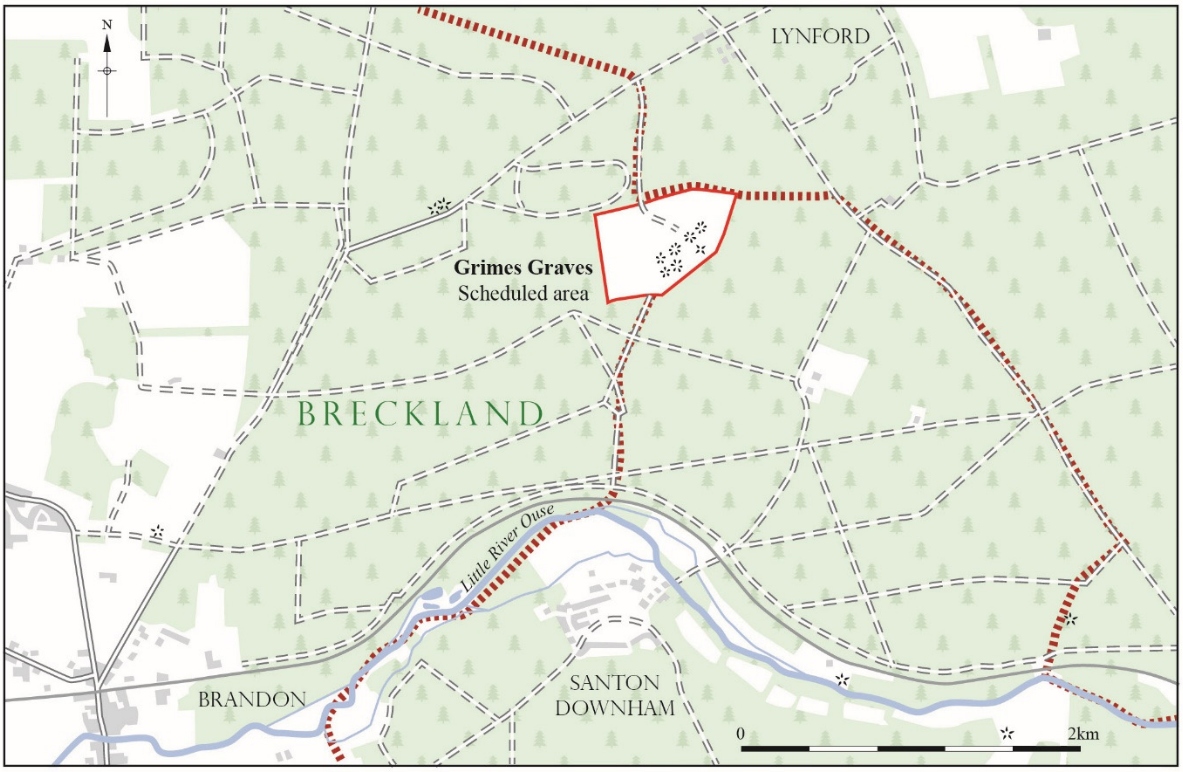


Figure 1: Location of the Scheduled Site of Grime's Graves within the heavy forested Breckland (Cate Davies)

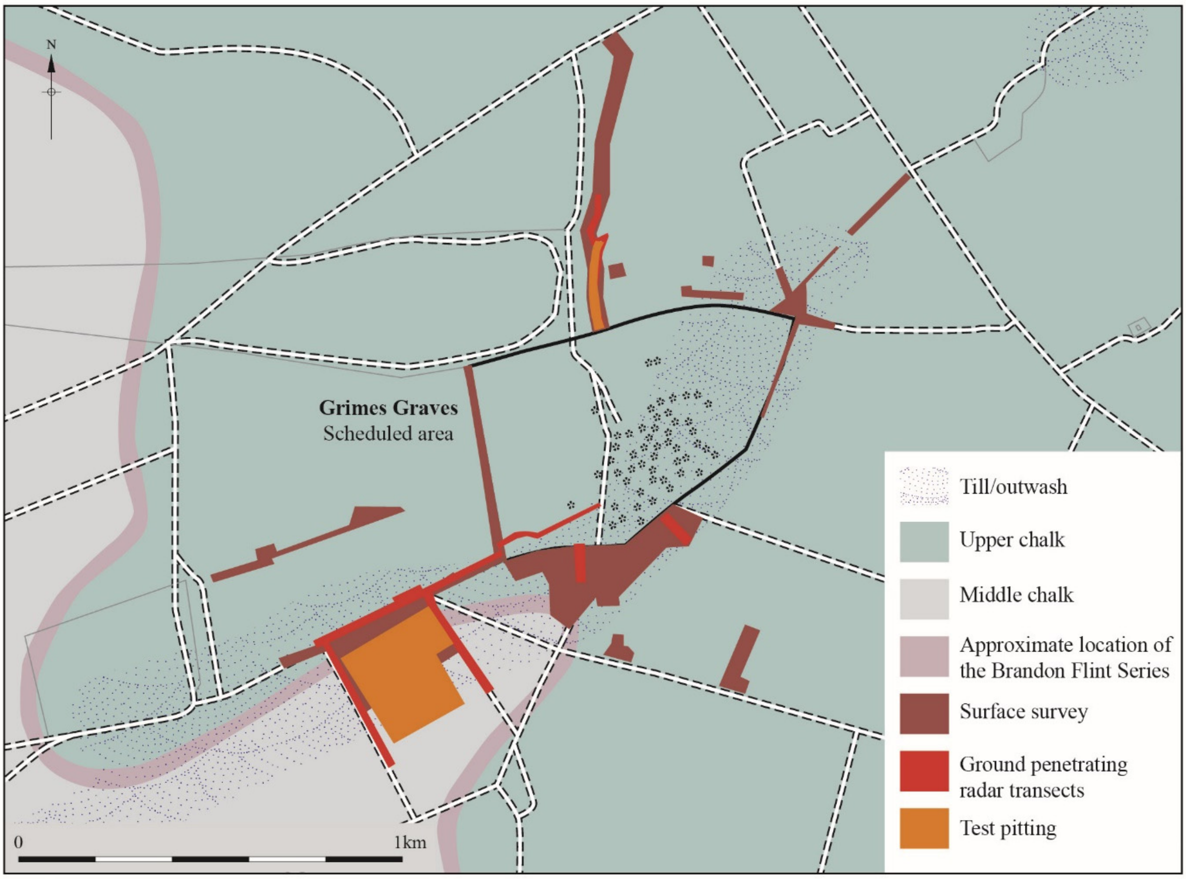


Figure 2: The Environs of Grime's Graves showing Geology and Location of Surveys (Cate Davies)

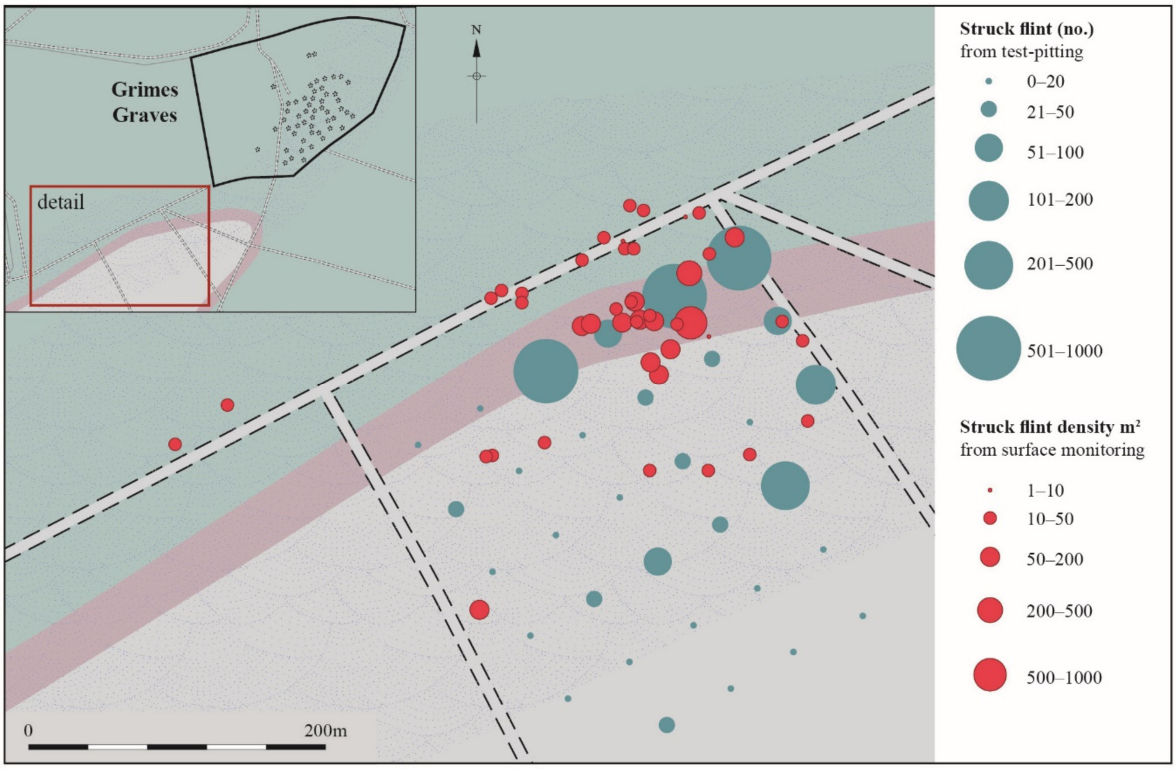


Figure 3: Densities of Struck Flint from Surface Monitoring and Test-pitting in the Area around Compartment 3235 with respect to Geology (Cate Davies)

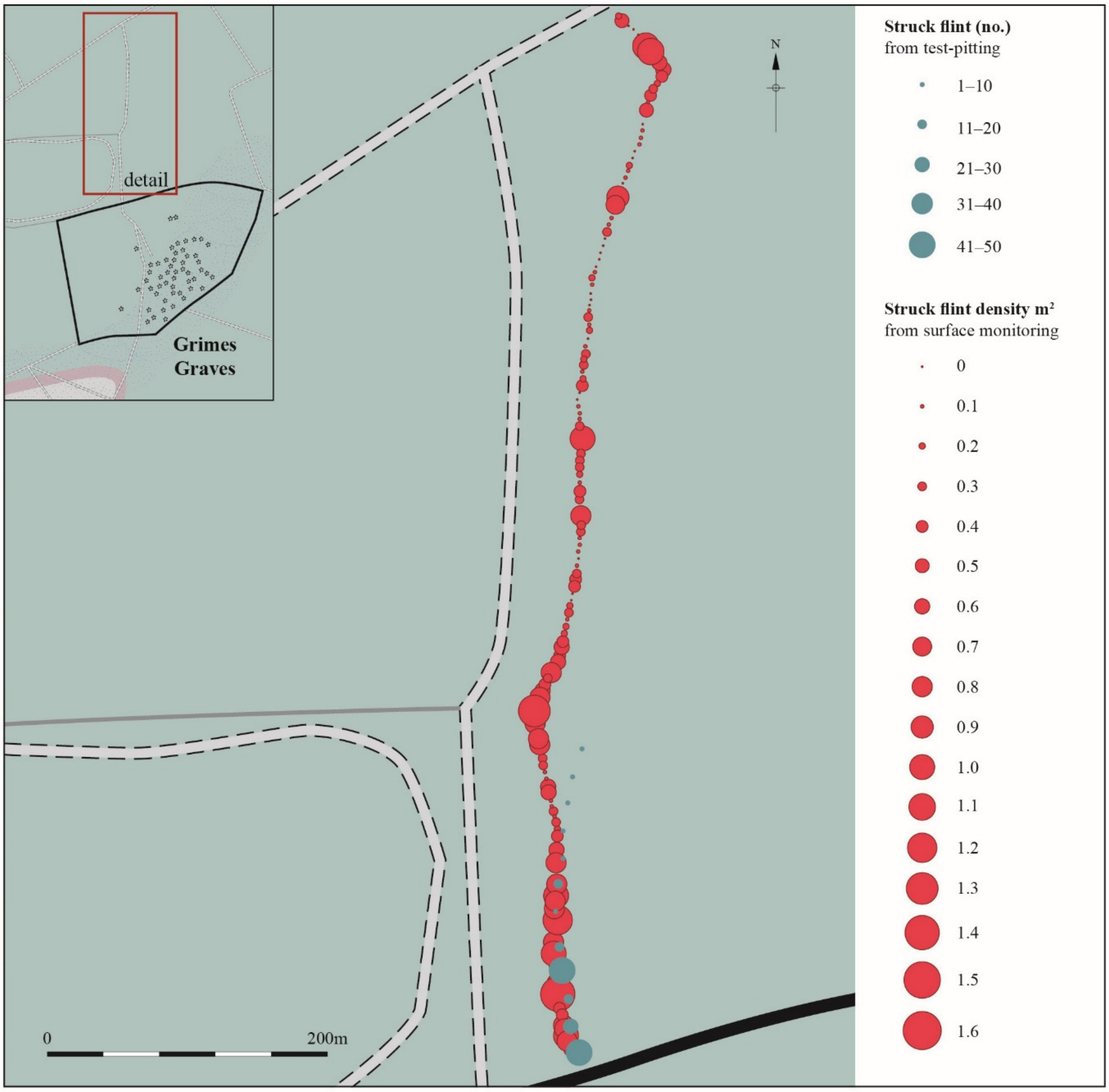


Figure 4: Densities of Struck Flint from Surface Monitoring and Test-pitting in the Area around Compartment 3204 with respect to Geology (Cate Davies)

Figure 5: Local volunteers digging test-pits and engaging with their heritage (Barry Bishop)

Case Study 6: Mesolithic and Neolithic Lithic Scatters at Stainton West, Carlisle, Cumbria

Antony Dickson (Oxford Archaeology North) and Paul Clark (CgMS Limited)

Introduction

This case study describes the excavation methodology, the post-excavation assessment and the analytical studies applied during the analysis of a large chipped stone and coarse stone tool assemblage recovered during excavations at Stainton West, Carlisle, Cumbria (Brown *et al*. in prep.). The date, size and good preservation of the lithic assemblage, as well as the extended sequence of activity it represents, make it one of the most important early prehistoric sites investigated within the North West, and indeed, nationally. Due to this significance, along with the potential of the lithic resource to inform on many of the aims and objectives included in the Regional Research Framework Research Agenda, a programme of analytical studies was designed and agreed on by Oxford Archaeology North (OAN), the developer and local planning authorities (LPA).

Background

The trial trench evaluation of Stainton West identified a palaeochannel and alluvial deposits along with eight lithics. Based on this, the site was originally identified by the project brief as an area for strip and record excavation. This phase of works was duly undertaken by OAN in 2009 and revealed little beyond the deposits identified during evaluation. However, following heavy rainfall, a significant number of lithics weathered out of the stripped surface. This material was mapped and recovered, and a series of test pits were hand excavated to assess the density of the lithic distribution across the site. These produced a substantial number of lithics, exhibiting a similar technological character to the material recovered from the surface. Upon excavation, it was found that the site comprised features and an extensive lithic assemblage, associated with a complex sequence of deposits within a palaeochannel, spanning the Late Mesolithic period to the Bronze Age.

It is apparent that the site could have been missed at the early stages of characterisation and demonstrates the difficulties of identifying archaeological sites within flood-plain environments. Even if it had been ploughed, fieldwalking would not have readily identified the significance of the site, due to the fact that the lithic assemblage and associated structures were buried under alluvial and colluvial deposits. This demonstrates the need to implement appropriate evaluation methodologies, which take into account a broad range of issues including landscape setting and geomorphological context, in order to manage lithic sites effectively at the pre-predetermination and/or post-determination stages of the planning process.

Excavation Methodologies

The site was excavated using a grid-square system (Fig. 1), utilising whole-earth sampling, except for cut features which had their finds recorded in three dimensions. The site area, excluding the palaeochannel, was subdivided into 886 1m x 1m grid-squares. These were excavated stratigraphically, by context, in spits, and all the spoil was retained and stored. The palaeochannel was excavated by hand, in bays, and the lower levels produced Mesolithic organic remains and palaeoenvironmental sequences which could be reconciled with occupation in the grid-square area.

All the retained spoil from the grid-squares was processed on-site through a system of mechanical sieves which were provided and set-up, specifically for the project, by ADC ArcheoProjecten, an archaeological unit based in Amersfoort in the Netherlands (Fig. 2). This system proved extremely reliable in rapidly processing large volumes of sediment to very gently recover archaeological finds. Approximately 270,000 litres of spoil were sieved, producing a large number of residues, which were logged, dried, and labelled.

Post-excavation Methodologies

All the lithic material contained in the context residues was subject to assessment. This involved sorting the lithics into their relevant typological category relating to core technology, debitage and retouched items, by raw material type, which included various cherts and flint, chalcedony/agate, tuff, pitchstone, quartz, and raw materials that were not readily identifiable. During the assessment, it became clear that some of the context assemblages contained collections of lithics that showed enough similarities in colour, texture, lustre, inclusions and cortex type to indicate that they had been struck from the same nodule. These, along with a few short re-fitting sequences, were recorded as knapping groups.

Once each context assemblage had been sorted, the subsequent data were then entered into an online relational database. Each lithic-type entry represented a row of data forming a single record relevant to a specific context and group. This amounted to a record of over 303,000 lithics, including approximately 5,900 microliths; 236 coarse stone tools; 21 complete and fragmented axe/adzes; and 610 pieces of ochre.

The database was developed by Oxford Archaeology to collate and manage information and integrate the project archive, while also having further functionality such as remote access, facilities for multiple users and advanced querying. The latter proved invaluable, especially in regards to generating sub-samples of lithics for a variety of integrated studies, including a detailed lithic typological and technological attribute analysis, use-wear analysis, spatial analysis, and a variety of raw material sourcing studies (Table 1).

Results

The results of the use-wear study were exceptionally good (Table 1), with a higher than average success rate in terms of the number of pieces within the sample preserving evidence for microwear, allowing a greater understanding of the range of tasks undertaken at the site. One of the main observations from the analysis is that microliths were used in a variety of tasks and not just as armatures for hunting weapons. The spatial analysis of the results (Table 1) has shown that some tasks, such as hide working and butchery, were consistently undertaken in the same areas of the encampment over several phases of occupation (Fig. 3). The study also helped understanding of the formation processes behind the creation of some stratigraphic units, thus benefiting the interpretation of the site.

The results of the raw material sourcing studies have provided added detail with regard to the connections which the people who visited Stainton West had with the wider landscape (Table 1).

Chert from southern Scotland and the northern Pennines arrived at the site, along with pitchstone from the western coast of Scotland and flint from the north-east of England (Fig. 4). The procurement of these materials was part of the wide-ranging mobility patterns practised by those visiting the site, elements of which were also probably connected to the negotiations and obligations bound up in extensive social networks. By examining the chronological and spatial distribution of the raw materials tested during the studies it can be suggested that these networks were in place by the middle of the fifth millennium cal BC and probably continued until, at least, the early Neolithic. Thus, the use of raw material studies has highlighted the importance of the site and its place within a wider social landscape. The chert sourcing also confirmed the coherence of over 100 knapping groups identified during the lithic assessment, concomitantly affirming the spatial integrity of the lithic assemblage and the success of the methodologies employed during excavation.

Conclusions

In summary, the excavation and post-excavation methodologies employed at Stainton West were invaluable for the interpretation of the site. The grid-square system was demonstrated to be of sufficient resolution to allow the successful identification of spatial patterns across the site, including the identification of structures, and the distribution of knapping groups (Table 1). Additionally, the sieving setup proved an excellent system for the high quality recovery not only of lithic artefacts, but also of organic remains. It has shown to be an incredibly useful tool for the archaeologist, and should certainly be considered for much wider use on archaeological projects, across a range of periods and geographic regions. Moreover, the analytical methodologies employed during the analysis of the lithic assemblage have countenanced a more subjective engagement with the people who made and used stone tools, something that is not usually considered in sufficient depth in the conventional technological analysis of late Mesolithic struck lithic assemblages.

References

Brown, F, Clark, P, Dickson, A J, Gregory, R and Zant, J, in prep. *From an ancient Eden to a new frontier: an archaeological journey along the Carlisle Northern Development Route*, Lancaster

Case Study 6 figures

Figure 1 The grid-square area under excavation (© 2018 Oxford Archaeology North; all rights reserved).

Figure 2 The sieving system in operation (© 2018 Oxford Archaeology North; all rights reserved).

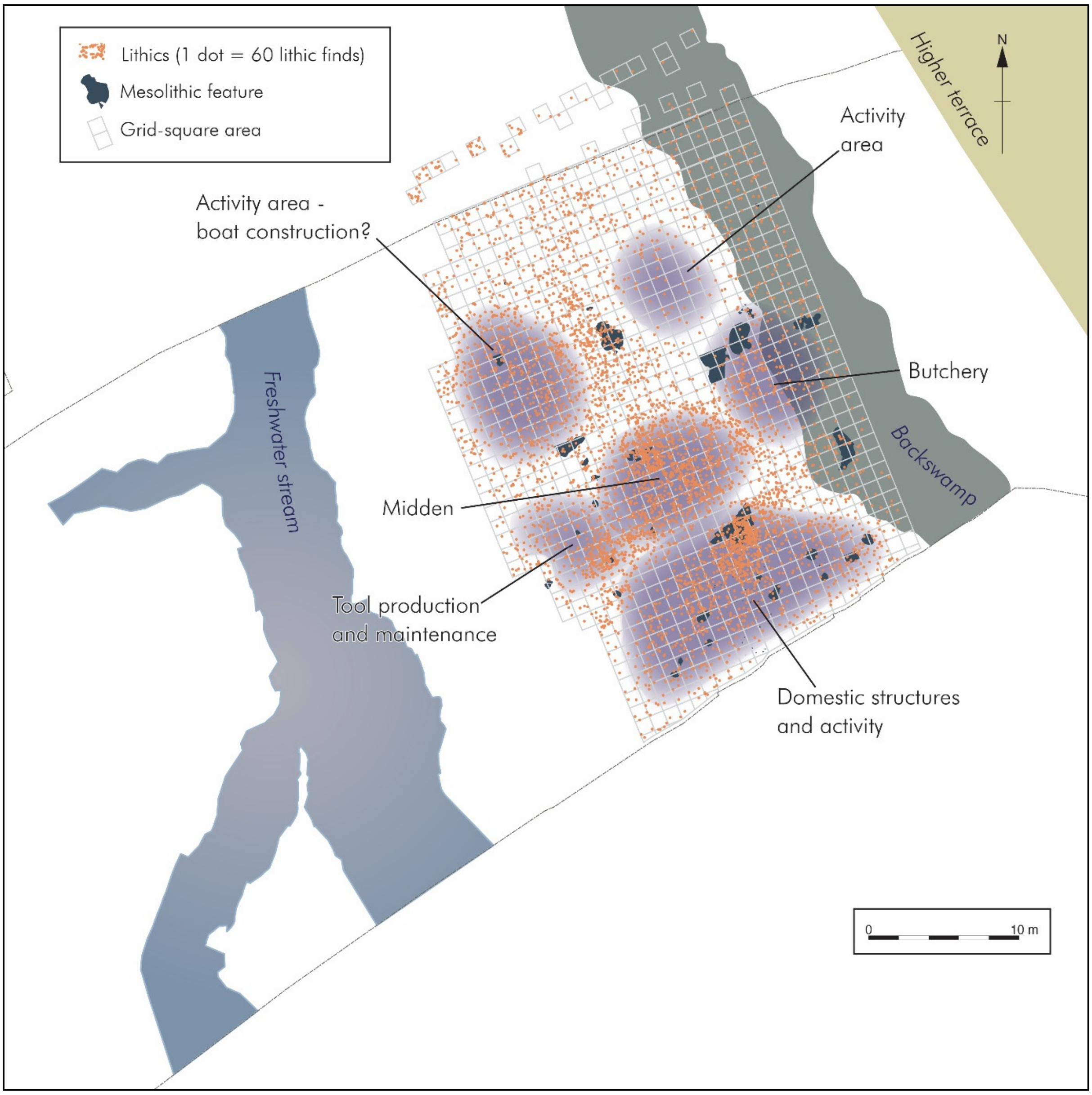


Figure 3 Interpretative figure of the Mesolithic encampment (© 2018 Oxford Archaeology North; all rights reserved).

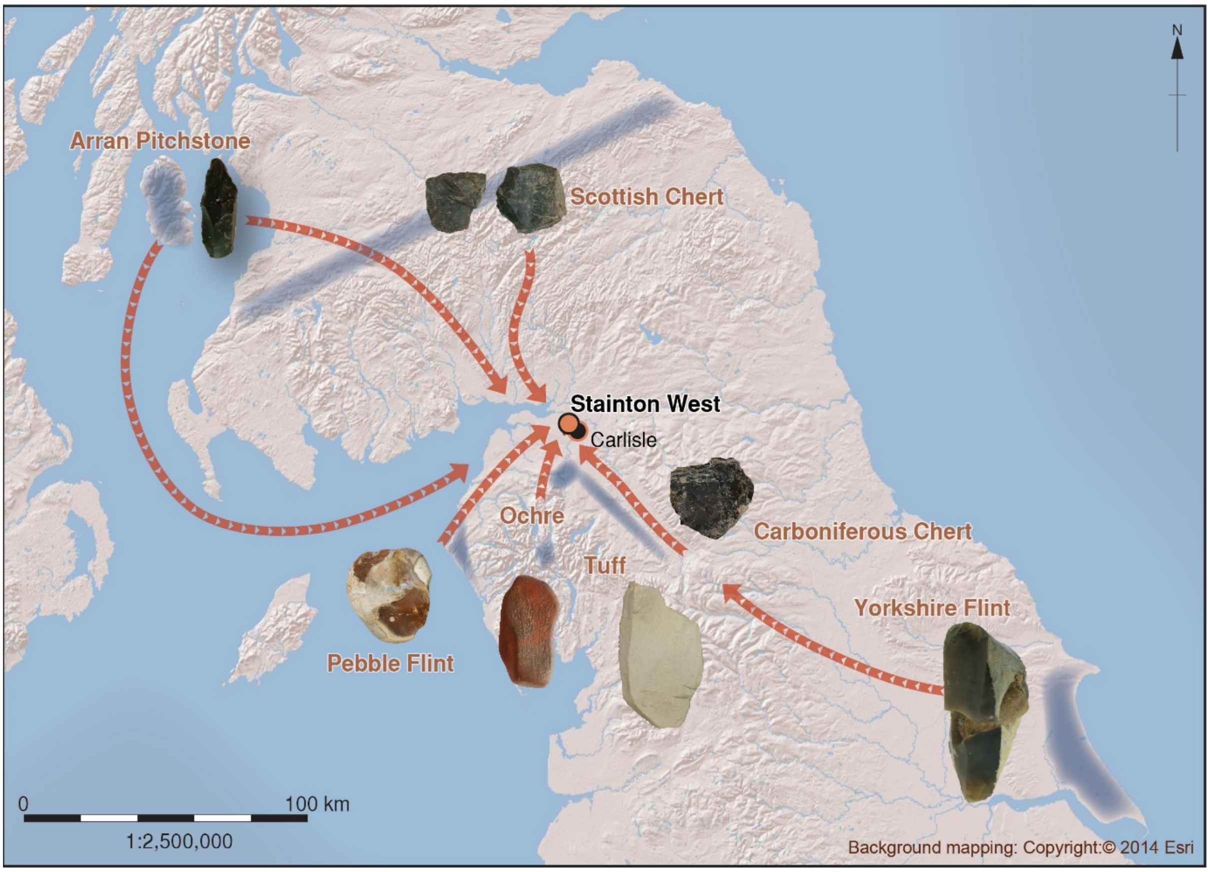


Figure 4 The geographic distribution of lithic raw materials (© 2018 Oxford Archaeology North; all rights reserved).

	Sample size	Methods	Results	Number of staff	Rationale	Interpretative value
Technological analysis	c 19,000	Typological and technological attribute analysis of chipped stone cores, debitage and tools. Technological analysis of coarse stone tools. Technological analysis of ochre.	Identified chipped stone reduction strategies across different types of raw material. Identified different types of coarse stone tools and interpreted their use. Identified the use of ochre and its spatial relationship with the chipped stone and coarse stone tools.	2	Integral to Updated Research Aim 5 in the Stainton West post-excavation assessment report. The worked stone assemblage, due to its size, composition and chrono-technological character, is considered to be of regional, national and, certainly of north-west European, if not, international importance. Technological analysis of a sample of the assemblage undertaken to explore the technological character of the worked stone assemblage; to identify chrono-technological developments; and social organisation across the site area. Analysis undertaken to complement the study of the site stratigraphy, chronology and palaeoenvironment.	The results aided the interpretation of patterns of occupation across the site; the technological character of this distribution; and the landscape value of the site within a regional context.
Raw material analysis	c 400	A variety of geochemical analyses were used: Inductively Coupled Plasma Mass Spectroscopy (ICP-MS); Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES); X-Ray Fluorescence (XRF); Petrological Thin Section (PTS)	Identified that raw materials were derived from a variety of sources local to and beyond the region. Confirmed the integrity of the knapping groups. Aided in the interpretation of social organisation across the site area.	Staff and students from Bradford university; Reading University; the University of Central Lancashire; the Implement Petrology Group and two independent researchers.	Integral to Updated Research Aim 5 in the Stainton West post-excavation assessment report. The wide variety of materials at Stainton West met the need for the development of a programme of scientific analysis for characterising the sources of Mesolithic flint and chert implements, which has been established as an important research priority in the Regional Research Framework. Confirm the integrity of the knapping groups identified during assessment and understand the spatial distribution of raw materials and their significance to social organisation across the site.	The geochemical study of lithic raw materials at the site was used to answer questions about the nature of population mobility and range of influence of the communities that visited the site. It also allowed a greater understanding of the social organisation of stone working activities and the chronological development of procurement strategies.
Microwear analysis	774	Microscopic analysis of ware patterns on stone tools and debitage undertaken within a laboratory using specialist equipment and recording procedures.	Identified tool and debitage use across the site area potentially indicating task organisation. Also the study of wear pattern preservation informed on site formation processes.	Staff from Bradford University's Lithic Microwear Research Laboratory	Integral to Updated Research Aim 5 in the Stainton West post-excavation assessment report. Microwear analysis can identify how individual tools were used; the character of activities undertaken at the site; the use of particular resources; settlement organisation; seasonality; and site formation. Therefore, it can contribute greatly to a regional and national understanding of Mesolithic practices.	Highly effective in adding a human dimension to the study of worked stone from the site. Highlighted the potential for the spatial organisation of specific tasks across the site area. Also identified the multi-functional role of some microlith types.
Residue analysis	44	Chemical analysis of residues adhering to stone tools and debitage in order to identify the composition of the material. Attempted dating of organic residues.	Identified birch bark tar on a leaf shaped arrowhead. Unfortunately the analysis of potential residues on the microliths and debitage revealed contamination by plasticisers.	Staff from Bradford University's Hunter Gatherer Laboratory	The potential to date organic residues offered an alternative method to refine the site chronological model. Unfortunately this did not take place due to sample size and contamination.	In the context of Stainton West this analysis added extra interpretative value to social organisation at the site.
Spatial analysis	All worked stone from the site area	The use of a Graphic Information System (GIS) to compile shapefiles showing dot density distributions of all types of chipped stone, coarse stone tools and ochre. The creation of interpolation plots to define spatial relationships between specific lithic types. Plotting the results against the site area and associated features in order to identify the spatial organisation of stone working at the site.	Identified stone working areas across the site area relating to the reduction of specific raw materials. Identified meaningful distributions of specific tool types relating to the social organisation of the site. Identified the integrity of the worked stone assemblage in relation to the stratigraphic sequence. Identified the presence of structures as semi-circular settings of worked stone, which had not been identified during excavation.	1	Integral to Updated Research Aim 5 in the Stainton West post-excavation assessment report. Due to the collection strategy employed during excavation which practised 100% recovery the spatial preservation was found to be excellent and allowed detailed spatial analysis to be undertaken.	Spatial analysis was highly effective in picking apart what would ostensibly have been seen as a palimpsest. It was the main technique used to draw together the results of the other analytical techniques. Highly effective in defining social organisation and the spatial distribution of activities and tasks across the site area.

Table 1 The methods, results, rationale and interpretative value of the analytical techniques used during the analysis of the Stainton West worked stone assemblage (© 2018 Oxford Archaeology North; all rights reserved).

Case Study 7: A Mesolithic lithic and early prehistoric landscape at Bexhill to Hastings Link Road, East Sussex

Mike Donnelly (Oxford Archaeology South)

Introduction

This case study describes the evaluation techniques, excavation methodologies and the post-excavation assessment approaches applied during work on a very large number of in situ flint scatters found during the Bexhill to Hastings link road project in East Sussex (Donnelly *et al*. 2019). Around 260 scatters were identified totalling 465,000 struck flints. Theses scatters were difficult to uncover due to the three-dimensional nature of their preserved burial environment which necessitated a shift in standard operating procedures for their excavation. The potential of these scatters was immediately apparent, and every effort was made to fully record and recover all useful data from them. Theses excavations revealed a nationally important early prehistoric landscape with activity dating from the late Upper Palaeolithic through to the Bronze Age, thereafter buried under peat and estuarine silts. Post-excavation assessment is ongoing but already the analyses have yielded over 100 radiocarbon dates and identified palaeoenvironmental sequences directly associated with the scatters. We also have very detailed spatial information from these scatters that strongly imply a relatively small typical group size, very probably a nucleated family group and this has wide ranging implications for the interpretation of social structure, population densities and mobility patterns.

Background potential and evaluation

The area impacted by the proposed new road was known to have very good potential for well-preserved early prehistoric activity. However, in many ways the timing and methods used to evaluate this area were inimical to the recovery of flint scatters. A field walking exercise conducted in the autumn of 2012 recovered very little lithic material. This of course could be taken to indicate low potential. However, it is only by understanding the buried soil profile here that these results could be fully understood. In effect, this lack of material in the plough zone indicated the potential for very well preserved flint scatters to survive.

The evaluation occurred during late autumn 2012, a period in which substantial rainfall led to the rise in the local water-table making the identification of flint scatters extremely difficult. Moreover, machine stripping, confined to a single bucket width and tied closely to existing topography, resulted in truncation of numerous scatters. Even where the slope matched the underlying prehistoric topography, subtle changes in that land surface would have been removed resulting in a significant reduction in flint numbers within the evaluation trench.

Only two main scatters were identified during evaluation. However, small numbers of flints were recovered from several locations that were identified as potential scatters, something that was confirmed by the later excavation in all but one instance. Assessment of the evaluation data resulted in a change in the methodology in favour of test pitting during the main phase of works at Bexhill.

Excavation Methodologies

The excavation phase of works at Bexhill also included additional evaluation. Hand- or sometimes machine-dug test pits were used alongside augering to determine the potential at impact depth for several large areas. Of these, the hand-dug test pits were excellent for identifying potential scatters while the machine dug pits had the same problems as the evaluation trenches. Machine-hand hybrid test pits were a suitable alternative, here the bulk of the often very deep overburden was removed by machine and a hand-dug test pit was placed in the base to remove the final layers. These methods successfully identified an area of dense scatters on one site but very nearly missed a similar density of activity on another. Test pit grids, like any form of evaluation, can miss key archaeological deposits.

One of the key decisions made at Bexhill was to strategically under-strip areas of scheme, where preserved old land surfaces had been identified. In effect, this meant that any impacted areas below 5m OD were under-stripped leaving a moderately thick layer of overburden (usually peat) over the flint scatters. Where truncation had already occurred, the sites were stripped normally but the machines would follow the predicted buried slope to minimise additional truncation. This strategy not only prevented the truncation of the scatters but also protected the undug portions from trampling by the large archaeological team and disturbance from the heavy pumps utilised for water management.

As with most in situ flint scatters a grid system was used to excavate these deposits. This evolved from individual grid squares covering areas of flint concentrations to finally covering entire sites in a series of 5m grids. We avoided the usual numbering system applied to infrastructure jobs where context numbers tended to be in high thousands range and instead allocated the numbers 1-99 for flint scatters. The scatter number was always used rather than the context number of the layer from which the flint was recovered, as in reality all the flint scatters belonged to the same archaeological horizon. The grids themselves used a simple lettering system. All of this was done to minimise numbering errors and to massively reduce the amount of time needed to record and label these finds, allowing for the complete excavation of numerous scatters.

All significant flints (greater than 10mm or any identified smaller tools) were 3D recorded. This was carried out on site with either differential GPS, paired GPS with fixed base stations or robotic total station, all of which were relatively quick to implement on site, with between 600-1000 flints per day being recorded by each survey team. This allowed for remarkable resolution of activities on site and has allowed us to postulate quite complex group dynamics. One example of this was at scatter 7 where it appears as if two knappers of varying skill attempted the same tasks while a very experienced knapper sat across a hearth from them and corrected any complex errors (Fig. 3). Such a teaching scenario would have been impossible to infer through whole earth sampling. Other more prosaic examples include identifying 'butterfly' gaps in the scatters where an individual had sat (Fig. 4).

Half of all spoil from the grid-squares was processed on-site through a system of mechanical sieves originally obtained by OA for the CNDR project (see Case Study 6 above). The samples recovered through the sieving system were excluded from any microwear analysis, to avoid any complications.

Post-excavation assessment

All the lithic material recovered from excavation was assessed. This was carried out by a team of five under the supervision of the author. The assessment was quite detailed and included a full analysis and refitting exercise for six of the scatters. These works are ongoing but there are several key points that this assessment has currently raised. As mentioned earlier, the resolution on the data has allowed for some quite detailed narratives to be constructed and should allow for artefact life histories to be examined (Conneller 2005). This should allow us to link various scatters in the landscape and to map these taskscapes in remarkable detail. These activity patterns strongly suggest that small groups of around 2-4 individuals were responsible for the bulk of these scatters. Some of the denser scatters contrast with this and these often display quite low levels of knapping skill. These are currently interpreted as teaching areas and the implications of these two scatter types taken together is for the fragmentation of a larger family unit into smaller task-specific sub units. While this may imply simple environmental determinism, the nuances of the flint scatters, in terms of skills apparent, teaching dynamics etc, strongly suggest aspects of human behaviour often absent from early prehistoric narratives. They also indicate the importance of children in any social unit. What is currently absent from the Bexhill late Mesolithic flint scatters is any form of recognisable base camp of the form that is frequently cited in the archaeological narratives of late Mesolithic life.

Conclusions

The analysis also allowed us to tentatively identify five chronological phases in the late Mesolithic assemblages largely based on microlithic forms. These have been tested by radiocarbon dating and have so far produced very encouraging results but much more work is needed here (Fig. 5). The results of pollen analysis have identified concentrations of charcoal and episodes of woodland clearance that may indicate woodland management or the creation of water edge clearings. These results have the potential to greatly enhance our understanding of the late Mesolithic in South-East England, but caution must be exercised as full analysis is still to be undertaken and it is not clear how representative the density of activity is for other areas.

References

Conneller, C 2005 Moving beyond site: Mesolithic technology in the landscape in Milner, N and Woodman, P (eds) Mesolithic Studies at the Beginning of the 21st Century, Oxford, Oxbow books, 42-55

Brown, F, Clark, P, Dickson, A J, Gregory, R and Zant, J, in prep. *From an ancient Eden to a new frontier: an archaeological journey along the Carlisle Northern Development Route*, Lancaster

Donnelly, M, Champness, C, Davies, S and Boothroyd, J, 2019 Bexhill to Hastings Link Road: post-excavation assessment and updated project design, unpubl. report, Oxford Archaeology, Oxford

Case Study 7 figures

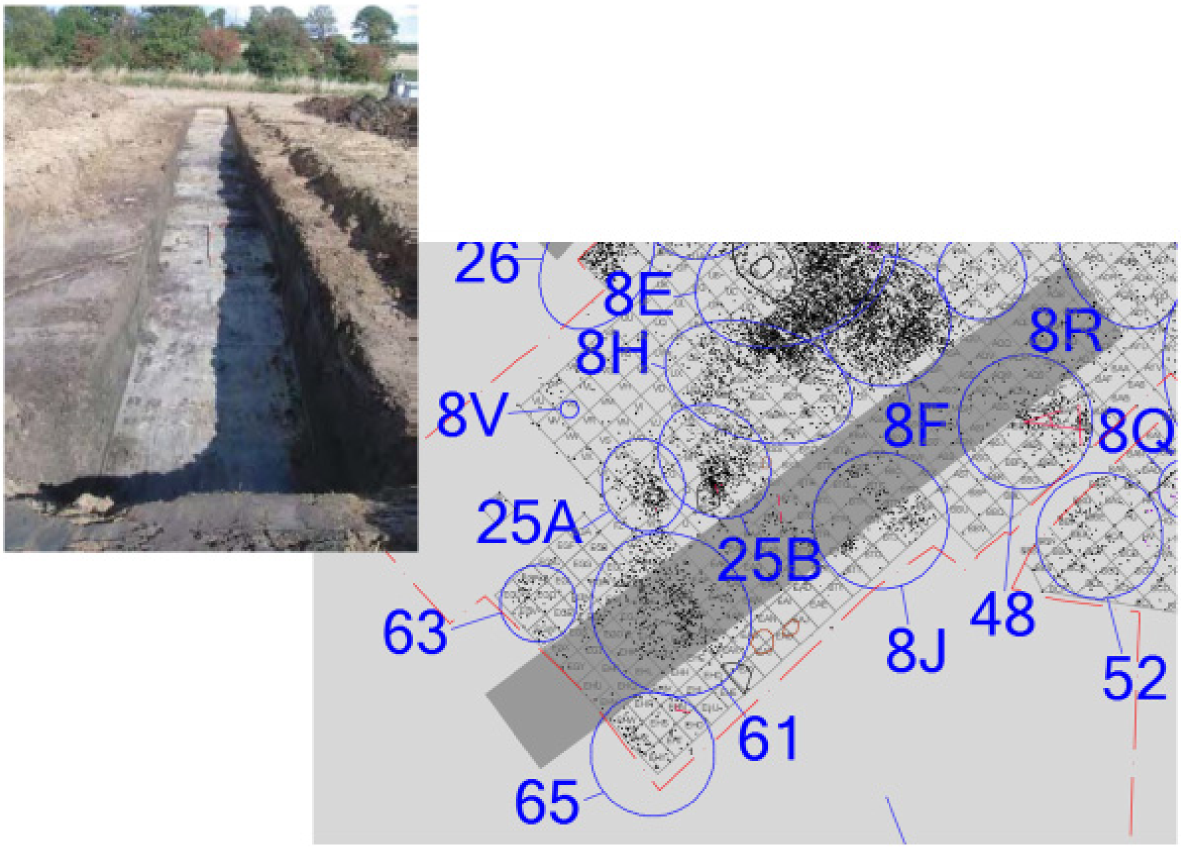


Fig 1. example of evaluation trench 76 from Bexhill, overlying and underlying topography match, but note the drop in flint numbers in scatters 8J and 48

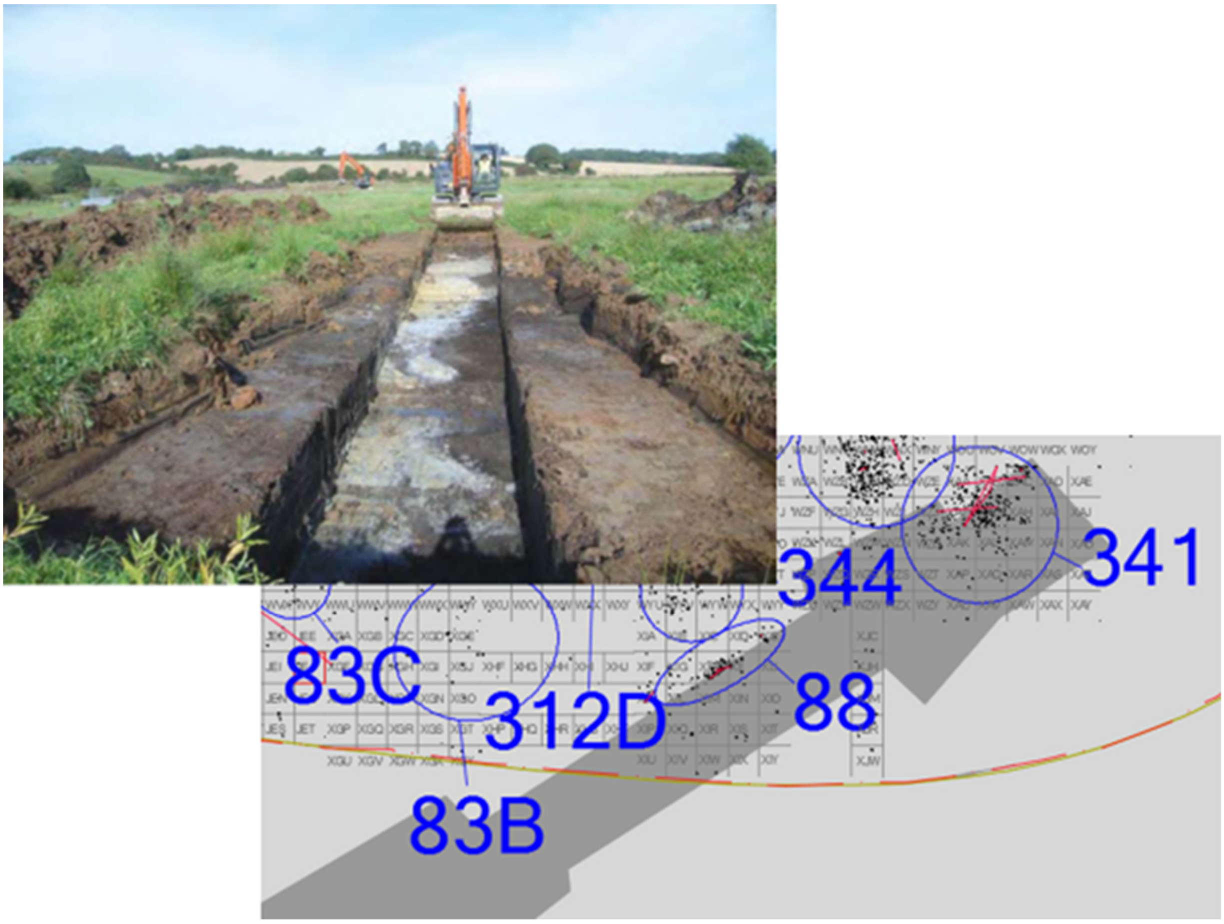


Fig 2 example of evaluation trench 86 from Bexhill, overlying and underlying topography do not match resulting in enormous damage to lithic scatters 88 and 341

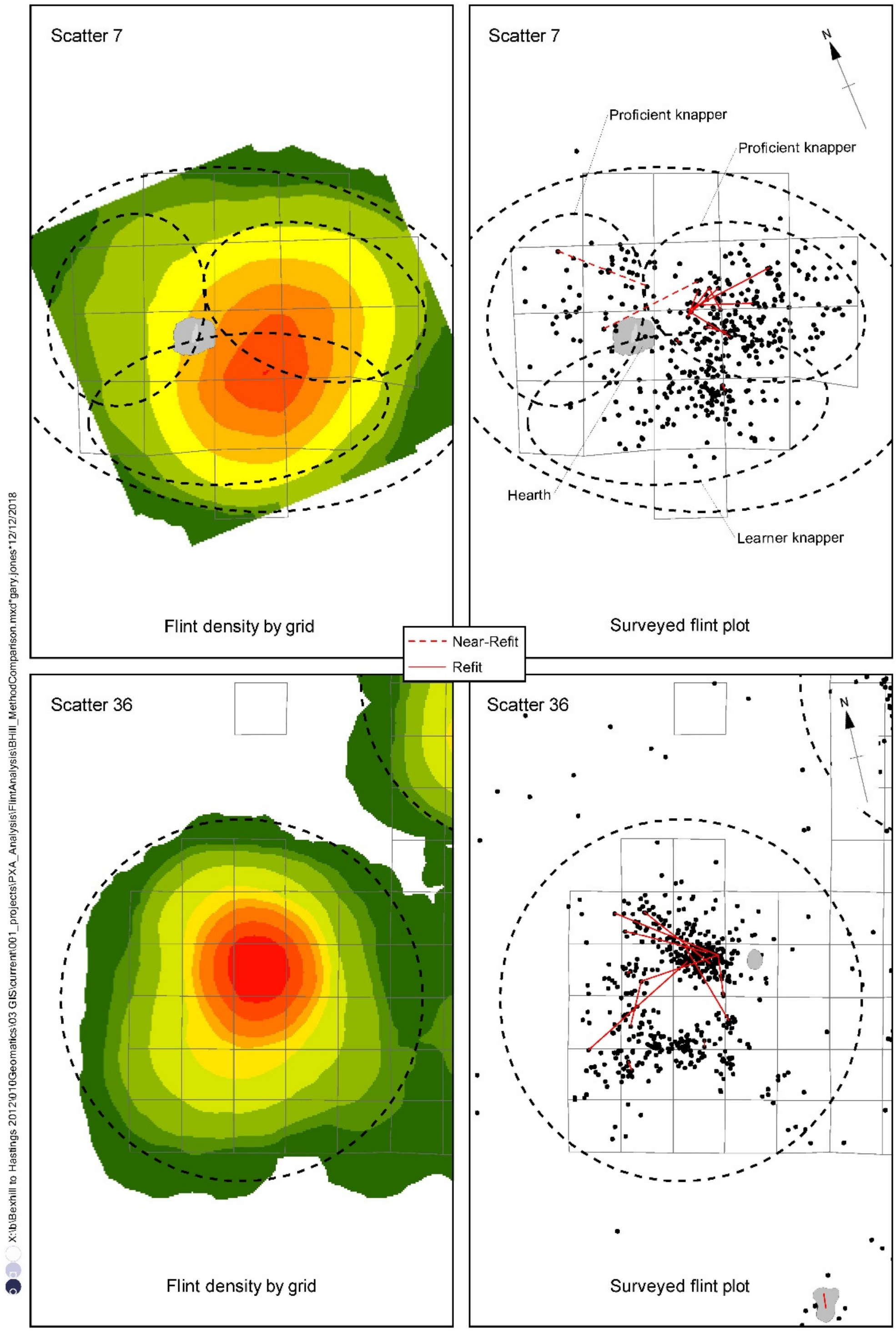


Fig 3 Scatter 7 3d plot and example of bulk recovery of same scatter

Fig 4 Scatter 36 3d plot and example of bulk recovery of same scatter

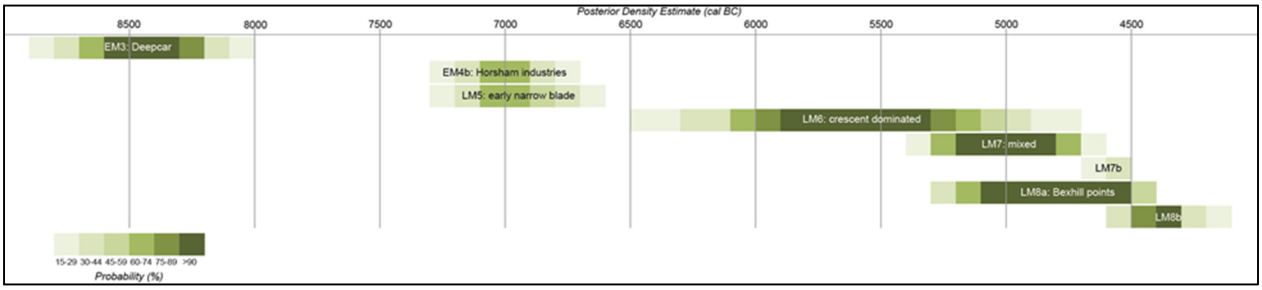


Fig 5 Current phasing of the late Mesolithic activity at Bexhill (OA forthcoming)

Case Study 8: Spatial statistics and multi-proxy methodologies, Lessons from Flixton Island 2, North Yorkshire

Charlotte Rowley (POSTGLACIAL Project, University of York)

Introduction

Flixton Island 2 is one of the lesser known sites from the Vale of Pickering, Yorkshire, that was excavated as part of the ERC and Historic England funded 'POSTGLACIAL Project', under the direction of Nicky Milner (University of York) and Barry Taylor (Chester) from 2012 to 2014. Post-excavation analyses of the Late Upper Palaeolithic and Early Mesolithic lithic assemblage and associated soil samples from Flixton were undertaken and the datasets visualised and statistically analysed as part of an ERC/AHRC funded PhD by the author. A site monograph is in preparation and expected to be published in 2019 (Milner *et al*. forthcoming).

Background

While Star Carr was on the shores of what would have been palaeo-Lake Flixton (now peaty farmland), Flixton Island itself was a small bipartite island in the lake, not far to the east. Rather than finding the rest of a small scatter (as originally anticipated based on previous work by local archaeologist John Moore in the 1940s and the Vale of Pickering Research Trust and Chantal Conneller in the 1990s and 2000s), a surprising palimpsest of over 21,000 finds of Late Upper Palaeolithic and Mesolithic material was retrieved during the POSTGLACIAL project by a team largely made up of dedicated volunteers and students.

In a bid to understand the deposition of material on the 'dryland' area of the island in particular, where trench depth was a matter of tens of centimetres and there was no clear stratigraphy to differentiate occupations or use events, a programme of geochemical sampling was designed by Lisa-Marie Shillito and Helen Williams to complement the retrieval of the dense deposit of lithic artefacts. Organic preservation was very poor and there were no clear archaeological features that might have suggested a reason for the deposition. Lithic and geochemical sediment analyses were then undertaken as PhD research by the author. Spatial visualisation and statistical analyses were applied to integrate the datasets generated to form a multi-proxy study (Rowley 2017). The aim was to maximise the information retrieved from the two main forms of evidence from the site: knapped stone and sediment.

Methodologies

Detailed recording and high-resolution sampling were both key to generating viable datasets for this approach. Every find larger than a thumbnail from an archaeological (non-topsoil) layer was assigned a unique find number and 3D located by total station. This was most efficient when finds were geolocated in batches periodically, having been tagged in the ground as an interim step by excavators, employing a dedicated team of two people while excavation could largely continue around them. Smaller debitage was collected and bagged by horizontal 1 m^2 grid square and context. Topsoil finds and those retrieved from the sieving (100% of sediments) were also collected this way. This provided a phenomenal resource for spatial analysis of the lithic artefacts, only hindered by the fact that negative numbering was used for grid squares for a time which generated errors in the dataset and meant some information had to be discarded. Recording orientation, akin to applications at Boxgrove and Seamer C (ref), would have added a further layer of information that could have been advantageously utilised. Naturally, the higher the resolution of the spatial data, the more intimate the level of spatial patterning that can be investigated.

All the lithic material was subject to visual assessment. Similar to Star Carr, and many other sites, this involved recording typological categories, suggested raw materials, and signs of pre- and post-depositional modifications or damage in a relational database. Every row represented a unique find (including sieved and spall pieces). This allowed the database of artefact attributes to be easily merged with the 3D location data so that it could be integrated into a GIS, visualised and statistically analysed. Pieces bagged by grid square and context were generally visualised using representational symbology overlaid on an estimated grid layout. This work would be further complemented by a comprehensive refitting study akin to Conneller's work at Star Carr, and although it was not feasible within the time constraints of the PhD research, a York undergraduate student dissertation yielded promising preliminary results (Nash 2017).

Archaeological sediment samples were taken for geochemical laboratory analyses or analysed in the field at high resolution horizontally across the in-situ occupation layers. At Star Carr, there were clear features that could also be sampled. A range of geochemical methodologies were applied to these sediments to establish their attributes and composition which could be plotted visually as well as statistically analysed. Such a multi-proxy study is preferable to applying a single methodology because it allows better critical evaluation and greater confidence in the interpretation eventually proposed (see Shillito 2018). High resolution, well planned horizontal and/or vertical sampling is needed if datasets are to be integrated most effectively with high-resolution lithic artefact spatial data. It was noted that archaeological sediment sampling was best complemented with a thorough strategy for both control sampling and running repeat readings, which allowed more robust and confident interpretation of the results. Results from applying a similar approach at Star Carr strongly suggested support for the proposed delineation of the 'central structure' and surrounding occupation zones (Rowley *et al*. 2018).

Spatial visualisation allows exploration of patterns in the datasets, but the human eye is excellent at identifying even random patterning so statistical analysis establishes whether those patterns are likely to be genuinely significant. As with the geochemical methods, where multiple different statistical analyses were applied, the interpretative case could be better evaluated and more strongly argued. A little time invested in understanding the general mathematical principals behind the statistical analyses, which is much easier when there is a genuine dataset in mind than when learning purely theoretically, prevented misapplication of inappropriate statistical tests and built confidence in the arguments made. Texts such as that by Field (2000) were found to be remarkably accessible whilst also developing knowledge of relevant software as well. Online GIS training, tutorials and communities were a powerful bank of shared knowledge, and frequently more up-to-date than many textbooks, so these should always be explored even if with caution. When visualising the data, accessibility as well as general clarity was emphasised (see text box).

Spatial Visualisation and Colour Blindness

Visualisations feature heavily in lithic analysis publications, such as for showing spatial distributions of specific categories of artefact, refit connections, or annotations over magnified microwear images. However, visualisations purely based on contrasts between red/green or, less commonly, blue/yellow can be problematic for those with colour vision deficiency (commonly known as colour blindness). According to NHS estimates (2016), around 1 in 12 men and 1 in 200 women in the UK are impacted by red/green colour vision deficiency. There are many online tools available that allow specific images to be checked for how their colours might appear to someone with colour vision deficiencies. Using different symbols and distinct shades, rather than different colour hues of a similar shade or using the same hue in very subtle variants of shade, can avoid the issue completely. This is one accessibility issue that can be easily addressed with a little thought.

Results

While the geochemical results aligned well with the structural features at Star Carr (Rowley *et al*. 2018), the signals from Flixton immediately appeared to be more homogenised, which was unsurprising given the shallow stratigraphy and dense distribution of artefacts retrieved (Rowley 2017; Rowley *et al.* forthcoming). However, applying the multiproxy approach still allowed for areas of interest within the palimpsest of material to be suggested, where patterning in subtle variations was complementary. Figure 1 provides an example of the process of data visualisation and analysis for one of the POSTGLACIAL trenches at Flixton Island 2.

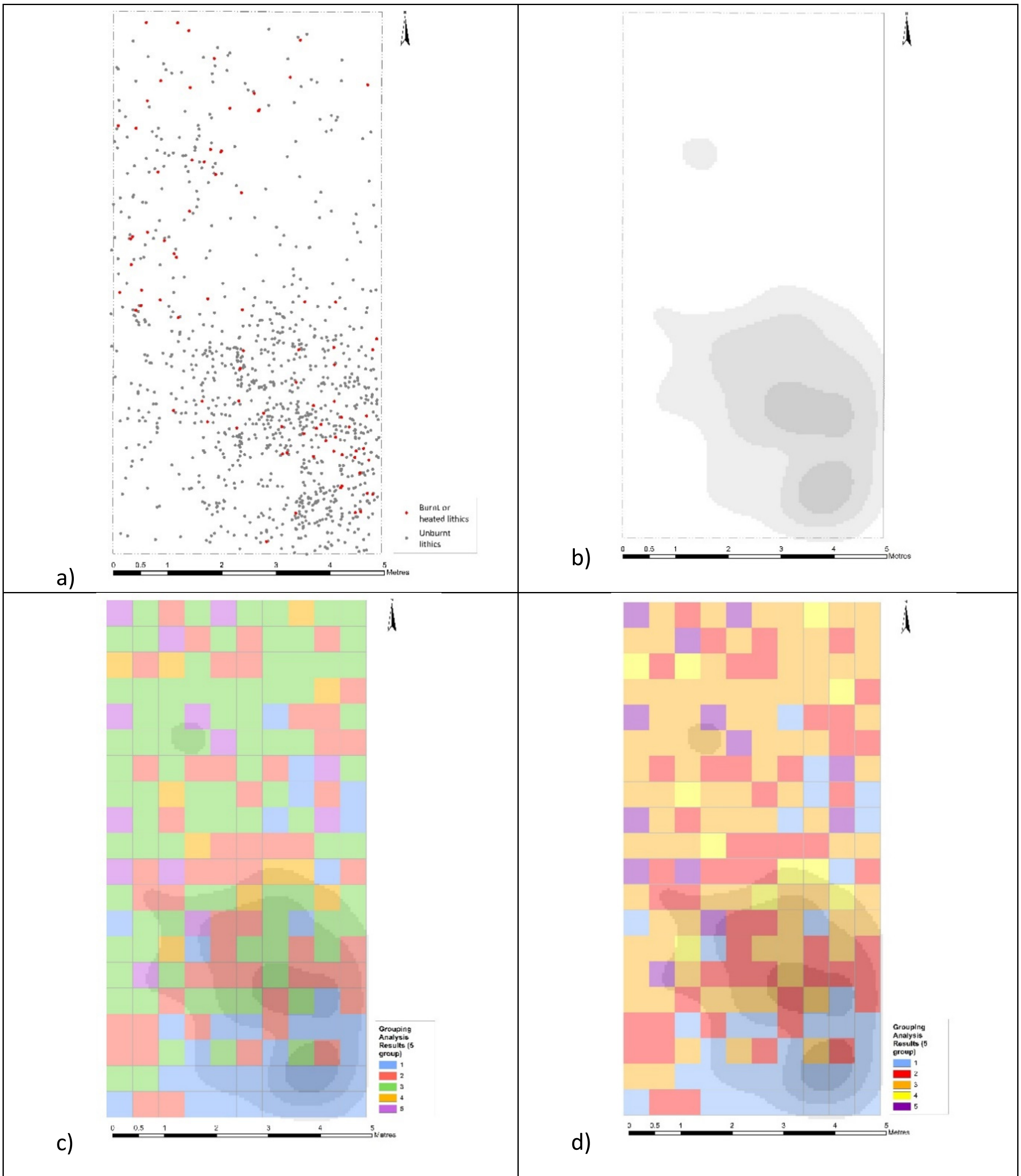


Figure 1. A plot of one of the Flixton Island 2 trenches, showing a) the lithics distribution (just 3D located lithics) with the burnt/heated material within that trench in red; b) a statistical Density Analysis visualisation on the lithic assemblage conducted in ArcGIS; c) The Density Analysis (grey) over the statistical analysis for geochemical groupings (colour grid), using the standard colour palette generated by ArcGIS; d) The same trench visualisation as 1c with the colour palette modified, as using the standard palette the green/red/oranges and blue/purples could not be easily differentiated by those with colour vision issues.

Discussion and Conclusions

High resolution recording and sampling takes time. The time investment needs to be evaluated according to the depth of information desired, but where that time can be dedicated a truly detailed, in-depth study of the life history of a particular site and its deposited assemblage can start to be recreated. This is not just an approach that should be taken at larger sites with clear patterning and structures such as Star Carr and Stainton West, but indeed in some ways it is more important that it is applied at smaller, more ephemeral and enigmatic sites lacking good preservation or features because it can help elucidate how they were utilised. Data visualisation should always be implemented with clarity and accessibility in mind. Finally, carefully selected statistical evaluations should be used to test and strengthen any patterning proposed and multi-proxy methodologies can truly enhance understanding of the lithic assemblage when the output datasets are properly integrated.

Acknowledgements

With thanks to Chantal Conneller for her guidance on the lithics analysis and all the volunteers for their time and care during excavations.

Case Study 9: Lithic Refitting: A case study from Star Carr, North Yorkshire

Chantal Conneller (Manchester University)

Introduction

Refitting is a technique that was employed by the pioneers of prehistoric research (Spurrell 1880; Smith 1894) and has become a common tool in understanding lithic material (Cziesla *et al*. 1990; Hofman and Enloe 1992). Though many classes of artefacts can be refitted, the technique is more frequently employed on lithics, because as a 'subtractive technology' the entire manufacturing process can be reconstructed and its spatial dimensions understood. The uses that refitting can be put to are numerous: it is an important tool for understanding site taphonomy, for unpicking palimpsests, for understanding techniques and both the social and spatial aspects of lithic technology and its organisation in the landscape. Above all it can provide a temporal narrative of the occupation of a site, particularly useful on sites where other artefact classes are lacking.

Practical considerations

Refitting is a time-consuming technique that demands a certain amount of space to lay out material. It works best if it is undertaken in short bursts of around an hour or so a day and is much quicker if undertaken by someone with a good knowledge of lithic technology. While it can be employed on any excavated lithic scatter, certain variables make refitting more labour-intensive on some sites. Refitting takes relatively little time on a small, single occupation Upper Palaeolithic site, particularly one with heterogeneous raw material. Large sites, diminutive raw material, taphonomic issues and homogeneous or patinated raw materials all make refitting more difficult. On such sites it is worth thinking carefully about how refitting should be employed; what questions might be answered given the nature of the site. On very large sites, for instance on the scale of Stainton West (see case study 6), refitting on a large scale is clearly unfeasible, but targeting rare raw material types might be useful in understanding how particular materials were transported to site (eg as blades or tools, or unworked nodules) and how products were moved around site. Refitting also aids considerably in pattern recognition, so even a small-scale refitting project focusing on one particular area of a complex site will aid the analyst in understanding the parameters of the technology and patterns of transportation of lithics across a site. Star Carr, the main case study of this contribution, is a large, complex, repeatedly re-occupied site and here targeted refitting was used to understand the complex palimpsest on the dryland part of the site and discrete activity episodes on the lake edge.

Site taphonomy

Refitting is a vital taphonomic tool. Very few sites that predate the Loch Lomond Stadial have survived unaffected by landscape processes and refitting can help assess the evidential value of a particular site. It can provide an understanding of the extent of vertical movement through the soil profile, but also of more complex issues of site taphonomy, such as the effects of colluviation, winnowing or truncation. At Hengistbury Head, two distinct artefact horizons were present, leading Campbell (1977) to suggest two occupations - a lower horizon dating to the Upper Palaeolithic and an upper, Mesolithic, scatter, produced by size-sorting. However, refits between the two layers indicated a single Late Upper Palaeolithic assemblage (Collcutt *et al*. 1990). More sophisticated use of refitting to understand site taphonomy depends on refitting success - or lack of it. Work on two

Final Palaeolithic scatters at La Sagesse Convent (Conneller *et al*. 2007) on the alluvial plain of the river Test, revealed that one was intact (indicated by coherent refit sequences) while the other had been truncated by a flooding event (indicated by poor refitting success and gaps in the sequence that did not make sense in terms of human activity).

Contemporaneity

Early prehistoric excavations often reveal a number of discrete or overlapping scatters with uncertain relationships. Refitting has often been used as a way of determining contemporaneity between them (eg Cahen *et al*. 1979), but caution and judgement do need to be used. De Bie and Caspar (2000) found a number of refits between the different scatters of the Belgian site of Rekem, but refits were relatively few, and in one direction only (eg towards a particular scatter), suggesting scavenging of flint from an earlier occupation. In this case, a judgement needs to be made of number of refits, direction and whether refits might make sense in terms of different activity areas from a single occupation.

Technology and skill

Refitting has long been used to reconstruct the knapping sequence and thus offers a window into prehistoric technologies and decision making. It can also provide a nuanced understanding of the technological process, and the balance between learnt ways of proceeding and individual variation in knapping style. It is an important way of assessing individual skill, the extent to which an individual is able to anticipate and correct knapping problems. Schlager (1996) has used refitting to argue that early Neanderthals at Maastricht-Belvedere were able to respond flexibly to both problems and potentials in the raw material, anticipating the problems that poor raw material might bring and ably exploiting larger nodules. Assessments of skill has also been used to elucidate both the presence of specialists and unskilled children. At the Paris Basin Magdalenian site of Etiolles, Pigeot (1991) has used refitting to discern a specialist knapper in close proximity to a hearth; this specialist produced large blades that were distributed across the site. The specialist was surrounded by part-skilled apprentices and beyond these by children, learning to knap flint by imitating the gestures of the specialist.

Movement

Refitting provides important information on movement of lithic material – both round the site, where tools produced in one area may be used in other areas, and in the broader landscape, where refitting permits an understanding of the form in which raw material entered a site (as nodules, cores, blanks or tools) and what was removed for future use elsewhere. Reftting (and a lack of it) has revealed different raw material transportation strategies in the Vale of Pickering from the Final Palaeolithic to the Mesolithic. Final Palaeolithic lithic scatters at Seamer K demonstrate the presence of finished tools in speckled grey flint, contrasting with knapping sequences in white Wolds flint. This suggests that raw material was carried mainly in the form of finished tools and retooling occurred at the site, using local flint. By contrast, refitting long blade sequences show that people were bringing prepared, exotic, nodules of flint to Seamer C, along with a stock of blades that do not refit to knapping sequences (see Fig. 1). Finally, in the early Mesolithic people brought complete, tested, or partially knapped beach pebbles to a number of different sites in the area (Conneller 2007).

Results: Lithic refitting at Star Carr

At first glance Star Carr does not seem a suitable site for a programme of refitting. It is a large site with nearly 25,000 lithic artefacts recovered; it was also repeatedly occupied, with Bayesian modelling suggesting repeated revists over a period of around 800 years (Milner *et al*. 2018). As a result, refitting was targeted in certain areas, either where it was anticipated that refitting would be easier, or where refitting would be able to address particular problems of site interpretation.

Star Carr is made up of three different zones: first, the area that during occupation would have been open lake water; secondly the peaty lake edge area that over time developed into an area of fen carr; and finally the densely and repeatedly occupied area of the dryland. Each of these zones has a very distinctive type of archaeology. The area of the lake water was a zone of deposition where knapping did not occur. The assemblage from this area consists of blades and tools from a vast number of sources. Refitting was not attempted in this area though distinctive raw material types were checked in case they could be integrated into dryland sequences and thus inform on the date of a particular dryland lithic scatter (these could not be fitted into the Bayesian model which was focused on the wetland).

The second zone of the site, the lake edge and fen carr, is characterised by build-up of peat over several centuries. Here people came on occasions to carry out particular tasks. These short episodes are characterised by small, discrete, high resolution scatters and were thus prime candidates for successful refitting. A scatter of flint around a hearth was refitted and found to represent the reworking and resharpening of axes. As well as providing an understanding of the technology of this process (longitudinal removals along one face, followed by a tranchet blow on the other), the refitting showed that several axes were resharpened, some were discarded within the scatter, while others were removed for future use (see Fig. 2).

Refitting was undertaken more extensively across the dryland where repeated occupation and poor faunal preservation rendered the area less readily readable. The dryland was characterised by a series of structures and middens (often associated with large quantities of lithic material), knapping scatters and activity areas. One large midden in the west of the site consisted of a high frequency of burnt material which would make refitting very difficult so none was attempted here, but the remainder of the lithics from the dryland were laid out in trays by area. While there was a high level of success in a couple of areas (see Fig. 3), in general even fairly discrete-looking scatters did not refit well. This seems to be because material was being scavenged during later occupations of the site and also because some scatters represent midden materials cleared from elsewhere; it is likely that the scatters that refitted well were relatively late in the sequence of occupation.

Refitting particularly focused on one of the structures (the eastern structure) to understand how it was used: whether it had been cleared out or different occupations could be discerned. Refits occurred over some vertical distance, suggesting movement through the profile or disturbance by people when the house was cleared out. Long refit sequences were not present. If that extensive knapping of cores was not undertaken within the structure, this was a task for workshops outside. Instead the people would remove a couple of blades or flakes from a core for immediate use. Also present in the structure were personal tools brought in for repair – a small axe with a refitting resharpening sequence, for example (Fig. 4). Material also appeared to have been cleared out of the structure to midden areas to the north and north east, as indicated by refits (Fig. 5).

Refitting at Star Carr enhanced the understanding of complex areas of the site, particularly the use of structures, and provided a detailed picture of discrete activities in the peaty lake-edge zone. While refitting is an open-ended task through which more information will always be acquired (albeit with gradually diminishing returns), targeting particular areas in an effort to answer particular questions, or focusing on areas where the flint is likely to be more readily refitted, is a useful means of extracting maximum information using this technique without huge time investments.

References

Cahen, D, Keely, L H and Van Noten, F, 1980 Stone tools, toolkits and human behaviour in prehistory, *Current Anthropology* **20**, 661-683

Campbell, J B, 1977 *The Upper Palaeolithic of Britain*, Clarendon Press, Oxford

Collcutt, S N, Barton, R N E and Bergman, C A, 1990 Refitting in context: A taphonomic study from a Late Upper Palaeolithic site in sands on Hengistbury Head, Dorset, Great Britain, In E Czeisla, S Eickhoff, N Arts and D Winter (eds), *The Big Puzzle. International symposium on refitting stone artefacts*, Studies in Modern Archaeology I, Holos Verlag, Berlin, 219-236

Conneller, C, 2007 Inhabiting new landscapes: settlement and mobility in Britain after the last glacial maximum, *Oxford Journal of Archaeology* **26(3)**, 215-237

Conneller, C, Ellis, C, Allen, M J, Macphail, R and Scaife, R, 2007 A Final Upper Palaeolithic Site at La Sagesse Convent, Romsey, Hampshire, *Proceedings of the Prehistoric Society* **73**, 191-227

Cziesla, E, Eickoff, S, Arts, N and Winter, D (eds) 1990 *The Big Puzzle. International symposium on refitting flint artefacts*, Studies in Modern Archaeology I, Holos Verlag, Berlin

De Bie, M and Caspar, J P, 2000 *Rekem; a 'Federmesser'Camp on the Meuse River Bank*, Leuven and Asse-Zellik: Leuven University Press and Instituut voor het Archeologisch Patrimonium

Hoffman, J L and Enloe, J G, 1992 *Piecing Together the Past: Applications of refitting studies in archaeology*, BAR International Series **578**, Oxford

Milner, N, Conneller, C and Taylor, B, 2018 *Star Carr: Volume 1. A persistent place in a changing world*, York, White Rose Press

Pigeot, N, 1990 Technical and social actors: Flintknapping specialists and apprentices at Magdelenian Etoilles, *Archaeological Review from Cambridge* **9(1)**, 126-41

Schlanger, N, 1996 Understanding Levallois: lithic technology and cognitive archaeology, *Cambridge Archaeological Journal* **6(2)**, 231-254

Smith, W G, 1894 *Man the Primeval Savage*, Edward Stanford, London

Spurrell, F C J, 1880 On the discovery of the place where Palaeolithic implements were made at Crayford, *Quarterly Journal of the Geological Society* **36**, 544-549

Case Study 9 figures

Figure 1. Prepared nodules imported to Seamer C

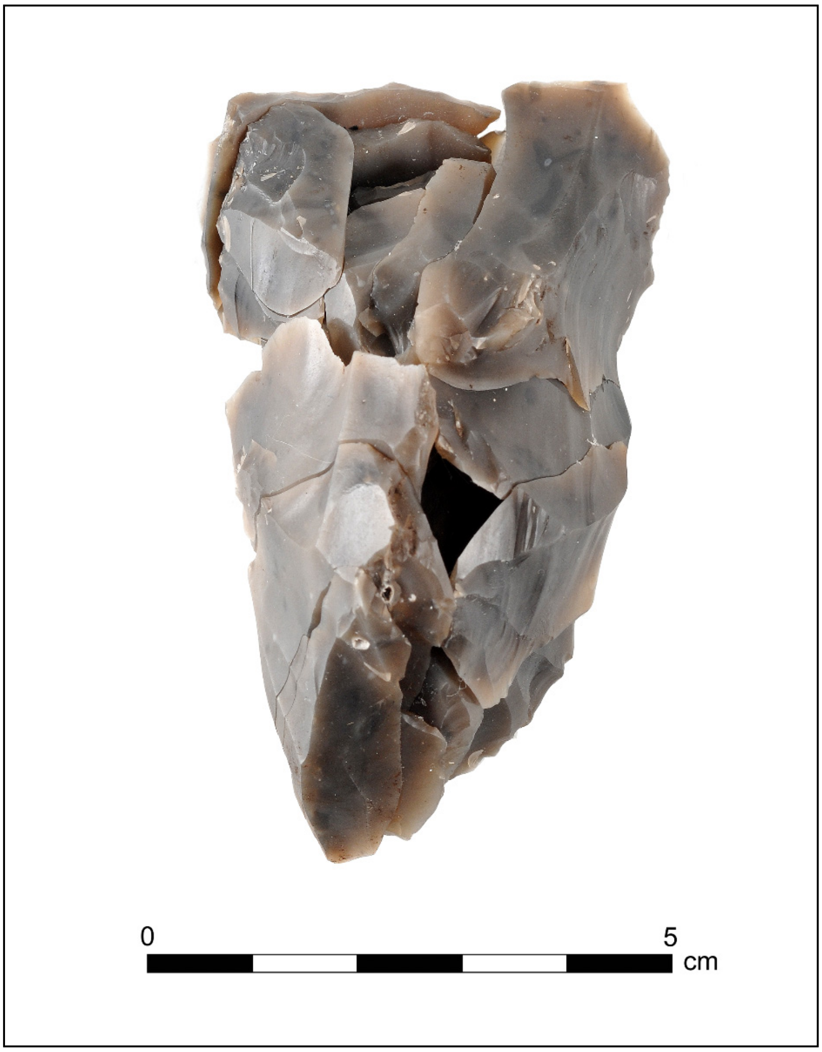


Figure 2. Refitting axe reworking/resharpening sequence

Figure 3. Coherent refitting sequence including burin from one of the later, intact scatters

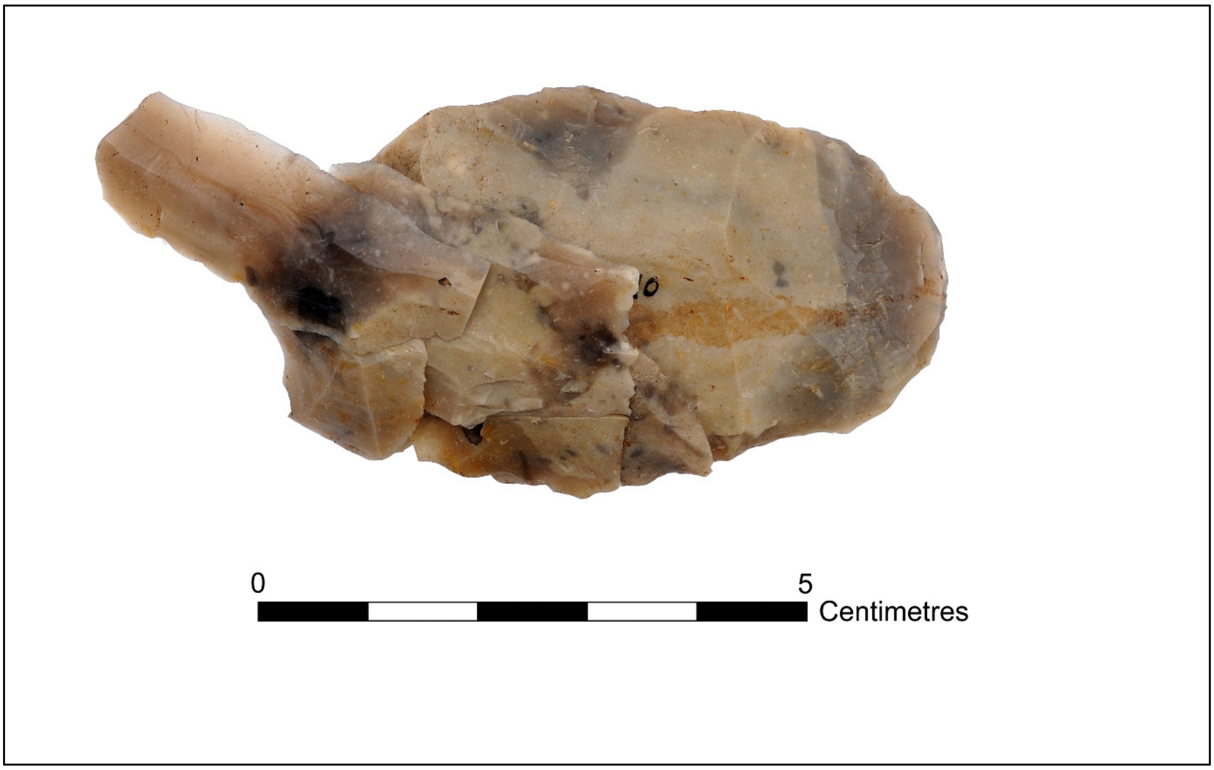


Figure 4. Refitting axe resharpening sequence from inside the eastern structure

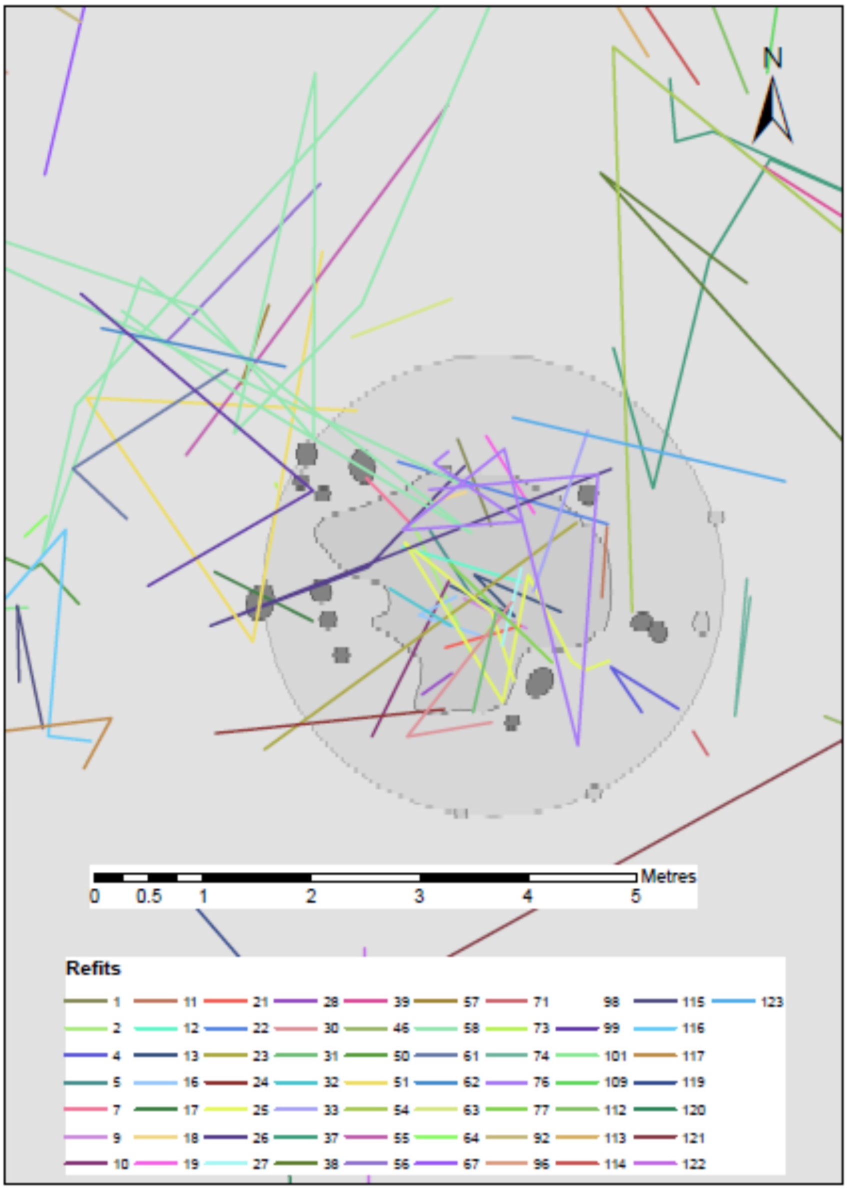


Figure 5. Refits between the eastern structures and middens to the north