Historic England

Managing Lithic Sites

Archaeological guidance for commercial and research projects, planning authorities, land management agencies and developers

Summary

This guidance is intended for everyone working with lithic material, from developers to those involved in community projects. As such, it covers key themes relating to the definition and significance of lithic sites; their identification, assessment, evaluation and excavation; and their mitigation and management. Therefore, it encompasses a broad range of advice on approaches and techniques that can be applied to a wide variety of project types and budgets.

Lithic sites are an important archaeological resource that can provide valuable insights into prehistoric occupation. Most commonly they are found as scatters of worked stone, usually suspended in modern ploughsoil deposits, which have been disturbed from their original archaeological context. However, undisturbed lithic sites can also be found where assemblages have been sealed by cover deposits or preserved in sub-surface features or horizons. For much of prehistory these two types of lithic site provide most or all of the evidence for human activity and subsistence strategies. By studying their formation, spatial distribution and technological attributes we can get closer to understanding the activities of the people who created these artefacts.

This guidance should be read in conjunction with other relevant Historic England guidance documents such as the scheduling selection guide on Sites of Early Human Activity (Historic England 2018), advice on geoarchaeological deposit mapping and modelling (Historic England 2015a; 2020), advice notes on good practice in planning (Historic England 2015b), and guidance on Palaeolithic sites (Historic England 2023).

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Front cover: Neolithic leaf-shaped arrowhead recovered during excavations on the A585 Windy Harbour to Skippool Road Improvement Scheme, Lancashire © Oxford Archaeology

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1 Introduction

Figure 1: Excavation of *in situ* lithic sites using both grid squares and GPS plotting of lithics along the Bexhill to Hastings Link Road, East Sussex © 2010 Oxford Archaeology; all rights reserved

1.1 About this guidance

It is over 20 years since the publication of Managing Lithic Scatters (English Heritage 2000) to help planning authorities and developers understand some of the key issues relating to this kind of archaeological site. That document raised awareness of the significance of the lithic resource, highlighting that in some regions assemblages of worked stone from ploughzone contexts are almost the only available archaeological evidence for prehistoric occupation. As such, the value of lithic scatters for understanding human prehistory is significant. Since the document's publication a number of research projects have helped to develop new techniques for locating, managing, excavating and analysing lithic scatters (eg Chan 2011; Billington 2016).

However, Managing Lithic Scatters did not explicitly cover undisturbed lithic sites preserved in buried soils below the ploughzone (eg Brown *et al*. in prep). A number of major recent discoveries have shown the need for guidance that also covers these sites (Figure 1). There is no established nomenclature to distinguish lithic scatters that are devoid of a secure archaeological context from those that remain *in situ*. For the purpose of this guidance, and in keeping with the original Managing Lithic Scatters, the former are referred to as (**ploughzone**) **lithic scatters** whilst those sites retaining contextual integrity are described as **undisturbed** or ***in situ*** **lithic sites** (see below).

Despite these developments and discoveries, some curators and heritage professionals are still cautious over the logistical and financial challenges associated with the investigation and management of lithic sites, which risks undervaluing this significant heritage resource (Bond 2011). This updated guidance on managing and dealing with lithic sites of both types, within and outside the planning process, therefore aims to ensure they are valued appropriately by raising awareness of their significance and vulnerability. It has been prepared with a wide range of interested parties in mind, but especially those with a planning or conservation background. The guidance supports the National Planning Policy Framework (NPPF; DLUHC 2023) by providing advice on assessing, evaluating, mitigating and researching lithic sites in a development-led context, but can also be applied to academic and community projects. It can be read alongside similar guidance that has been prepared in Scotland (Wickham-Jones 2020).

The information contained in this guidance is supplemented by a selection of case studies which are presented in accompanying web pages (see Appendix 1 for a summary). The case studies provide examples of prospection, recording, excavation, analysis, interpretation and management of the lithic resource, in order to explain and amplify the themes addressed in the guidance.

1.2 What are lithic sites?

The two main categories of lithic site covered by this guidance are:

- **Lithic scatters:** These are assemblages of worked stone displaced from their original context and predominantly contained in active or former ploughsoil deposits, rather than in cut features such as pits or ditches. The material visible on the ground surface (when conditions allow) is only a small proportion of the total assemblage (usually estimated to be no more than 7 per cent: Billington 2016; Case study 2): most of the lithics will remain below the surface in the ploughzone or other disturbed deposits. Some scatters may be associated with *in situ* features or assemblages that are still preserved below the ploughsoil while others will be all that remains of prehistoric activity in that place. In many cases reworking of the lithic-bearing deposits by the plough will disperse scatters and create mixed assemblages comprising artefacts from different archaeological periods (Case studies 2 and 4).

- **Undisturbed lithic sites:** These are assemblages associated with their primary depositional context, usually buried palaeo-land surfaces or soil horizons (Case studies 3 and 7), which retain their spatial integrity and represent largely *in situ* or undisturbed deposits (Case study 6). These sites are often sealed by superficial geological deposits and whilst they may have been subjected to limited post-depositional disturbance, particularly bioturbation moving objects in the vertical plane, and frequently represent palimpsests of activity, they retain a high archaeological value and can be of national and/or international significance (see section 2).

It is worth noting that while lithic sites most commonly contain artefacts made of flint – hence the often-used term flint scatter – many lithic sites are not located close to flint deposits and contain a range of stone types from their wider regions. Also, this guidance does not deal specifically with extraction sites for flint and other types of stone, which have their own special characteristics (see Teather *et al*. 2019).

1.3 What is the research value of lithic sites?

Lithic scatters form a vast body of archaeological evidence and are common features of all periods from the Palaeolithic to the Bronze Age. They are regularly identified and recorded in fieldwalking surveys undertaken during commercial archaeological projects and community research (Case studies 2, 4 and 5; Figure 2). However, they are often characterised as being of low interpretative value and can be marginalised both in academic studies and in the wider context of protecting and managing the historic environment (Bond 2011). As a result, policymakers, fieldworkers and curators may not be fully aware of their potential or equipped with the information necessary to make informed decisions concerning the investigation, management and protection of lithic scatters, either individually or in a landscape context.

However, in many cases – particularly for early prehistoric periods when other diagnostic artefacts and cut features are extremely rare – lithic scatters are likely to be the only available archaeological evidence of past occupation and are therefore an important and significant resource. When well-designed and appropriate research strategies are applied to the study of lithic scatters, they can provide high-quality evidence, allowing detailed interpretation and providing significant academic value (Case studies 2, 4 and 5). Thus, by studying their formation, spatial distribution and technological attributes, we can get closer to understanding the activities of the people who created these artefacts.

Figure 2: Surface lithic collection by a local society in Cumbria
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Given that undisturbed lithic sites are recovered from secure archaeological contexts and are therefore associated with a specific place and time, they are perceived as having greater potential for detailed study, such as refitting and spatial analysis (see below). Despite their significance, however, the majority of undisturbed lithic sites are considered to be 'sites without structures' (Historic England 2018, 10–11), and cannot legally be designated (scheduled). However, in accordance with the NPPF, if they can be demonstrated to be of national importance they should be accorded equal significance with scheduled monuments and treated as if they have designated status.

1.4 How can we date lithic sites?

Appendix 2 and Figure 3 provide lists of the main diagnostic lithic types and industries associated with each broad period from the Palaeolithic to the Bronze Age, after which time stone tools were largely replaced by metal and other materials. Although utilitarian domestic industries continued into the Iron Age (Humphrey and Young 1999), and specialised industries into much later periods, such as the manufacture of tools for shale-working (notably in Iron Age and Romano-British Dorset), post-medieval gunflint production, and the dressing of flint for building stone in the medieval and post-medieval periods, these types of activity are unlikely to be represented by the same kind of sites discussed here.

Lower and Middle Palaeolithic sites, preceding the last glaciation, take a variety of forms from deeply buried *in situ* sites like those at Boxgrove, West Sussex, to surface scatters, as at Harnham, Wiltshire, and collections of artefacts in fluvial deposits accumulated from a wide area. These are covered in more detail in separate guidance on *Curating the Palaeolithic* (Historic England 2023).

Mesolithic scatters appear to be very abundant (but may include misidentified Early Neolithic and Upper Palaeolithic sites as they all tend to have high numbers of blades). They can also be very dense with over 100 pieces per square metre on the surface of a field and up to 1000 pieces per square metre in undisturbed knapping floors. While small discrete Mesolithic scatters are perhaps the norm, some sites cover considerable areas and most likely represent repeated visits to a favoured location. In general Mesolithic sites contain a mix of tools (retouched and unretouched), including many microliths, as well as large quantities of debitage including very fine knapping shatter.

Neolithic scatters mirror Mesolithic sites to a great extent but may be less dense on average and focus more on tool use than production. The common practice of deposition of sometimes very large quantities of debitage in pits has no doubt removed many Neolithic knapping floors. However, large scatters do exist and include extensive surface middens, such as at Eton (Allen *et al*. 2015), and primary reduction sites associated with flint mines, such as at Grimes Graves (Saville and Mercer 1981).

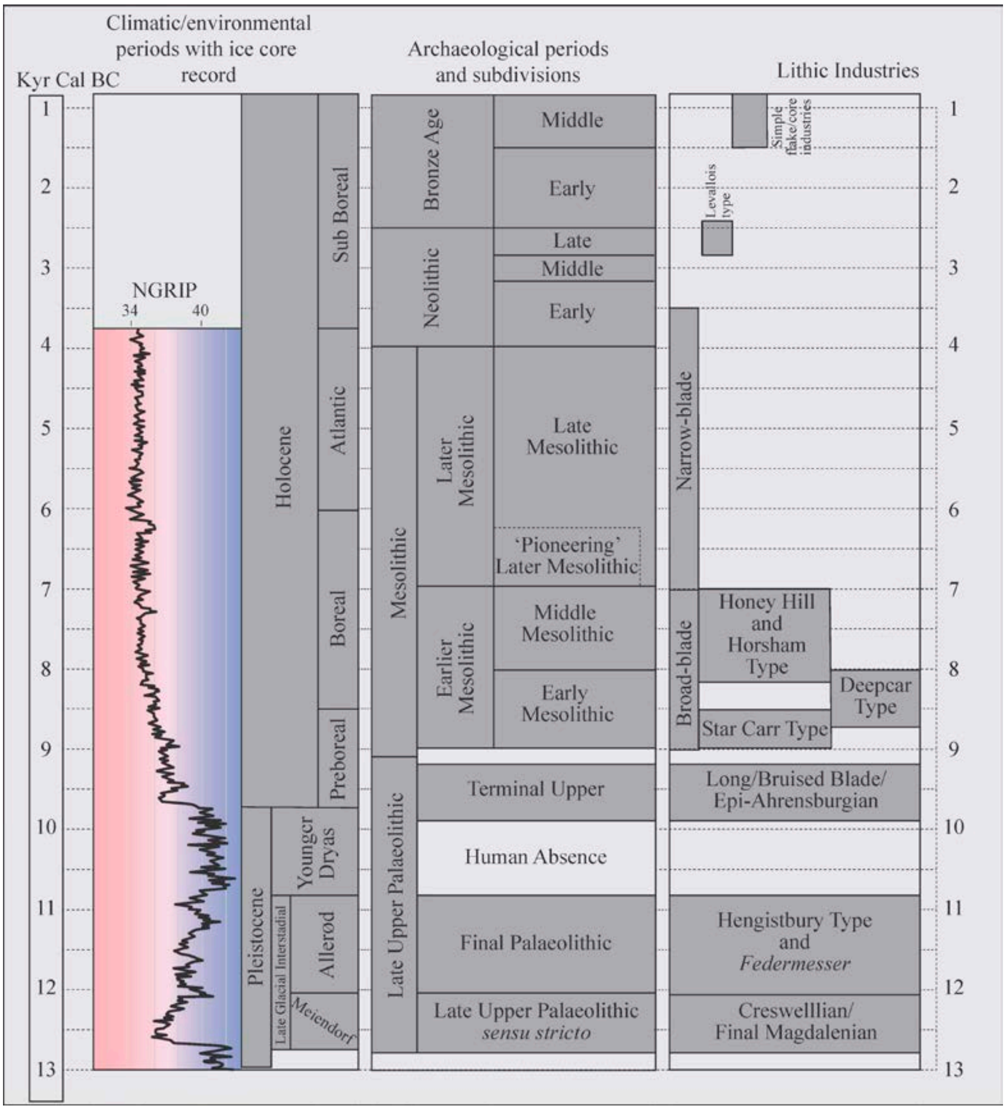

Figure 3: Archaeological periods and lithic industries after the Last Glacial Maximum © 2018 Oxford Archaeology; all rights reserved

Bronze Age scatters have received the least attention and may in many instances simply represent expedient production of tools for immediate use. However, extensive spreads do exist, such as that recently investigated at Cross Levels Way in East Sussex, where a spread of flint, pottery and presumably many less durable materials made up a massive assemblage of more than 100,000 artefacts (Oxford Archaeology 2020). Both Neolithic and Bronze Age scatters are likely to contain worked tools alongside knapping debris but may also show marked specialisation or ritual associations, such as the fine tool assemblages found around many important monument clusters.

Human activity has often occurred over centuries or millennia at the same locations, which can be termed 'persistent' or 'favoured' places (natural crossing points, vantage points etc), even if the activity was not continuous. Many lithic scatters are thus mixed palimpsest sites that combine elements from different periods. However, we can still use the distinctive tool types produced during different periods as the basis for dating scatters (Appendix 2). The waste produced during manufacture also changed in technological character over time, making some of this material characteristic of specific periods (Pitts and Jacobi 1979). On the other hand, unretouched flakes, as well as some tool types, were ubiquitous throughout prehistory, meaning that it can be difficult to separate the evidence for different periods. Scrapers, for example, occur on sites of all periods and it may need an experienced specialist to distinguish between them.

In some cases the application of scientific dating techniques may be possible, depending on the nature of the deposits and other materials associated with a lithic site. Luminescence dating is discussed further below but this document does not deal with radiocarbon dating, which is discussed in separate guidance (Historic England 2022; see also Case study 7).

1.5 Where would we find lithic sites?

The majority of lithic scatters are found on cultivated arable land, but only become visible when it has recently been ploughed. In areas with other forms of land-use, disturbances such as animal burrows or tree-throw holes can reveal scatters. They are also uncovered in areas subject to repeated erosion, such as deflated coastal sand dunes or peatland, or where water levels have recently dropped at the edge of a lake or estuary. Smaller areas of disturbance may also be revealed along footpaths, at the edges of ditches, or in the upturned ridges of forestry cultivation. Any activity that disturbs or erodes the land surface has the potential to reveal a scatter.

Lithic assemblages derived from secure archaeological deposits are comparatively rare in relation to surface scatters. Undisturbed lithic sites can be recovered from a variety of contexts and from a range of geomorphological settings, such as valley, coastal and upland environments (Figure 4). The even rarer sites that have associated faunal remains and/or palaeoenvironmental evidence can provide a wealth of information not only on the organisation of settlement but also its significance within the wider landscape (eg Milner *et al*. 2018a and b).

Both lithic scatters and undisturbed sites can be hard to locate in development-led work. As noted above, lithic scatters require some ground disturbance, usually ploughing, for visibility and opportunities for the surface to weather. Scatters can most effectively be located through fieldwalking and test pitting but are less visible in evaluation trenches or geophysical surveys (see Case study 7). Many development-led projects fail to adequately consider lithic potential in their evaluation strategy, meaning that opportunities to identify lithic sites at an early stage can be missed, potentially leading either to loss of significant remains and/or unexpected costs later on.

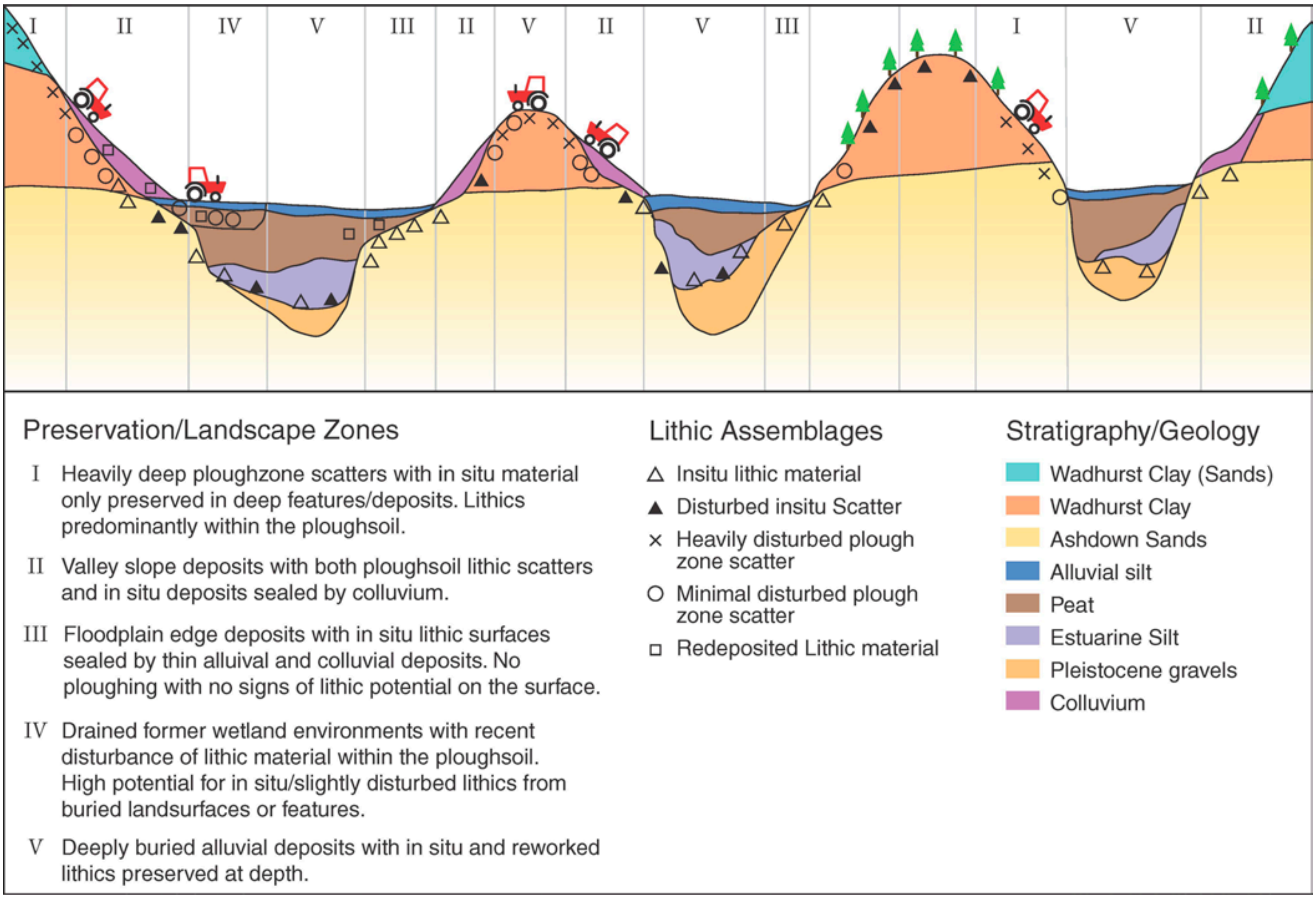

Figure 4: Schematic cross-section of lithic preservation within a valley sequence in East Sussex © 2010 Oxford Archaeology; all rights reserved

Mention should also be made of lithic assemblages held in museum archives. These mainly consist of collections of worked stone recovered during previous archaeological projects, both commercial and research-led, and deposited as part of the project archive. In addition, many museums also hold assemblages of worked stone collected by amateur collectors in the nineteenth and twentieth centuries. While the majority of these legacy collections are without detailed context, and in some instances are unprovenanced, they can still provide an invaluable resource, much of which has seen very little analysis and investigation. As such, their study, when integrated into broader research enquiries, can provide supplementary information on intra- and inter-site associations and landscape distributions (Case studies 1, 2 and 4).

1.6 How are lithic sites researched?

Ploughzone scatters and undisturbed lithic sites can contain core reduction material, debitage (primary technology) and tools (secondary technology) produced during knapping (Inizan *et al*. 1992; Butler 2005). As such they provide information on manufacturing techniques as well as tool use. As mentioned above, many retouched tools are typologically diagnostic of specific periods and can be ascribed a function and date, such as arrowheads, some scrapers and axes/adzes (Figure 5). However, microwear analysis (see below and Case study 6) has shown that apparently unmodified blades and flakes were also used as tools. Both retouched and unmodified tools were utilised in a variety of tasks including hunting, butchery, woodworking, and other processing of plant and animal resources.

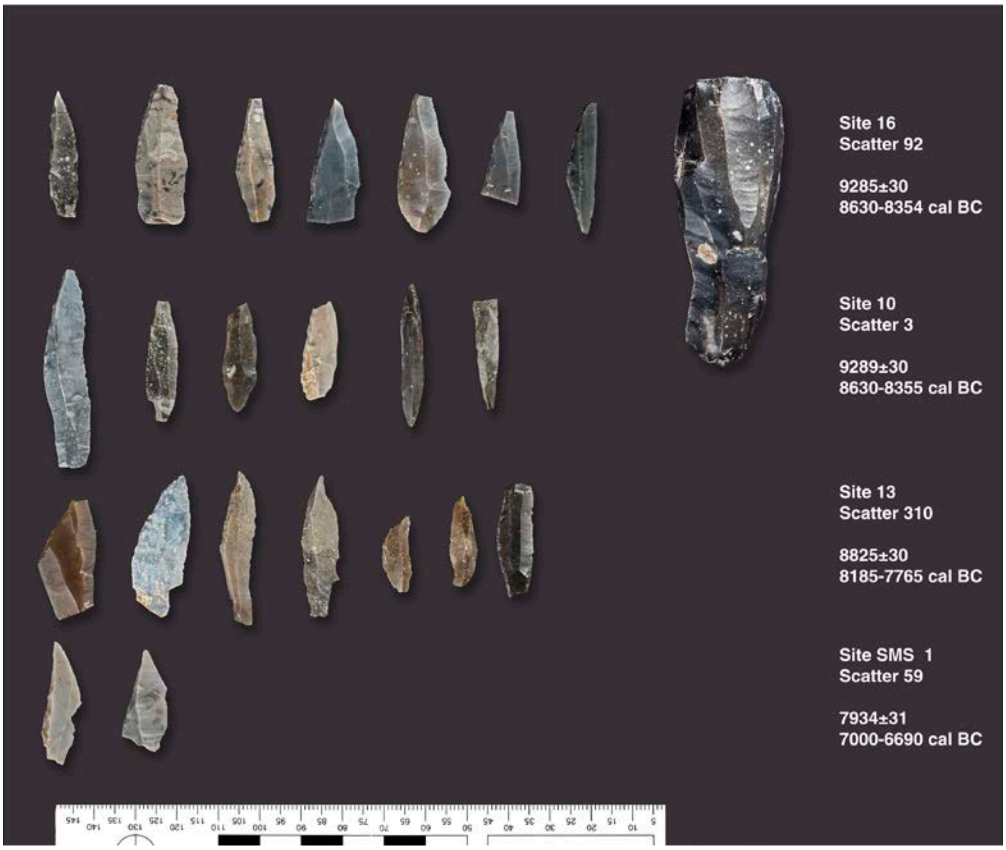

Figure 5: Chronological sequence of Mesolithic tools from excavations at Bexhill, East Sussex (see Case study 7) © 2010 Oxford Archaeology; all rights reserved

Lithic analysis is fundamental to the study of worked stone assemblages. It is an essential part of understanding the process of the *chaîne opératoire*, which describes the series of events and social actions behind the stages of stone working, from procurement and manufacture through to discard and recovery during archaeological investigations. The analysis of core reduction strategies can inform on the different ways that nodules were worked. Through a detailed analysis of core types in conjunction with an assessment of the metrical and technological attributes of blade and flake debitage, statements can be made about the date and function of an assemblage (Case studies 2, 4 and 5). There can also be regional variations between stone tool assemblages depending on the raw materials (see below) and local knapping traditions.

While undisturbed sites are usually encountered during development-led projects (see Case studies 6 and 7) the investigation of lithic scatters more commonly forms a component of academic research and community projects (Bayer 2011; Billington 2016). Indeed, programmes of ploughzone fieldwalking and test pitting are ideally suited to community work as they offer a real contribution to research without all the complexities of organising an excavation (Case studies 2, 5 and 10). However, the importance of lithic scatters in relation to the development of landscape archaeology in the 1980s and 1990s was considerable (Brown and Edmonds 1987; Richards 1990) and they still have a significant role to play in interpretations of past settlement. Therefore, fieldwalking and test pitting, proven methods for recording and researching lithic scatters, should be considered alongside other evaluation techniques in any development case where there is potential for them to survive.

2 Research frameworks

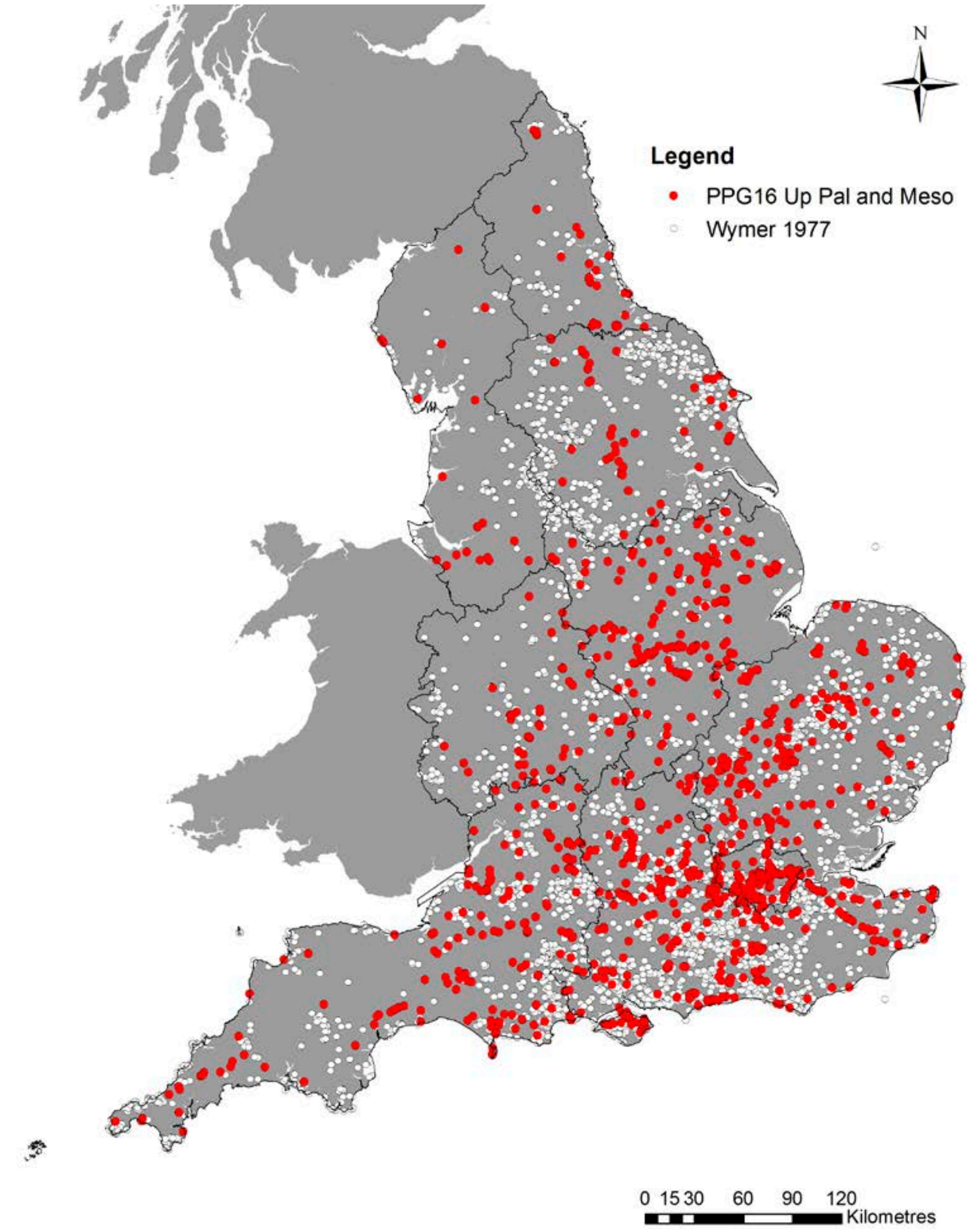

Figure 6: Distribution of Late Upper Palaeolithic and Mesolithic sites: PPG16 era and Wymer (1977) (see Case study 1) © 2018 E. Blinkhorn; all rights reserved

2.1 Research Frameworks

Regional Research Frameworks (RRFs) discuss the significance of lithic sites and their importance in understanding the development of settlement patterns across England (https://researchframeworks.org/). RRFs include information which is useful for all stages of investigating lithic sites from Desk-Based Assessments (DBAs) to post-excavation analysis (see sections 3, 4, 5). Along with period- and material-specific research frameworks (see below), they provide information from which researchers can justify the study of lithic sites. They emphasise the strengths and weaknesses of current knowledge of the lithic resource and advise on the work needed to enhance it, relevant to both commercial projects and academic research.

In addition to the RRFs, research frameworks also exist for specific periods, including the *Research and Conservation Framework for the British Palaeolithic* (English Heritage 2008a), and the *Mesolithic Research and Conservation Framework 2013* (Blinkhorn and Milner 2013). These documents summarise current understanding of the period and set out research themes, agendas and strategies which can be used to define a Palaeolithic or Mesolithic site's significance and value. The Lithic Studies Society's publication *Research Frameworks for Holocene Lithics in Britain* (2004) contains information on research themes and strategies specific to the study of lithic artefacts from the Mesolithic onwards. Collectively, regional and national research frameworks provide a benchmark from which the importance of a site or group of sites can be assessed in relation to wider research objectives at regional, national and international levels of significance. For example:

- A regionally significant lithic site could aid understanding of the development of local patterns of occupation within a particular chronological period or periods (Case study 2).

- A nationally significant site could also inform broader understanding of the chronological development of prehistoric technology and society within the British Isles (Case studies 6 and 7; Figure 6).

- An internationally important lithic site will also have unique features in terms of its value for understanding the development of human social organisation, activities and technologies (Case study 9).

The analytical techniques required to realise a site's significance should be considered at all stages of a project, as this can affect fieldwork methodologies (see section 4).

2.2 Lithic desk-based assessments

The NPPF and Planning Practice Guidance (PPG) set out the government's planning policies for England and how these are expected to be applied to the management of the historic environment. As part of these conditions, a DBA may be commissioned (CIfA 2014a; Historic England 2015b, 3) and this should include an expert assessment of the known and potential lithic resource.

2.3 Sources of information

Information on known lithic assemblages is accessible from a number of sources. The most significant of these are local authority Historic Environment Records (HERs), most of which can be queried through the Heritage Gateway (http://www.heritagegateway.org.uk/Gateway/CHR/). For lithic sites, HERs should include a variety of information about various forms of archaeological investigation including developer-funded evaluations (for example fieldwalking and test-pit surveys) and excavations, as well as academic and community-based research projects. Due to the circumstances of recovery those records often contain technological and spatial detail making them a valuable tool for research and management plans. HERs can also include reference to antiquarian collections and lithics collected by amateurs (Case studies 2 and 5). Although the vast majority of those records refer to single implements or small assemblages, have little associated spatial and technological detail, and can be difficult to locate geographically, they may still have value for management and research projects.

HERs are constantly being updated as new sites and monuments are identified and reported and should therefore hold a relatively up-to-date record of lithic sites; nonetheless, it is essential to recognise that the records have limitations and are of variable quality (Billington 2016; Case study 1). Details are often partial or lacking, and sometimes even misleading. In some regions, sites are ordered by period, but this may be misleading given that most lithic scatters can be representative of multiple phases of activity (see section 1). In some cases, records refer to information from other sources which can be out of date. They often reflect a biased site distribution based on the research interests of local groups and individuals, sometimes producing an unbalanced record of settlement activity.

Historic England has funded several projects designed to overcome some of these issues by enhancing the records held for the Palaeolithic and Mesolithic periods by a selection of local authority HERs (Cattermole 2018). These were undertaken to augment existing records and create new ones for known sites not recorded on the HER. Additionally, a project designed to assess the use of ploughzone data in development management, covering all types of artefacts and including lithic scatters, was conducted across a selection of HERs (Oxford Archaeology 2014). This survey highlighted the usefulness of ploughzone data, but also conceded that there is variability between HERs in how data are recorded and searched for, which can lead to sites being missed. The project also found that some data, particularly those recovered from fieldwalking surveys and held by other organisations, are not always included on HERs. This emphasises the need to consult all sources of information relating to lithic sites, including development-led, research and community projects. There is great potential value in synthesis of the diverse data generated by the planning process (Case study 1).

Other potential sources of information on lithic sites include the following:

- **Historic England Research Records** include information on archaeological sites and other heritage assets derived from the former National Record of the Historic Environment (NRHE), which is available via the Heritage Gateway (https://www.heritagegateway.org.uk/Gateway/Resource_Desc.aspx?resourceID=19191).

- **The National Heritage List for England** (www.HistoricEngland.org.uk/listing/the-list) holds details of scheduled monuments. Although not generally eligible for scheduling in their own right (see section 1), lithic assemblages can occasionally form part of a scheduled monument, for example within a multi-period site.

- **The Portable Antiquities Scheme (PAS)** (https://finds.org.uk/) was primarily set up to record metal-detecting finds but incorporates other artefacts, including lithic finds. PAS records provide a valuable source of information on lithic sites, though it has to be remembered that the bulk of the records comprise individual artefacts and small assemblages (Bond 2010). Although PAS records are designed to be uploaded into HERs, the ploughzone study (Hind *et al* 2014) showed that this does not always happen in practice. Also, as the database was designed to record potentially sensitive metal-detecting finds, for security reasons locations are often assigned imprecise grid references, which can be carried over to the HER. It is also worth noting that the majority of PAS Finds Liaison Officers (FLOs) are not lithic specialists; therefore, in some cases the identification of lithics included on the database may be unreliable.

- T**he Archaeology Data Service (ADS)** (http://archaeologydataservice.ac.uk/) is a digital repository for heritage data, including grey literature reports on archaeological investigations. This service also holds digital copies of documents relating to Palaeolithic and Mesolithic archaeology including The English Rivers Project (TERPS) (https://archaeologydataservice.ac.uk/archives/view/terps_eh_2009/) and the Palaeolithic and Mesolithic Lithic Artefact (PaMELA) database (https://archaeologydataservice.ac.uk/archives/view/pamela_2014/).

- Many older publications and journal articles, including specialist publications such as those of the Prehistoric Society and the Lithic Studies Society, as well as grey literature produced by archaeological contractors, can be found online on companies' or publishers' websites, and through portals such as Researchgate (https://www.researchgate.net/) and Academia.edu (https://www.academia.edu/).

Integral to any DBA is an assessment of the significance and setting of identified or potential heritage assets. The examination of HERs and other sources can produce data on the geographical location of known lithic sites within a study area but important information relating to their landscape context is unlikely to be recorded. This could include the spatial relationships of lithic sites in relation to wider social dynamics such as patterns of movement (eg Case studies 2, 4, 5 and 7; Figure 7) and/or resource procurement (Case study 6). Assessment should therefore consider how to contextualise sites within landscape characterisations in order to inform the planning process and other heritage management processes.

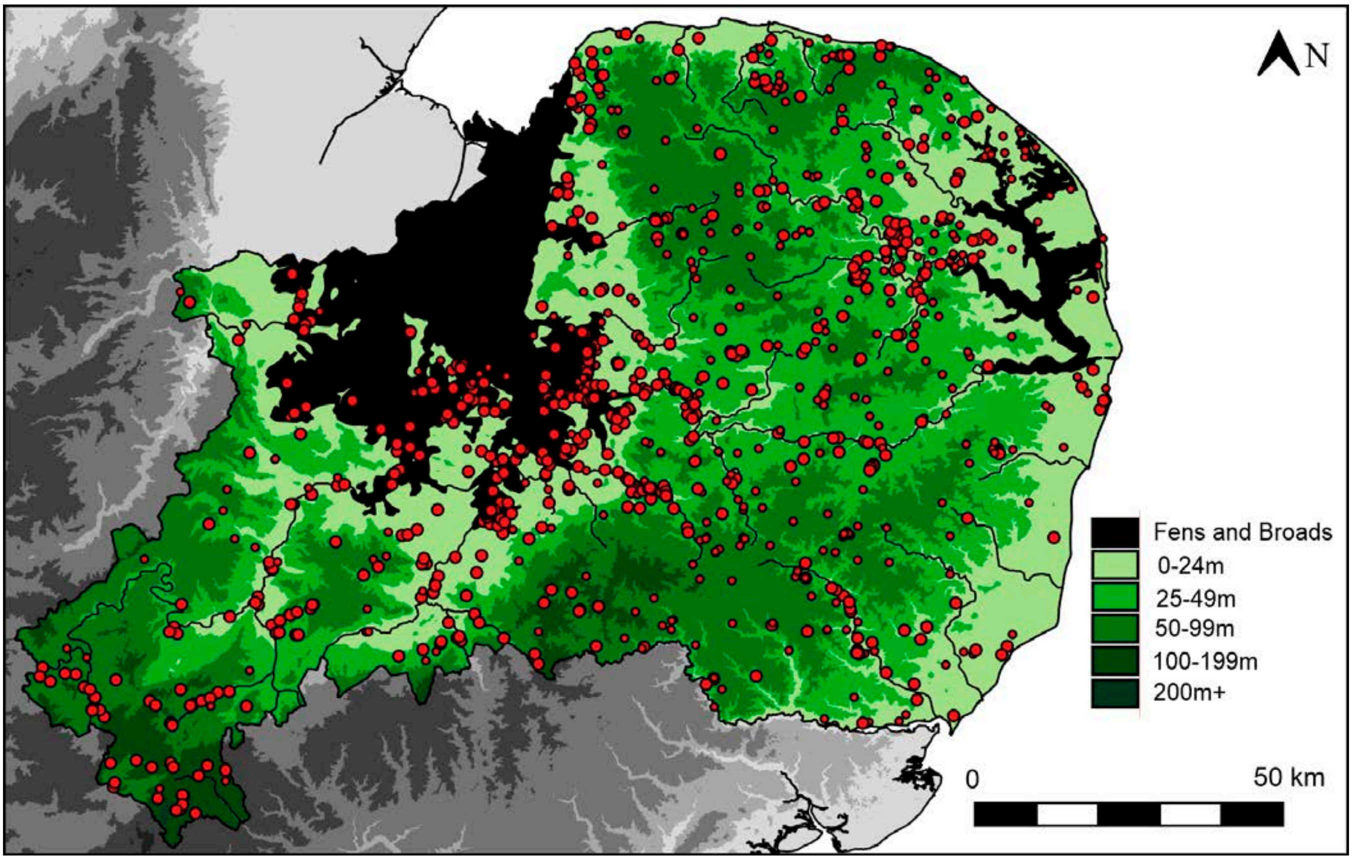

Figure 7: Distribution of accurately located findspots of Mesolithic flintwork from a study area in Eastern England (see Case study 2) © Lawrence Billington

2.4 Georchaeological approaches

HER data and information derived from other sources can be limited in terms of characterising the geomorphological and geological setting of a study area, and thus informing on the potential for lithic sites to be preserved and discovered. In particular, the presence of cover deposits such as alluvium, colluvium or drift deposits may mask and preserve lithic sites, especially those dating to the Palaeolithic and Mesolithic (Case studies 3, 6 and 7; for further information on buried Palaeolithic sites see Historic England 2023). The British Geological Survey (BGS) (see https://mapapps2.bgs.ac.uk/geoindex/home.html) provides general information on superficial formations but has limitations; for example, it does not map deposits less than one metre in thickness.

The analysis of aerial photographs and lidar (https://historicengland.org.uk/research/methods/airborne-remote-sensing/lidar/), often carried out in conjunction with a walkover survey as part of a DBA, can also be useful for characterising the landscape of a study area.

Geoarchaeological deposit modelling and/or predictive modelling can benefit desk-based studies and can be extremely useful for investigating the potential for finding lithic sites in a variety of environments. Deposit modelling uses geological data gathered from sub-surface investigations such as geotechnical test pitting, borehole surveys and specific types of geophysical survey techniques (eg electromagnetic ground conductivity) as well as surface data relating to palaeotopography and superficial geology to create three-dimensional reconstructions of sedimentary sequences and palaeolandscapes (Historic England 2020; Case study 3). Such sequences may identify archaeological horizons with the potential for associated lithic assemblages and/or preserved organic remains.

Predictive modelling seeks to identify and define the potential distribution of archaeological sites across the contemporary landscape based on known patterns of activity. In this approach, the distribution of lithic sites within a study area, along with other related sites and monuments, can be combined with geomorphological and environmental data as a baseline to predict the potential locations of as-yet-unidentified sites (Carey *et al*. 2017; see Figure 8).

Figure 8: The use of geoarchaeological deposit modelling to identify and map buried lithic horizons on the Carlisle Northern Development Road project (see Case study 6)
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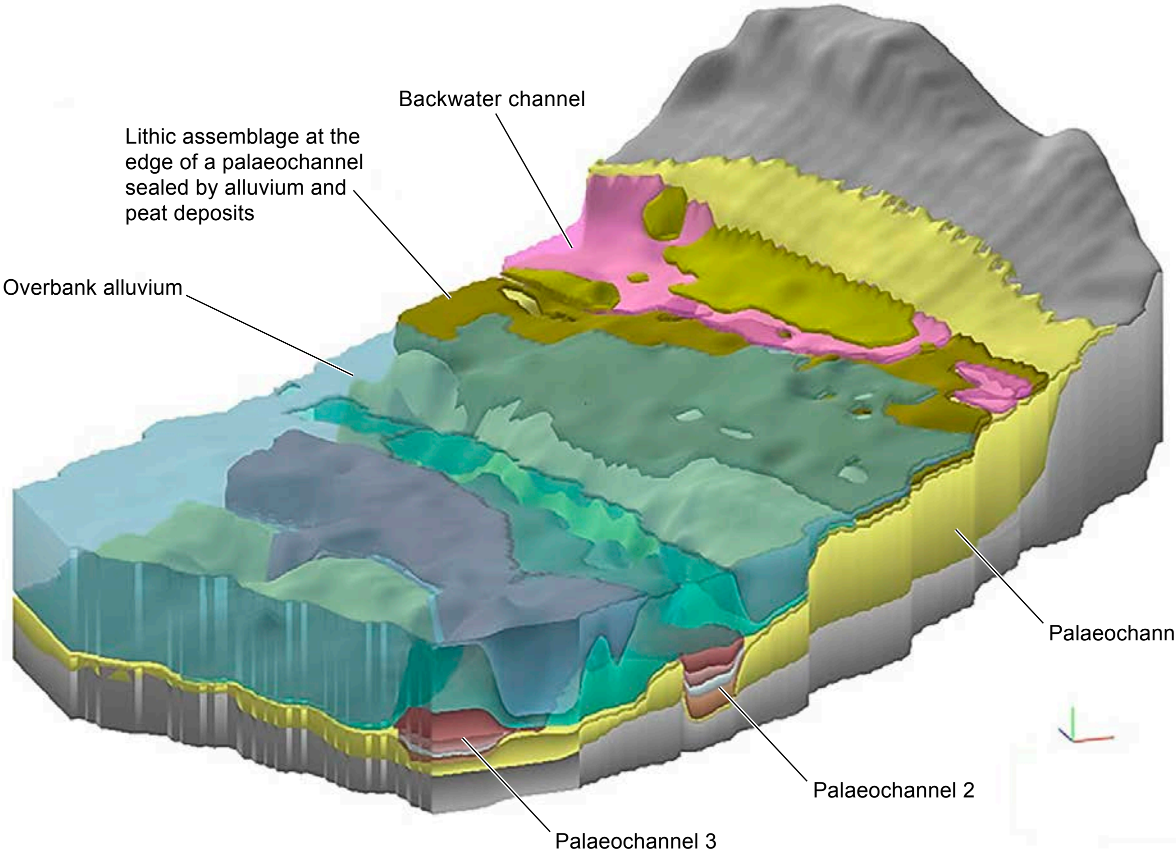

3 Field evaluation and excavation techniques

3.1 Field evaluation approaches and techniques

A DBA may have identified the presence of or potential for lithic scatters or undisturbed sites, and assessed the wider landscape value of the resource within and beyond the confines of the development or research area (CIfA 2014a). Consideration of a lithic site's, or group of sites', spatial relationship with known prehistoric sites and monuments will have provided information on its potential value for understanding settlement and land-use patterns (Case study 4; Figure 9). This provides essential information for assessing the resource's significance and setting. However, more detailed understanding of site-specific attributes and character is often required to further define significance. This is usually gained through an archaeological evaluation of the resource using an appropriate strategy, detailed in a Written Scheme of Investigation (WSI) (Historic England 2015b, 10–11). The evaluation should aim to understand the lithic resource's extent, technological composition and date range, function, spatial pattern and, potentially, its geoarchaeological context (Historic England 2018; see Case study 2).

Lithic scatters are often perceived as being particularly problematic from a heritage resource and development management perspective, because the standard archaeological methodologies presently employed are often not sufficiently subtle to ensure their effective identification and characterisation (Last 2016). Prospective techniques suited to identifying them, such as fieldwalking and test pitting, have been in relative decline since the 1980s, whilst the application of less receptive techniques, such as geophysics and trench evaluation, has significantly increased (Blinkhorn 2012). This trend has only been reversed in the last 15 years through the rapid growth of geoarchaeological deposit modelling and the use of more targeted evaluation approaches (Carey *et al*. 2018). Nevertheless, many recent discoveries of undisturbed lithic sites have highlighted the need to develop more robust and accurate methods for predicting their presence and evaluating their potential (Case studies 3, 6, 7 and 8).

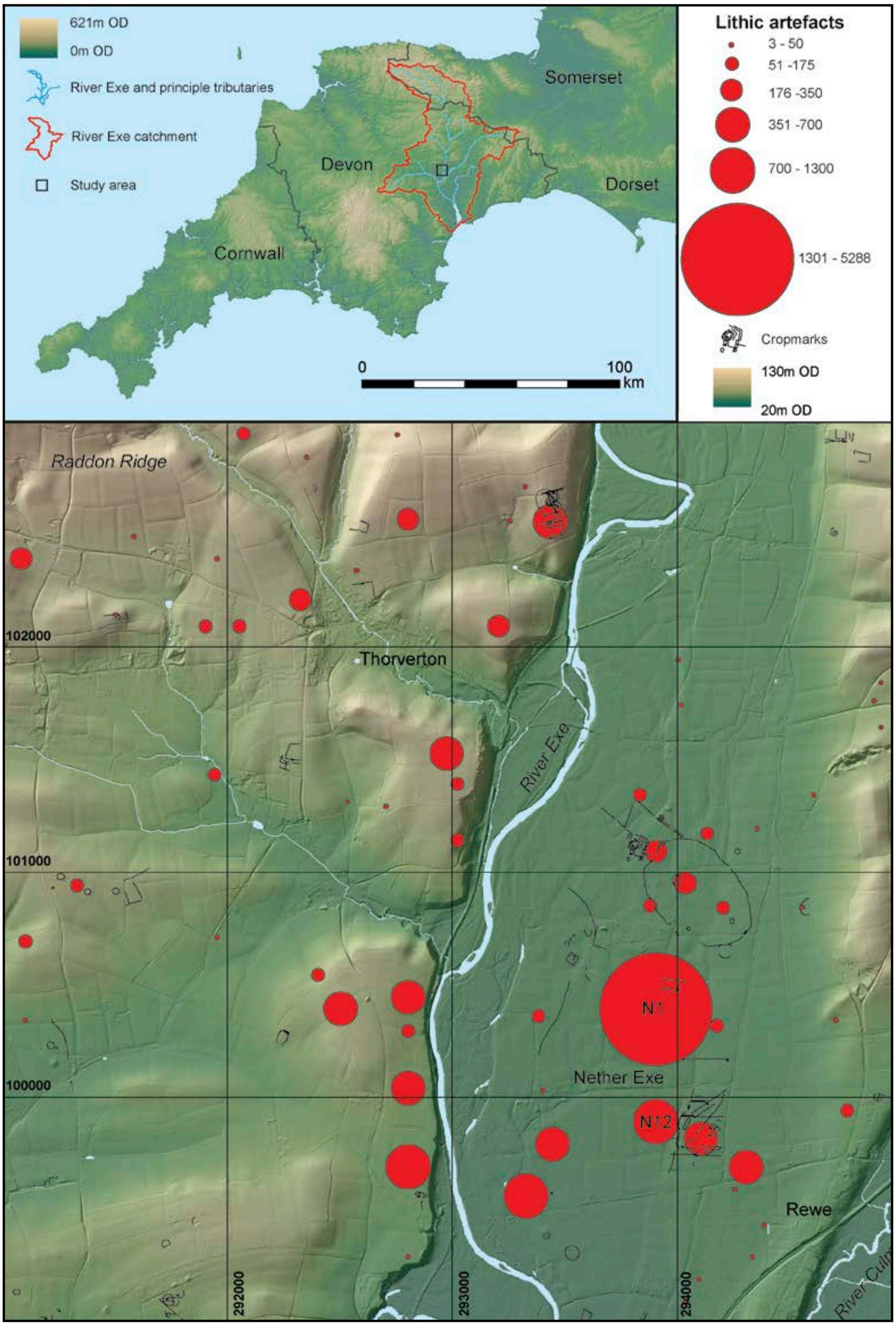

Figure 9: Lithic scatters and monuments in the Lower Exe Valley, Devon, illustrating the relationship between different landscape elements (see Case study 4) Topography derived from 90m SRTM topography data courtesy of CGIAR (http://srtm.csi.cgiar.org), and 1m lidar digital terrain model © Environment 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.

Archaeological investigations (trench evaluation, strip, map and record, and area excavation) can also result in the destruction of the resource – specifically in the case of scatters within active ploughsoils or at the interface between soils and underlying deposits. This is because the removal of such deposits is integral to those types of archaeological investigations (see Case study 7). This can either lead to a loss of important evidence, or under-estimation of the resource's scale and importance, leading in turn to missed research opportunities or, in a development context, potentially avoidable expense and/or delay.

At present, there are no set methodologies in place for dealing with lithic sites, particularly surface scatters, in the planning process, and it is usually left to the discretion of individual Local Planning Authorities (LPAs) as to what form of evaluation and/or post-determination recording is undertaken should lithic sites be suspected or encountered. However, there are a number of methodologies available which can be applied during prospection and evaluation of the lithic resource (CIfA 2014b). These can be employed separately or in combination within development contexts, as well as in academic and community projects:

- **Monitoring the collection of data from geotechnical investigations**, which are often undertaken during the initial stages of a development, can inform on the geoarchaeological potential of a site and be used in the construction of a preliminary deposit model (see section 2.4; Case study 3; Figure 10). This type of investigation can be particularly useful where sediments with potential to contain lithic sites are known or suspected to be present.

- **Geoarchaeological investigation of buried environments** using appropriate techniques in the form of augering, boreholes, test pitting and geophysical sediment mapping, in order to develop a sub-surface deposit model and predict areas and horizons with lithic potential that may require further investigation (Figure 10). It is worth noting that both geoarchaeological and geotechnical investigations (when monitored by a geoarchaeologist) can produce the same information and that it is unlikely both methods will be required in the same project area unless there is a need to generate supplementary data or samples.

- **Surface collection or fieldwalking survey** within the development or project area, ideally when the field has been recently ploughed, rolled and weathered, with minimal crop growth such that more than 50 per cent of the field surface is visible. The survey should include three-dimensional recording of finds using Global Navigation Satellite Systems (GNSS; see Historic England 2015c), in order to clearly define the extent of the resource and any discrete concentrations of artefacts (Bayer *et al*. 2013), which could indicate the presence of buried structures or specific activity areas (Case studies 2, 4 and 5). Fieldwalking surveys should be based on either transects (spaced a maximum of 20–25m apart) with material collected over a nominal area extending 1m either side of each transect, or for a dense lithic area, a grid with appropriately sized collection units (a minimum of 5m x 5m grid squares or 25m^2) spaced at suitable intervals. Transect widths or grid sizes should be carefully considered in relation to the aims and objectives of the project or evaluation. For example, lithic scatters containing Palaeolithic or Mesolithic material can be of limited size and extent and could be missed during wide-spaced surveys. Additional collection units can be added should concentrations of lithic finds be encountered as it is important to recover sufficient information to make an informed judgement on the size, typological and technological composition, chronology and function of lithic scatters (Historic England 2018; Case studies 1, 2, 4, 5, 6 and 7).

Well-preserved older sites can also first present as ploughsoil scatters and Lower and Middle Palaeolithic material found during fieldwalking surveys should not be dismissed as isolated finds. Sites like Harnham, Wiltshire, have shown significant well-preserved early human signatures can be under direct threat from plough damage (Bates *et al*. 2015). Where sites lie on Clay-with-Flints, river terrace or fine-grained loessic Brickearths, Lower and Middle Palaeolithic material should be anticipated, and its source determined through follow-up intrusive fieldwork based on meaningful sampling. Sometimes condition can be a guide to recent exposure from a secure Pleistocene context (Pope *et al*. 2015).

- **Sample test pitting or shovel pitting** of the resource within the development or project area (Case study 2; Figure 10). This type of evaluation should ideally be targeted on scatters identified during fieldwalking, but sometimes it can be used as an alternative prospection technique, depending on the timing of the fieldwork or the land use and landscape setting of the survey area. Sampling intervals are usually based on 5m to 20m grids and should aim to provide up to a one or two per cent sample of the investigation area, preferably combined with other evaluation techniques. Higher resolution sampling should be used in areas where lithic scatters have been identified to help better define the extent of the activity. Good examples of fieldwalking survey coupled with sample test pitting undertaken on a large scale include work in the Cambridgeshire fenlands (Edmonds *et al*. 1999) and more recently on the Farndon Fields Palaeolithic site near Newark (Garton *et al*. 2015). This approach could be extended to large-scale test pitting of geological deposits where the potential for buried lithic-bearing deposits has been predicted by geoarchaeological surveys (Case study 7).

- **Targeted sample sieving of ploughsoil or potential lithic-bearing deposits** based on fieldwalking or geoarchaeological surveys, within the development area or project area (Case study 2; Figure 10). This could be implemented in tandem with other evaluation techniques, such as a test-pit survey or trial trenching (Case study 11). On the Bexhill to Hastings Link Road a programme of 1m by 1m test pits was targeted on fieldwalking lithic spreads to better define and characterise lithic scatters (Case study 7). These test pits were hand-dug through the topsoil

> and subsoil to solid geology, with both hand recovery and sieving of lithic material. The test pits continued through the natural sandy bedrock to ensure full recovery of lithics, taking into account that many had been vertically displaced by post-depositional processes. On average just over half as many lithics were recovered by hand as from sieving, with a clear bias in the hand recovery towards larger and more easily identifiable tools.

An assessment of the lithic material recovered during the application of the above survey techniques is required to inform further stages of a phased investigation (Case studies 2, 4, 5, 6, 7, 8 and 11; Appendix 3). The report should provide an appropriate quantification and detail the physical quality (raw material and condition) of the struck lithics, their technology and chronology.

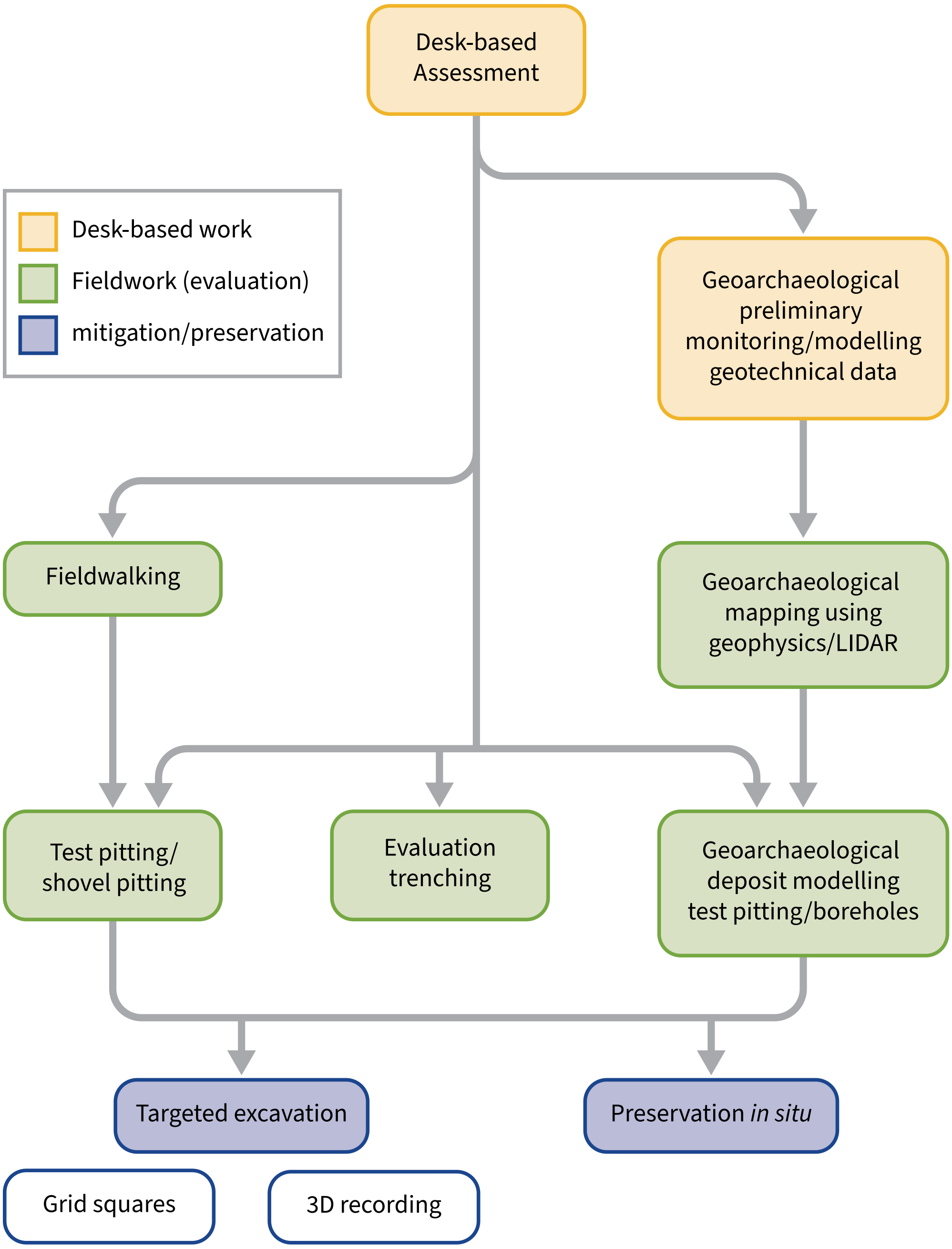

Figure 10: Sequential methodologies for the investigation of lithic scatters
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3.2 Significance and mitigation

The significance and setting of lithic scatters and undisturbed sites within the historic environment should be considered at an early stage of the planning process in relation to the policies set out in the NPPF and accompanying guidance in order to justify their consideration in management plans, whether they relate to development or other activity. Unlike other asset types where significance is reasonably well understood, for many lithic sites a staged approach to assessing significance will be required (Case studies 2 and 5).

Following the initial evaluation further work may therefore be proposed. For example, the evaluation may have identified discrete distributions of artefacts within the wider extent of a lithic scatter which may suggest the presence of buried structures or features. In this instance, further investigation may include targeted trial trenching or test-pit survey in order to detect potential sub-surface archaeological features.

From this work, strategies relating to the protection, management and/or mitigation of a lithic site can be formulated. Within a development context a range of measures to mitigate the impact of proposed work in proportion to the significance of the site can be considered (Case study 7). In some circumstances the option to preserve the resource *in situ* may be a practicable solution. Where an undisturbed lithic site is sealed by sedimentary overburden, preservation *in situ* will have to be carefully managed in order for the site to retain its secure context (including maintaining water levels where organic material is known or predicted to survive). There is a danger that if this is not undertaken effectively it will lose some of its significance.

In many development situations, for a variety of reasons, the option to preserve a site *in situ* is not viable and full or partial excavation may be deemed appropriate mitigation of the development impact (Case studies 6, 7 and 11). When excavation of a lithic site is proposed a WSI will be produced by the archaeological contractor (or the developer's consultant), detailing the background, methods, aims and objectives of the excavation. Appropriate specialist advice should always be sought in planning such work.

3.3 Excavation methodologies

In order to ensure a detailed understanding of the site's stratigraphy and formation processes and the artefacts' relationship to these, excavation methodologies require accurate spatial control of artefact positions through excavation in 1m to 2m grid squares (Case studies 2, 6, 7 and 8; Table 1) and/or ’three or four-dimensional’ recording (ie recording the angle of incline, in two directions, of the object as well as its three-dimensional position; Figure 11). The sieving of excavated spoil at an appropriate resolution complements hand recovery (Case studies 6 and 7). In particular, systematic wet-sieving of samples from each grid square through 10mm to 5mm meshes can be an efficient means of retrieval (Case study 11).

All lithics that measure over 10mm in maximum linear dimensions (MLD) would typically be recorded three-dimensionally by survey using a total station or GNSS. All such lithics will be individually bagged and issued with small find numbers. Tools or tool fragments less than 10mm in size would not normally be three-dimensionally recorded or bagged separately but would be assigned to a particular grid square and layer or spit number. Similarly, lithics recovered from sieving would also be recorded by grid square and spit, with many recovered pieces representing small chips or whole/fragmentary microliths, many of which would have been missed by hand excavation.

Figure 11: High-resolution four-dimensional recording of an Upper Palaeolithic site at Guildford Fire Station, Surrey © 2021 Oxford Archaeology

The surface deposit within each grid square will be excavated in spits of varying depths dependent on the density of material and significance of the scatter, both of which will be closely interrelated. Spits will generally be in the order of 0.05-0.1m thick but may be reduced in thickness based on individual circumstances. Lithics can work their way down a sediment profile to a considerable degree and in areas of peat formation can be dragged upwards into the peat. Such lithics still belong to a scatter even if they now occur in three or more different geoarchaeological contexts. Often this will take the form of low levels of lithics of varying sizes in the peat, a dense scatter sitting on and in a weathered surface or buried soil horizon and levels of lithic density and object size in any underlying subsoil horizons decreasing with depth, particularly in coarse-grained deposits like sand. In some instances, six or more spits may be required to fully recover an *in situ* scatter that may have originally lain on a former land surface.

Such methodologies are pertinent to lithic sites in primary contexts (Table 1), that is undisturbed sites, but can be adapted as needed for secondary depositional environments, where lithic assemblages have been reworked by marine, glacial, fluvial or colluvial action (Pope *et al*. 2016; Historic England 2018). Ploughzone scatters are formally excavated less often but this may be appropriate where they are particularly significant, such as in the landscape around Stonehenge (Richards 1990).

Table 1: Excavation procedures

Context (primary context and/or *in situ*)	Cut feature (pits, ditches, postholes etc)		Layers (middens, surfaces etc)		Sedimentary deposits (buried palaeolandsurfaces/ palaeochannel	
Artefact Density	Low	Medium-High	Low	Medium-High	Low	Medium-High
Sample excavation	yes	No	yes	No	yes	No
Grid square excavation (at least 1m resolution)	No	No	No	yes	No	yes
3 dimensional recording	No	yes	No	No	yes	No
3/4 dimensional recording	No	No	No	yes	No	yes
Excavation by spits (at least 0.05m thick)	No	yes	No	yes	No	yes
Sample recovery of spoil for sieving	yes	No	yes	No	yes	No
Recovery of all spoil for sieving	No	yes	No	yes	No	yes

During the formulation of the excavation methodology a lithic specialist should provide advice on the lifting, handling and storage of artefacts for specialist study, such as microwear and residue analysis (see section 5). As not all sites are the same, the methodology should be tailored to the site in question and have a clear set of aims and objectives in order to capture maximum information from the lithic resource.

4

Analytical methodologies and post-excavation techniques

4.1 Post-excavation

Once excavation is complete the site archive generated during fieldwork should be the subject of a post-excavation assessment (PXA). The PXA will recommend the analytical methodologies to be applied to the lithic assemblage (Case study 6), in each case geared towards answering specific research questions relating to the interpretation of the site: for example, understanding chronological developments; the sedimentary and palaeotopographic setting; the spatial organisation of activity; or raw material procurement strategies (Case studies 3, 6, 7 and 8). It is important to recognise that no two sites are the same and therefore the programme of analysis will be tailored to each project.

4.2 Levels of analysis

Even though ploughzone lithic scatters are recovered from insecure archaeological contexts they still warrant a certain level of analysis proportionate to their significance and landscape value (see section 2). At the very least this should include a typological and technological assessment of the lithic assemblage; an evaluation of the condition of the material; and a study of its spatial composition and extent (Historic England 2018; Case studies 2, 4 and 5; Appendix 3). Where cost precludes typological and technological attribute analysis of each piece in a large assemblage, a sample of appropriate size to address the research aims of the project should be selected for detailed analysis (Case study 4).

Undisturbed lithic sites identified during excavation have clear heritage significance as a result of their archaeological interest. Due to their secure context and the fact that they are often associated with stratigraphic deposits, they are particularly responsive to rigorous analytical applications (Case studies 6, 7, 8 and 9; see Figure 12).

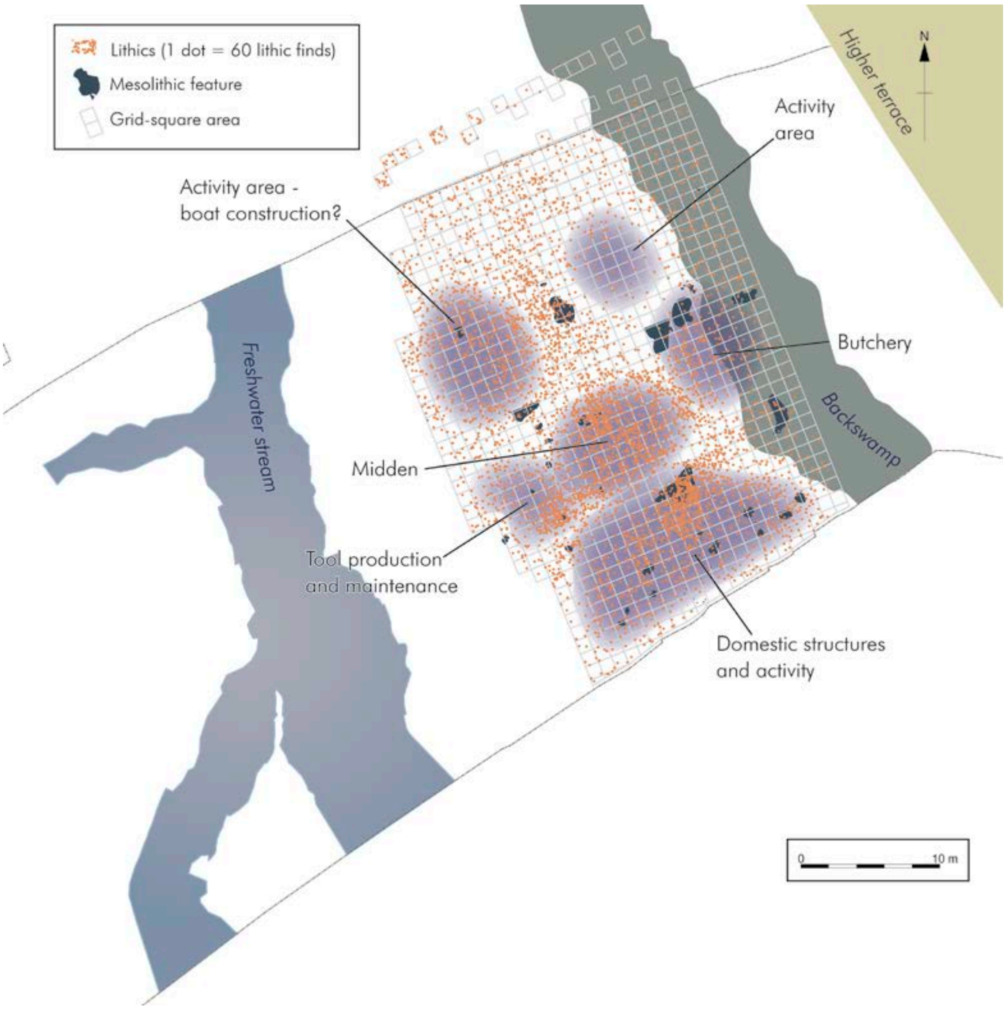


Figure 12: Interpretative zones of Mesolithic activity on the Carlisle Northern Development Route, Cumbria, based on lithic analysis. Specific areas of activity were identified through detailed analysis of lithic typologies and spatial distributions (see Case study 6) © 2018 Oxford Archaeology; all rights reserved

The application of these techniques should be proportionate to the significance of the site, and should be considered in relation to the research objectives set out in the relevant RRF and other frameworks (see section 2).

Relevant analytical techniques will be defined in the lithic assessment report which forms part of the project PXA. This report usually includes a summary of an assemblage's stratigraphic/sedimentary associations and spatial distribution; an assessment of its physical character, typo-technological composition and integrity; a statement of potential for further analysis; and a description of the techniques involved in order to undertake the work, with an estimate of costs. Occasionally, the potential of a particular analytical technique, such as microwear or protein residue analysis, will be evaluated at the PXA stage in order to test its viability and value in relation to the project's research aims and objectives (Case studies 6 and 7). Once again, the programme of analysis needs to be proportionate to the significance of the site and the research value of the lithic assemblage.

4.3 Specialist analysis

Depending on the variables outlined above, a number of techniques can be applied during the analysis of a lithic assemblage (see also Appendix 3):

Technological analysis: This comprises the identification of stratigraphic associations and raw material types, recording in an appropriate database the metrical, typological and technological attributes of the assemblage in order to define its composition, date and function (Case studies 2, 4, 5, 6, 7, 8 and 9). The work should also include scaled line drawings (Martingell and Saville 1988) and photographic images of lithics selected by the specialist during analysis. These should be at an appropriate scale and include a suitable scale bar; photographic images should be in colour, angled correctly to show technological detail and have a suitable background to aid definition (Fisher 2009). The drawings and images should not be an exhaustive record of the whole assemblage, but designed to support specific interpretative arguments, and include a representative sample of cores, debitage, tools and utilised pieces.

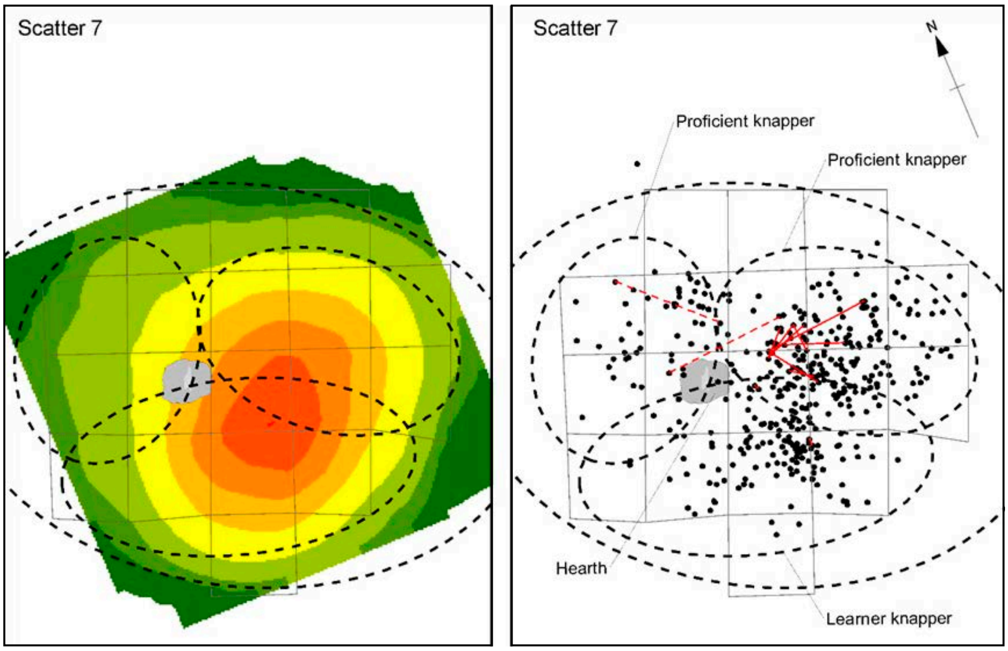


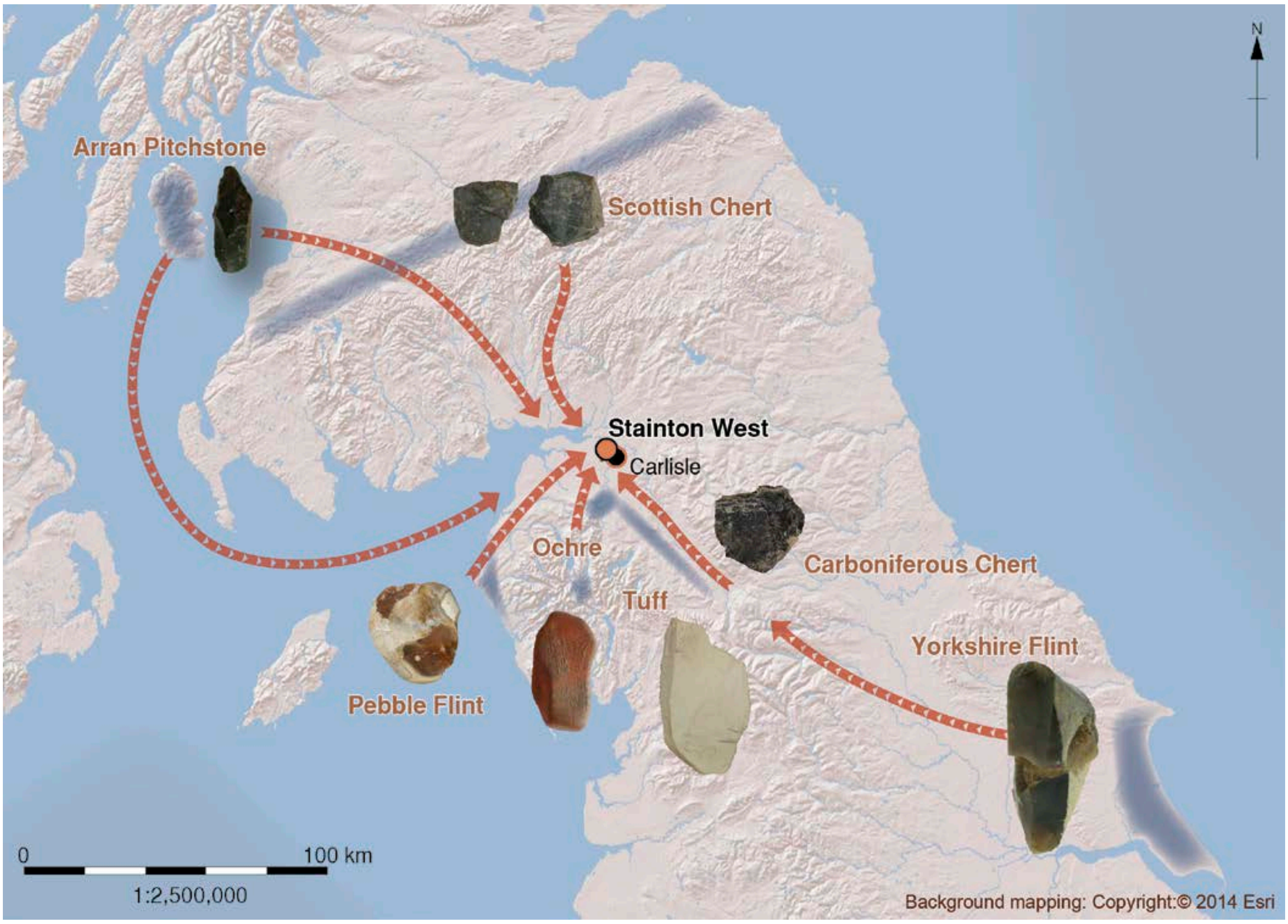
Figure 13: Lithic distribution analysis showing an in situ lithic working surface with three knappers of different proficiencies working next to a central hearth from the Bexhill to Hastings Link Road, East Sussex (see Case study 7) © 2018 Oxford Archaeology

Spatial analysis: This has a wide range of uses in lithic analysis at both landscape and individual site scale (Figure 13) though its effectiveness depends on the recovery methodology employed during artefact collection, which can range from three-dimensional recording of individual artefacts during fieldwalking surveys (Case studies 2, 4 and 5) to 100 per cent sample recovery of lithic material from a grid-square excavation area (Case studies 6, 7, 8 and 9). Lithic artefacts associated with three-dimensional data can be plotted and queried in Geographic Information Systems (GIS) in order to understand densities and relationships across a study area (Case studies 2, 6, 7, 8 and 9).

Spatial analysis can also be used to investigate the wider landscape setting of a site in order to understand its context within regional settlement patterns and land-use strategies (Case studies 4 and 5).

Raw material sourcing: Sourcing analysis assigns lithic sources to geochemical groups according to distinct geochemical compositions, where unique elemental signatures represent separate lithic sources. This can be very useful in identifying prehistoric mobility strategies, trade and exchange networks, not only at a site level but across landscapes and regions. While obsidian sourcing is a relatively reliable and popular technique, flint and chert sourcing is more difficult and historically less successful largely due to variability in formation processes. However, recent advances in this field using multi-layered approaches combining visual comparative studies, stereo-microscopic analyses of microfossil inclusions, and geochemical trace element analyses shows increased promise for identifying potential sources (eg Pettitt *et al*. 2012). At Stainton West the results of geochemical analysis of archaeological lithic raw materials were cross-referenced with analogous geological samples in order to define procurement strategies (Figure 14; Case study 6). This identified that both local and non-local sources were used. The non-local sources included chert and pitchstone from Scotland and flint from east of the Pennines, a pattern of procurement that was initiated in the late Mesolithic and continued into the Neolithic (Brown *et al*. 2019).

Figure 14: The geographic distribution of lithic raw materials from Stainton West, Carlisle, Cumbria (see Case study 6) © 2018 Oxford Archaeology; all rights reserved



A variety of techniques can be applied to identify the geochemistry of lithic artefacts, including:

- **Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS):** These techniques involve chemical diagnosis of materials; while ICP-MS and ICP-OES require the reduction of the sample into a powder and are therefore destructive LA-ICP-MS is non-destructive, although its results can be difficult to correlate with the other techniques;

- **X-Ray Fluorescence (XRF) analysis:** XRF analyses which elements are present within an object and in what quantity, creating an elemental "fingerprint" for identifying potential geological sources for that artefact (Fig 14; see Case study 6);

- **Petrological thin sectioning (PTS):** This technique involves removing a small core of material from stone tools, such as axe blades, which is used to produce a thin section that can be examined microscopically in order to define the mineralogical composition of the raw material from which the tool was made and potentially reveal its source area. PTS has been extensively applied in the sourcing of ground stone tools such as axe blades from the Central Lake District (Bradley and Edmonds 1993). XRF can also be used in tandem with PTS to refine the results of analysis.

Microwear analysis: This comprises the microscopic identification of edge-wear traces on stone tools and debitage, which can be compared with those on tools used experimentally. This analysis can be useful in identifying patterns of activity across a site, especially when combined with the results of other techniques (Case studies 6 and 7), and in interpreting site formation processes. For example, evidence of fish processing was recently identified through microwear analysis of some of the tools from Star Carr, despite a general lack of fish remains recovered from the site (Robson *et al*. 2018).

It is important that advice on the lifting, handling and storage of artefacts is sought from a microwear specialist at an early stage in the excavation process. The wearing of powder-free sterile gloves during the lifting of artefacts, which should not be cleaned, and storing single items in appropriate bags will help to preserve wear traces until they reach the specialist.

Residue analysis: Lithic artefacts can have remnants of residues adhering to their surface. In some instances, they relate to hafting technologies, such as the use of birch bark tars, while in others they can be organic residues which relate to a stone tool's use (Case study 6; Pawlik 2004; Croft *et al*. 2018 ; Croft 2021). Analysis such as gas chromatography-mass spectrometry (GC-MS) can define the organic nature of the residues and, if sufficient remain, these can potentially be used for scientific dating. However, there is potential for contamination, so as with microwear, appropriate methodologies for the lifting, handling and storage of artefacts should be implemented at an early stage in the excavation process (Högberg *et al*. 2009, 1728–9).

Protein residue analysis (PRA): Also known as blood residue analysis, this can be used to collect information on tool and debitage use, diet and site function, and can be combined with microwear analysis (Högberg *et al*. 2009). For this to be effective artefacts have to be lifted during excavation in a block with a sample of the surrounding matrix and should not be subjected to cleaning so, again, the implementation of appropriate excavation techniques at an early stage in the project is important.

Thermoluminescence (TL) dating: Luminescence dating can be used to date the last heating of stones and flints that have been inadvertently burnt in hearths (English Heritage 2008b; Barton *et al*. 2009). Heating to more than about 250°C will release the energy stored in the mineral grains. TL dating may be employed where the interpretation of the site within a chronological framework is limited and other means of scientific dating are unavailable. TL dating is often applied in the study of complex Palaeolithic sites, particularly those associated with the Middle Palaeolithic period (for example Preece *et al*. 2007; Richter 2007). Whilst this dating method undoubtedly has its value it also has problems, including the detection limits of the equipment used for very young samples and the saturation of the signal measured for very old samples. A critical part of calculating a luminescence age is to measure the natural radioactivity at the site. Some measurements can be made in the laboratory, but *in situ* measurements are preferable, using a gamma spectrometer close to the dating sample.

Optically Stimulated Luminescence (OSL): This type of dating can be an effective means of directly dating sediment contexts (and archaeological features) which are associated with lithic artefacts (English Heritage 2008b; Barton *et al*. 2009). In contrast to TL dating, OSL measures the energy emitted after a deposit has been exposed to daylight and then covered; this is normally when the sediments were deposited by a river, the wind or some other geomorphological process. When the mineral grains are exposed to daylight any energy stored in them is released, and this sets the 'clock' to zero. Once mineral grains are buried by further deposition energy starts to accumulate within them, and this continues until they are collected for measurement. Sediments suitable for dating should contain either fine silt (4–11µm) or sand grains (90–300µm). Aeolian sediments are ideal, but fluvial and some colluvial materials are also suitable. The key consideration is whether there is a high probability that the mineral grains were exposed to daylight at, or prior, to deposition.

Samples for luminescence dating can be collected by non-specialists, but it is preferable for a specialist to be involved. The luminescence signals used for dating are sensitive to light, and thus samples must be collected in such a way to exclude daylight. Sampling methods usually involve hammering a metal or plastic tube (typically 30–70mm in diameter and 150–200mm in length) into the sedimentary unit. The ends of the tube are packed with plastic and sealed using tape to avoid moisture loss and movement of the sample during transportation back to the laboratory. Again, natural radioactivity measurements of *in situ* sediments are required, preferably using a gamma spectrometer close to the dating sample.

Refitting studies: The refitting of lithic artefacts from the same reduction strategy or knapping episode usually involves the partial reconstruction of a manufacturing sequence or sequences (Figure 15; Case studies 7 and 9). The technique is based on macroscopic inspection of lithic artefacts from an assemblage, but digital refitting is currently under development (eg Holland *et al*. 2022). Refitting not only allows lithic specialists to understand the technological character of an assemblage but can provide a wealth of information on site formation processes, including modes of refuse accumulation and its occupation history.

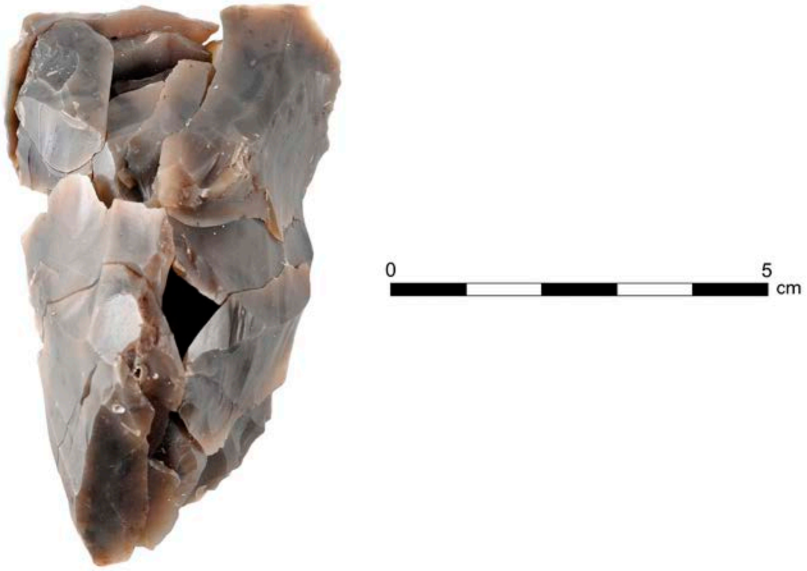


Figure 15: An example of refitting an axe reworking/resharpening sequence from Star Carr (see Case study 9) Photograph taken by Paul Shields © University of York (CC BY-NC 4.0)

Statistical analysis: Given that most lithic assemblages are partially representative of an activity or set of activities, the use of statistical models can provide a variety of additional information on the composition and function of the assemblage and/or its constituent parts (Case study 8). The statistical technique to be applied will depend on the questions being asked of the data set. Analyses can be used to identify specific spatial patterns of artefacts across an area, activities within a site, and the relationship of a lithic artefact with other variables (Herbertson 2016). For example, cluster analysis can be useful in determining differences in spatial patterns between lithic types across a site and also clarifying the potential variation in reduction schemas applied to different raw material types.

5

Management of lithic sites

5.1 Designation

At present, ploughzone lithic scatters and most undisturbed lithic sites cannot be scheduled under the terms of the 1979 Ancient Monuments and Archaeological Areas Act because they lack direct evidence of structures (Historic England 2018). Although lithic scatters cannot generally be designated, criteria for national importance were set out in *Managing Lithic Scatters* (English Heritage 2000, 7):

- Can the site's boundaries be identified?
- Does the quality/type of the artefacts from a recent collecting episode indicate that they were recently derived from sub-surface features?
- Has any additional investigative work been undertaken, which indicates the presence of structures?
- Does any part of the site remain undisturbed?
- Has any technological analysis been undertaken which can be used to date and interpret the site?
- Is there any diversity in technology and diagnostic artefact composition to indicate phases of repeated occupation and/or differences in activity?

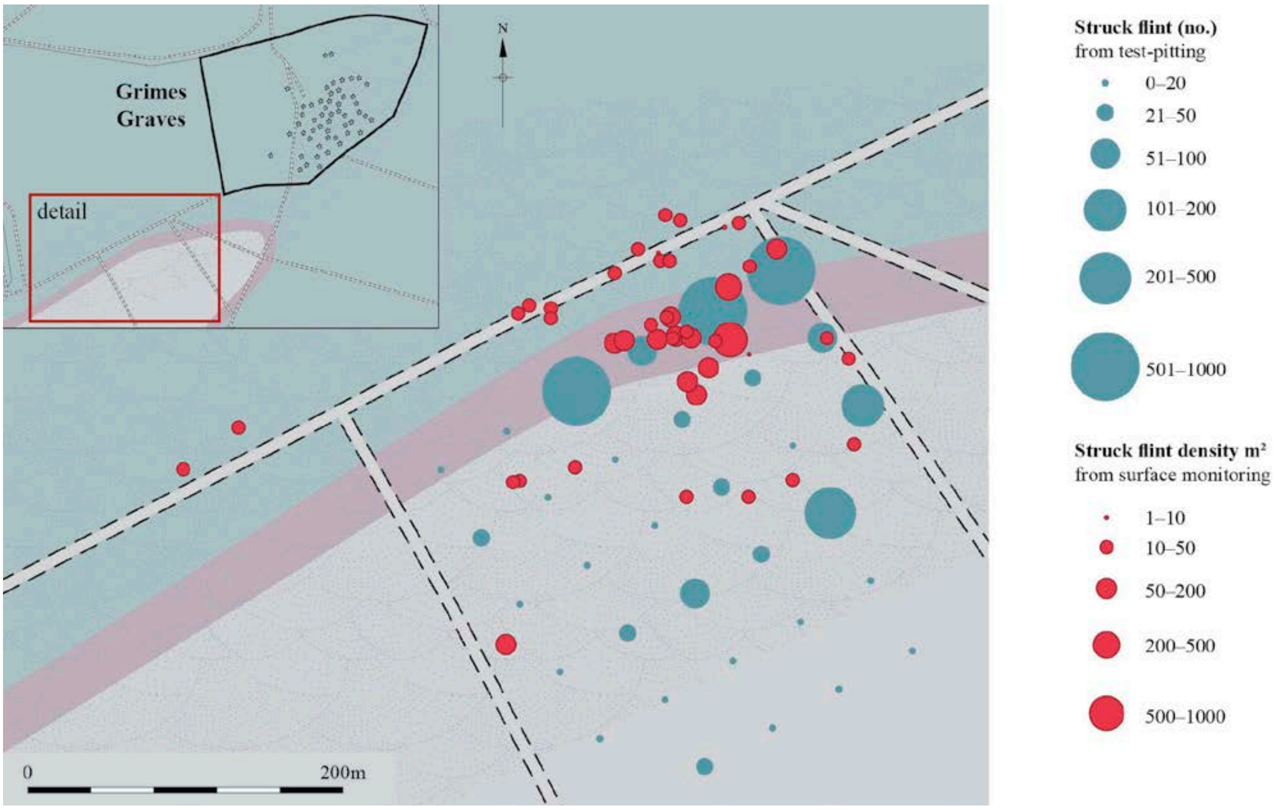
It was proposed that any site fulfilling three of the criteria could be deemed of national importance. More recently the *Scheduling Selection Guide for Sites of Early Human Activity* (Historic England 2018) suggested that sites with a significant concentration of material that met four of these criteria were sufficiently rare to be nationally important, though some sites would have national importance on the basis of fewer, exceptional aspects.

5.2 Stewardship

The management and protection of lithic sites can sometimes be included in Countryside Stewardship agreements (Oxford Archaeology 2015b). In the design and implementation of these and other agri-environment schemes, a balance is struck between wildlife, landscape, historic elements, public access, practical land management and agricultural factors. Avoidance of damage to the historic environment is a requirement of the scheme, and this includes heritage assets not specifically entered into the arrangement, so should in effect provide protection for lithic sites. However, lithic scatters are excluded from the Selected Heritage Inventory for Natural England (SHINE), which informs agri-environment schemes, on the basis that they do not fulfil the selection criteria for assets in stewardship, thus making it difficult for LPAs and others to make the case for their management, and if sites are unknown they have the potential to be subjected to further impacts.

In some instances, however, significant lithic sites have been managed through stewardship agreements. For example, at Thornborough, North Yorkshire, a ploughzone scatter which had been identified through fieldwork and landscape characterisation as having a spatial association with features and monuments of national importance was taken out of development proposals and entered into a stewardship agreement (Atkins Heritage 2008). Under the terms of this agreement, the landowner was encouraged to enter into a long-term management plan, comprising reduced cultivation in order to diminish impact on the archaeological resource and promote preservation *in situ*.

Figure 16: Densities of struck flint from surface collection and test pitting in the area around Grime's Graves
(see Case study 5)
illustration by Cate Davies
© 2018 Bayer



One problem with large-scale lithic sites, such as the landscape around Grime's Graves (Figure 16; Case study 5) or the Central Lake District axe-production sites is that their extent can make wholesale management difficult to implement, although the latter sites are covered by a Heritage Partnership Agreement (HPA) which, despite being non-statutory, sets out an understanding of the significance of the asset and a management plan for the overall resource.

Being on or near the ground surface, lithic scatters can be subject to a variety of disturbances which would need factoring into management plans, such as changes to cultivation practices and the different depths of ploughing needed for different crops (English Heritage 2004).

5.3 Monitoring change

In some areas very little can be done to protect lithic scatters and sites which are under threat of destruction from natural processes. Coastal landscapes, such as Walney Island and the Duddon estuary in south-west Cumbria (Eadie 2013, 202ff and 227), are a prime example, with lithic scatters located within sand dune systems under threat from wind and sea erosion. In such cases ongoing monitoring and recording of known sites and new exposures can at least provide a record of the lithic resource, which may be highly significant (eg Waddington 2007).

Lithic scatters in upland landscapes can also be difficult to manage. For example, on the North York Moors, lithic scatters are under threat from a variety of processes, including peat restoration schemes, which, paradoxically, can have a negative impact on the lithic resource and are generally not regulated through the planning process (Carter 2015; Case study 10).

5.4 National Importance case studies

The National Importance Programme was set up by English Heritage (now Historic England) with representatives from the Association of Local Government Archaeological Officers (ALGAO) and the Department for Culture, Media and Sport (DCMS) to explore, via a series of pilot projects, how we might help create a shared understanding and mechanism to identify non-scheduled but nationally important archaeological sites. Of particular significance to the present guidance, three pilot projects were either specifically aimed at analysing aspects of national importance on lithic sites or included such sites within their remit.

The most relevant study assessed lithic scatters and extraction sites in Cumbria and East Anglia. The project explored how lithic sites are presently ascribed archaeological significance, their suitability for inclusion in management plans, and the existing measures available for recognising the importance of lithic sites (Dickson *et al.* 2023). This report considered several approaches that were integral to defining lithic sites as nationally important and measures to assist those involved in the management of the resource. The report concluded that:

- effective approaches for defining the extent of lithic sites and areas of archaeological landscapes are critical for assessing the importance of the resource;
- discussions have served to highlight the complexity and difficulty inherent in the management of lithic sites and the recognition of national importance through statutory or non-statutory processes;
- the present criteria and definitions used for assigning national importance to lithic sites need collating, updating and specifying.

Such measures would assist LPAs in the management of lithic sites of different type. By flagging up the relevant records relating to lithic sites held in HERs at the pre-determination stage of a development proposal, LPAs can ensure that the information is used to assess the importance of the resource (see section 3). Once this is established LPAs can recommend further evaluation of the resource, mitigation of the impact from development and/or effective management of the resource (see section 4).

A report on the identification and mapping of sites of national importance within the East Sussex wetlands (Champness *et al.* 2023) proposed that nationally important sites which are not currently eligible for scheduling, including many early prehistoric sites, such as lithic sites identified along wetland edges, should be highlighted as such in HERs. When threatened, the lithic sites should be evaluated through the planning process by pre-determination evaluation (see sections 3 and 4). A judgement could then be made on the heritage asset's significance to determine if all or part of the asset is worthy of preservation *in situ*, as a site of national importance, or whether loss should be accepted with recording constituting suitable mitigation.

A third project investigated how the significance of non-visible and ephemeral lowland Mesolithic sites of national importance is assessed and how they are mapped, with direct reference to a section of the Middle Kennet Valley in West Berkshire (Milwain and Gittins 2023). Using a number of case studies from wetland areas, and a contrasting upland landscape, the project considered how to define, record and map sites and explore the role of the HER in these processes. It also proposed example methodologies for recording and defining sites and assessing their group value through the application of GIS. The analysis also considered mitigation of the resource against key risks by applying the existing national importance criteria to archaeological sites, including significant lithic sites that would not meet the legal criteria for designation.

6 Glossary of terms

Alluvium: sedimentary deposits laid down through the action of water, such as in a floodplain environment.

Bioturbation: a form of post-depositional disturbance whereby artefacts associated with an archaeological context have been displaced, either within or beyond its extent, due to the effect of living organisms, such as earthworm activity or tree roots.

Blade: a *Flake* produced during *Knapping* activity which is twice as long as its width. Blades of different form characterise *Lithic* production in certain periods, particularly the Upper Palaeolithic and Mesolithic, forming blanks from which specific tools were made (Appendix 2).

Chip: a small irregular *Lithic* artefact produced as a by-product of *Knapping*.

Colluvium/colluvial: deposits associated with the movement of sediments downslope such as hillwash within a valley environment.

Core: a distinctive artefact that results from the practice of *Lithic* reduction, by the detachment of one or more *Flakes* from a lump of source material.

Debitage: unmodified Lithic material including *Chips*, *Blades*, *Flakes* and indeterminate pieces produced during the reduction of *Cores* and the production of tools.

Designated heritage asset: scheduled monuments, listed buildings, conservation areas etc which have been identified as being of national importance and afforded legal protection.

Electromagnetic (EM) Ground Conductivity Survey: a geophysical method that characterises the bulk geoelectric properties of near-surface sediments, and can be used on floodplain sites and other wetland environments to produce a high-resolution map of different sediment zones and buried landscape features such as palaeochannnels and islands.

Fieldwalking: the systematic recovery of artefacts from the surface of a ploughed field, typically using a transect or quadrant system.

Flake: a *Lithic* artefact produced during *Knapping* activity which has an identifiable ventral surface with dimensions greater than 10mm and a length less than twice its width (Ballin 2017).

Geographic Information System (GIS): a computer application designed to capture, store, query and present spatial or geographic data.

Heritage asset: A building, monument, site, place, area or landscape identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest. It includes *Designated heritage assets* and assets identified by the local planning authority.

Holocene: the current geological epoch which started after the last glaciation c 11,650 calendar years before present.

Knapping: the process of shaping a piece of stone, typically flint, by striking it to remove *flakes*; or the process of producing *flakes* which can be used as tools

Lithics: pieces of stone, or an assemblage, which have been intentionally flaked. Flint was the most common raw material used for the production of lithics and was widely available on the chalk formations of eastern and southern Britain. In other areas where chalk flint was not accessible, pebble flint was often available from secondary deposits and/or other types of stone were utilised, such as chert, chalcedony, agate, pitchstone, bloodstone, carnelian, rhyolite, various types of quartz and volcanic tuffs.

Microlith: a small *blade* tool characteristic of the Mesolithic, usually in a geometric shape and used in composite tools

Palaeoenvironmental: relating to past environments and their study, and/or the analysis of preserved organic archaeological remains from archaeological deposits.

Palaeo-land surface: a former land surface which can survive where buried by sediments and/or peat, and beneath certain types of monuments, such as burial mounds.

Palimpsest: in relation to lithics, this describes an assemblage produced during different chronological phases which, due to the effects of a variety of natural and anthropogenic processes, has become intermixed, often with a loss of contextual integrity.

Pleistocene: a geological epoch that began *c* 2.6 million years ago and stretched to the beginning of the Holocene. The epoch includes repeated glaciations and in archaeological terms corresponds with the Palaeolithic period.

Ploughzone: topsoil horizons which are predominantly the result of modern agricultural practices and are continually reworked for the duration of those practices. Ploughing effectively destroys *in situ* archaeological deposits that come into contact with the plough, incorporating artefacts such as lithics into the topsoil horizon and removing their contextual integrity.

Retouch: the working of the edge of an implement in order to make it into a functional tool, or to reshape a used tool.

Scraper: typically, a thick retouched *Flake* or *Blade* used for processing hides and a range of other tasks.

Strip, map and record: a method of archaeological evaluation and/or excavation whereby a designated area, such as the footprint of a development, is stripped of topsoil deposits and/or other layers of overburden. The extent of any archaeological features revealed during this process are then mapped to produce a plan and a sample are excavated.

Test pits: usually the hand excavation of small trenches of a predetermined size to recover artefacts from specific archaeological contexts or topsoil/subsoil deposits. When used to investigate topsoil/subsoil deposits they are usually set out in a grid or transect. Machine-dug test pits are also used in some circumstances to remove overburden overlying an archaeological horizon, particularly for the investigation of deeply buried *Pleistocene* deposits.

Trench evaluation: the opening of a given number of machine-cut trenches, of a predetermined size, covering an agreed sample of a development area. Features and deposits revealed within the trenches are characterised by hand excavation to evaluate the presence/absence of archaeological deposits and define the function and date of any remains encountered, thereby providing a basis for decisions about the nature and scope of further work.

Trial trenching: see *Trench evaluation*

Walkover survey: in a commercial context this involves the physical archaeological examination of a development site at the pre-determination stage of enquiry, often in the context of preparation of a DBA. The survey is undertaken to identify, locate and record surviving earthwork features, including tracks and boundaries, and areas with *palaeoenvironmental* potential which may retain evidence of archaeological activity.

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8 Appendices

Appendix 1: Summaries of project case studies

Case Study 1: Lithics Scatters and the Planning Process - Ed Blinkhorn (Archaeology South-East UCL)

Case Study 2: Assessing the Potential of Ploughsoil Scatters: Fieldwork at Oily Hall, Lode, Cambridgeshire - Lawrence Billington (Oxford Archaeology East)

Case Study 3: Using Geoarchaeological Deposit Modelling to Aid in the Identification, Evaluation and Targeting of Lithic Scatters and Sites - Carl Champness (Oxford Archaeology South)

Case Study 4: Investigating Prehistoric Landscapes with Lithic Scatters in the Lower Exe Valley - Olaf Bayer (Historic England)

Case Study 5: Beyond the Fence: Lithic Scatters and the Grime's Graves Environs - Barry Bishop (Pre-Construct Archaeology and University of Buckingham)

Case Study 6: Mesolithic and Neolithic Lithic Scatters at Stainton West, Carlisle, Cumbria - Antony Dickson (Oxford Archaeology North) and Paul Clark (RPS Consultancy)

Case Study 7: A Mesolithic Landscape on the Bexhill to Hastings Link Road, East Sussex - Mike Donnelly (Oxford Archaeology South)

Case Study 8: Spatial Statistics and Multi-Proxy Methodologies: Lessons from Flixton Island 2, North Yorkshire - Charlotte Rowley (POSTGLACIAL Project, University of York)

Case Study 9: Lithic Refitting: A Case Study from Star Carr, North Yorkshire - Chantal Conneller (Manchester University)

Case Study 10: North East Yorkshire Mesolithic Project - Mags Waughman (Head of Historic Environment, North York Moors National Park Authority)

Case Study 11: Applying Lean Processes to the Excavation of Flint Scatters on Major Infrastructure Projects - Kristina Pill (Costain), Caroline Raynor (Costain), Sean Taylor (Cornwall Archaeological Unit)

Case Study	Author	Area	Period	Type of Investigation	Mehods	Type of scatter	Priciple theme
Case Study 1: Lithics Scatters and the Planning Process	Blinkhorn	National	Mesolithic	Development-led fieldwork	Evaluation Excavation	*In-situ* and ‘residual’	Planning process
Case Study 2: Assessing the Potential of Ploughsoil Scatters: Fieldwork at Oily Hall, Lode, Cambridgeshire	Billington	Cambridgeshire	Mesolithic	Academic fieldwork	Fieldwalking Test-pitting	Ploughzone	Ploughzone sites
Case Study 3: Using Geoarchaeological Deposit Modelling to Aid in the Identification, Evaluation and Targeting of Lithic Scatters and Sites	Champness	National	Mesolithic–Bronze Age	Development-led fieldwork	Deposit modelling Evaluation	*In-situ*	Geoarchaeological approaches
Case Study 4: Investigating Prehistoric Landscapes with Lithic Scatters in the Lower Exe Valley	Bayer	Devon	Mesolithic–Bronze Age	Collections research Academic fieldwork	Lithic analysis	Ploughzone	Value of historic collections
Case Study 5: Beyond the Fence: Lithic Scatters and the Grime’s Graves Environs	Bishop	Norfolk	Neolithic	Academic fieldwork	Fieldwalking Geophysics Test-pitting	Ploughzone	Landscape approaches
Case Study 6: Mesolithic and Neolithic Lithic Scatters at Stainton West, Carlisle, Cumbria	Dickson & Clark	Cumbria	Mesolithic–Bronze Age	Development-led fieldwork	Evaluation Excavation Lithic analysis	*in-situ*	Excavation methodologies and interpretation
Case Study 7: A Mesolithic Landscape on the Bexhill to Hastings Link Road, East Sussex	Donnelly	East Sussex	Mesolithic	Development-led fieldwork	Evaluation Excavation	*in-situ*	Evaluation and excavation methodologies
Case Study 8: Spatial Statistics and Multi-Proxy Methodologies: Lessons from Flixton Island 2, North Yorkshire	Rowley	North Yorkshire	Mesolithic	Academic fieldwork	Excavation Geochemistry Lithic analysis	*in-situ*	Spatial analytical approahes
Case Study 9: Lithic Refitting: A Case Study from Star Carr, North Yorkshire	Conneller	North Yorkshire	Mesolithic	Academic fieldwork	Lithic analysis	*in-situ*	Refitting
Case Study 10: Case Study 10: North East Yorkshire Mesolithic Project	Waughman	North Yorkshire	Mesolithic	Collections research Management-led fieldwork	Monitoring exposures	*In-situ* and surface	Conservation approaches Volunteer participation
Case Study 11: Applying Lean Processes to the Excavation of Flint Scatters on Major Infrastructure Projects	Pill, Raynor & Taylor	Cornwall	Mesolithic–Bronze Age	Development-led fieldwork	Fieldwalking Test-pitting Excavation	Volunteer participation	Excavation methodologies

Appendix 2: Archaeological periods and their diagnostic stone tool typology

Period	Date (BP/BC)	Knapping technique	Tool blanks	Lithic typology
Lower Palaeolithic	*c* 900,000–150,000 BP	Flake production from cores	Nodules Flakes	handaxes scrapers utilised flakes
Middle Palaeolithic	*c* 150,000–40,000 BP	Levallois reduction technique	Flakes	handaxes cleavers points scrapers backed knives
Early Upper Palaeolithic	*c* 40,000–24,000 BP	Blade cores	Blades	points scrapers backed pieces burins piercers notches denticulates
Late Upper Palaeolithic	*c* 12,700–9800 BC	Cylindrical blade cores	Large, broad blades	tanged points shouldered points backed points end scrapers burins piercers and awls
Earlier Mesolithic	*c* 9800–8400 BC	Single platform cores Soft hammer	Broad blades	broad microliths scrapers burins piercers and awls
Later Mesolithic	*c* 8400–4000 BC	Single platform cores Soft hammer	Narrow blades	microblades narrow microliths scrapers burins piercers and awls
Early Neolithic	*c* 4000–3300 BC	Single platform cores Soft hammer	Broad blades	leaf-shaped points scrapers serrated pieces
Later Neolithic	*c* 3300–2200 BC	Hard hammer Anvil technique Multi-platform cores ‘Levallois’ type cores Bipolar cores	Flakes and blades	leaf-shaped points chisel-shaped points oblique points scale-flaked knives scrapers serrated pieces polished knives
Bronze Age	*c* 2200–800 BC	Hard hammer Anvil technique Multi-platform cores Bipolar cores	Flakes	barbed and tanged points thumbnail scrapers serrated flakes and blades

Appendix 3: Summary of lithic analytical techniques

Analytical Technique	Application	Methods	Value	Staffing/costs
Lithic assemblage assessment	Fieldwalking assemblages, excavated assemblages, museum/legacy collections	Assessment and quantification of an excavated assemblage	Quick means to assess potential and significance of an assemblage	Days to several months by one or more researchers depending on the size of the assemblage
Typological and technological analysis	Fieldwalking assemblages, excavated assemblages, and museum/legacy collections	Metrical and attribute analysis of a sample or an entire assemblage	Essential analysis for understanding the typological and technological composition, date, function, and wider significance of a lithic assemblage	Typological and technological analysis is usually undertaken by an individual lithic specialist. Time and budget depend on the size of the assemblage.
Spatial analysis	Mainly fieldwalking and excavated assemblages, but data from the analysis of museum/legacy collections can also be plotted if locations are recorded	Spatial analysis of the distribution of a lithic assemblage, often using GIS	Effective means of studying the integrity, composition, distribution and wider associations of a lithic assemblage and/or a group of sites	Usually undertaken by an individual lithic specialist or can involve a GIS specialist
Raw material sourcing	Fieldwalking assemblages, excavated assemblages, museum/legacy collections	Macroscopic and/or geochemical or petrological analysis in order to define a source or the source area/s of specific raw material types	Identifying assemblage raw material composition to inform on issues such as mobility patterns, resource procurement patterns and distribution and social interactions	Specialist technique that can be relatively expensive for large studies
Microwear/ use wear	Excavated assemblages	Microscopic analysis of the survival of and wear patterns on the micro-surface topography of lithic pieces	The results can inform on site function and/or the distribution of activities and benefit the interpretation of the site	Microwear analysis is a specialist analytical technique which can be time consuming and relatively expensive
Residue analysis	Excavated assemblages	Microscopic analysis of the remnants of organic residues identified on the surface of a lithic artefact	When they are present their study can identify hafting technologies and artefact function which can benefit assemblage interpretation. In some instances direct dating of a residue is possible.	Organic residue analysis is a specialist analytical technique which can be time consuming and relatively expensive

Analytical Technique	Application	Methods	Value	Staffing/costs
Protein residue analysis	Excavated assemblages	Microscopic analysis of protein residues derived from plants, animals and humans from contact during the use of a lithic artefact	Protein residue survival can be rare and when identifiable, proteins can be used to identify various proteins derived from stone tool use and benefit site interpretations	Protein residue analysis is a specialist technique which can be time consuming and costly
Luminescence dating	Excavated assemblages	Method for dating burnt lithics and lithic bearing sediments by measuring the luminescence signal of certain minerals contained in the artefacts and/or deposits	A method of dating human activity when other means of scientific dating are not available.	Luminescence dating is a specialist dating technique which is about four times the cost of radiocarbon dating
Refitting	Excavated assemblages	Refitting is a technique that has become a common tool in understanding lithic material, the manufacturing process and its spatial dimensions	Refitting is an important tool for understanding site taphonomy, for unpicking palimpsests, for understanding spatial aspects of lithic technology and its organisation in the landscape	Usually undertaken by an individual lithic specialist on small assemblages
Statistical analysis	Excavated assemblages and in some instances fieldwalking assemblages	Statistical analysis can be applied at several levels of enquiry to lithic assemblages to help validate the effectiveness of sampling procedures used during a fieldwalking survey	Statistical analysis can be used to make large amounts of data, into manageable proportions, making the data more readily available for comparison with other types of artefacts or other site assemblages	For some projects it can be beneficial to use a specialist statistician. However, with widely available statistical software packages now offer quick and relatively cost-effective forms of analysis.

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