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CUMBRIA AND LANCASHIRE, NATIONAL ARCHAEOLOGICAL IDENTIFICATION SURVEY: UPLAND PILOT

PROJECT REPORT

Matthew Oakey, Marcus Jecock, Zoë Hazell, Neil and Paul Linford, and Andrew Payne

ENGLISH HERITAGE

CUMBRIA AND LANCASHIRE

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Cover Image: An Iron Age/Roman settlement at Gillsmere. 28366/33 11-DEC-2012 © Historic England.

SUMMARY
This report describes the results of the National Archaeological Identification Survey: Upland Pilot (RaSMIS 6304) which comprised interpretation and mapping of air photographs and lidar, analytical field survey, geophysical survey, excavation, palaeoenvironmental study and scientific dating. It was carried out under the auspices of English Heritage but the teams involved in the project are now part of Historic England.

The project covered an area of 174sq km. This was mostly within south Cumbria but small parts of the south of the project area were within north Lancashire. It comprised a landscape transect from Brigsteer in the north-west to Kirkby Lonsdale in the south-east but also included an area to the west of the M6 as far south as Carnforth. The project encompassed those parts of the Arnside & Silverdale Area of Outstanding Natural Beauty (AONB) that were not surveyed as part of the North-West Rapid Coastal Zone Assessment Survey (RCZAS) as well as parts of the proposed extensions to the Lake District and Yorkshire Dales National Parks.

The project created 535 new monument records in the National Record of the Historic Environment (NRHE) and amended a further 136 – a substantial increase in archaeological knowledge of the area. Our understanding of the later prehistoric and Roman periods has been enhanced through the identification of seven new settlements and reassessment of previously identified sites. These include significant monument types such as three probable Bronze Age ring cairns. Mapping of the Lune Valley in particular, has enhanced previous work to provide a picture of settlement and land division.

Features from the medieval and post medieval periods were previously under-represented in the archaeological record and the project has gone some way to addressing this. Newly identified features include a series of probable crofts, probably relating to medieval village, at Hale and earthworks at Helsington that could represent remains of the 'lost' village.

This report provides a summary of the nature and distribution of archaeological remains seen on air photographs and lidar, some of which were subsequently investigated by other techniques. It describes the methods, scope and sources of the project and assesses how the results have contributed to the aims, objectives and research questions set out in the Project Design. There are recommendations for further work within the project area and issues relating to heritage protection and potential designation are discussed.

CONTRIBUTORS
The project team comprised staff from the English Heritage Remote Sensing, Assessment, Intervention & Analysis, Designation and Imaging & Visualisation teams. Support was also provided by the Strategic Planning & Management Division. Since April 2015 these teams are part of Historic England.

Aerial mapping was carried out by Yvonne Boutwood, Edward Carpenter, Sally Evans, David Knight, Matthew Oakey and Fiona Small. Analytical field survey was undertaken by Marcus Jecock and Rebecca Pullen. Dave Went acted as supervisor for Ian Hardwick. Neil Linford, Paul Linford and Andrew Payne carried out the geophysical surveys. Excavation and palaeoenvironmental fieldwork was undertaken by Vicky Crosby, Alice Forward, Zoë

Hazell, Paddy O'Hara, Ruth Pelling, David Roberts and Fay Worley. Post-excavation work was undertaken by Matt Canti, Hugh Corley, Karla Graham, Nicola Hembrey, Andrew Lowerre, Peter Marshall, Angela Middleton and Claire Tsang. Radiocarbon dating samples were processed and measured by Scottish Universities Environmental Research Centre (SUERC) and Queen's University, Belfast. Ken Robinson acted as the Designation Advisor for the project.

Ian Hardwick and Zoe Edwards, on HLF/IfA Workplace Learning Bursary funded training placements in Non-Invasive Archaeological Techniques, assisted with the survey work. Matthew Jones of CR Archaeology assisted with the excavation at Kitridding Farm and the OSL work was undertaken by Dr Phil Toms of the University of Gloucester.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to the various land owners who granted access to allow survey work to be undertaken. HER data and access to aerial photographs were provided by the Cumbria, Lancashire and Lake District HERs. Thanks also to Tim Gates for granting permission to scan his aerial photographs. Photo loans were managed and delivered by Luke Griffin at the English Heritage (now Historic England) Archive and Alun Martin of the Cambridge University Collection of Aerial Photography. Project support for the Intervention & Analysis teams was provided by James Pearce and Andy Roy. Advice was provided to the project by Tom Gledhill, Jacqui Huntley and Sue Stallibrass. Technical survey and graphics support was provided by John Vallender. Thanks to the members of the Liaison Group for providing information and advice and Darren Green of Natural England for assisting with land ownership details.

ARCHIVE LOCATION

Fort Cumberland and the Historic England Archive

DATE OF SURVEY

The survey was undertaken between Feb 2013 and March 2015. Post excavation analysis and scientific dating is on-going and will be the subject of separate Research Reports.

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CONTENTS

INTRODUCTION

Background to the project

The National Archaeological Identification Survey: Upland Pilot was carried out between February 2013 and March 2015. It was one of two pilot projects initiated for the English Heritage National Heritage Protection Plan (NHPP) Activity 3A4 Identification of Terrestrial Assets via Non-Intrusive Survey under Measure 3 Understanding: Recognition and Identification of the Resource. The aim of the pilot projects was to develop methods and produce guidance on best practice for the recognition of archaeological remains over large areas to inform heritage protection on a landscape scale. Each pilot project used archaeological air photograph and lidar survey as a framework for further work.

A contrasting landscape in West Wiltshire was chosen for the lowland pilot project due to potential changes linked to development and agriculture (Last et al 2015). A third ongoing project, to the south-west of Cambridge, also aims to assess the potential contribution of large-area archaeological air photo mapping to inform heritage protection, especially in terms of contextualising the results emerging from commercial excavations (Last 2014).

The main aim of the Upland Pilot was to explore how to maximise the potential of various techniques, given limited resources, to improve our understanding of the historic environment in a large upland area where basic identification of heritage assets was felt to be poor. The methods and processes established during the pilot project will inform Historic England guidance for future projects of this kind.

The work was carried out by the English Heritage (now Historic England) Investigation and Analysis Division with the assistance of the Strategic Planning & Management Division and Designation Department. Information derived from air photograph and lidar mapping and analysis informed targeted ground-based work including geophysical survey, analytical field survey, palaeoenvironmental investigation, scientific dating and sample excavation. The application of the targeted work was informed by iterative stages of investigation.

A main project outcome was enhanced protection for the historic environment through the recognition and definition of heritage assets and historic landscapes, and the accessibility of this information through the Historic England Archive, National Record of the Historic Environment (NRHE), local authority Historic Environment Records (HERs) and the Selected Heritage Inventory for Natural England (SHINE). The information will inform the planning process and other local initiatives such as management plans, agri-environment schemes, local plans or mineral resource assessments that may have heritage protection outcomes. Sites of potential national significance were identified and discussed with the Designation Department to determine potential designation assessment. The main products of the project are digital air photograph and lidar mapping, survey data and monument records, ADS digital archive, finds/environmental remains and project reports.

The upland pilot area was chosen, given limited resources, to sample a range of different landscapes and partly fulfilled the need for a survey of a range of topography covering '… the coastal fringe or estuarine environment, across the lowlands and into the upland zone.' which was identified in the Archaeological Framework for North West England (Brennand 2007, 176).

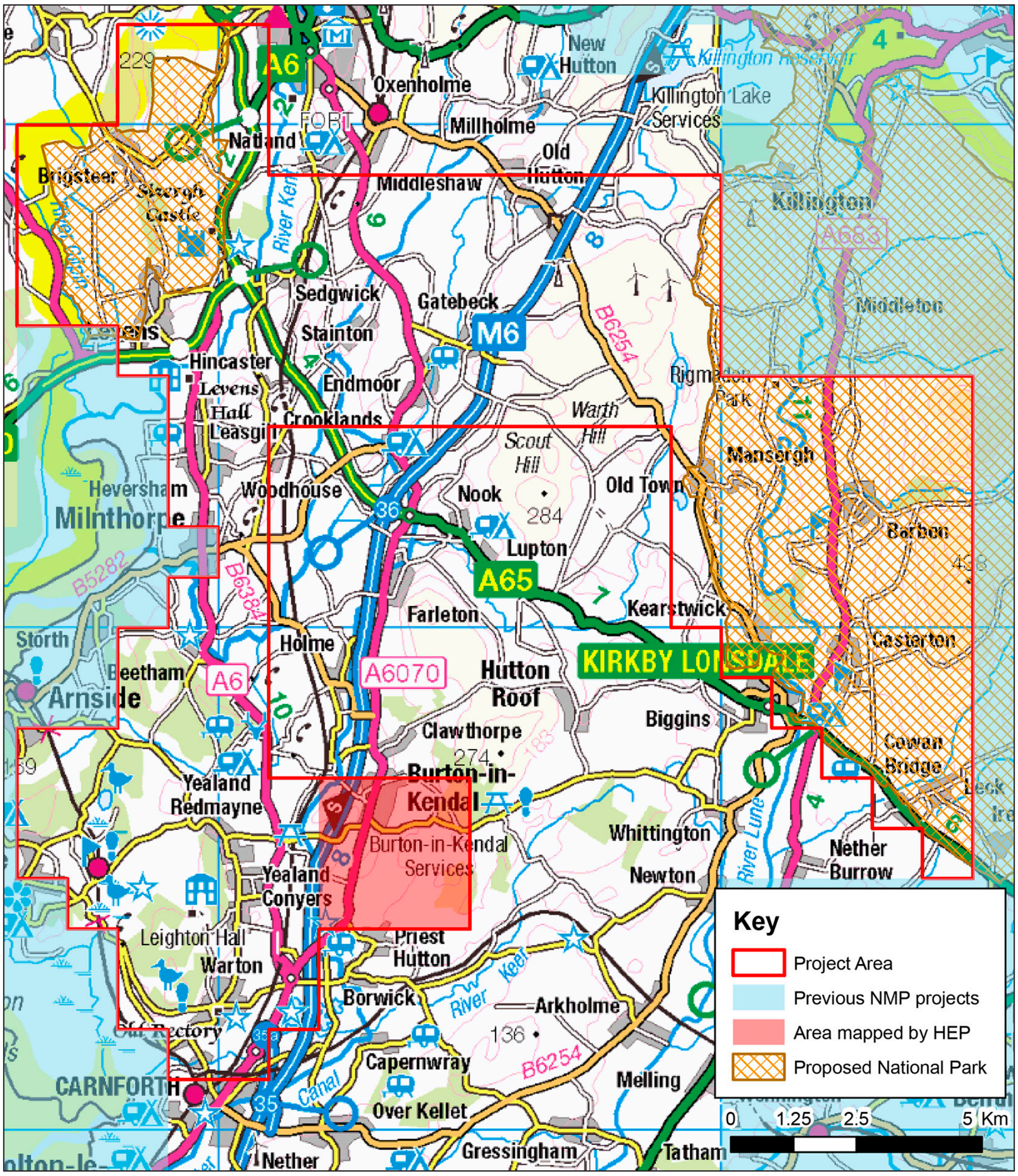


Fig 1: Project Area. © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100024900.

The NAIS Upland Pilot project (Fig 1) covered 174sq km, mostly in south Cumbria but with small parts in north Lancashire. It comprised a landscape transect from Brigsteer in the north-west to Kirkby Lonsdale in the south-east and an area to the west of the M6 as far south as Carnforth. This included part of the Arnside & Silverdale Area of Outstanding Natural Beauty (AONB) not covered by the North-West Rapid Coastal Zone Assessment Survey NMP component (Bacilieri *et al* 2009) and parts of the proposed extensions to the Lake District and Yorkshire Dales National Parks (Natural England 2013a).

A 9sq km area around Burton-in-Kendal, was carried out as a training project for the HLF/IfA Historic Environment Placement. Ian Hardwick undertook this work including the aerial survey followed by Level 2 field investigation, as well as undertaking Level 3 analytical field surveys of some sites within the main project area. The combined results of the work at Dalton are presented in a separate report (Hardwick 2014) but selected results of all his work are included within the current report as appropriate.

Summary of results

This report summarises the methods and provides an overview of archaeological highlights. This includes the main results from the air photo and lidar analysis, and the analytical field survey. Details of the geophysical surveys, excavations and palaeoenvironmental work are in other Research Report Series reports (Linford *et al* 2013a; 2013b; 2013c, 2013d, Hazell *et al* forthc). In this report, reference to NRHE monument numbers (in brackets) can be used to find further information on sites, available on the PastScape website (www.pastscape.org.uk).

The project area is topographically diverse and straddles five of Natural England's National Character Areas (NCAs), 19, 20, 21, 31 and 33 (see chapter below on **Nature and Distribution of Archaeological Remains**). It ranges from a predominantly lowland landscape, punctuated by steep limestone escarpments in the west, to the upland fringe of the Yorkshire Dales in the east. Modern land use is mainly managed pasture and uncropped land with a small number of arable fields in lowland areas. The pattern of settlement is generally one of small dispersed villages and hamlets with occasional larger settlements such as Burton-in-Kendal and the small market town of Kirkby Lonsdale.

A combination of remote sensing and analytical field survey was very successful in identifying sites and suggesting a broad chronology for the development the landscape from the later prehistoric period onwards. This overview provides an important framework to target further work, including excavation and scientific dating, to establish a more detailed understanding of the phases of settlement and land division.

The project resulted in 535 new monument records in the NRHE and amendments to 136. Archaeological remains ranged in date from the later prehistoric period to the 20th century. Most features were defined by earthworks, which often had the appearance of turf-covered stony banks. Comparison between the earliest and most recent aerial images showed there was relatively little levelling or destruction of archaeological earthworks in the post-Second World War period (see chapter below on **Nature and Distribution of Archaeological Remains**). Subsequent field assessment confirmed this overall impression.

Evidence for land use in the later prehistoric and Roman periods comprised enclosed settlements, cairn fields, embanked field systems and a small number of potential Bronze Age burial and/or ceremonial monuments. In the east of the project area – particularly

Fig 2: NCA 19 looking eastwards to the Lune Valley and beyond into the Yorkshire Dales (NCA 21). 28366/45 11-DEC-2012 © Historic England.

Fig 3: Looking westwards to Kendal and the Lake District. The A65 runs from the bottom left of the frame and forms the division between NCAs 19 and 20. 28376/19 02-FEB-2013 © Historic England.

in the Lune Valley and the Pennine fringe – there were areas of extensive coaxial field systems and settlements, probably Iron Age or Roman in date but with potential Bronze Age origins. Notable later prehistoric sites included the so-called hillforts at Warton Crag (41541) and Castlesteads (43089) plus a large ditched enclosure, or possible hill-slope fort, at Castle Hill (43942) (Fig 4). The project re-interpreted three further sites (Kitridding Hill (43113), Terrace Wood (44013), Low Barn (44014)) that could have fulfilled similar functions as impressive and/or defensible sites.

It is possible that some of the settlements recorded as Iron Age or Roman had continuity of occupation into the post-Roman period, but such continuity cannot be recognised from site morphology alone. It is hoped that scientific dating results from the targeted excavations at Kitridding Farm (outlined below) may begin to elucidate such questions.

Readily identifiable early medieval site types are relatively rare in this region which meant that few features were attributed an early medieval date during either the aerial mapping or field investigation stages of the project. This partly reflects a lack of work on early medieval sites in the region. Those that have previously been attributed an early medieval date are concentrated in the east of the project area and mainly comprise field boundaries and rectangular buildings identified during the RCHME High Park survey (Jecock 1998). A small number of additional features (1093184 and 1574843) were identified by the project and tentatively dated to the early medieval period due to their morphological similarities with the boundaries and buildings at High Park. Two curving boundaries and a potential building near Grove Gill (44127) may represent further early medieval structures but this interpretation is very uncertain.

Fig 4: Castle Hill, scheduled as a defended enclosure. Traces of later prehistoric field boundaries survive close to the enclosure along with later improvement rig. 28364_001 11-DEC-2012 © Historic England.

The project identified evidence of deserted or shrunken medieval settlement toward the west of the project area in the valley of the River Kent and in the lowlands south of Milnthorpe. Several examples are new discoveries, such as earthworks south of Briggs House Farm (1575159) which may represent part of the 'lost' medieval village of Helsington (41605). Buildings in the shrunken village of Yealand Storrs (41511) and a probable deserted farmstead (1575145) in Helsington parish were already known but their true nature or extent was not recognised before the project, in particular after field investigation (Fig 5).

Fig 5: The remains of a medieval building identified at Yealand Storrs during field survey. This discovery demonstrates the potential returns from ground survey in areas that lack high resolution lidar coverage. © Historic England, Marcus Jecock.

The widespread evidence for the medieval and post medieval agricultural landscape included lynchets formed by contour ploughing, embanked field systems and ridge and furrow. Few furlongs of ridge and furrow were attributed a medieval date. Some examples, particularly in the west, were thought to have possible medieval origins because of the reverse-S curve of the ridges, which is characteristic of that produced by oxen-drawn ploughs in open fields. However, some of these furlongs were narrower and more regular than might be expected, possibly suggesting post medieval reuse. A system of strip fields (1002759) at Hale, south of Beetham, recorded during the aerial mapping stage of the project (Fig 6), was reinterpreted following field investigation as a series of long crofts behind the houses of a planned medieval village (1589722). However, most of the furlongs of ridge and furrow were probably improvement ploughing associated with later (probably post medieval) enclosure of open fields and communal pasture. Several sheep folds, mainly in the upland areas to the east, provide evidence of the seasonal use of the fells for grazing. Some of the folds may have medieval origins but further investigation would probably be required to prove this.

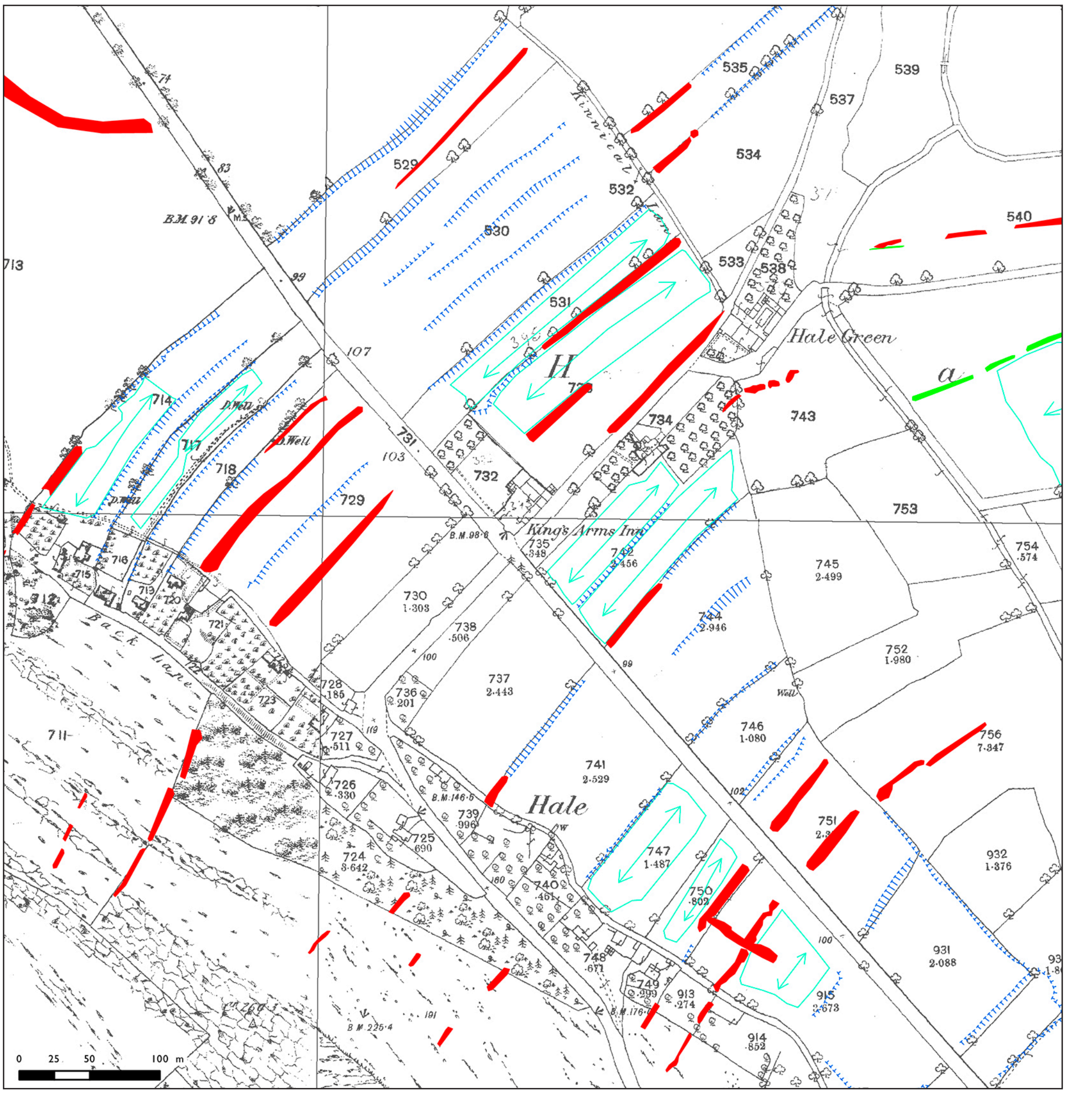


Fig 6: Strip fields at Hale, later reinterpreted as croft boundaries. © and database right Crown Copyright and Landmark Information Group Ltd (All rights reserved 2015) Licence numbers 000394 and TP0024.

There are a number of large, designed landscapes in the project area and redundant earthwork elements of these such as terraces and banks were sometimes visible. Many of the parks, including Dallam, Dalton, Levens and Sizergh, contain earlier features with origins ranging from the prehistoric to early post medieval periods (Fig 7). These areas of historic parkland, together with the fringes of former common land, are important islands of earthwork survival in a landscape that, although now predominantly pastoral, was heavily ploughed at various times during and since the medieval period either for arable or to improve the sward. Probable late medieval garden compartments associated with Beetham Hall (1002490) were recognised for the first time during the field investigation stage of the project.

The west of the project area has evidence of post medieval industrial activity. Several limekilns are remnants of once extensive quarrying and burning of limestone in the Arnside and Silverdale area. In the eastern part of the project area a number of charcoal burning platforms at Barbon Park (1574919 and 1575141) were identified from lidar data and thereafter subjected to targeted excavation and coring (Hazell *et al* forthc) (Figs 8 and 16). Radiocarbon dates obtained from charcoal in the platforms suggest they are post medieval in date and the wood types found may shed some light on how the charcoal was used and research on this continues. The post medieval date suggests that the charcoal was not destined for iron production, at least not at the (uncorroborated) medieval iron production site at Barbon (Cumbria HER No 15986). Further afield there is evidence of 18th-century iron production at Leighton Furnace (41491), although it is unlikely this was fuelled by Barbon charcoal.

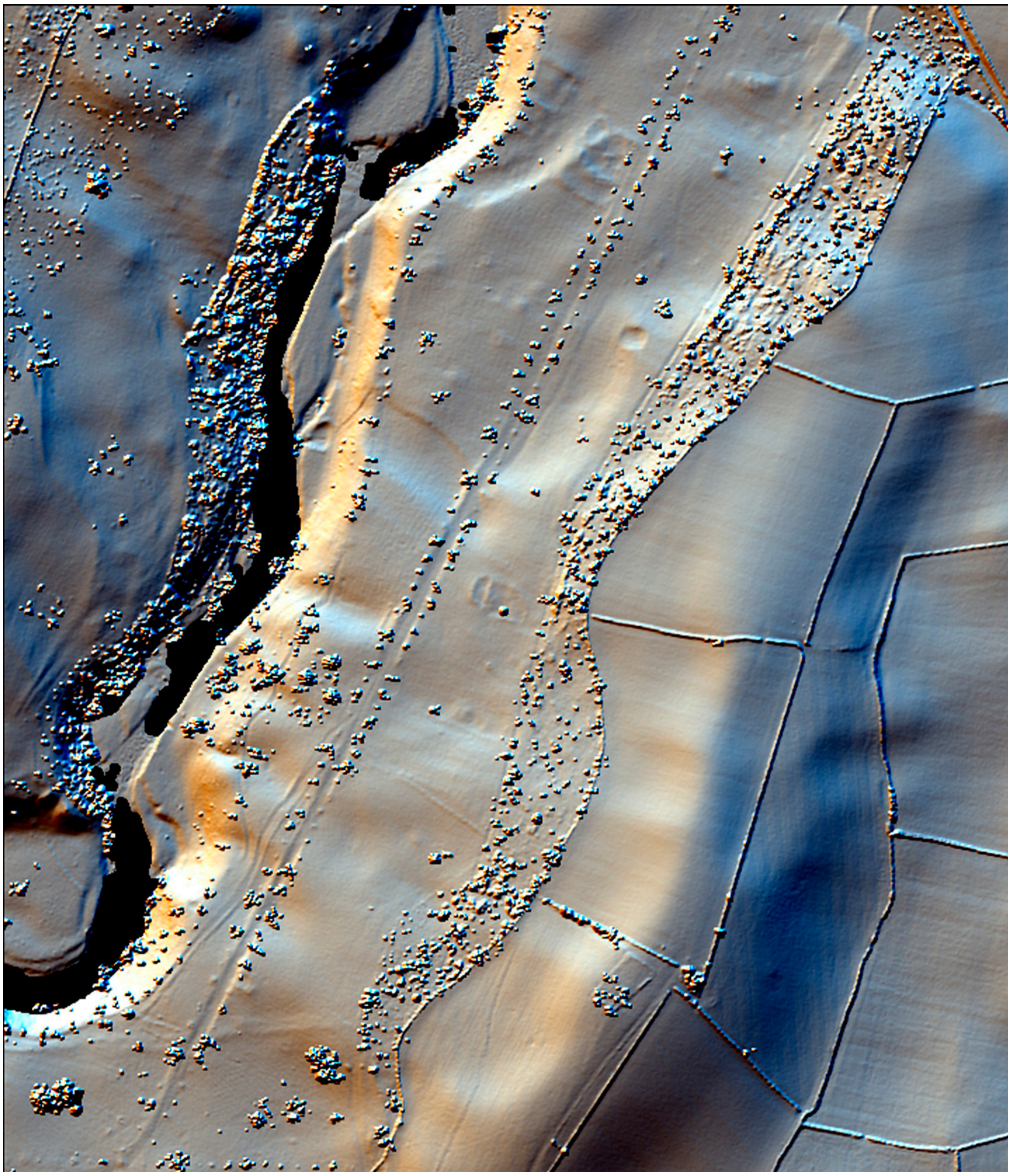


Fig 7: Iron Age/Roman settlements surviving as earthworks within Levens Park. The fields to the east (beyond the parkland boundary defined by the tree belt) have been heavily improved in the post medieval period. © Historic England; source Environment Agency.

Fig 8: Excavation of a charcoal burning platform at Barbon Park. © Historic England, Rebecca Pullen.

Charcoal was a constituent part of gunpowder (Cocroft 2000, 2) so there is a potential link with the gunpowder works at Old Sedgwick (1077948), New Sedgwick (1074024), Basingill (1169037) and Low Gatebeck (1086908). However, charcoal produced from *Alnus* sp (alder) was favoured for this process (Rackham, 2003), and the charcoal assessment results do not report that taxon present. An alternative use could be to fire the post medieval lime kilns (1054998 and 971076) that lie further up Barbondale, but it has been suggested that wood and coal were more usual fuels for this type of industry (Smith 2011). Examination of estate documentary records may help determine where and how the charcoal was used.

It was already known that the gunpowder works of New Sedgwick and Low Gatebeck were used for military activities during the Second World War (Dunn *et al* 2003; Jecock 2009). A small number of other military sites were identified by the project including pillboxes (1575229, 1418934 and 1320014), a searchlight site (1574226) and a large military munitions dump on Beetham Fell (1574686). This relatively low density of military remains reflects the picture in the coastal zone to the west around Morecambe Bay (see Bacilieri *et al* 2009).

Summary of survey methods

The results from the survey of air photographs and lidar provided a framework to target different techniques to discover archaeological remains over large areas. Combining techniques helped to determine where an apparent low monument density is a reflection of past land use or the result of poor visibility of archaeological sites.

Archaeological remains visible on air photographs and lidar or through ground observation were mainly seen as earthworks or stone structures because of a combination of modern and past land use, topography and soils. Current land use, mainly pasture, and the soil types in much of the project area are not usually conducive to the formation of cropmarks so the scope for identifying subsurface deposits from aerial photographs was limited. Fieldwalking was not applied as the scope was limited because of the small area of land under arable cultivation.

Rapid walkover survey can target areas where aerial photograph or lidar cover is poor or not possible. The field survey element of the Upland NAIS project mainly aimed to enhance our understanding of known sites, rather than prospect for new ones. However, some sites were identified *en route* to known sites during the field survey stage, eg adits at Casterton (1583408) and a ruined dovecote at Yealand Storrs (1592355) (Fig 14) which was recorded in the HER but not on the NRHE. Field survey enhanced our understanding through the identification of subtle chronological relationships and slight earthworks.

Geophysical survey targeted areas where there were suspected subsurface deposits that were not visible or poorly understood from the air. The geologies within the survey area were not considered favourable for geophysical survey. However, it was successfully applied and demonstrated the potential of this technique within the project area and wider region (Linford *et al* 2013a; 2013b; 2013c, 2013d). During the three geophysical surveys of known archaeological remains, magnetometry was successful and detected additional detail not previously recorded. The survey at Gowrey Farm showed the potential of newer rapid-acquisition towed systems to quickly investigate relatively large "blank" areas (~10 hectares in 2 days) even with challenging steep topography and uneven ground conditions.

There has been a lack of modern excavation, scientific dating and environmental work within the survey area so our depth of understanding, particularly of the later prehistoric, Roman and early medieval periods, was limited. Preliminary assessments proved to be invaluable prior to excavations, in order to assess the suitability of specific sites for further investigation. This was particularly important for the OSL dating where the suitability of the technique at each site was assessed using *ex situ* gamma spectrometry to compare the dose readings obtained from the clasts and their adjacent sediment matrix. Acquisition of dating evidence for the Kitridding Farm settlement will help to produce a site chronology and provide absolute dates for features currently dated on morphological comparison to excavated sites elsewhere in the country. Palaeoenvironmental sampling should enhance understanding of the broader landscape context of the settlements.

Comparison with the other NAIS projects

Due to the deliberate choice of different landscapes and contexts, the approaches used and results from each NAIS project were slightly different. Planning of the ground-based stages of the South-West Cambridgeshire NAIS is in progress. Although the aerial survey component applied the same methods, the results and best sources varied. The upland area had relatively low levels of historic and mid- to late 20th and 21st-century ploughing. A relatively high number of archaeological earthworks remained undisturbed, many dating from the later prehistoric or Roman periods. Although not covering the whole area, the recent lidar survey was a main source of information and provided an accurate georeferenced 3D record of many of the earthworks.

The lowland, West Wiltshire, project area had more extensive historic and modern arable cultivation that levelled many archaeological earthworks in the past and more recently. Here, the earliest aerial photographs, usually from the 1940s, were an important source for sites prior to conversion of pasture to arable in the post-war period. These aerial photographs recorded extensive earthwork remains of medieval and later field systems and some earthworks with potentially earlier dates. Where available, the lidar was still useful for identification and mapping of archaeological earthworks in pasture, and more rarely in areas of arable. Conversely, the relatively large areas of arable revealed the buried remains of many pre-medieval settlements and fields that were seen as cropmarks.

The evidence so far in the South-West Cambridgeshire project area is also complex and includes a very large system of field boundaries, many medieval or later in date but some of potentially earlier origin. These extend across modern fields in arable cultivation and the lidar proved invaluable for recording these slight earthworks. Aerial photographs recorded the buried remains of a variety of Iron Age and Roman settlements and fields seen as cropmarks.

The field survey element for the upland and lowland pilots used similar methods with slightly different responses due to the nature of the landscapes and the archaeological evidence. In both upland and lowland areas, fieldwork targeted archaeological sites and landscape questions identified during the aerial survey. This added detail and better understanding of chronological relationships at key sites seen as earthworks and rapid prospection identified some new sites.

Geophysical survey in the upland project included a test of a large 'blank' area from the air, a site seen as a cropmark but not investigated further, and the earthwork sites identified for archaeological intervention. The lowland work mainly targeted cropmark and earthwork sites prior to excavation.

In the lowland area, excavation, scientific dating and environmental work investigated two sites comprising buried remains revealed as cropmarks and a site mainly seen as earthworks. The Upland pilot, however, was tailored to test how we might best characterise the ubiquitous earthwork survival.

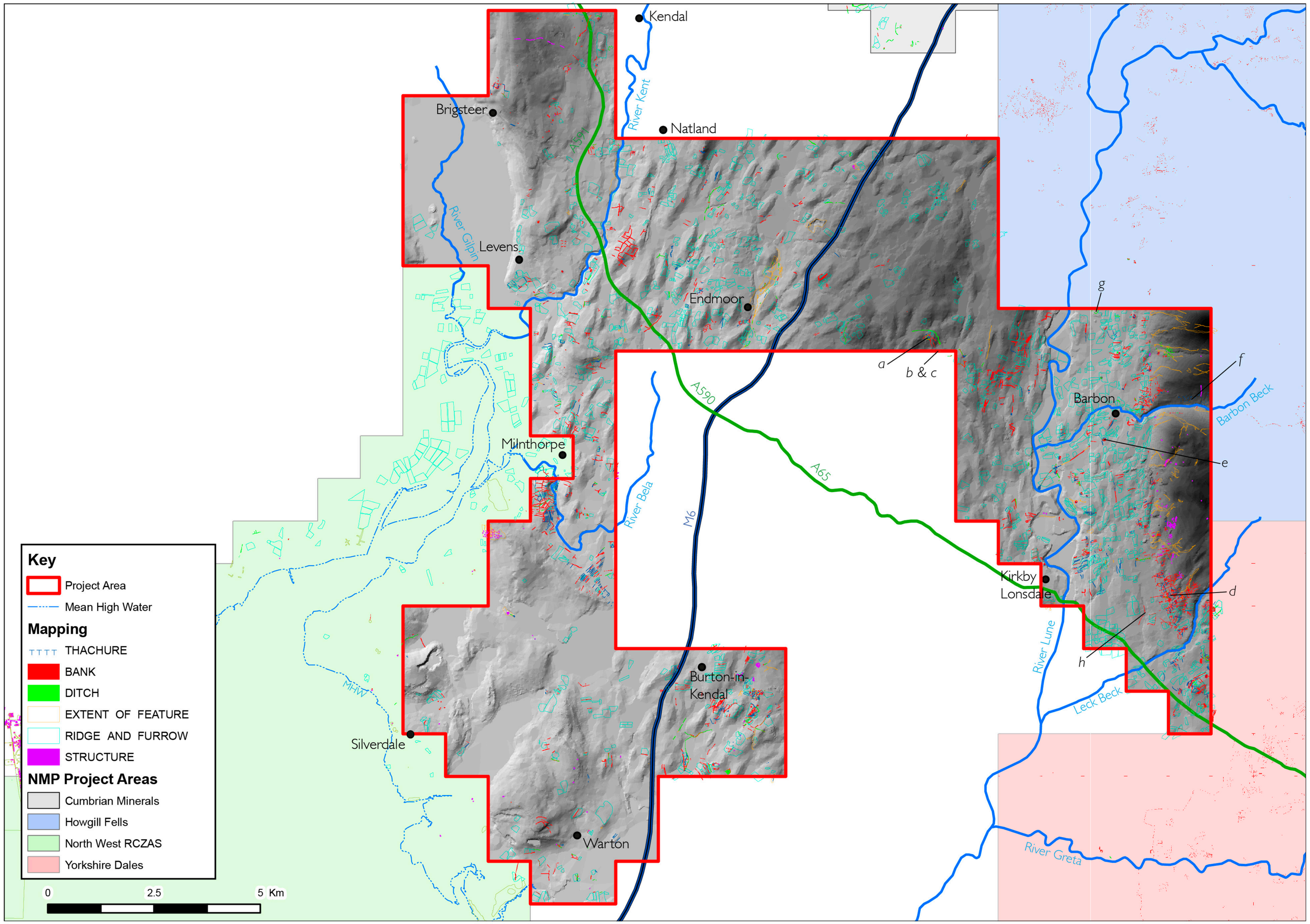


Fig 9: Results from the air photograph and lidar mapping. Locations of sites targeted for geophysical survey and archaeological intervention are marked as (a) Kitridding Hill; (b) Kitridding Farm; (c) Kitridding Mire; (d) High Park; (e) Howerigg; (f) Barbon; (g) Millbeck Farm and (h) Gowrey Farm. Height Data – ©Bluesky International/Getmapping PLC.

METHODS, SCOPE AND SOURCES

The following section briefly summarises the methods used during the project. This includes a discussion of the benefits and limitations of these methods in this landscape. Consideration is given to how best to integrate these methods and how the work could inform and focus future investigations in the project area or wider region.

Further details of the methods and scope for the individual project stages are in **Appendices 1–4** except the field survey which is described below.

Air photograph and lidar mapping

The project began with interpretation and mapping from air photographs and lidar, to NMP standards, for the whole of the project area. Adjacent projects (Fig 9) which used NMP standards include, to the west, the North West Rapid Coastal Zone Assessment Survey or RCZAS (Bacilieri *et al* 2009), and, to the east, the Yorkshire Dales and Howgill Fells Pilot NMP projects (Horne and MacLeod 1995). The Howgill Fells project mapped whole Ordnance Survey 1:10,000 scale quarter sheets so covered parts of Yorkshire and Cumbria but the Yorkshire Dales mapping only extended to the county boundary. Although not abutting the NAIS project, one of the 11 survey areas mapped as part of the Cumbrian Terrestrial Mineral Resource Assessment (Deegan 2013) is located 2km to the north.

This report concentrates on results within the NAIS project area but it is important to stress that the archaeological landscapes recorded continue across project boundaries. Future work in the region will be able to draw on the combined results of each project. In places this will allow analysis of a continuous landscape transect from the west coast to the eastern edge of the Yorkshire Dales National Park.

Air photograph and lidar interpretation, mapping and recording were undertaken by the Aerial Investigation & Mapping team based in York and Swindon. Full details of the methods, scope and sources are in **Appendix 1**.

The scope included all archaeological features ranging in date from the Neolithic to the 20th century. The distribution and type of archaeology recorded is defined by the nature of the archaeological evidence visible on air photographs. This usually includes surface features defined by ditches, banks or stonework and subsurface remains visible as cropmarks, soilmarks or parchmarks. Features defined as structures in a military or industrial context are also routinely recorded. The project scope included archaeological features that were visible on historic air photographs but have since been plough-levelled or removed.

Aerial photographs were consulted from the English Heritage (now Historic England) Archive, Cambridge University Collection of Aerial Photography (CUCAP), images supplied to Historic England through the PGA (now APGB) agreement by Next Perspectives, Local Authority HERs and Google Earth. The vertical photographs ranged in date from 1945 to 2011 and oblique photographs from 1932 to 2012. Environment

Agency airborne laser scanning data (lidar) flown in 2008 and 2009 were supplied through Geomatics as 1m resolution gridded ASCII data. This was processed to produce 16 direction hill shaded images as GeoTIFFs. Non-photographic sources included NRHE and HER monument and event records, Ordnance Survey mapping, from the earliest to current editions, soils and geology maps, archaeological reports and publications.

The main products of the aerial mapping phase comprised a GIS dataset created in AutoCAD (Fig 10) and monument records created or amended in the NRHE AMIE database. The GIS data are accessible for staff via the Historic England corporate GIS and are publicly available on request from the Historic England Archive. The NRHE monument data are available to staff via the corporate GIS or AMIE and are publicly accessible on the PastScape website (http://www.pastscape.org.uk). All data were supplied to the Cumbria, Lancashire, Lake District and Yorkshire Dales HERs and the Arnside and Silverdale AONB.

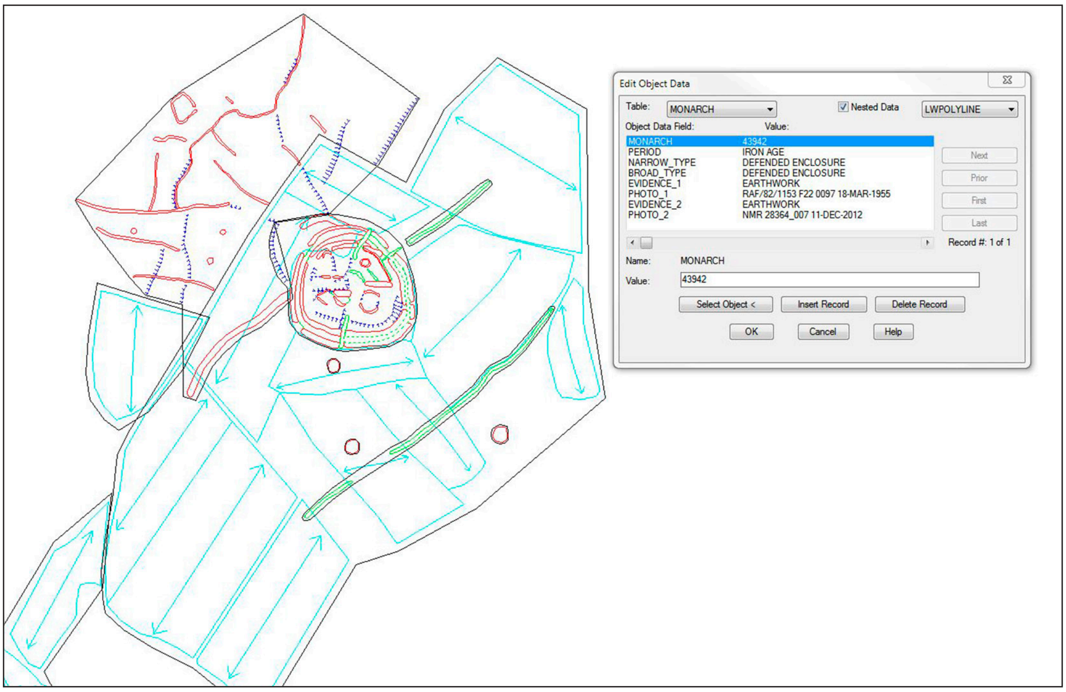


Fig 10: Aerial mapping of the landscape around Castle Hill showing features ranging in date from the prehistoric to post medieval periods. The AutoCAD object data table records selected information to allow easy interrogation and analysis. © Historic England.

The mapping conventions were based on the form of remains, such as bank or ditch, and included a polygon defining the extent of the features described in the relevant NRHE monument record. The layer structure is listed in **Appendix 1**. Selected monument data were attached to the mapping (see **Appendix 1**) equivalent to a sub-set of the information in the relevant NRHE monument record. Where ground-based stages enhanced the results of the aerial survey by providing more information on the date or function, the attached data were amended and NRHE records updated to reflect this.

The monument records comprised location information, indexed interpretation, description of the main components of the site, details (where relevant) of previous site investigations, other numbering schemes such as HER or National Heritage List for England (NHLE) records, and the main sources.

Lidar was considered the best aerial source due to the almost complete coverage of the project area (Fig 11) and the high percentage of archaeological features visible as earthworks. There was relatively little levelling of archaeological earthworks between the 1940s, usually the date of the earliest air photographs, and the very recent date of the lidar survey. This is in contrast to many other areas where the earlier air photographs often provide the only information on earthworks ploughed level since the 1940s. Although there were instances where air photographs were used in preference to lidar, these were relatively rare. They included the few examples of slight features such as cord rig cultivation (Fig 12) or buried features revealed as cropmarks (Fig 26). However, a key role of the air photographs was to inform interpretation of lidar data.

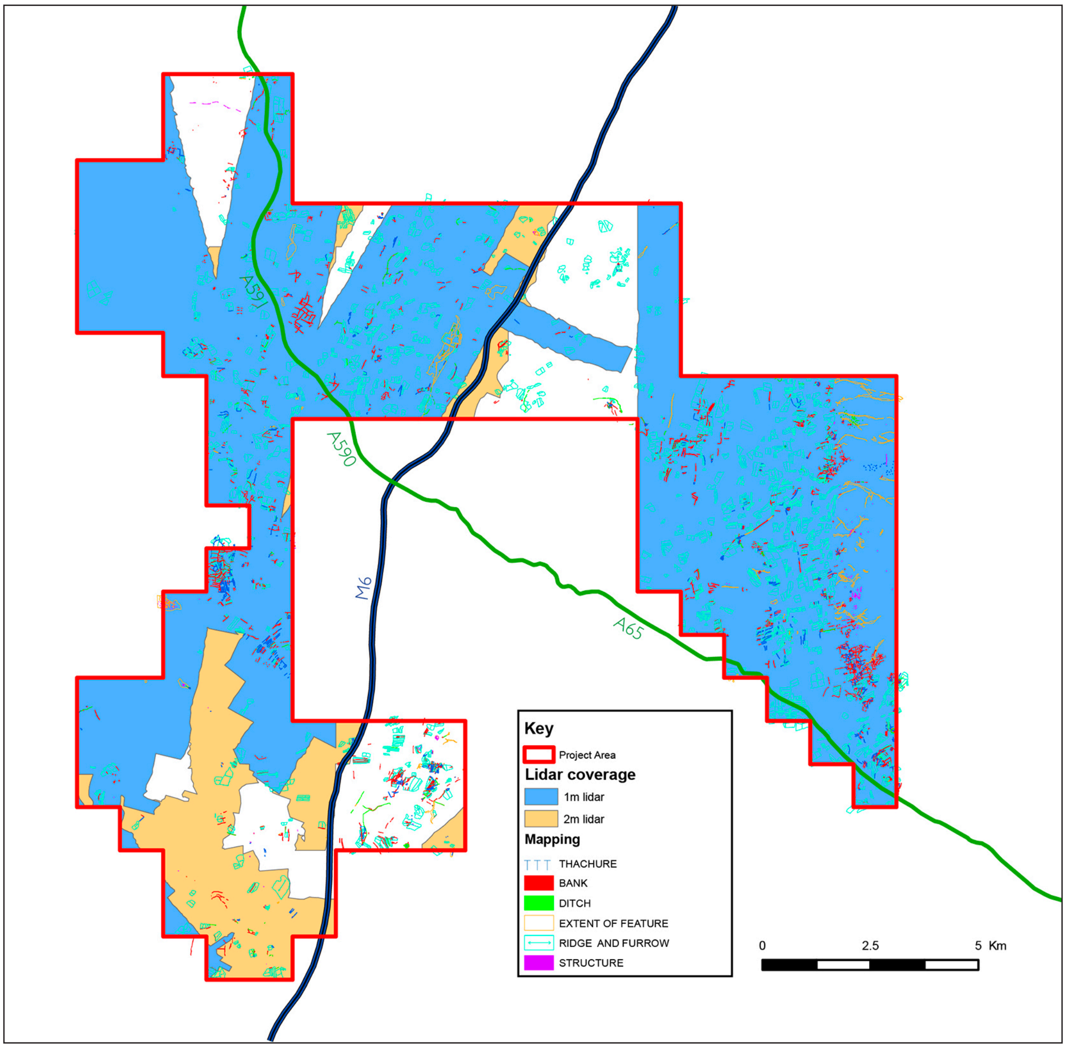


Fig 11: The coverage of Environment Agency lidar in relation to the results of the air photograph and lidar mapping.

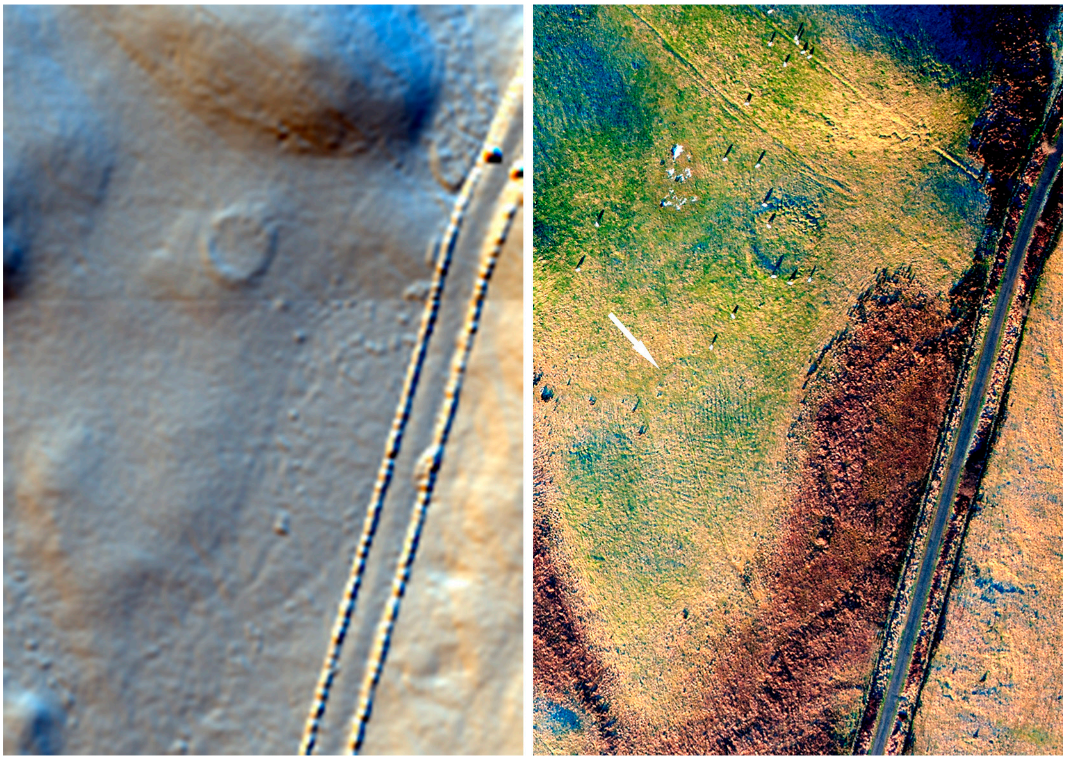


Fig 12: Traces of very fine prehistoric or Roman cord rig (1574168), indicated by the arrow, are visible on the enhanced photograph (right) but are too slight to be picked out in the lidar data (left). Lidar image © Historic England; source Environment Agency. Photograph 28366/7 11-DEC-2012 © Historic England.

The nature and distribution of oblique and vertical aerial photographs had an impact on the amounts of archaeological information recorded and is discussed in **Appendix 1.** Where lidar exists, and there has been a low level of ploughing in the last 50 years, there should be a high degree of confidence that archaeological earthworks will be recorded by airborne laser scanning. This certainty is lower in areas where land use is not conducive to survival of archaeological earthworks, vegetation is too dense for the laser scanning to reach the ground or the lidar data is of relatively low resolution. This is a particular consideration for archaeological prospection when gaps in the lidar coverage coincide with low densities of vertical and oblique photography.

Much of the south-western part of the project area lies within the Arnside & Silverdale AONB and is covered by woodland or scrub. Coverage of 1m resolution lidar for this area is quite sparse but is supplemented by more extensive 2m resolution data. The area also has high concentrations of generally good quality vertical air photograph cover that should have enabled the identification of earthwork sites (if they existed) in open terrain. Relatively few archaeological features were identified from aerial photographs in open ground in this part of the project area, so it is reasonable to assume that the woodland had a similar low monument density.

As discussed below, the nature of the lowland wetlands in the south-west of the project area and the Lyth Valley mean they are not conducive to the identification of archaeological features. These areas require specific approaches beyond the project remit and were already the subject of detailed study as part of the North West Wetlands Survey (Middleton *et al* 1995; Hodgkinson *et al* 2000).

The gap in the lidar coverage to the east of the M6 in the northern part of the project area (Fig 11) coincides with the lowest density of vertical photography and has very few archaeological features recorded. It is possible that the distribution and nature of archaeology mapped from air photographs in this area has been biased by the lack of adequate coverage so the probability of identifying additional features through field survey is higher than elsewhere.

Because the soils, geology and land use in the region are not conducive to cropmark formation in all but the driest years, it has not been subject to regular reconnaissance flights like other neighbouring areas. Therefore, it is probable that cropmark sites are under-represented and continued reconnaissance is required to address this.

Fig 13: Low winter sun reveals subtle detail of an Iron Age/Roman settlement at Gillsmere (1574268) along with medieval or post medieval ridge and furrow ploughing. The settlement is situated in an area with no lidar and was not identified until 2012. 28366/33 11-DEC-2012 © Historic England.

Rapid and analytical field survey

As already stated, most archaeological remains recorded by the aerial mapping stage of the project survive as earthworks because of the largely upland character and pastoral nature of the modern landscape. Given the large area and the limited resources allocated, only a handful of sites could be the subject of a Level 3 analytical field survey as defined in Ainsworth *et al* 2007. Therefore it was decided to carry out rapid field investigation and assessment of as many sites as could be visited in the time allocated to verify and, if possible, expand on the date, function and significance attributed to them by the aerial survey. Although the existing reports were frequently refined and enhanced, especially by the addition of a description of landscape context, in very few cases were interpretations radically altered. Such visits, however, served a number of useful secondary purposes, namely: acting as a general reconnaissance and overview of the resource; enabling the identification of targets for subsequent examination by geophysical survey, palaeoenvironmental investigation and targeted small-scale excavation; and last but not least enabling landowners to be identified and contacted for permission to carry out such investigations.

Sites selected for rapid field investigation were normally those which fulfilled one or more of the following criteria, broadly corresponding to objectives O3, O5, O6, O9–11 and O14-16 in the Updated Project Design (Oakey *et al* 2013, 15). That is they:

- lay within the proposed National Park extensions.
- had the potential to inform the Arnside & Silverdale AONB Management Plan Review.
- were newly identified or at least had not previously been visited by Archaeological Field Investigators (whether working for the Ordnance Survey, RCHME or English Heritage), and therefore had the potential to yield information that was new to local HERs and the NRHE.
- were of a form and date which could not be confidently determined from aerial imagery alone.
- were already designated but had amendments proposed to their detail and extent on the basis of aerial mapping.
- were identified as potential new designation candidates by aerial mapping.

The aerial transcription together with other datasets such as historic Ordnance Survey mapping was uploaded to a hand-held mapping-grade GNSS device and taken into the field. This proved invaluable for locating mapped sites, checking positional accuracy and completeness of depiction but most importantly for assessing the quality of interpretation of the associated textual records.

A 'long list' of sites selected for assessment is in Appendix 2 of the Updated Project Design (Oakey *et al* 2013). Not all sites could be visited, largely because of issues of time or difficulties in identifying and contacting landowners and tenants. There was no systematic search for new discoveries but new sites were recorded as and when they were encountered - eg a ruinous dovecote at Yealand Storrs (1592355) (Fig 14) which was recorded in the HER but not on the NRHE. In the end, 86 of the 109 sites on the original list were assessed in the field, 28 sites were added to the list during the course of fieldwork and 16 new sites identified on the ground. Therefore, 130 NRHE site records were either created or enhanced by field investigation. Most (87) of these 130 were in the eastern part of the project area, but this merely reflects the greater degree of earthwork survival in and around the Lune valley and on the upland flanks of the Yorkshire Dales massif compared to areas further west (see **Nature and Distribution of Archaeological Remains** below).

Fig 14: The ruins of a probable medieval dovecote at Yealand Storrs. This is an example of the kind of sites identified during field survey, enhancing the results of the aerial mapping. © Historic England, Rebecca Pullen.

The field assessments corresponded broadly to Level 2 survey (as defined in Ainsworth *et al* 2007, 23), namely basic descriptive and interpretative textual records. The existing aerial transcription of the monuments' form was deemed sufficient to serve as the surveyed plan element required of a Level 2 record, and no attempt was made to alter or update these in the field. Although on occasion limited schematic mapping was undertaken using the hand-held GNSS device (accurate to under 1m), this was simply to record the map position of unrecorded features or as an *aide-memoire* for stratigraphic or other pertinent detail not apparent from aerial imagery to aid the later write up of the textual record.

No survey was undertaken of any of the new monuments discovered with the exception of adits on Casterton Fell (1583408) which happened to form part of one of four sites chosen for subsequent more detailed survey and earthwork analysis at Level 3. However, those earthwork surveys were undertaken as training for the HLF/IfA-funded HEP (Ian

Hardwick), not as an integral part of the project. Centre points for remnant shooting butts at Barbon (1589059) were also taken.

All field accounts were entered as new or enhanced NRHE monument records directly to the AMIE database.

Geophysical survey

The 'long list' of sites selected for field assessment described above was reviewed to determine where ground-based geophysical survey might provide further information to answer unresolved questions. Selection was based on the likelihood for further subsurface remains with no surface expression and therefore not detectable by other forms of non-intrusive survey. The list of potential targets for geophysical survey was then prioritised in consultation with colleagues in Designation Team and at the local HER to determine those sites where any additional information would be most valuable. As a result four sites, all situated in the Lune Valley, were selected and the specific reasons in each case are outlined in **Appendix 2**.

Fig 15: The caesium magnetometer towed array being used at Millbeck Farm. © Historic England, Pete Horne.

A defining feature of the NAIS methodology is to carry out a rapid assessment of the area in question with minimal resource investment. For this reason, geophysical survey was largely restricted to use of magnetometry which can cover large areas quickly and responds to a wide range of different types of archaeological remains. The predominately Silurian geologies of the region have seen comparatively little archaeological geophysical survey in the past and are amongst those believed to be less favourable for magnetometer survey (English Heritage 2008, 15). Hence, it was decided to trial a prototype towed array of high sensitivity caesium magnetometer sensors (Fig 15) to gather the magnetic data for the project as this promised high speed data acquisition at high resolution. Although there was relatively little scope for testing other techniques, a trial area of vehicle towed ground penetrating radar coverage (GPR) was measured at Kitridding Hill over the earthwork remains of the enclosure.

All geophysical survey was carried out in accordance with the guidelines for best practice set out by English Heritage (2008) and technical details of instrumentation and systems employed are described in **Appendix 2**.

Excavation and palaeoenvironmental work

Two phases of interventions took place as part of the pilot project at three sites: i) Barbon Park, Barbondale, ii) Kitridding Farm, Lupton (near Kirkby Lonsdale), and iii) High Park. The over-arching aim was to confirm and enhance the interpretations of the features as derived from the aerial mapping. Where previous detailed survey had been carried out, notably at High Park (Jecock 1998) but more recently at Kitridding Farm, those results were used to inform the selection process of the features to be targeted, and more specifically, the location of trenches.

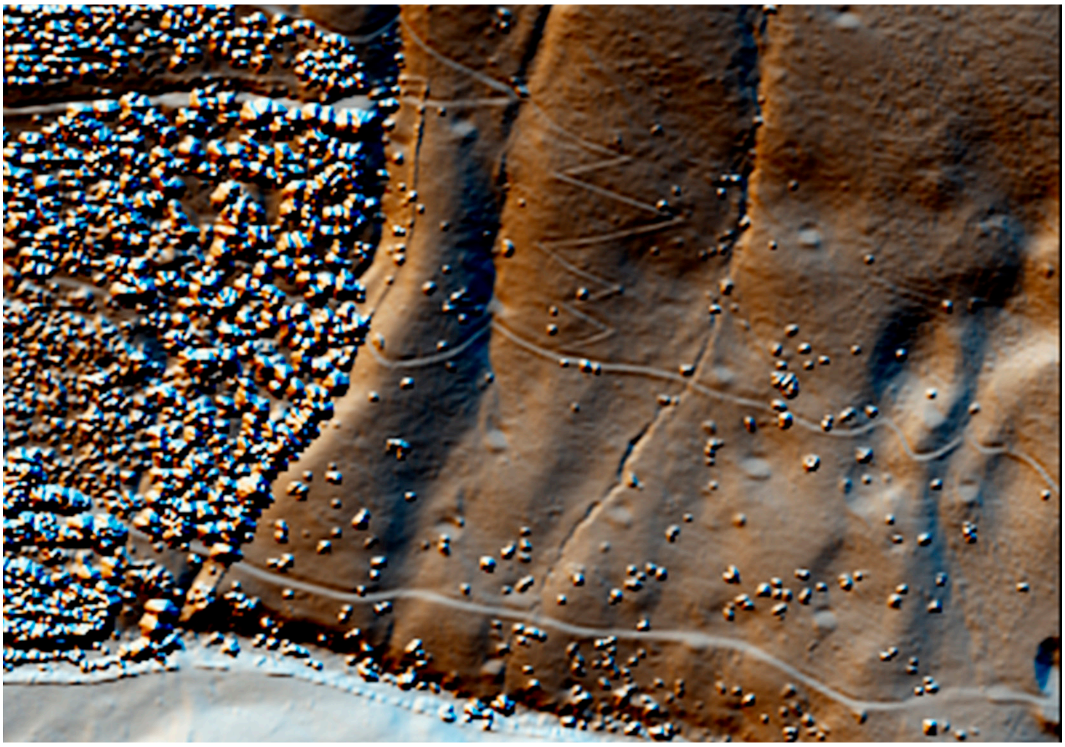


Fig 16: Lidar image showing charcoal burning platforms at Barbon Park (1574919), terraced into the hillside. © Historic England; source Environment Agency.

At Barbon Park, a series of charcoal burning platforms (CBPs) were the subject of small-scale excavations (in 2013), with the main aim (once confirmed as CBPs) of recovering charcoal for radiocarbon dating and wood charcoal analysis. The group of CBPs to the east (1574919) of Barbon Wood (Fig 16) was selected for excavation, as these were more-clearly defined features than the more subtle earthwork remains of the group to the west (1575141) of Barbon Wood. Within the eastern group, three individual platforms were selected on the basis of: i) ease of access (the platforms are terraced into the sloping valley side, and had to be accessed by foot), ii) shape and form of the remains (preference was given to some of the better-defined platforms, one of which had stone revetments at its rear and front slopes), and iii) distance from Barbon Wood (works could not be carried out on any platform close to the wood due to pheasant rearing). The western group was investigated in order to determine whether these were also CBPs. Two platforms were cored using a Dutch auger and the recovered sediment was examined in the field for the presence of charcoal. The platforms selected here were chosen on their ease of identification in the field.

The work at High Park and Kitridding Farm took place as part of the same, later phase of interventions (in 2014). The over-arching aim of this phase was to attempt to scientifically date a selection of earthwork features (field boundaries at High Park, and a settlement feature at Kitridding Farm) and compare the results to their purported ages based on the morphology of the mapped features. This phase included two stages of work: i) an initial preliminary coring exercise recovering sediments to assess their suitability for OSL-dating, followed by ii) a small-scale excavation at Kitridding Farm (the only one of the two sites where the OSL-dating was deemed to have potential) to recover samples for dating (namely OSL samples, but also charred plant remains for radiocarbon dating). An advantage of the Kitridding site was the adjacent wetland, Kitridding Mire, that was also sampled (by coring) for recovery of waterlogged organic remains to determine whether the wetland site had the potential to provide a palaeoenvironmental record contemporaneous with the period of the settlement enclosure's occupation. Excavation of the nearby enclosure on top of Kitridding Hill (43113) was also proposed to complement the rapid field and geophysical surveys carried out on it (Linford *et al* 2013), but the necessary permissions were not obtained.

The work will be signposted using the Archaeology Data Service's OASIS database. Results will be published in an appropriate journal.

Further details of the methods, scope and sources are in **Appendices 3–4**.

Recommendations and conclusions

- Large area or landscape-scale research projects should include mapping from aerial photographs and lidar to NMP standards as an early stage.

- The use of lidar data is strongly recommended to identify and record archaeological features in landscapes with low levels of historic or modern ploughing. This should always be combined with analysis of other aerial images.

- Rapid walkover survey may need to be used in wooded areas, especially where lidar data are missing, although this has severe implications on the time and resources necessary and a reasoned case should be made before prospection is attempted.

- Air photo and lidar mapping should be used to target and prioritise rapid field investigation, which is itself a necessary precursor to the selection of sites for analytical survey or other ground-based techniques. Deployment of complementary techniques depends on understanding of aerial survey results (eg do we have 'unresponsive' areas where other survey techniques are required for identification?) and research questions (eg is there a need to more fully understand the function, dating and significance of a site or class of monument?).

- Uploading the aerial transcriptions to a hand-held mapping-grade GNSS device is an efficient means of carrying out rapid field investigation to enhance understanding of transcribed sites.

- Sufficient time should be allowed for the synthesis and analysis of data derived from different project stages. This will ensure that decisions to target ground-based stages will be well informed.

- Small-scale targeted intervention within a research-led framework – with a focus on recovering material suitable for dating or where an uncertain stratigraphic relationship can be resolved – is an effective way of applying limited resources.

- While the geologies of the region (Carboniferous and Silurian siltstones as well as Carboniferous mudstones, sandstones and conglomerate) were considered to be difficult, magnetometer survey should be considered as a component of any ground-based survey. The project results demonstrated that magnetic anomalies are developed over sites of past occupation, although these are weak, typically in the 1-2nT range. Where possible, high sensitivity instruments and methods to reduce measurement noise (eg cart or sledge mounted array systems) should be used.

- Further work is required to test the potential of geophysical techniques other than magnetometry in the region, particularly earth resistance survey and ground penetrating radar (GPR) but also electromagnetic induction. A test survey using GPR at Kitridding Hill showed promise but logistics precluded further tests with the single-channel instrument available at that time. GPR and earth resistance survey may prove valuable for mapping the internal organisation of settlement sites such as those at Kitridding and Howerigg.

- When considering using OSL dating, it is essential to carry out initial investigations into the suitability of the sediments to the technique. This is particularly important where sites are likely to be relatively young and remains of interest are shallow.

NATURE AND DISTRIBUTION OF ARCHAEOLOGICAL REMAINS

Form and distribution of features

The distribution and form of archaeological features recorded during the project was influenced by the techniques applied and a combination of soils, geology, topography and land use. The nature and scale of the survey excluded a range of evidence from the project results such as small finds, intact architectural remains or detailed documentary research. Where this evidence was readily available, such as NRHE/HER records, it was used to inform the results of survey and analysis.

Apart from excavated sites, few pre-medieval features identified by the project correlated with other forms of evidence such as find spots. In part, this reflects a dearth of previous archaeological work but is also due to the nature of the landscape – largely permanent pasture and marginal land – being unconducive to surface recovery of artefacts via field walking. Conversely, there is considerable scope for future research into the medieval and post medieval landscape to incorporate the results of the project with documentary evidence and architectural survey. Work such as that undertaken at Dalton (Newman and Newman 2009) clearly demonstrates the potential of this approach.

The landscape within the project area is varied, ranging from the fells of the Pennines in the east to the estuarine fringe in the west. As a result, the distribution of archaeological monuments recorded on air photographs and lidar (Fig 9) also varied considerably. The lowest densities of archaeological sites were in the Lyth Valley, the Arnside and Silverdale AONB and immediately east of the M6 corridor. The highest density of monuments was east of the River Lune, particularly on the lower slopes of the Pennine fells. As previously mentioned, these archaeological remains were mainly defined by earthworks, or turf covered stony banks.

Prehistoric and Roman settlement and land division were mainly found in the east of the project area, particularly the Pennine fringes and the Lune Valley. These included a high number of settlements and large areas of field systems surviving as earthworks. Fragmentary field boundaries and a small number of enclosures were identified as prehistoric or Roman in the central and western parts of the project area. The extent to which unenclosed settlement is under-represented in the record is difficult to quantify.

There was little evidence of medieval or post medieval ridge and furrow in the Lyth Valley, the Pennine uplands and the limestone escarpments of the Arnside and Silverdale area. Fragments of probably medieval or post medieval field boundaries were identified across much of the project area but were more common in the west, where some field systems were identified. Fragmentary evidence of medieval or post medieval settlement earthworks was more common in the west.

Influence of land use on the form and distribution of results

The distribution and condition of archaeological monuments has been affected by both past and present land use. The predominant current, mainly pastoral, land use meant that relatively high numbers of archaeological remains were seen as earthworks. Arable accounts for a very small percentage of the managed farmland within the project area, although historic photography from the 1940s and 1950s did indicate that this was slightly more extensive in the western part during this period. This lack of 20th-century ploughing has meant that earthwork survival is generally very high compared to other areas of the country that saw post-war arable intensification.

The lack of arable land limited the potential for prospection for buried remains that might appear as cropmarks seen from the air. Buried remains are relatively rarely recorded as marks in grass as this requires extremely dry ground conditions coinciding with aerial photography. The buried remains of an enclosure were recorded as cropmarks in pasture in the Lune Valley (1476760) (Fig 26). This demonstrated the potential for archaeological sites to survive as subsurface features, and to show as vegetation marks from the air, in some parts of the study area. Continued aerial reconnaissance in the correct conditions may yield further results in these apparently 'blank' areas.

Geophysical survey was applied to the cropmark enclosure with good results (Fig 25). As well as revealing more detail of the enclosure itself, it also identified two probable coaxial field boundaries, which were not apparent from the cropmark evidence. This indicates the high potential for subsurface features to be identified with appropriate geophysical survey techniques. Future ground-based work should in part be targeted at these areas to evaluate the potential for subsurface survival and to characterise and date those features.

The extensive evidence of, mainly post medieval, ridge and furrow indicated high levels of grassland improvement or arable cultivation in large parts of the project area. This is particularly so on the freely draining soils in lowland areas where most evidence was seen of ploughing, ranging from medieval cultivation to 19th-century land improvement. In some areas, such as the Lune Valley, pre-medieval earthworks were seen between, or under some of the ridge and furrow. This indicates that the cultivation or improvement was fairly recent and/or short-lived there. However, elsewhere there was little evidence of pre-medieval features. This may indicate a genuine absence of archaeological remains from earlier periods but the greater survival of earthworks in areas of historic parkland and on the fringes of marginal or common land – not just in the Lune Valley – serves to underline what was probably levelled and obscured by past and recent ploughing elsewhere.

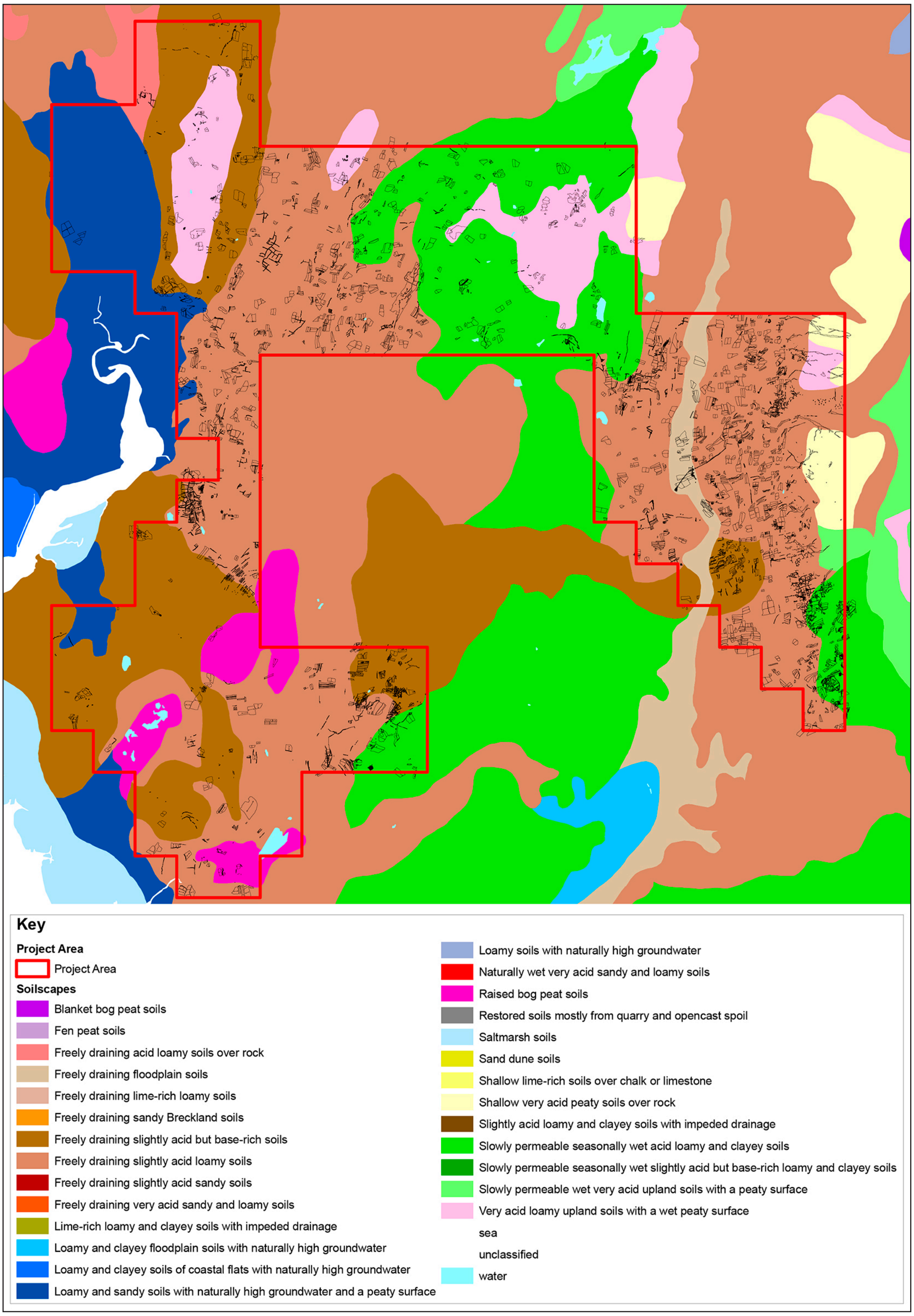


Fig 17: Results of the air photograph and lidar mapping (shown in black) against soils. Soil data © Cranfield University (NSRI) and for the Controller of HMSO 2015.

Form and distribution of features in relation to landscape character

The project area mostly straddles parts of Natural England's National Character Areas (NCAs) 19: South Cumbria Low Fells (Natural England 2013b) and 20: Morecambe Bay Limestones (Natural England 2014). The course of the A65 defines the division between these two areas. The easternmost edge of the project just lies within NCA 21: Yorkshire Dales (Natural England 2013c). Just under 2.5sq km lies within NCA 31: Morecambe Coast and Lune Estuary (Natural England 2013d) and an area of around 1.3sq km lies within NCA 33: Bowland Fringe and Pendle Hill (Natural England 2012).

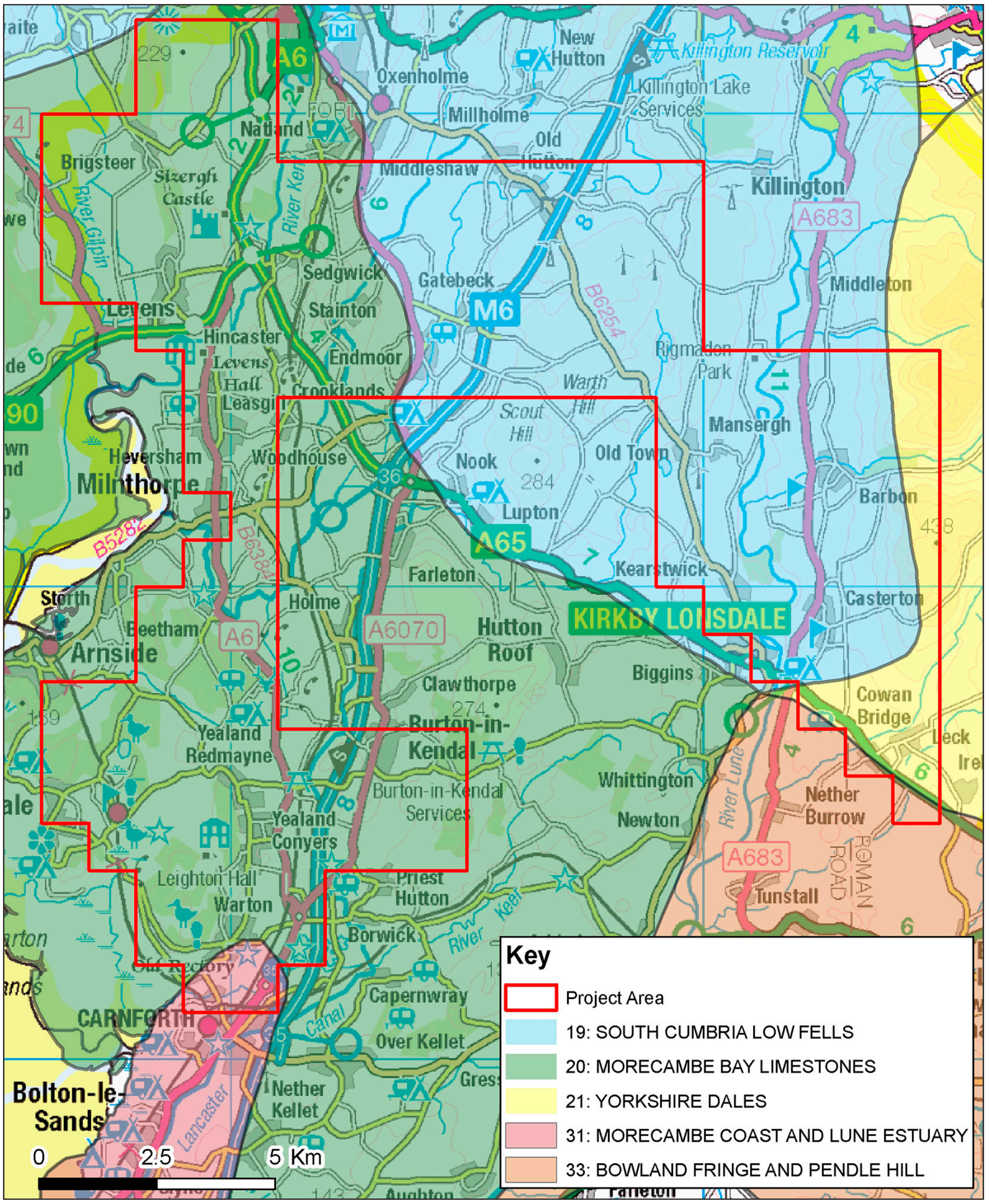


Fig 18: Natural England National Character Areas. Base map © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100024900. NCA data © Natural England.

The following sections consider the distributions of archaeological features in relation to the soils, geology and topography of each NCA from west to east. Broad trends in the data derived from air photographs and lidar along with analytical field survey can be observed but more detailed analysis will be required to establish whether we can identify similarities or differences in the patterns of settlement and land use in the different landscape zones. For the purposes of this report Natural England's NCAs will be used as the definition of a 'landscape zone' but future work may require a more nuanced division. Because of the very limited areas of NCAs 31 and 33, results from these areas are amalgamated with their adjacent NCAs (20 and 21 respectively).

NCAs 20 & 31

NCA 20 lies to the west of the A65 and is a predominantly lowland landscape punctuated by steep limestone escarpments. Soils are mostly freely draining but there is an area of naturally wet and peaty soils along the Lyth Valley. There are also small areas of raised bog peat soils at Leighton, Hale, White, Holme, Burton and Hilderstone Mosses. Most of the lowland agricultural land is Grade 3 (good or moderate) with a mix of Grades 4 (poor) and 5 (very poor) on the limestone escarpments. Woodland is particularly extensive in limestone areas of the AONB where there has traditionally been a link with the production of lime.

NCA 31 covers just under 2.5sq km in the far south-west of the project area between Carnforth and Warton. This area is predominantly low-lying with a maximum elevation of 20m OD. The geology is limestone overlain by clay, silt, sand and gravel at lower elevations. It comprises freely draining slightly acidic loamy soils and raised bog peat soils which are classified as Grade 3 (good or moderate) agricultural land.

Numbers of sites identified from air photographs and lidar in the south western part of the project area (Fig 19) were very low. This is partly because large expanses of woodland, already established at the time of the earliest photography, masked these areas from view. A lack of 1m resolution lidar meant it was hard to assess whether airborne laser scanning would provide a comprehensive enough record of the ground surface below the trees to enable identification of archaeological features. Therefore, it is difficult to assess to what degree the geology and topography has influenced past land use in this area.

It has been suggested that there is high potential for the discovery of earthworks in locations such as the eastern edge of Arnside Moss (Middleton *et al* 1995, 136), but this was not borne out by the results of the NAIS project. Buried landscapes under peat and alluvium are known in the region (Middleton, *et al* 1995, 200) so it is possible that, in places, peat deposits are masking archaeological features. Problems associated with identification of archaeological remains from surface survey and issues affecting site visibility in the Arnside and Silverdale mosses have been noted before (Middleton *et al* 1995, 139–40; 199–201) so are not repeated in detail here. Identification of activities that did not result in the construction of substantial earthworks or stoneworks will therefore probably require ground-based, probably intrusive, work.

Unfortunately in both alluvial and wetland environments prospects for ground-based geophysical prospecting are similarly unfavourable and structural remains under deep alluvial cover or in waterlogged sediments are often undetectable (see for instance English Heritage 2008, 16–17). Within these environments, traditional land based geophysical survey is often most successful where alluvial overburden is shallower and on the wetland margin. Profiling techniques such as earth resistance tomography and low frequency GPR can also be successful in detecting the depths of alluvial peat over more solid deposits which may have indirect bearing on the most likely location of archaeological remains. Hence, given present capabilities, the best strategy to investigate these areas remains aerial and lidar survey in order to initially identify and locate suitable features, linked to a programme of subsequent ground-based augering and test pitting, with geophysics being deployed over less deeply buried or marginal sites.

Interspersed between the limestone uplands and lowland wetlands are small areas of enclosed pasture and few archaeological remains were found in these areas. This apparent lack of remains may be a product of pasture improvement and, to a smaller degree, some of the pasture being reclaimed wetlands.

Beyond the north-eastern limit of the AONB at Beetham Fell, the landscape is lower-lying and more gently undulating. Archaeological remains recorded in this area comprised remnants of medieval and post medieval settlement and field systems; large areas of continuous ridge and furrow survive as earthworks, for example, in and around Dallam Park and Beetham. The pattern presumably reflects the preferred zone for medieval and post medieval settlement, albeit tempered by the inevitable contraction and mobility of settlement foci over time. Superficially they are comparable in form to those in the Lune Valley, indicating that similar patterns of settlement and land use were developing in the medieval period. However, more detailed characterisation, possibly incorporating architectural survey, would be required to confirm this assertion. As elsewhere in the project area, post medieval ridge and furrow is evident across much of the NCA, some of which relates to phases of land improvement.

To what degree the area also represents the preferred zone of prehistoric and Roman occupation is unclear because of this later activity. In the Lune Valley, medieval and post medieval ploughing in the form of ridge and furrow is less common and a large number of early settlements survive as earthworks. This suggests that later land use has been less intensive and destructive than in the west of the project area, possibly indicating that the lack of pre-medieval sites in the west is due to visibility.

The presence of fragmentary earthwork remains of prehistoric and Roman features in Levens Park demonstrated that this landscape was settled and farmed to some degree before the medieval period. This region has mainly freely draining soils, some areas of which are under arable agriculture today, so there is no clear reason why soils, geology or topography would have prohibited more extensive prehistoric and Roman settlement. There is a high probability that the continued cultivation or improvement of these soils has levelled archaeological remains, leaving islands of better survival in emparked areas.

The few later prehistoric settlements that have been identified within NCA 20 are morphologically comparable to those found elsewhere in the project area but far fewer in number. There is no evidence for the large-scale land division observed in the Lune Valley, with just a few fragmentary boundaries identified, but these findings again need to be balanced against issues of site visibility.

The numbers of features identified from the air increased to the east of the A6070 around Burton-in-Kendal. Here, there was a contrast between the steeper slopes and woodland, where earthwork survival is better, and the terrain to the west where there is more land improvement and modern infrastructure (Hardwick 2014, 34).

A combination of low-lying land and damp, peaty soils meant few archaeological remains were identified in the Lyth Valley – similar to the situation in the wetland and former wetland areas of the Arnside & Silverdale AONB. Just five fields of post medieval ridge and furrow were recorded. This area was assessed as part of the North West Wetlands Survey (Hodgkinson *et al* 2000) and the application of intrusive investigative techniques is likely to be required to investigate this area further.

Few features were mapped on the exposed limestone of Helsington Barrows, mirroring the results from the limestone escarpments within the Arnside & Silverdale AONB. This may mean that the surrounding lower-lying areas were favoured in the past or these areas were exploited in other ways, such as for seasonal grazing, which left few physical traces.

East of the River Kent, the area to the south of Kendal is characterised by a more rolling drumlin landscape. The archaeology of this area is characterised by ridge and furrow (largely post medieval in date) and medieval and/or post medieval field boundaries. Again, the presence of quite widespread ridge and furrow highlights the possibility that pre-medieval settlement and land division has been largely levelled or destroyed by subsequent improvement. The presence of Castlesteads Iron Age fort (43089) just over the border in NCA 19 suggests potential for further prehistoric or early medieval occupation in the vicinity.

NCA 19

NCA 19 lies to the east of the A65 and principally comprises Silurian siltstones, overlain in places by alluvium, notably along the Lune Valley. The uplands of Barbon Low Fell, Leck Fell and Middleton Fell are formed of a combination of limestone, siltstone, sandstone and mudstone. The western part of the NCA has a combination of slowly permeable seasonally wet acid loamy and clayey soils and very acid loamy soils with a wet peaty surface but extensive areas of freely draining slightly acid loamy soils lie to the east and west of the River Lune. Barbon Low Fell and Middleton Fell comprise areas of moorland on shallow acidic peaty soils while the area of Leck Fell within the project area is covered by loamy and clayey soils.

Topographically, it is predominantly a rolling drumlin landscape. To the east of the River Lune the topography is more gently undulating before rising up to the Pennine fringe. Most of the agricultural land is classified as Grade 4 (poor) with Grade 3 (good or moderate) along the Lune Valley and Grade 5 (very poor) on the fells. The landscape is divided by a pattern of stone-walled or hedged fields of varying size enclosing the lower-lying land with the fells in the far east remaining unenclosed. There are relatively small areas of isolated woodland.

The combination of soils, geology and topography appear to have had a marked effect on the distribution of archaeological features within NCA 19 (Fig 20). A very low density of archaeological remains was seen in the western part of the NCA and these features mainly comprised isolated pockets of narrow ridge and furrow associated with post medieval land improvement. However, three settlements of probable Iron Age/Roman date are located within this zone at Gillsmere (1574268), Kitridding Farm (43117) and Kitridding Hill (43113); all lie on the edges of former common or marginal land that has seen later attempts at improvement.

The current distribution of archaeological features may reflect a genuinely low density. Although this area could have been occupied or utilised in some way in the past, it appears likely that the poor soils in this area affected the pattern of settlement and land division. Areas of more favourable land lie immediately to the east and west so it could well be the case that the more marginal landscape was not extensively settled or farmed in prehistory. More work to establish to what degree the quality of the present soils reflects those in prehistory would be needed to verify this assertion.

In contrast to the western half of the NCA, the density of archaeological remains along the Lune Valley is considerably higher. To the west of the river is a very undulating drumlin landscape of siltstone. Several isolated fields of post medieval ridge and furrow are recorded, along with contemporary, and often fragmentary, field boundaries. These closely correspond with a band of freely draining soils along the course of the Lune.

There is no clear evidence for pre-medieval settlement or land division in this area, although the possibility that some of the field boundaries attributed a medieval or post medieval date could have their origins in the late Iron Age or Roman periods cannot be discounted. The soils are identical to those found to the east of the river where extensive archaeological remains survive as earthworks on the lower slopes of the fells and fragmentary remains have been identified in the valley bottom. Topography may have influenced settlement and land division – the more regular topography to the east of the river being favoured over the more undulating terrain to the west. Perhaps a more likely explanation, though, is that this disparity is the result of medieval and later land improvement which has levelled earlier features.

The landscape to the east of the Lune is more gently undulating before rising up to Middleton, Leck and Barbon Low fells. A number of apparently isolated enclosures of later prehistoric or Roman date were identified here. Post medieval ridge and furrow ploughing was particularly extensive on the freely draining soils and may have been responsible for levelling older features. The presence of a ditched enclosure and probable coaxial field boundaries, only surviving as subsurface deposits, in the valley bottom hint at the possibility that further settlements and land division were once situated along the valley but no longer leave surface traces.

The densest concentrations of later prehistoric and Roman settlements and field systems are located on the lower slopes of the fells, usually on the freely draining soils. Because of the high probability that prehistoric and Roman features on the shallower slopes of the valley have been levelled by later ploughing, it is difficult to assess how far down into the Lune Valley pre-medieval settlement and land division once stretched. However, based on current evidence, there does appear to be a quite clearly defined upper limit to this band of settlement of around 240m above Ordnance Datum (OD) or sea level. This pattern of settlement and land division is not one that can be observed anywhere else in the project area but, as discussed above, it is difficult to establish to what degree this represents a true picture.

NCAs 21 and 33

NCAs 21 and 33 cover the Pennine uplands in the far eastern edge of the project area and the lower-lying areas to the south-west of Kirkby Lonsdale (Fig 20). Within the project area they principally comprise mudstones, siltstones and sandstones overlain in places by small pockets of alluvium. There are freely draining loamy soils along Barbondale and to the south-east of Kirkby Lonsdale but the fells are covered by shallower peaty soils. On the uplands agricultural land is Grade 5 (very poor) with a mix of Grades 4 (poor) and 3 (good or moderate) at lower elevations.

There is little evidence for settlement beyond the upper limits of the current enclosed land, which was largely established in the 18th century. Very few archaeological features were identified above 240m OD and these principally comprised braided trackways and sheepfolds of post medieval date. This pattern suggests that there is an established tradition of utilising the uplands for seasonal grazing, probably extending as far back as the prehistoric period.

Heather and moorland grass can mask slight banks and ditches or stone-built remains on air photographs and use of lidar may be restricted by dense low vegetation. Ground-based prospection could identify further features in these areas. The more-favourable climatic conditions of sheltered lower slopes and valley bottom locations will have promoted valley settlement, and other activities, such as seasonal grazing and hunting that are likely to have occurred in the more marginal uplands, are unlikely to have left surface traces.

The southernmost part of NCA 21 encompasses the lower slopes around High Park and Leck. The extensive archaeological remains clearly represent a continuation of the topographic zone of settlement remains recorded along the upper valley side to the north in NCA 19. Similarly the lower-lying areas near Kirkby Lonsdale reflect the pattern and density of archaeology observed further up the Lune Valley at lower elevations where later ploughing and land improvement is likely to have levelled earlier features.

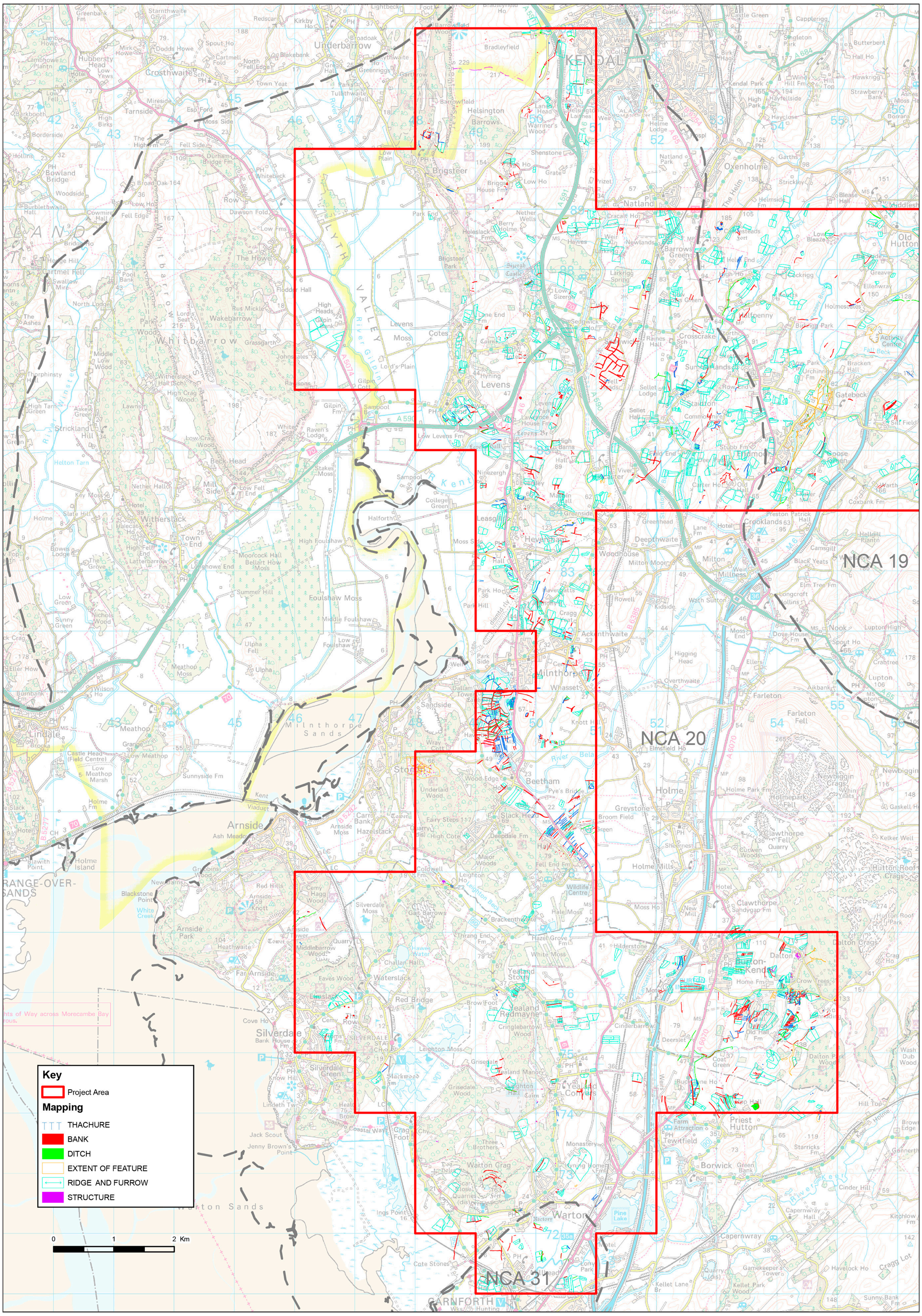


Fig 19: Results from the air photograph and lidar mapping in NCAs 20 and 3. This mainly comprised medieval and later cultivation, field boundaries and fragments of settlement © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100019088.

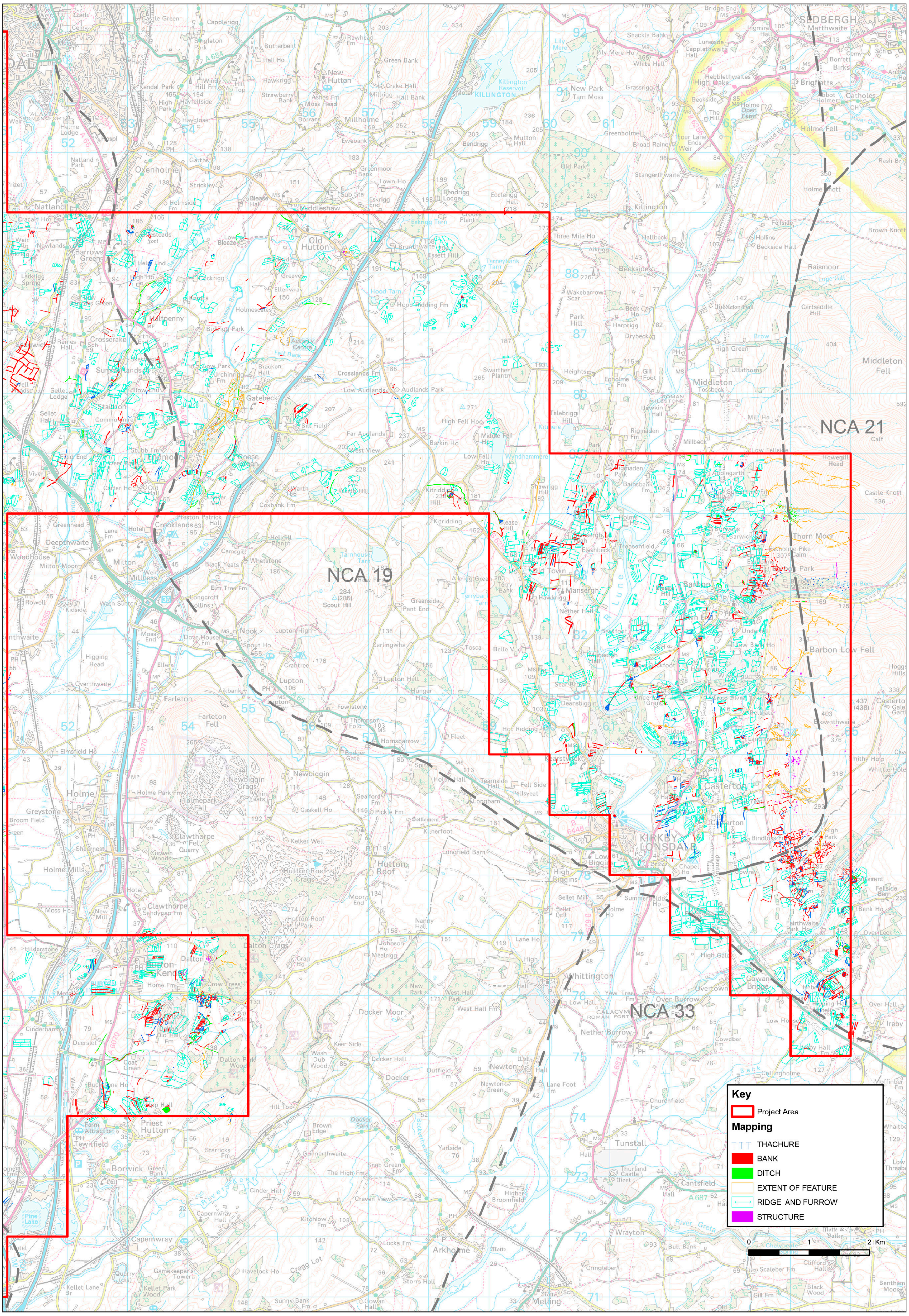


Fig 20: Results from the air photograph and lidar mapping in NCAs 19, 21 and 33 showing extensive later prehistoric and Roman fields and settlements on the eastern fringes of the Dales and medieval and post medieval cultivation further down the valley.

DISCUSSION OF ARCHAEOLOGICAL RESEARCH QUESTIONS

The project set out to address a number of research questions derived from the Regional Research Framework (Brennand 2006, 2007). Other research questions have arisen from the broader aims of the NAIS pilots. The following section summarises how the project contributed to answering these questions and highlights where additional work is required. Specific recommendations for further work are outlined in **Recommendations for Further Work** below.

Archaeological research questions

How well does the current archaeological record reflect the distribution, density, nature and significance of archaeology within the survey area?

A definitive statement on how well the archaeological record reflects the actual distribution, density and nature of past land use is not achievable. This is partly due to the problems associated with dating and site visibility discussed elsewhere in this report. However, the impact of the project on the archaeological record can be assessed and the landscape-scale approach allows for a better assessment of significance. This should provide an idea of the potential for large-scale multi-disciplinary landscape survey to enhance the record in similar landscapes.

The number of monument records created provides a basic indication of the impact of a survey in an area. The archaeological 'site' described in a monument record will vary greatly in date, size and complexity. A monument record might include a single burial mound, or an extensive field system, or a settlement comprising numerous different elements such as hut circles, large enclosures and field boundaries. The significance of these records will vary depending on current archaeological knowledge of an area and the viewpoint of the researcher.

Before the project commenced, there were 661 NRHE monument records for the project area. The aerial mapping phase produced 521 new NRHE records and amended a further 135, representing a percentage increase of about 80%. If we compare only those records that are routinely recorded from the air, (eg excluding finds and buildings) the number of recorded sites was more than tripled by the systematic examination of aerial photographs and lidar. The impact of the survey on the Local Authority HERs was assessed by counting the numbers of new NRHE records cross-referenced with an HER record. This suggested that the project increased the record in Cumbria by about 60% and in Lancashire by 14%. The relatively low increase in Lancashire reflects the limited impact of aerial survey in the Arnside & Silverdale AONB compared to the relative abundance of other types of evidence such as buildings and findspots.

The 16 monument records, serendipitously identified *en route* to other sites, show the potential impact of field survey. However, it does not indicate the scale of what could be achieved by systematic walkover survey of the area.

Figure 21 shows the distribution and density of monuments recorded in the NRHE records before and after the project and illustrates how they have changed. It gives a visual representation of the relative increases in monument records, demonstrating where the greatest impacts – in terms of numbers – have been. The calculation is based on those monuments that fall within or intersect each square kilometre so some large area features may be counted more than once. Ridge and furrow may have multiple monument polygons within the GIS but be recorded under a single monument UID. Each of these polygons will also be counted individually. For this reason the illustrations are indicative of the distribution and density rather than exact figures. These also include monuments that were out of scope for the non-intrusive elements of the project.

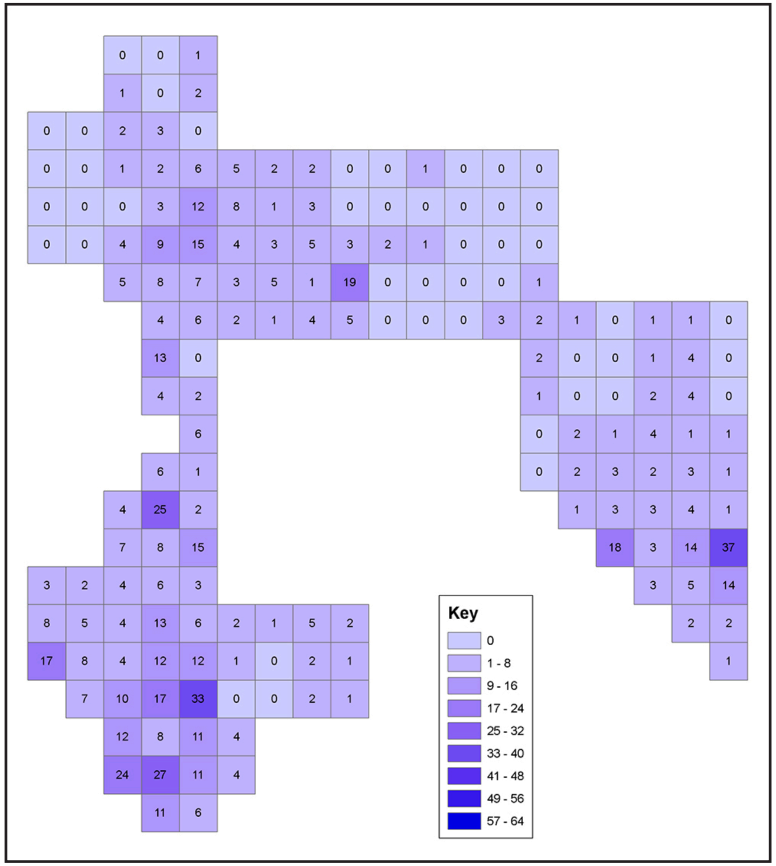
In general terms, many parts of the survey area have seen an increase in monument records with the number of square kilometres that contain no records reduced from 48 to just six. The lowest increases have been in the south-west and north-west and reflect a combination of lack of susceptibility to airborne remote sensing methods and an already low monument record density. Greater increases can be seen in the central and eastern areas, particularly in the Lune Valley and on the Pennine fringe, and indicate that these areas were not as well represented in the existing record.

No new sites of Neolithic or earlier date were identified, indicating that the distribution and density of these sites was well represented in the record – at least in terms of those site types that can be readily identified using the methods employed by the NAIS project. There is undoubtedly potential for further sites to be identified and strategies for this are considered below.

Over 100 newly identified clearance cairns of probable later prehistoric date were identified, almost exclusively confined to the eastern side of the Lune Valley. These are co-located with extensive coaxial field systems and settlements and fill out the previously recognised pattern of later prehistoric and Roman land use. The character of the newly recorded features broadly reflects the site types that were already known in the area so the principal outcome of the aerial mapping has been an increase in the number and density of the remains. Systematic recording and mapping of these features will, however, enable a better understanding of their nature and significance on a landscape scale.

In addition to those monument types that were already well represented in the existing record, the project also identified sites of greater rarity and significance. Two conjoined probable Bronze Age ring cairns (1575283) were recorded in the Lune Valley along with the two further examples noted below (43118 and 44001) which resulted from reassessment of known monuments. In close proximity to one of the ring cairns were traces of later prehistoric/Roman cord rig (1574168), one of only 11 such sites recorded in Cumbria on the NRHE.

For the early medieval period, three new records were added to the 16 already in existence. Reasons for this low number include the rarity of early medieval sites and problems of making identifications based on morphology alone but due to their comparative rarity, any early medieval site represents one of potentially high significance. Any future enhancement of the record for this period is more likely to come from excavation evidence than non-intrusive survey.



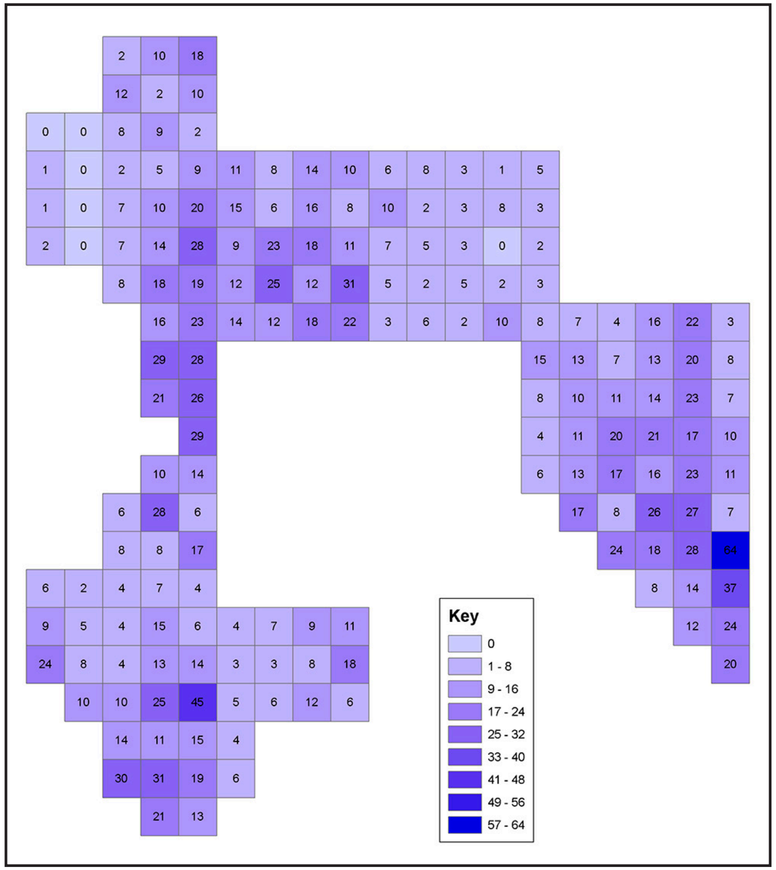


Fig 21: Density of NRHE records per square kilometre before (left) and after (right) the project. Large area features that straddle multiple kilometre squares will be counted more than once.

There were far greater increases in records dated to the medieval period onwards, suggesting that medieval and post medieval sites were significantly under-represented in the record. Many records relate to widespread and common medieval and post medieval features such as lynchets, field boundaries and ridge and furrow. Although not nationally or regionally rare monument types, these are nevertheless important for understanding the development of the landscape.

Comparison between the NRHE/HER and the results of the project suggests that the monument record did broadly reflect the nature, if not the quantity, of the archaeological features in the survey area. Relatively few interpretations in existing records were radically changed but dating of sites was often enhanced. This was particularly so with a number of records for settlements with 'uncertain' or 'unknown' dates which have since been amended to probable Iron Age/Roman dates. Site descriptions were also enhanced in many cases, particularly for sites assessed in the field by EH archaeological investigators.

Re-evaluation of some previously recorded sites has altered their significance. A total of 17 sites were considered likely to meet the criteria for designation assessment and will be subject to a sifting process in due course. The large enclosures at Kitridding Hill (43113), Terrace Wood (44013) and Low Barn (44014) have all been identified as unusual in form and size for the survey area and possibly of a similar date and function to the scheduled 'defended enclosure' at Castle Hill (43942). The circular enclosures at Blease Hill (43118) and Casterton Fell (44001) have both been reinterpreted as probable Bronze Age ring cairns, potentially placing them in a nationally rare category of monument.

The significance of larger historic landscapes has also been enhanced by systematic and large-scale mapping and recording. The Lune Valley, for example, had been previously recognised for the importance of its later prehistoric and Roman settlements and field systems (Higham 1979). Through systematic analysis of aerial imagery and ground-based observations we have been able to develop a more coherent view of this landscape which is more expansive and articulated than existing records indicated. An understanding such as this can only be achieved by taking a broad landscape based approach to understand large-scale trends, patterns and distributions which can then be refined by targeted fieldwork.

Can we identify appropriate strategies for increasing the number of known Mesolithic and Neolithic sites in the region?

Because of the nature of Mesolithic activity, archaeological sites of this period very rarely leave any traces that are detectable on air photographs or lidar. Almost without exception, sites of this date will only be identified through ground-based techniques such as field walking (eg regularly monitoring eroding deposits) and excavation. Targeting deposits such as upland peat sites (eg as per the North East Yorkshire Mesolithic Project (Waughman 2015)), could yield evidence of early human activity in the form of artefact remains. The overlying, waterlogged peat deposits are themselves good archives of organic and palaeoenvironmental remains (eg pollen) that can provide information on past activities and the landscapes in which they were taking place.

Using geophysical survey as a prospecting technique could also help discover sites. This was demonstrated at Kingsdale (Thornton in Lonsdale, North Yorkshire) which lies 8.5km east of Kirkby Lonsdale. Here, an excavation by a local archaeology group at the location of a geophysical survey anomaly, revealed remains of what is reported to be a Mesolithic burnt pit (see Howard, 2007); charcoal from the feature was radiocarbon dated to 7030-6640 cal BC (95% confidence) (7900+/-35 BP; SUERC-11499) (see Batty and Batty, 2007). Small wetland sites within the karstic landscape could also yield archaeological (as well as palaeoenvironmental) remains. These are often found in clusters of 'springs', 'ponds', 'swallets' and 'sinkholes', for example, at Leck Fell (mapped on Ordnance Survey maps).

Remotely sensed imagery, particularly lidar, may provide contextual information on geomorphology such as the location of palaeochannels so its use should be considered alongside other techniques. Geomorphological mapping techniques may also prove useful for identifying discrete small waterlogged features (as outlined above). Unfortunately, mapping of geomorphological information was not within the scope of the project so will only have been noted where relevant to a known archaeological site. This was the case at Kitridding where waterlogged deposits ('Kitridding Mire') sit adjacent to the settlement feature – although the ages of the settlement and the organic deposits are yet to be resolved.

There are very few records relating to Neolithic activity in both the NRHE and HERs and most describe find spots. A field survey identified a potential long cairn at High Park and the possibility that some of the round cairns may have late Neolithic origins was proposed (Jecock 1998). No other features were identified that could be confidently dated to the Neolithic period due to an absence of morphologically distinct Neolithic ceremonial monuments, such as causewayed enclosures, cursus monuments, long barrows, etc. It is also partly due to a current lack of understanding about the nature of Neolithic settlement and some ceremonial activity.

Analytical field survey may be able to identify further potential Neolithic monuments through subtleties in phasing and chronology, which were not evident from the remotely sensed datasets. However, it is more probable that any strategy to increase the number of Neolithic sites will rely heavily on intrusive survey and scientific dating. Further work on the characterisation of Neolithic monuments in the region could help inform future work by identifying morphologically distinct site types. It may also be possible to identify Neolithic phases at sites that have had a continuity of use into later periods or reuse after a hiatus and are currently recorded as Bronze Age or later in date.

Does the current archaeological record for later prehistoric and Romano-British rural settlement reflect the true geographical distribution of settlements of these dates?

The term settlement was assigned in the record to enclosures that contain features such as hut platforms or have evidence of internal sub-divisions. Where sites have no evidence of internal structures they were simply described as 'enclosure'. It is likely that sites identified as settlements performed multiple functions and that some of the 'enclosures' contained or were closely associated with settlements.

It is hard to quantify to what degree unenclosed settlement is under-represented in the record due to the lack of archaeological intervention in the region and the difficulties recognising unenclosed Iron Age settlement have been noted before (Hodgson and Brennand 2006, 53). Slight earthworks such as hut platforms and drip gullies are likely to have been levelled, destroyed or the subsurface remains of such features may not be substantial enough to cause cropmarks. The drip gullies or slot trenches of buried round houses can be identified from the air but the land use and soils in the project area are not usually conducive to cropmark formation. Therefore, unenclosed settlements are more likely to be identified by other methods.

The aerial investigation and field survey stages suggest a marked variation in the distribution of later prehistoric and Roman settlement but this is almost certainly a reflection of post-Roman land use, medieval and later ploughing and land improvement in particular, as discussed above. However, the presence of a ditched enclosure at Millbeck in the Lune Valley (1476760) (see Fig 26), identified from a cropmark and further explored through geophysical survey (see Fig 25), demonstrates the potential for further discoveries through a combination of continued aerial reconnaissance and other investigative techniques such as geophysics.

Of the 44 settlements identified of probable later prehistoric (potentially Bronze Age onwards) or Roman date, most were clustered along the edge of the uplands on the eastern side of the project area (Fig 22). Seven of the settlements were additions to the archaeological record.

The project has enhanced knowledge of the extent and range of forms of settlement and field systems. Relative chronology of components of sites and adjacent features is possible but dating of the settlements more precisely than the later prehistoric and/or Roman periods, is difficult. This is due to the largely aceramic nature of the material culture of the region prior to the medieval period coupled with the lack of modern excavation and recovery of samples suitable for absolute dating. Without such work it is impossible to know when and for how long individual settlements were occupied, and therefore which are contemporary and which represent settlement growth or shift over time.

A settlement at Kitridding Farm (43117) was chosen for further investigation. Small-scale excavation was trialled with the key aim of recovering samples suitable for scientific dating. It was hoped this could provide a model for similar interventions at sites elsewhere in the region. Another objective was to trial the use of Optically Stimulated Luminescence (OSL) dating for settlement earthworks in upland contexts.

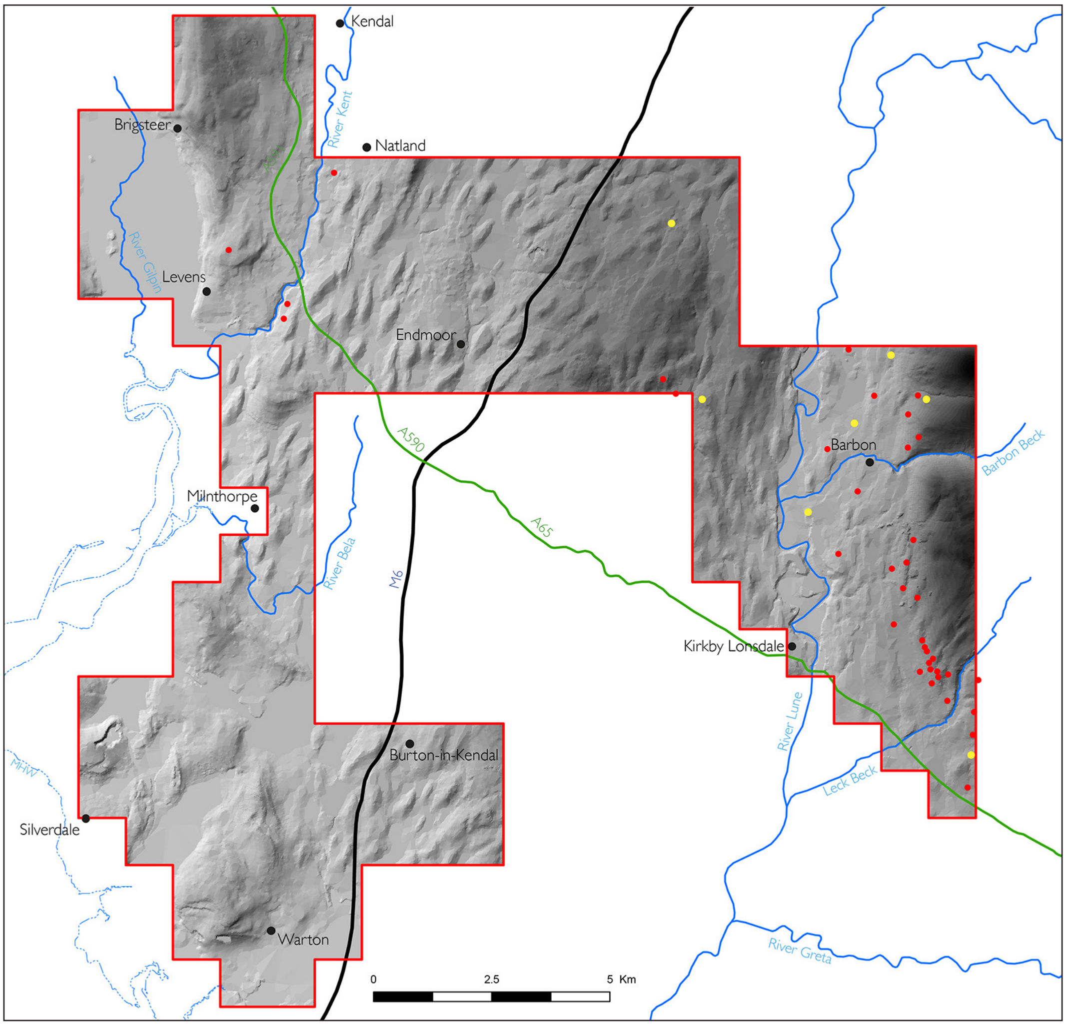


Fig 22: Distribution of probable later prehistoric and Roman settlements. Those that are new to the record are yellow. Height Data – ©Bluesky International/Getmapping PLC.

The potential for dating the settlement was clearly demonstrated, firstly from the positive results of the OSL assessment (ie determining that the sediments were suitable for OSL dating) and secondly, during the excavations themselves, when remains suitable for radiocarbon dating (charred plant remains, in particular charcoal) have been recovered. The recovery of generally identifiable palaeoecological remains (plant macrofossils, waterlogged wood, beetle, testate amoebae, pollen and micro-charcoal) from the waterlogged site of Kitridding Mire (as part of the evaluation of the core samples recovered during preliminary coring) demonstrated the potential for obtaining palaeoenvironmental information and material for radiocarbon dating. The results of this work will be reported elsewhere in due course (Hazell in progress).

It is more difficult to assess to what degree the current archaeological record for prehistoric or Roman settlement reflects their original distribution. As noted in **Nature and Distribution of Archaeological Remains** above, the different soils, geology and land use affected the survival and visibility of archaeological sites across the project area.

Areas such as the Lune Valley probably had a higher number of settlements than is currently recorded – the results of the geophysical survey at Millbeck Farm hint at what may survive as subsurface remains.

The noticeable lack of settlements in the western part of the survey area is probably also partly due to site survival and visibility. Survival of prehistoric earthworks within areas of historic parkland indicates that there were probably settlements elsewhere, now plough-levelled but preserved as subsurface deposits. Targeted aerial reconnaissance in the right conditions and more geophysical survey in the region may go some way to further assessing the distribution and extent of these levelled settlements. Other types of evidence such as small finds could also enhance understanding but the chances of recovering such evidence through techniques such as fieldwalking in a largely pastoral landscape are very limited.

What is the broader landscape context for later prehistoric and Romano-British settlements?

Previous work emphasised identification of sites at the expense of work on the context of later prehistoric and Roman settlements and land use in the region (Hodgson and Brennand 2007, 51). Our understanding of field system development in this region is relatively poor due to a lack of modern excavation and the application of scientific dating techniques, and phasing is reliant on morphological comparison to sites elsewhere. Work at High Park (Jecock 1998) provided relative phasing of later prehistoric and Roman land division, but without absolute dating this remains a floating chronology. However, it demonstrated a development of the landscape from the later prehistoric period, including large-scale reorganisation in the later Iron Age/Roman period represented by a coaxial field system. Several settlements were inserted into this system, probably in the Roman period, and some have indications of reuse in the medieval period.

Evidence for prehistoric and Romano-British land division was fragmentary in the western and central parts of the project area. This pattern was also seen in the low numbers of later prehistoric and Roman records derived from other sources. As discussed previously, additional work could establish whether this is a result of survival and visibility or an indication of a genuine lack of occupation or different use in the pre-medieval period.

To the east of the Lune, our understanding of the landscape context for the settlements is much better. Many of the settlements here were incorporated into a landscape divided by extensive coaxial field boundaries that survive as earthworks. At High Park (1109071) and Barbon Park (44123) (Figs 23 and 24) large areas of field system survive and further fragmentary boundaries on similar alignments suggest that they were once more widespread. Although a combination of remote sensing and analytical field survey of all these features has the potential to elucidate the general evolution of the landscape, targeted excavation and scientific dating will be required to establish a finer chronology and give a more detailed understanding of the phases of settlement and land division.

Archaeological survey can readily identify land division where there is evidence of earthwork or stonework boundaries, or clearance cairns. Land allotment by other means, such as hedges, fences, natural features or cooperation, leave little or no archaeological traces. Other techniques could be applied, such as environmental analysis, to better understand past land use where there is little evidence of physical boundaries.

There were similar settlements at lower elevations in the Lune Valley but with little evidence of associated land division. However, it is likely that the coaxial field systems found up slope once continued into the valley bottom. Later ploughing or grassland improvement probably levelled the earlier field boundaries while leaving the more substantial remains of the settlements unploughed. Earlier boundaries may be fossilised within the existing field pattern, as demonstrated by an example at High Park where a modern drystone wall follows an Iron Age/Roman boundary (Jecock 1998, 27).

Four areas were identified for geophysical survey to explore the broader landscape context of settlements. This included two settlement sites identified as earthworks, at Kitridding Hill (Linford *et al* 2013d) and Howerigg (Linford *et al* 2013c), and an enclosure

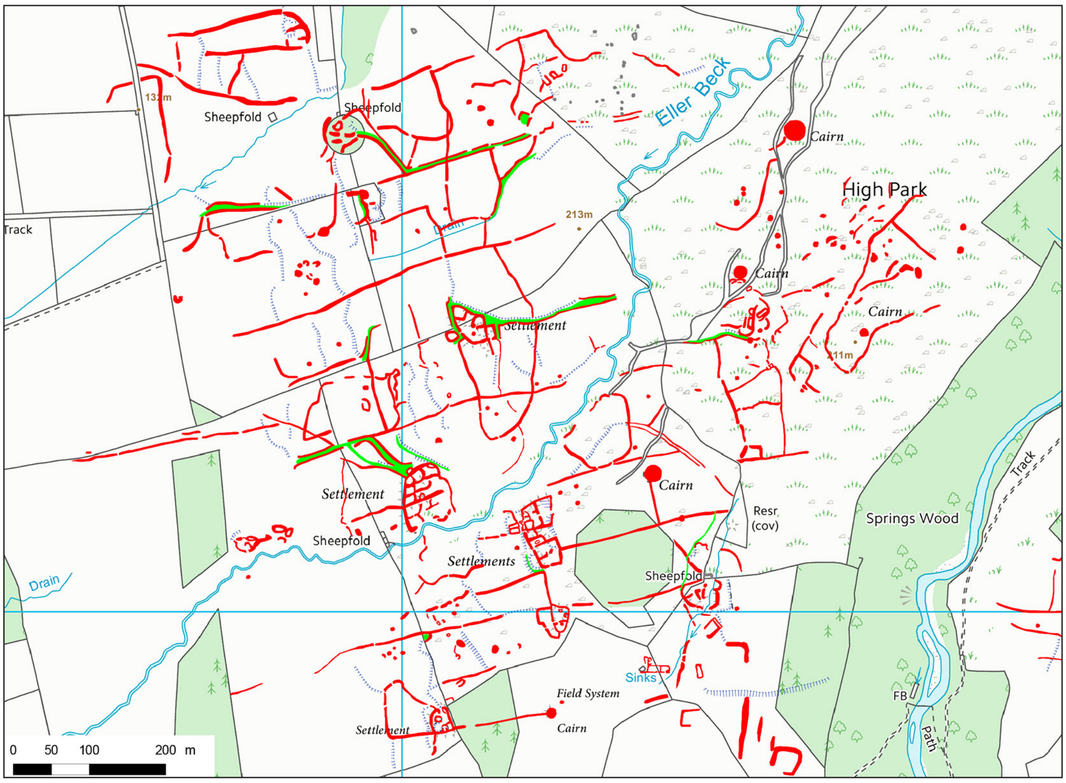


Fig 23: Coaxial field systems at High Park. These are broadly dated to the Iron Age/ Roman periods based on their morphology and were subject to analytical field survey by RCHME. © Historic England. Base map © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100024900.

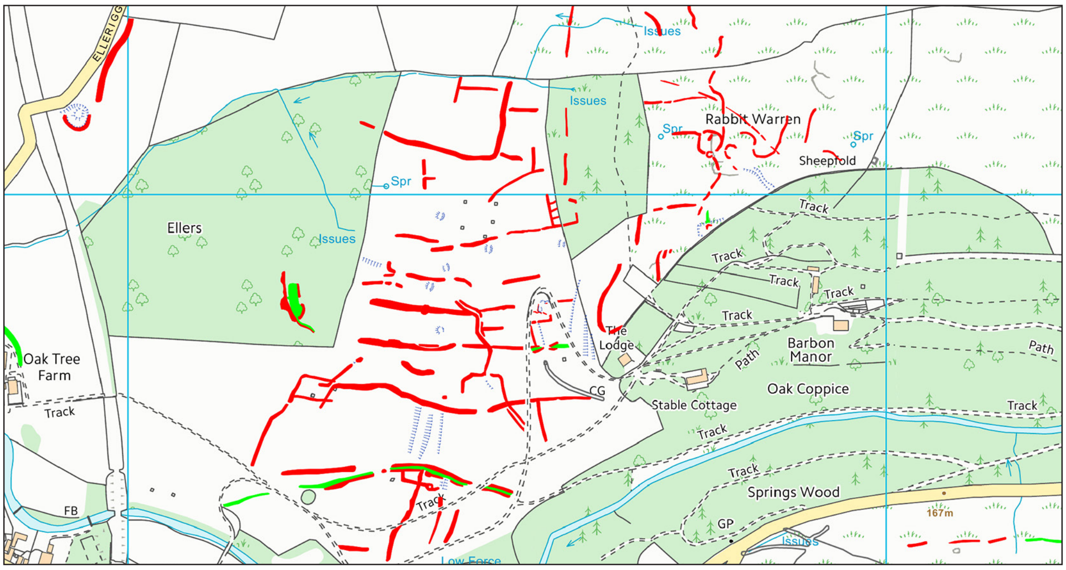


Fig 24: Coaxial field systems at Barbon Park. The alignment, scale and morphology indicate that they are analogous to the field systems at High Park. © Historic England. Base map © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100024900.

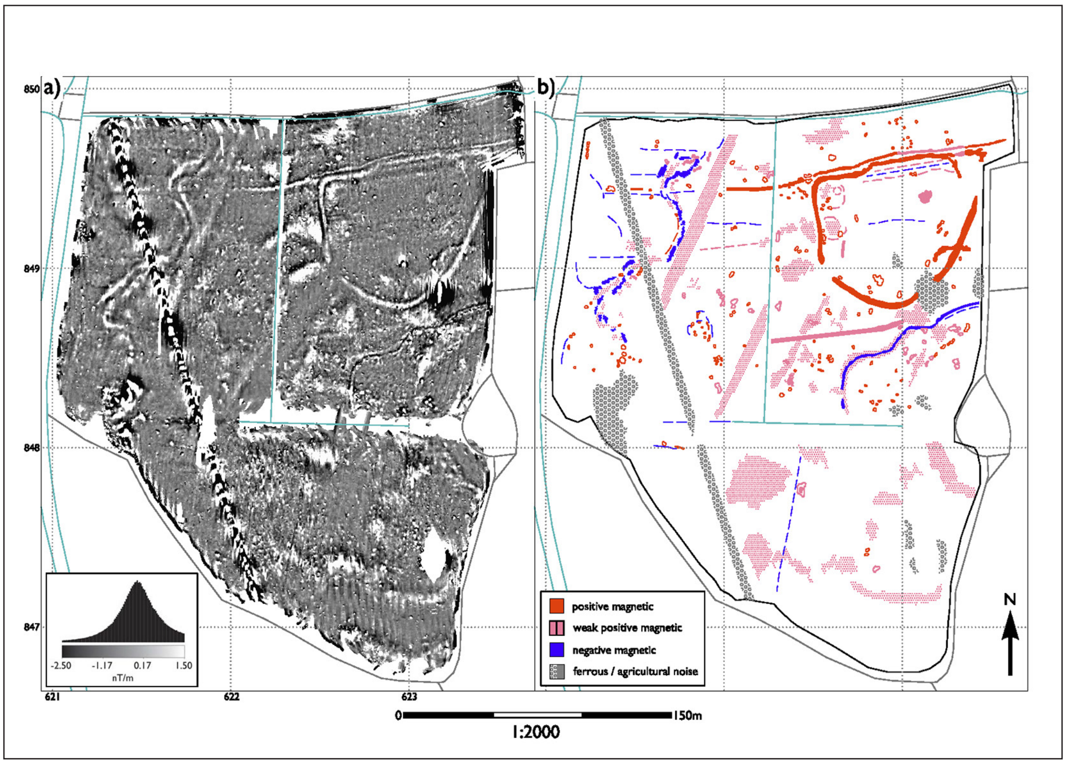


Fig 25. Caesium magnetometer survey (a) of the enclosure at Millbeck, identified as a cropmark on aerial photographs, and surrounding environs with interpretation of significant magnetic anomalies (b) including parallel linear positive anomalies thought to represent elements of an east west aligned co-axial field system.

Fig 26: The 'D' shaped ditched enclosure at Millbeck Farm (1476760) visible as a cropmark in grass in the Lune Valley. North is to the left of the image. 20588/47 27-JUL-2006 © Historic England.

seen as a cropmark by Millbeck Farm (Linford *et al* 2013a). A so-called "blank area" was chosen near Gowrey Farm on the lower ground between the river Lune and the Leck Beck (Linford *et al* 2013b) to explore whether the High Park coaxial field system may have extended down into the Lune Valley.

The results from Gowrey Farm were inconclusive – no field system remains were detected but it was not clear whether this is because they never existed in this area; whether they exist but do not exhibit a magnetic signature; or whether more recent field improvement works have destroyed traces of them.

Magnetometer survey on the 'D' shaped enclosure at Millbeck Farm (Figs 25 and 26) suggested the presence of coaxial field systems on lower slopes nearer to the River Lune. Geophysical survey provided additional detail for the enclosure and showed that it was located between two ditched field boundaries identified as positive magnetic anomalies. These boundaries were on a similar alignment to the coaxial field systems, like those at High Park. The spacing of the field boundaries, at 90m, also comfortably sits within the range of field widths observed on earthwork examples elsewhere in the project area.

More extensive survey is required to test the theory that coaxial field systems were once widespread in the Lune Valley. Geophysical survey may be the most effective technique. It is also possible that re-evaluation of some boundaries and lynchets, identified by aerial mapping as probably medieval, could demonstrate that they have earlier origins. This may be achieved by systematic analytical field survey, possibly allied to sampling of deposits for scientific dating. A similar model has been used in Swaledale, North Yorkshire where survey of surviving and relict boundaries demonstrated that coaxial boundaries were likely to have once reached the Swale flood plain (Flemming 1998, 134–5).

The model suggested by the work at High Park suggests that the coaxial systems were the result of wholesale reorganisation of the landscape in the Iron Age. Jecock (1998) also suggests that these systems may have been in decay by the time that the settlements were inserted into them. This general chronology reflects what is known from other sites in the region. Similar systems, both in terms of morphology and scale, have been recognised in the Yorkshire Dales (eg Horne and MacLeod 1995; 2001). Excavation and survey in Swaledale, for example, has dated a similar system to the mid Iron Age onwards, a date that is further attested in the pollen record (Flemming 1998, 138). That study also identified settlements as later insertions into an already existing coaxial system.

The function of these systems in this region is still unclear but their use – either arable cultivation or pasture – may be partially dictated by elevation. At Wharfedale it has been suggested that stock management is likely to be the primary purpose (Horne and MacLeod 2001, 78). However, in the Lune Valley their elevations, below around 240m OD, may have been low enough for limited cereal cultivation, at least during some phases of their use. Climate models in the north-west have suggested that the limit for cereal cultivation after c150 BC was between 200m and 250m OD but before this date could have been as low as 110m OD (Nevell 1999, 17). More research is required to establish the dating and function of these systems and this is the subject of an on-going PhD by Hannah Brown at the University of Bradford.

Does the nature of later prehistoric and Romano-British settlements vary within the project area?

Most settlements were identified in the eastern parts of the project area, particularly the Lune Valley. Of the 44 settlements identified on air photographs and lidar, just four are located in NCA 20: Morecambe Bay Limestones. Fourteen lie within NCA 21: Yorkshire Dales and the remaining 26 are located in NCA 19: South Cumbria Low Fells. No settlements were identified in NCA 31: Morecambe Coast and Lune Estuary but this represents such a small area that no reasonable conclusions can be drawn.

There is considerable variation in the nature of settlements (Fig 27) but there is no obvious relationship between this and the National Character Areas. Settlements are almost exclusively bank-defined. In upland areas these banks are probably the turf-covered remains of stone-walled enclosures. However, they do show variation in their size and plan. Around 17 can be grouped together as broadly rectilinear in form and these are often sub-divided internally, creating clearly defined areas within the settlements. Around six are curvilinear with the remainder irregular in form.

Scooped or cut back elements are evident at many sites and are a common feature of settlements of this date in upland Cumbria and Northumberland. This form of construction reflects the sloping topography on which many of the enclosures were situated (Fig 28). Sometimes these scooped areas lie within an external circuit of bank but at other sites the settlements appear to be defined by a combination of banks and scooped areas. One settlement however (1574172) stands out by being entirely scooped with no trace of an external bank (Fig 27).

There are hut circles inside a number of the settlements and the remains of hut platforms were also noted. Five settlements have embanked circular structures incorporated into the outer circuit of the enclosure (Fig 29). The function of these features is unclear but ground inspection suggested they are most likely some kind of hut circle, perhaps with a specialist function such as a shepherd's shelter; if so, it raises the possibility that some of what are here described as 'settlements' may rather be stock enclosures. Excavation on at least one of these sites is recommended to attempt to establish function and provide dating evidence.

The enclosures at Castle Hill (43942), Kitridding Hill (43113) (Fig 30) and Terrace Wood (44013) are unusual in the context of the survey area because of their size and form (Fig 31). Each is defined by a broad ditch with traces of inner and outer banks that enclose areas of 0.64ha, 0.67ha and 0.57ha respectively. Castle Hill was identified and scheduled as a 'defended enclosure' but survey work carried out as part of the NAIS project has questioned whether its topographic location supports a defensive interpretation. Similarities in size and form suggest that Kitridding Hill and Terrace Wood are comparable to Castle Hill. Further work would provide additional information on possible function and dates, with a view to assessment of their regional and national significance.

The settlement at Low Barn, (44014), which lies between Hipping Hall and Ireby, is also distinctive in the context of the other settlements (Fig 32). It is nearly circular in plan and

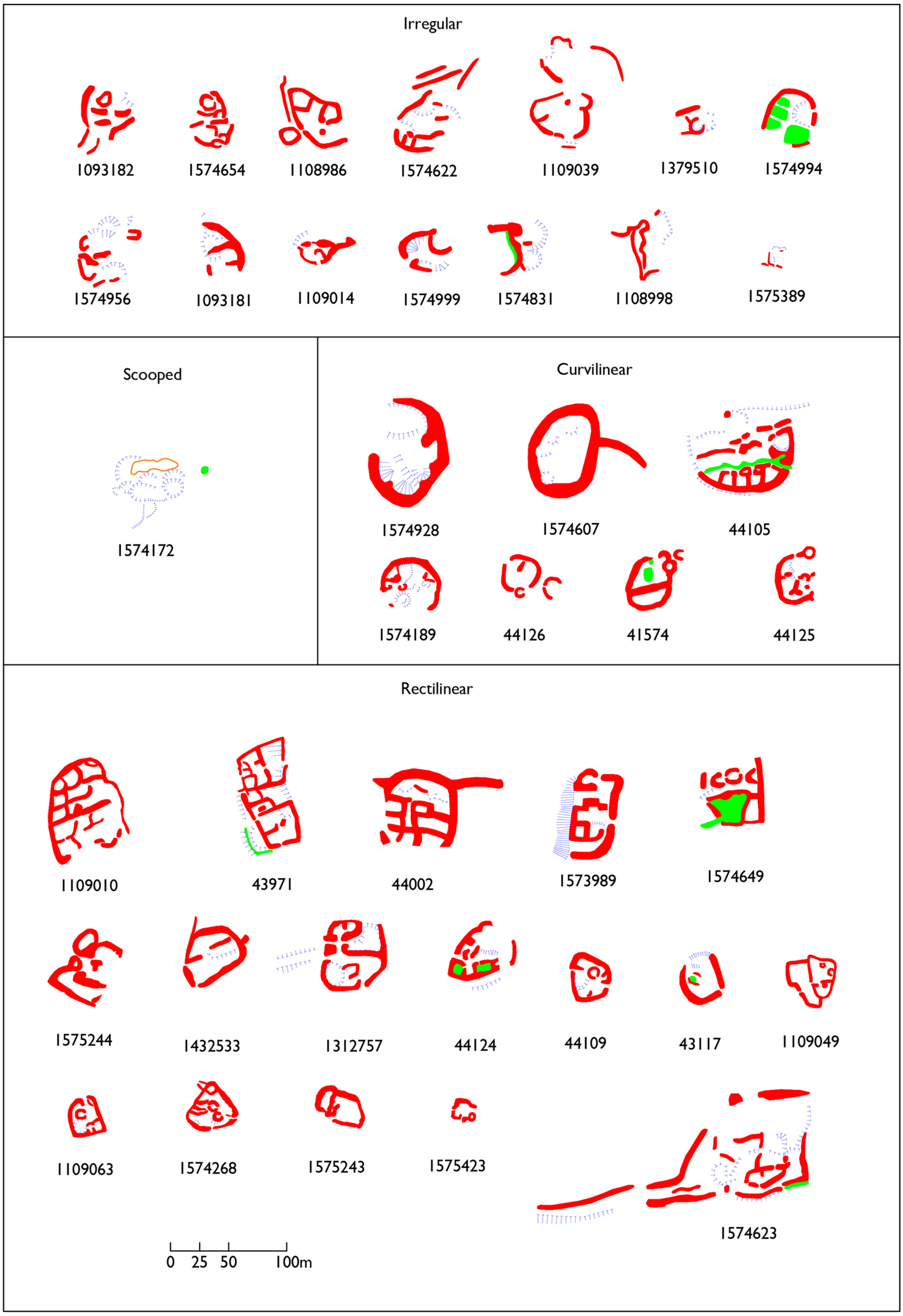


Fig 27: Enclosures interpreted as settlements of probable later prehistoric or Roman date.

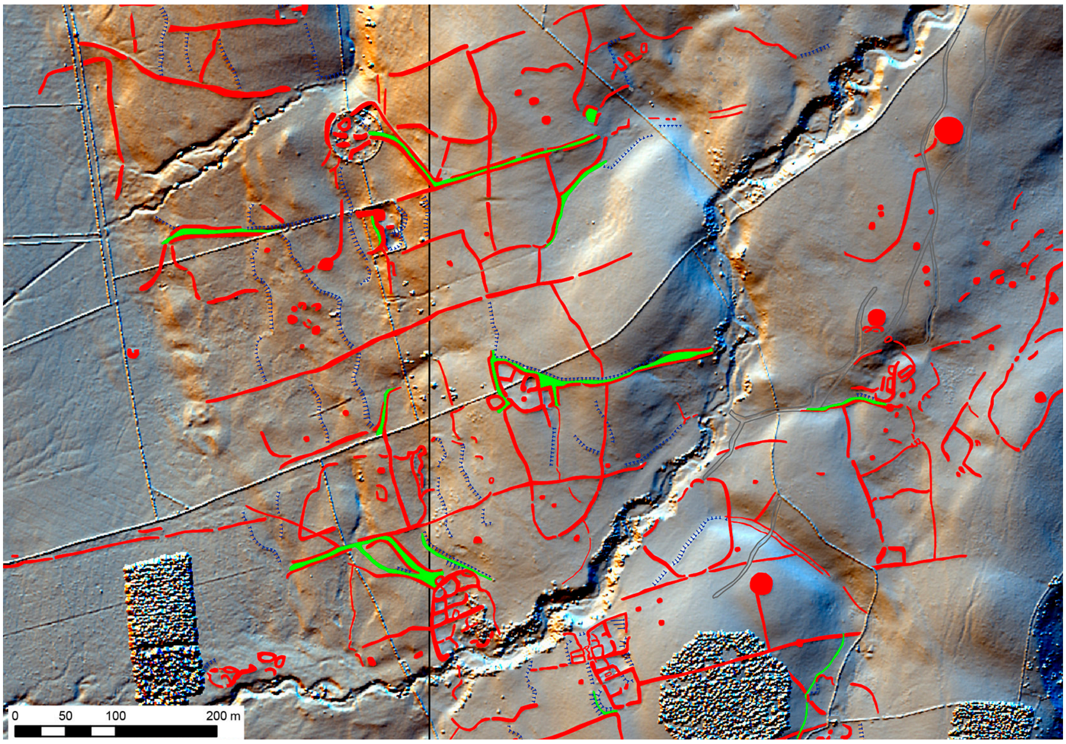


Fig 28: Settlements at High Park, sitting within a coaxial field system. They are located on sloping ground and are often partially terraced. © Historic England; source Environment Agency.

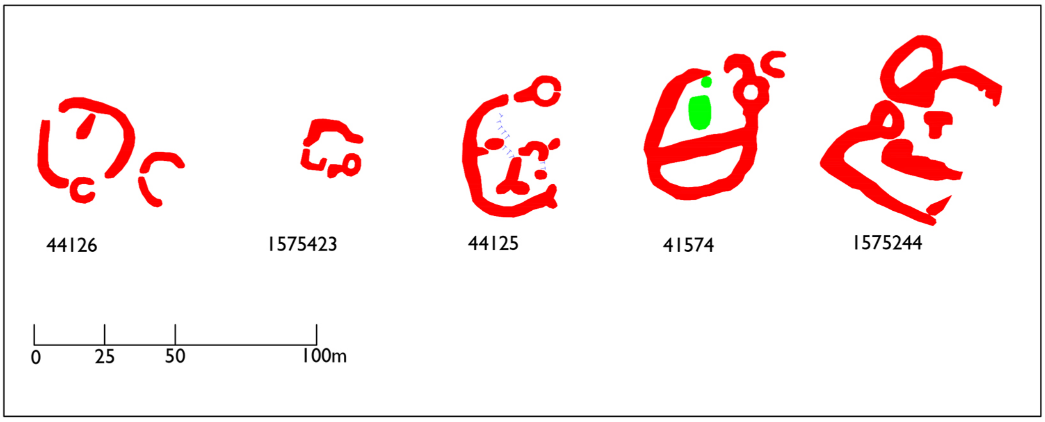


Fig 29: Settlements with incorporated circular structures at Barbon (44126), Berryby Fold Hill (1575423 and 44125), Sizergh Fell (41574) and Levens Park (1575244).

defined by a single bank that encloses an area of 0.67ha. An apparently later group of complex settlement earthworks is appended to the north-eastern side. The site would very much benefit from detailed field survey. Although not ditch-defined, it is tempting to make an association between this site and the three enclosures at Castle Hill, Kitridding Hill and Terrace Wood. In terms of size, it would comfortably sit within the same category of monument. Its location may also suggest a relationship with the other sites

Fig 30: The enclosure at Kitridding Hill (43113). 28366/17 11-DEC-2012 © Historic England.

as it sits in a perfect alignment with Castle Hill and Terrace Wood. The distance from Terrace Wood is also nearly identical to that between Terrace Wood and Castle Hill at 1.1km.

The only other ditched enclosure is near Millbeck Farm (1476760) and was identified as a cropmark (Figs 26 and 31). It is of similar size to the examples noted above, enclosing approximately 0.56ha. There was no evidence of flanking banks from air photographs or geophysical survey which suggests that the deeper soils in this part of the Lune Valley may have resulted in a different construction to the enclosures defined by stony banks further upslope. The geophysical survey indicated that the enclosure sits within a coaxial field system and it is possible it was a stock enclosure or settlement.

It is evident that there is variation in the nature of later prehistoric or Roman settlements. Additional analytical field survey and possibly targeted geophysics will help to characterise these settlements further but excavation will be essential to gain a fuller understanding of chronologies and functions. If carefully targeted, this evidence should help to establish whether morphological characteristics could be used as a reliable tool for non-intrusive interpretation of settlements in this region.

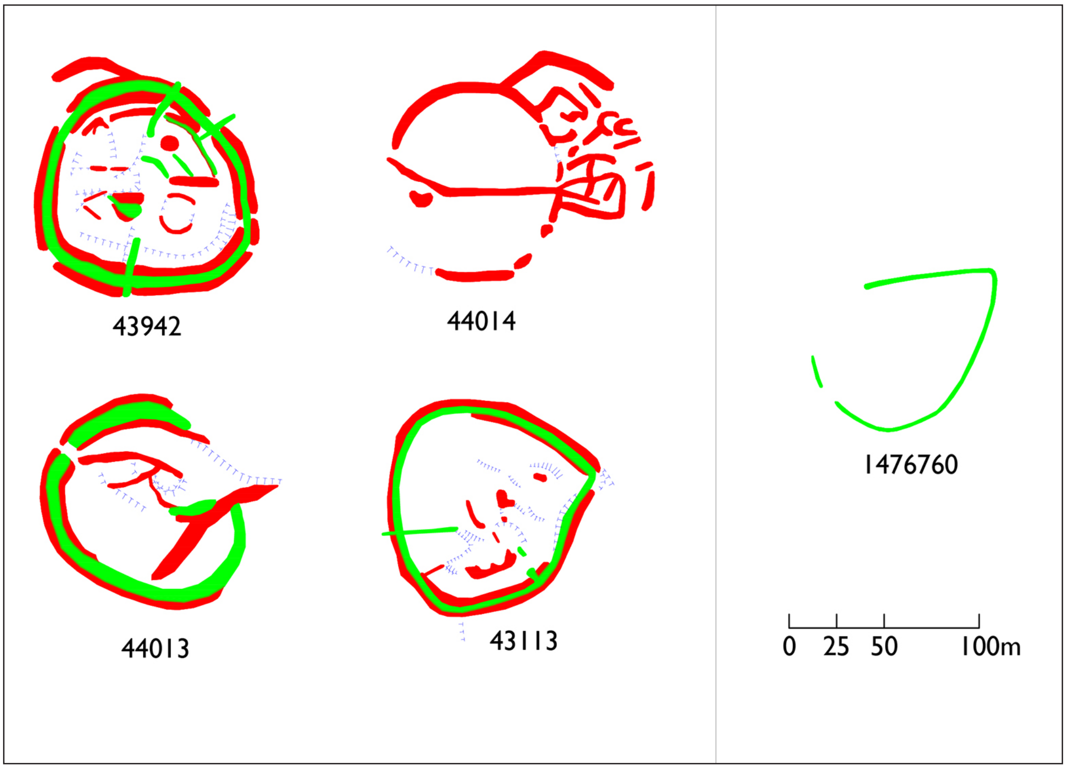


Fig 31: Examples of large and/or complex enclosures including Castle Hill (43942), Kitridding Hill (43113), Terrace Wood (44013), Low Barn (44014) and Millbeck (1476760).

Fig 32: The settlement at Low Barn (44014). The enclosure is bisected by a later field boundary and contains ridge and furrow ploughing. 28363/35 11-DEC-2012 © Historic England.

What is the broader landscape context for the known medieval settlements?

The project produced evidence for medieval and post medieval settlement, especially in and around the Kent valley where a number of shrunken and abandoned settlements were recorded, some for the first time. Most of the new information came from the rapid field reconnaissance rather than aerial mapping stage because of the relatively poor quality of aerial photographs and absence of lidar. Because no detailed earthwork survey was conducted of any of the sites, advancement of knowledge was largely confined to enhancement of the written record for categories such as the spatial extent of the settlements and the number and general disposition of identifiable building remains. The study of medieval settlement in the north-west of England is a much neglected area, but one that can only be tackled through a dedicated programme of aerial and analytical earthwork survey combined with documentary research and probably excavation – regrettably beyond the scope of the present project.

More commonly identified were the fields associated with the settlements. It can be difficult to date features such as field boundaries precisely, partly because they often had continuity of use from the medieval into the post medieval periods, but evidence of past ploughing in the form of ridge and furrow is widespread in the project area. There were few examples of characteristically medieval ridge and furrow where the ridges are broad and form a reverse-S shape, suggesting much is post medieval land improvement to improve the sward rather than evidence for arable cultivation. In some areas post medieval ploughing may have removed traces of earlier ridge and furrow. More common are instances of medieval/post medieval ridge and furrow where narrow regular furrows clearly follow a medieval field pattern. This is more often observed in the western parts of the project area with particularly good examples around Beetham (Fig 33) and Hale (Fig 6). It suggests that medieval arable cultivation was limited in extent and probably largely confined to the immediate surrounds of settlement foci.

Isolated or fragmentary abandoned field boundaries were common but more coherent field systems were identified around Beetham (1002729), Hale (1002759), Sedgwick (1575060) and Old Town (1574212). These systems were often defined by banks and included lynchets from contour ploughing in places. The data from aerial photographs and lidar should be viewed against historic OS mapping to include those medieval boundaries that were incorporated into later enclosure.

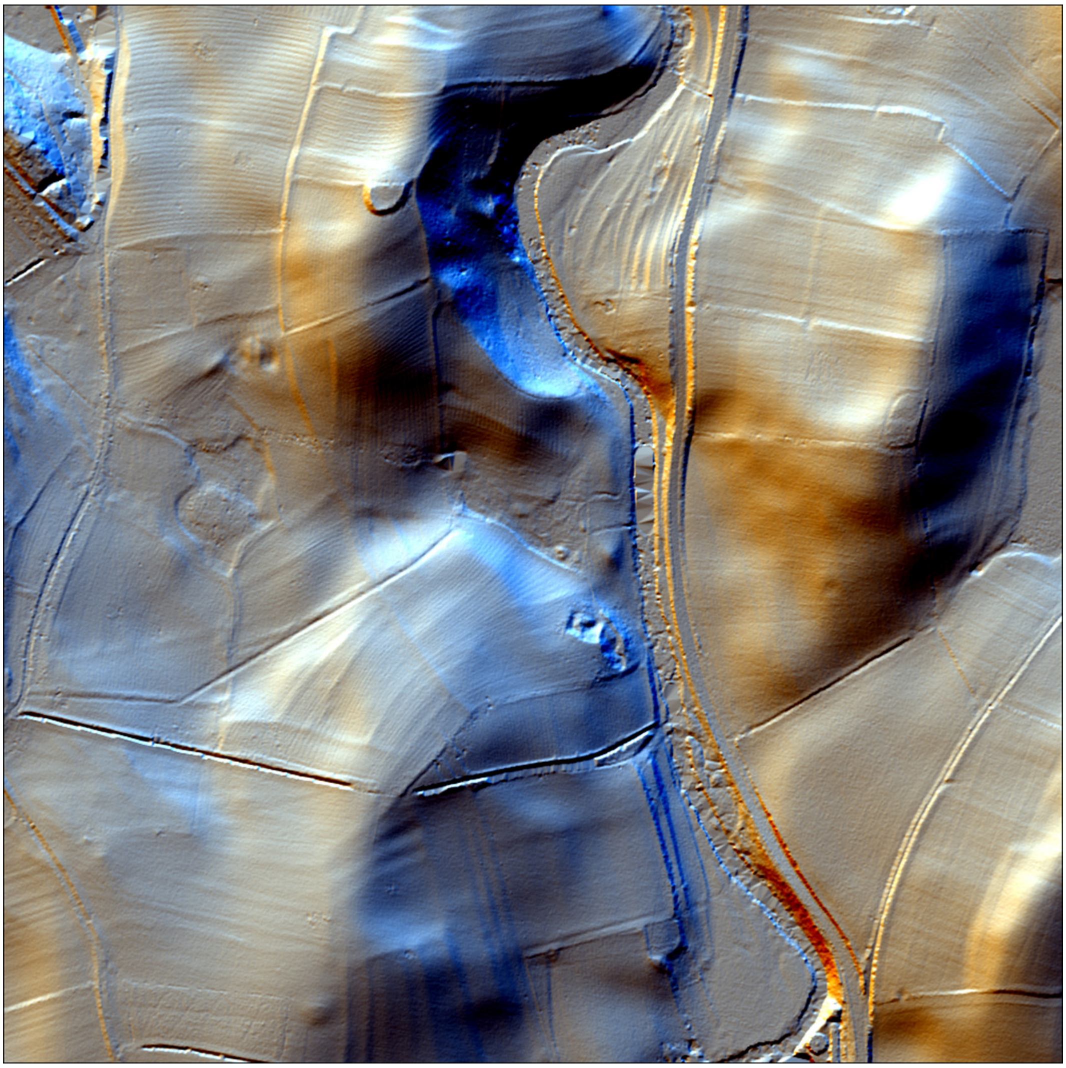


Fig 33: Lidar image (processed to remove surface features) showing post medieval narrow ridge and furrow following a medieval open field pattern at Beetham (1002729) along with traces of lynchets to the east. The 'D' shaped mound is scheduled as a ringwork but could represent a small motte. © Historic England; source Environment Agency.

Can we identify evidence of early medieval settlement and land use, and help to refine the dating of key features (ie longhouses and related fields)?

The Research Agenda and Strategy for the region highlighted problems of identifying early medieval settlement and land use in the north-west (Newman and Brennand 2007, 81–2). Dating of settlements from all periods mainly relies on morphological comparison and there is insufficient scientific dating evidence. Therefore, continuity of occupation from the later prehistoric period onwards or reoccupation in the early medieval period are potential scenarios at settlements within the project area but the lack of modern intrusive survey means that this is poorly understood and characterised.

Fig 34: The multi-phase landscape at High Park, focus of the 1998 RCHME earthwork survey. There are probable early medieval curvilinear boundaries (a and b) set within an earlier coaxial field system. 28364/11 11-DEC-2012 © Historic England.

There are only 17 records for early medieval features and all are concentrated in a relatively small area to the east of the Lune. Most were identified during the 1998 survey of High Park (Jecock 1998) (Fig 34). For the great majority of the project area no recognisable evidence of early medieval settlement or land use could be positively identified on air photographs or lidar. Analytical earthwork survey at High Park (Jecock 1998) suggested an early medieval date for a number of field boundaries and buildings. Morphologically similar elements of field systems and buildings were identified from air photographs (1093184 and 1574843) immediately to the north of the area covered by the High Park ground survey.

Approximately 3km to the north are two curving boundaries (44127) which are unusual in the context of the survey area. They do not fit the pattern of Iron Age or Roman land division but are also unusual in the context of the medieval and post medieval field boundaries. There is potential for them to be early medieval in date but this is by no means certain. Close to these, but with no obvious association, are the remains of a potential building. This could be of medieval or post medieval date but, again, the possibility of early medieval origins cannot be ruled out.

An enclosure at Howerigg (44105) was interpreted as a probable early medieval settlement (Lowndes 1963, 81–3), because it was thought to overlie the projected course of a Roman road, and appeared to contain the earthworks of a rectangular building. A broad date range (from pre-Roman to early post-Roman) was proposed in the earliest scheduling description, but an early medieval date was still considered probable.

Analysis of the lidar indicated the Roman road more likely passed immediately to the west of the settlement (966101 and 1574944). Magnetic survey for the project (Fig 35) found no evidence of the road under the enclosure. The slight linear earthwork to the west was corroborated by the magnetic data, but interpretation as the true course of the road could not be substantiated because the alignment is very similar to ridge and furrow in the vicinity.

The ditch defining the oval outline of the enclosure was detected as a curvilinear positive magnetic anomaly and magnetic disturbance within the enclosure indicates internal occupation features. A brief assessment of the settlement by analytical earthwork surveyors could not corroborate the existence of the alleged rectangular building. Morphologically the settlement would not be out of place with other later prehistoric or Roman sites locally but additional survey and excavation is required to corroborate this. While the new evidence casts serious doubt on the claim that the site originated in the early medieval period, it does not prove that it was unoccupied at that time.

It is clear that the early medieval period is currently under-represented in the archaeological record and further work on settlement and land use is needed. This work could in turn feed back into the results of aerial mapping and inform future work in the region. Field survey and/or geophysics may help to further enhance our knowledge but excavation and scientific dating will be essential to our understanding of this period.

Intrusive techniques could be used to confirm the dating of features presumed to be early medieval in date, such as the longhouses at High Park, but it should also be targeted at identifying early medieval phases of occupation at settlement sites currently dated as later prehistoric or Roman. Dating of other landscape features such as field boundaries and cairn fields should also be considered. The North West Research Agenda and Strategy (Newman and Brennand 2007, 83–4) outlines specific initiatives that may help to target follow-on work.

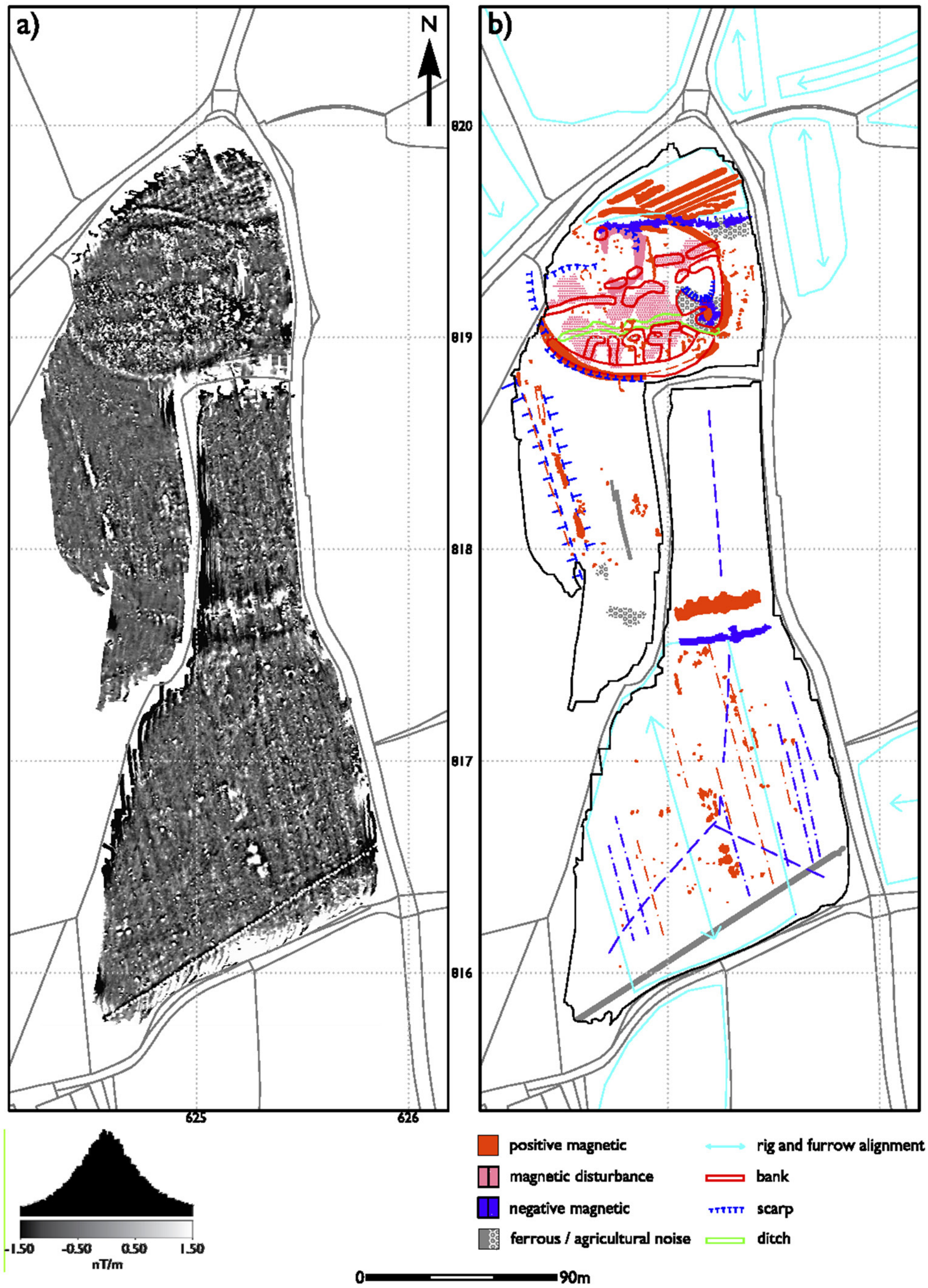


Fig 35: Caesium magnetometer survey (a) of the enclosure and surrounding environs at Howerigg and interpretation (b) of significant magnetic anomalies alongside air photo and lidar mapping.

Can the dates of early principal landscape components (eg co-axial field boundaries) be established with greater precision?

The air photograph mapping has better defined the known distribution of field systems but it was not possible to establish their date with any greater precision. Relative chronology can be established as demonstrated by the High Park survey and could be applied elsewhere, such as at Barbon Park (44123). This approach should be used as a framework to target a combination of excavation and, most importantly, scientific dating to provide firmer indications of dates.

Providing absolute dating for later prehistoric/Roman settlement was identified as a key objective during the NAIS pilot. Despite – and because of – the recognised difficulties associated with OSL dating these types of features in particular, it was decided to trial the use of OSL dating on earthwork sites in an upland context. This began with a scoping study, as recommended by Dr Phil Toms of the University of Gloucestershire, who advised that a preliminary coring exercise should assess the suitability of sediments. The coaxial field systems at High Park and a settlement enclosure at Kitridding Farm were selected (Toms 2014).

At High Park, two sets of intersecting field systems (as well as a settlement feature) were targeted for sediment coring and assessment for OSL dating but none of the samples collected were suitable because of the significant difference between the clast and matrix ex-situ dose readings. Results of an equivalent sediment scoping study at a settlement site at Kitridding were more promising. Therefore, full OSL dating procedures were carried out on sediment cores recovered from Kitridding during excavation in order to date the settlement's age. The scientific dating results (OSL and radiocarbon dating on charcoal remains) are still forthcoming, and until the full suites of ages are available for interpretation and comparison, it is not possible to draw firm conclusions about the applicability of these methods at this site.

The results of the OSL scoping study varied between High Park and Kitridding. Depending on the final results of the work at Kitridding, it may mean that carrying out an initial scoping study of sediments before any excavations take place, is considered necessary in order to assess the site-specific appropriateness of the technique.
At the very least the results so far suggest that sites not suitable can be identified and discounted at an early stage. The results of the OSL dating, together with the radiocarbon dating, may help resolve the difficulties of dating what are otherwise challenging features to date, by informing the recommended methodological approach.

Can we identify suitable locations to sample to improve the palaeoenvironmental record (ie sedimentary waterlogged deposits in close proximity to early settlement remains)?

Palaeoenvironmental investigations at Kitridding Mire, adjacent to the Kitridding Farm Iron Age or Roman enclosure (43117), demonstrated the potential to produce a palaeoenvironmental record from the time of the settlement's occupation (assuming the deposits are of the right timeframe, and have not been disturbed). The wetland itself is only alluded to on Ordnance Survey maps, and its palaeoenvironmental potential was only recognised during site visits to assess the adjacent earthwork settlement sites. This highlights the value of ground inspection in this respect, although other remotely-sensed datasets (eg lidar) are recommended too, as this may give geomorphological information that can inform the selection of targets (also identifying potential sites that may no longer be waterlogged at the surface). When identifying sites suitable for palaeoenvironmental investigation with respect to a particular settlement site, it is necessary to consider the 'catchments' of the palaeoenvironmental remains themselves (eg local versus regional pollen catchments).

Methodological research questions

How effective is the use of 16 direction hillshade and Principal Component Analysis (PCA) processed lidar in this landscape?

This landscape is ideally suited to the application of lidar because such a high proportion of archaeological features are earthworks and tree cover is relatively sparse. The use of processed lidar data was found to be a very efficient method of mapping archaeological features. Over 80% of features were drawn from lidar and this percentage increases if those areas with no lidar coverage are excluded.

This partly reflects a lack of high quality oblique and vertical photography captured under optimal conditions, meaning that features were often best seen on lidar (see **Methodology, Scope and Sources**). Ease of use was also a factor because the lidar was a georeferenced dataset which negated the rectification process required for aerial photographs. Sixteen direction hillshade also has the advantage of lighting features from multiple directions so was ideal for recording earthworks and structures which might be partially obscured when lit naturally from one direction.

Environment Agency 1m lidar data were used and processed by the Lidar Visualisation Toolbox in ArcGIS to produce 16 direction hillshade and PCA outputs in GeoTIFF format. These were inserted into AutoCAD Map 3D where features were digitised. The decision to use these visualisations was based on the recommendations of the Miner-Farmer Landscapes of the North Pennines AONB project (Oakey *et al* 2012, 75). This report noted a need to find a compromise between using lidar 'live' (ie manipulating and re-lighting the data in AutoCAD while mapping) and the single direction lit JPEG images supplied by the Environment Agency.

Lidar processed with Principal Component Analysis did show some features, such as ridge and furrow, that were not visible on the 16 direction hillshaded lidar but instances of this were negligible. Interpretation of PCA images was more difficult than 16 direction hillshade and it was particularly difficult to distinguish between embanked and cut features. This tallies with findings from other recent projects such as the Chalk Lowlands and the Hull Valley NMP (Evans *et al* 2012, 70). The findings from this particular project were, therefore, that the 16 direction hillshade visualisation was the best for mapping.

Evaluation of different lidar visualisations continues within Historic England and outside the organisation (eg Challis *et al* 2011; Doneus 2013). A recent project in the South Downs National Park (Carpenter *et al* forthc.) compared the effectiveness of five different visualisations. In that landscape, which was largely wooded, Local Relief Models (LRM) were found to be of particular value. This technique picked out traces of earthworks that were not visible in any of the other visualisations used.

Although the effectiveness of 16 direction hillshade and – to a lesser degree – PCA visualisations have proven to be effective at recording archaeological features within this landscape, future projects should consider their use alongside other visualisations. The effectiveness of different techniques may also vary in different landscapes so should be evaluated on a project by project basis.

How can we more efficiently interface with the designation process, including the development of local lists?

The need to input effectively to the designation process was identified early on in the Project Design stage of the NAIS pilots and the English Heritage Designation team were consulted from the outset. A representative from Designation was appointed to the NAIS project team to provide a point of contact throughout the life of the project.

Two key issues were identified – the need to minimise duplication of effort and to exchange data in an appropriate format. For example, information such as contact details for landowners was routinely acquired by investigators on the ground and could be usefully passed to the Designation team. A system was devised to highlight key information, in reports and by other means, to ease data exchange with Designation Advisors so they can gather relevant information for designation cases as quickly as possible.

An initial list of potential candidates for designation assessment and amendments to designated sites was compiled at the end of the aerial mapping stage of the project. This was refined after the ground-based stages to produce a finalised long list. An initial sift will be undertaken by a Designation Advisor in discussion with other members of the project team. The shortlisted sites will then have packaged information compiled to produce consultation reports.

Recommendations

- Consultation with the Designation team should be undertaken at the earliest possible stage.

- Whenever possible, a member of the Designation team should be part of the project team.

- Information required by the Designation team and the format this will be delivered in should be agreed at Project Design stage.

How can the NAIS surveys inform local non-statutory protection of monuments such as Environmental Stewardship Agreements?

The main project outcome was the identification and recognition of heritage assets and historic landscapes. The digital mapping, monument records and project reports will be deposited with the HERs where the data will be accessible on a day-to-day basis. This will enable the inclusion of assets in the planning process and other local initiatives such as Management Plans, agri-environment schemes, local plans or mineral resource assessments that may have heritage protection outcomes. The NAIS project is already signposted in the Arnside & Sliverdale AONB Management Plan (Arnside & Silverdale AONB 2014).

Incorporation of the records from the NAIS project into the HERs should enable this information to feed into the Selected Heritage Inventory for Natural England (SHINE) database to allow more active management in the future. However, this will depend on the HERs having the capacity to undertake the work. Monument records are also publicly available through the PastScape website providing direct access to information for other potential stakeholders.

What are the most appropriate survey techniques to apply to the different classes of archaeological remains and landscape zones in the project area?

As discussed elsewhere in this report, the application of airborne remote sensing techniques was an efficient and rapid way to identify and record upstanding archaeological features, much more than doing so by walkover survey. This included assessment of modern aerial photography and lidar data to record numerous earthworks and use of historic air photographs that recorded features that have since been levelled. Interpretation and mapping of these features was an effective and time-efficient way of identifying, understanding and recording archaeology over a large area.

Lidar was a particularly effective survey technique for the identification of earthworks in the project area, as it is elsewhere. The 1m resolution gridded data supplied by the Environment Agency were found to adequately record the morphology of archaeological features and picked out fine detail such as hut circles. Interpretation and mapping from lidar should follow best practice and always be undertaken alongside analysis of air photographs and other sources of information.

A key to the success of the rapid survey field carried out for NAIS was the use of experienced field investigators to gain an enhanced interpretation and overview of the resource as a whole. This was an efficient use of available resources, especially when it enabled subsequent stages of the project to be targeted accordingly.

Detailed analytical earthwork survey of a representative sample of sites was not possible within the resources of the project, and the involvement of the Assessment Team was focussed instead on making rapid visits to verify and if possible expand on the date, function and significance attributed to individual sites by Aerial Investigation & Mapping. However, Level 3 surveys were undertaken at Gillsmere (1574268), Casterton (1574654), Eller Rigg Lane (1575376) and Kitridding Farm (43117) as training for the HLF/IfA-funded HEP, Ian Hardwick. The survey at Kitridding Farm was essential for informing the location of the trenches during later excavation on the site (see **Appendix 3**).

Surveys of a range of sites of all periods would result in a much better and nuanced understanding of particular sites and wider processes of landscape development. If future investigations are triggered by the NAIS project, these will benefit from the breadth of understanding gained through the rapid field assessment phase. Informed recommendations for sites worthy of detailed survey could be compiled based on the results of the project.

As outlined in **Nature and Distribution of Archaeological Remains**, the combination of soils, geology and land use within the survey area is not generally conducive to the formation of cropmarks. The identification of an enclosure at Millbeck as a cropmark indicates the, albeit limited, potential for further discoveries of buried sites from the air in optimum conditions.

The application of geophysical survey allowed the opportunity for comparative ground-based magnetometer survey that demonstrated that magnetic anomalies developed over the Millbeck cropmark. Nevertheless, in comparison to more conducive geologies anomaly strengths are weak, typically 1–2nT for the more substantial enclosure ditches and 0.3–0.5nT for smaller cut features. This result is of interest as the predominately Silurian geologies of the region have seen comparatively little archaeological geophysical survey in the past but are amongst those believed to be less favourable for magnetometer survey. However, particularly with more sensitive instruments such as the caesium magnetometers used in the current project, magnetometry may well offer the best method for detecting archaeological cut features not showing as cropmarks.

The potential for other geophysical techniques, particularly ground penetrating radar, earth resistance and electromagnetic induction was only partially tested through the application of GPR at Kitridding Hill, and should be considered for future work. However, the challenges of surveying in the steeply sloped upland and unimproved pasture environments of the region should not be underestimated.

Although the survey techniques summarised above have the potential to identify and understand surface and subsurface remains, there is a need for targeted intervention. While chronological relationships and phasing may be identified through surface or airborne survey, intervention to recover samples for scientific dating is essential to gain a fuller understanding of archaeology in the survey area. This is particularly the case with settlement sites and field systems that probably had several centuries of continuous use and occupation. The kind of methodology used during the project might be applied effectively to sample a broad range of settlements across a wide landscape with limited resources.

What strategies can be employed to engage local communities?

The resources allocated to the project did not extend to community engagement but the results of the project could provide a framework for community archaeology projects. Any future work should aim for community engagement as a project outcome.

A number of themes noted below under **Recommendations for Future Work** could be taken forward with the help of amateur archaeology groups or local community projects. These could well follow similar models to other projects in the region such as the Sizergh: Dig in the Park. Heritage 2020 and the Historic England Action Plan 2015–2018 identify public engagement as a strategic priority and will provide a framework for such programmes.

RECOMMENDATIONS FOR FURTHER WORK

The following recommendations are based on the results of the project and informed by the Research Agenda and Strategy for the North-West (Brennand 2007). They address gaps in our current knowledge and highlight where further assessment is required of the survival, nature and significance of features recorded during the project. Any future projects should take into account the new framework for work across the historic environment sector, Heritage 2020, and the regional research framework.

Mesolithic and Neolithic activity

- Mesolithic and Neolithic activity is undoubtedly under-represented in the archaeological record for the project area. Strategies for addressing this using other investigative techniques (eg geomorphological mapping) should continue to be trialled and developed.

- Targeted intervention should be undertaken at key sites that have possible Neolithic origins to provide firm dating evidence.

Later prehistoric and Roman land use

- Targeted analytical earthwork survey of the field system and enclosures at Barbon Park (44123, 44126, 1575407, 1575271, 1575405, 1575389, 1575387 and 1575263) should refine the phasing of the principal landscape components.

- Small-scale excavation of carefully targeted elements of the coaxial field systems should be undertaken. This should aim to recover samples for scientific dating to refine the dating of the field boundaries. Even where OSL dating is not considered appropriate (such as at High Park), the preservation of charred plant remains or other samples suitable for radiocarbon dating should not be discounted (they have been recovered at Kitridding Farm, albeit a settlement site), so well-targeted excavation (eg informed by aerial, earthwork and geophysical survey) could lead to the successful recovery of datable material.

- Further evaluation of prehistoric field systems should ascertain to what degree the results from aerial and ground based survey indicate their true extent. Targeted ground-based work should be undertaken on the fringes of known field systems and in areas where there was no evidence. In particular, this could establish where medieval and later land use is masking earlier remains.

- A component of the field systems in the uplands should be surveyed through geophysical survey, preferably with several techniques, to establish whether these earthworks have a geophysical signature that could be prospected for in the 'blank' areas.

- An initial evaluation of the waterlogged organic sediments recovered from Kitridding mire demonstrated the potential for the preservation of organic remains both for palaeoenvironmental reconstructions, and for radiocarbon dating. Palaeoenvironmental sampling of other wetland or former wetland areas in close proximity to known sites could help to understand local activities and/or their broader landscape contexts (depending on the 'catchments' of the palaeoenvironmental proxies investigated), if their deposits are found to be contemporaneous.

- Detailed earthwork survey within the wider Lune Valley would benefit our understanding of this landscape as a whole.

Later prehistoric and Roman settlement

- The dates of construction and phasing for settlements in the region are not well understood due to a lack of modern excavation. This means that settlements are often attributed broad date ranges based on their morphology. Excavation and scientific dating should be undertaken at sample sites to better understand and characterise the settlements and inform future aerial or field survey.

- The NAIS work at High Park and Kitridding demonstrated that the potential for OSL dating of upland settlement sites should be investigated through an initial scoping study prior to excavations, at least to determine whether it is likely that sites will *not* be suitable for the method. Investigating this is particularly important because at sites such as these, remains suitable for other scientific dating techniques (ie organic remains for radiocarbon dating from secure contexts) are often rare/absent. It is hoped that the full results from Kitridding (when available) will inform how best to approach OSL dating in such settings, in particular, whether it should be considered as part of future interventions at other settlements in the region.

- Five enclosures were identified with circular structures incorporated into the outer perimeter (44126, 41574, 44125, 1575244 and 1575423). Excavation of a sample of sites would help to identify the function of these features and refine understanding of the dates and phasing of the enclosures. Furthermore, it could confirm whether they actually form a group of comparable site types.

- The aerial investigation and mapping suggested the ditched enclosures at Kitridding Hill (43113) and possibly Terrace Wood (44013) could be of similar date and function to the scheduled settlement at Castle Hill (43942). Analytical earthwork survey and geophysics should provide further information to assess their character and significance. Targeted small-scale excavation should aim to recover dating material. This could inform potential designation assessments.

- The settlement at Low Barn (44014) is unusual in the survey area. Further work is needed to characterise this site, particularly to establish whether it represents a class of site similar to Kitridding Hill, Castle Hill and Terrace Wood.

Early medieval settlement

- Early medieval settlement is currently under-represented in the archaeological record. Excavation and dating should be targeted at those sites considered to be of this date based on their morphology and phasing with other features.

- Excavation of settlements currently dated to the Roman and medieval periods should attempt to identify early medieval phases of occupation. (see Newman and Brennand 2007, initiatives 4.23 and 4.24).

Medieval settlement

- Further work is required to ascertain to what degree the pattern of medieval settlement recorded by the project represents the true distribution. Any work would need to include documentary research and standing buildings survey.

- Analysis of vestigial settlement remains should also consider current settlements that may have origins in the medieval period.

Wetland archaeology

- The wetlands and former wetlands were not suitable for archaeological survey using aerial photographs for the reasons explained in the report above. Different survey techniques, such as those used in the North West Wetlands Survey, should be employed. Future projects should be aware of the limitations of non-intrusive survey techniques in wetland areas.

- Sites under imminent threat from re-flooding for wildlife regeneration should be targeted.

HERITAGE PROTECTION AND DESIGNATION

Evidence and survival of archaeological features

The aerial investigation and mapping recorded the evidence for archaeological remains as defined in the Historic England Thesaurus. This typically included cropmarks, earthworks, levelled earthworks and, more rarely, structures. Latest evidence was recorded in the index of the NRHE (available online via PastScape) but additional information was recorded in the NRHE textual description and the project GIS to include an assessment of the site as seen on the earliest and latest aerial images. For example, an archaeological feature recorded as an earthwork in the 1940s (usually the earliest date of photography) may appear to be ploughed level, or not, on a 2010 lidar image. Where ground observations enhanced those made from aerial photographs and lidar – such as recent improvement ploughing of an Iron Age/Roman settlement near Casterton (1574649) – these were noted in the AMIE record.

Attaching this data to the archaeological mapping allowed a quantification of surviving earthworks and how many sites were ploughed level since the 1940s. This approach to recording means that data can be compared to results of other projects, using aerial photographs and lidar as a main source, to assess the relative survival of archaeological earthworks and structures in different areas. This method of recording should be treated with some caution as it relies on good quality lidar images or aerial photographs to assess latest condition. Poor lighting on aerial photographs, and inadequately processed or low resolution lidar images can obscure earthworks. These issues will also affect the identification of earthworks so they should be addressed in any archaeological resource assessment. Ground based survey techniques also need to be aware of the effects of ground conditions on visibility of very low earthworks. Finally, a plough levelled archaeological earthwork may have considerable surviving sub-surface elements.

The Upland NAIS pilot used extensive good quality lidar and the current, predominantly pastoral, nature of the area means that the aerial assessment is likely to represent an accurate picture of earthwork survival. Analysis suggested that, excluding ridge and furrow, only 24 sites (just under 4.5%) recorded as earthworks on earlier air photographs appeared levelled or partially levelled on the latest images. This demonstrates that the project area has a high degree of earthwork survival in contrast to some other parts of the country where many archaeological earthworks were ploughed level in the last 50 years (eg Carpenter 2008; Evans *et al* 2012). In the Hull Valley, for example, almost 70% of monuments recorded as earthworks on historic photographs had been levelled by 2008 (Evans *et al* 2012, 52).

Assessment of buried features seen as cropmarks depends on many factors and there is no correlation between the frequency of appearance or the 'quality' of a cropmark and the condition of the underlying archaeology. For example, a recent aerial photograph of archaeological cropmarks confirms the presence of buried features but absence of cropmarks does not indicate the opposite. Geophysical survey, using appropriate techniques in the right conditions, can positively confirm the extent and depth of buried archaeological remains. Understanding past and recent farming practices can help archaeologists make more informed judgements on the condition of the below, and above, ground archaeology.

Environmental Stewardship Agreements

Existing Environmental Stewardship Agreements are administered by Natural England and incentivise land owners to manage historic assets on their farm holdings in a positive way, either through multi-annual "in-field" options, or schemes of capital improvements. They supplement statutory designation which for Scheduled Monuments does not place a requirement upon owners to maintain the assets in favourable condition. In addition to actively managing assets however, it is a condition of the scheme that any heritage feature identified to applicants at the start should be retained for the length of the agreement. Large parts of the project area fell within agricultural holdings which were eligible for Environmental Stewardship schemes grants under either Entry Level Stewardship (ELS) or Higher Level Stewardship (HLS).

ELS was non-competitive and available to any farmer anywhere who undertook to carry out sufficient basic options to manage key assets on their holdings. HLS on the other hand was competitive, geographically restricted and involved more complex types of management (including capital works), and agreements more tailored to local circumstances. Information on historic assets for ELS applicants was provided via the Farm Environment Record (FER), populated through the Selected Heritage Inventory for Natural England (the SHINE database which has been constructed locally from material drawn from HERs). For HLS applications HERs were consulted directly as part of the Farm Environment Plan. The Environmental Stewardship Scheme ended in 2014 and has now been replaced by the Countryside Stewardship Scheme which is part of the 2014–2020 Rural Development Programme for England (RDPE) (DEFRA 2014).

The number of new and amended NRHE records were analysed in relation to areas under Environmental Stewardship Agreements (Fig 36). Ridge and furrow was excluded because large numbers of fields of ridge and furrow spread over a wide area may be recorded in a single record. Because this method uses the centre point of each NRHE record it cannot account for the size of the record so a monument covering a large area may only partially cover land under a stewardship agreement. The analyses showed that 247 monuments (37%) are under ELS and 87 (13%) are under HLS. Approximately 338 (50%) of monuments are under no stewardship agreement. This may be because they fall within areas not eligible for Environmental Stewardship but if this is not the case they could enable more farmland to be considered for future Countryside Stewardship Scheme applications.

Archaeological features can only be actively managed under an agreement if they were recognised when it was put in place. Of the monuments located within ELS agreements, 217 (88%) were new to the NRHE while 43 (49.5%) of monuments within HLS were new. Although some of these monuments may have been recorded in the local HER, it still indicates the possibility that a potentially high percentage of monuments were not recorded when the agreements were implemented. Incorporation of the records from the NAIS project into the HERs should enable this information to feed into the SHINE

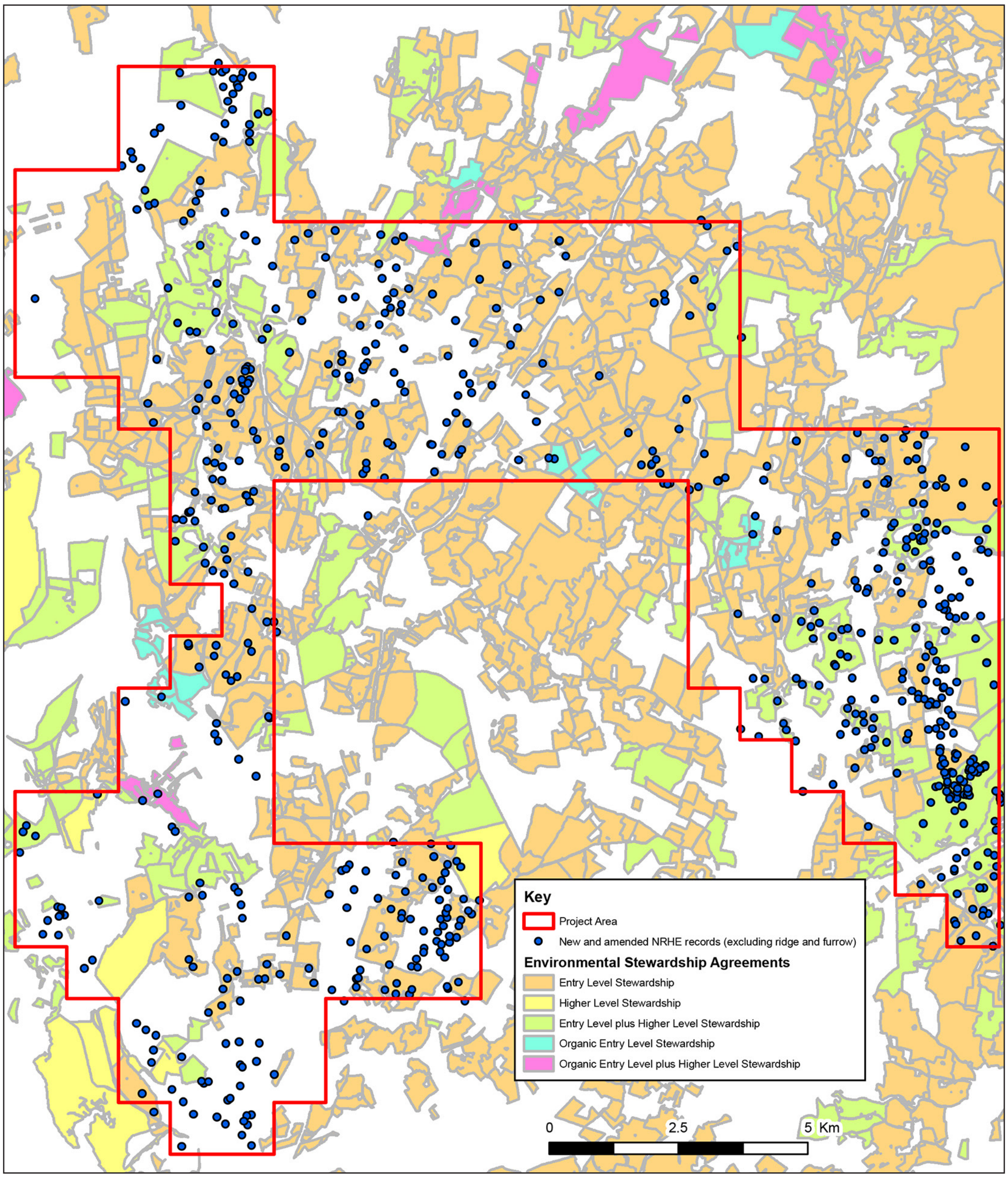


Fig 36: Environmental Stewardship Agreement areas. Contains information supplied by Natural England.

database to allow more active management in the future. However, this process will be dependent on the capacity of HERs to undertake this process, and indeed the future of SHINE in the context of informing Countryside Stewardship.

LEADER

Another strand of the RDPE is the LEADER scheme (a French acronym roughly translated as 'Liaison among Actors in Rural Economic Development') which provides funding for local community and business projects. One of the six LEADER priorities is to 'provide cultural and heritage activities'. The project area falls under the geographical remit of two approved LEADER groups – Cumbria Fells & Dales and Lancashire North & Bowland. Future LEADER funded projects could incorporate the results from the NAIS project to provide heritage protection outcomes.

Designated heritage assets

The project area contains 35 scheduled monuments, 16 of which are Old County Number (OCN) schedulings, some of the oldest designation records. Eleven scheduled monuments were noted where revision or amendment of the scheduled area or description may be required. A further 17 monuments were identified as possible candidates for designation assessment. These will be evaluated by a Designation Advisor who will recommend which sites, if any, should be progressed.

Any discussions within the current report do not constitute formal recommendations from the Designation Department (now the Historic England Listing Group). As standing buildings did not fall within the scope of the NAIS pilots, no recommendations relating to listings have been made.

Three potential enclosures at Kitridding Hill (43113), Terrace Wood (44013) and Low Barn (44014) were suggested. If their function can be confirmed and their degree of survival assessed all are potential candidates for designation assessment (English Heritage 2012a, 15).

Three embanked circular structures may be Bronze Age ring cairns (43118, 44001 and 1575283). This monument type is nationally rare and as such they are good candidates for further assessment (English Heritage 2012b, 13). A rare area of prehistoric/Roman cord rig cultivation was identified (1574168) and is one of only 11 sites recorded in Cumbria on the NRHE, none of which is scheduled.

In addition to those early medieval sites that fall within the High Park scheduled area, two further sites were considered to be of potentially early medieval date. The first (1093184) lies immediately north of High Park and comprises a curvilinear arrangement of boundaries and two possible longhouses. A second, more tentative site (44127) is located to the north of Grove Gill and is defined by curvilinear stone-built boundaries and a possibly unrelated rectangular structure. Additional fieldwork is required at both of these locations to better understand the remains but if they are considered likely to be of early medieval date they are strong candidates for designation assessment (English Heritage 2013, 16).

Coaxial field systems, probably of Iron Age/Roman date, were identified by the project. Aside from the scheduled area of High Park, the most coherent system was at Barbon Park (44123). Although this represents an area of extensive surviving field system, current scheduling criteria mean that statutory designation is unlikely to be the most appropriate mechanism for management (English Heritage 2012c, 16). Further analytical field survey in consultation with the Designation Department is recommended.

Forty four probable settlements of later prehistoric or Roman date were mapped by the project, some of which were new additions to the archaeological record. Due to the high number of settlements within the project area and the wider upland landscapes of Cumbria and the Pennines, no specific settlements have been highlighted. It is suggested that an assessment of the settlements is made with advice from the Listing Group to consider scheduling criteria, specifically condition, group value and archaeological potential (English Heritage 2013, 14–16).

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APPENDIX 1. AERIAL INVESTIGATION & MAPPING METHODOLOGY, SCOPE AND SOURCES

Archaeological scope

Cropmarks, parchmarks, soilmarks

All subsurface archaeological remains visible as cropmarks, parchmarks or soilmarks were mapped and recorded.

Earthworks

All archaeological earthworks visible on air photographs were mapped and recorded. This included features visible as earthworks on early photographs, which have since been levelled and archaeological features depicted on OS maps that are within the NMP sphere of interest.

Buildings and structures

The foundations of ruined buildings visible as cropmarks, soilmarks, parchmarks, earthworks or stonework were mapped and recorded. Standing roofed or unroofed buildings were not normally mapped. The exceptions were in specific archaeological contexts such as industrial and military complexes (see below), or when associated with other cropmark and earthwork features.

Sheepfolds and shielings were mapped if they had a demonstrably pre-20th century origin, even if they appeared on OS mapping of any date.

Ridge and furrow

Medieval and post medieval ridge and furrow were mapped and recorded, regardless of preservation. The extent of a contiguous block of ridge and furrow (including plough headlands) was defined by a closed polygon.

Post medieval field boundaries

Post medieval field boundaries (upstanding or levelled) that were depicted on OS first edition or later mapping were not generally mapped. The exception to this was where they formed part of an earlier field system that was not depicted by the OS.

Parkland, landscape parks, gardens and country houses

Man-made elements of parkland, landscape parks and gardens were mapped and recorded. Modern or 20th-century parks and gardens were not mapped.

Industrial features and extraction

Widespread and common small-scale extraction for local use such as quarries or gravel pits were not mapped. Extraction measuring over 1ha in area was defined as an extent of feature. Any extraction that directly impinged on an archaeological monument was mapped.

Industrial complexes were mapped as an extent of feature and the main elements of the process depicted. This included any roofed or unroofed structures that are still upstanding. The gunpowder works at Bassingill, Gatebeck and Sedgwick had already been surveyed by English Heritage at a higher level so were only mapped as an extent of feature.

Limekilns and their associated quarries (regardless of size) were mapped and recorded in the same record.

Transport

Major transport features (canals and main railway lines) were not mapped. Smaller features such as tramways were mapped and recorded, especially in the context of associated features.

20th-century military features

Second World War military were mapped and recorded. This included any roofed or unroofed structures that are still upstanding. Although within NMP scope, no Cold War features were identified.

Natural features

Natural features which are geological or geomorphological in origin were not mapped. If there was risk of confusion in contexts with other archaeological features, then the natural features were mentioned in the text record.

Methods

The following sources were consulted as part of the project:

Images

- English Heritage Archive vertical photographs.
- English Heritage Archive oblique photographs (prints and digital).
- Lancashire HER air photographs.
- Cumbria HER air photographs.

- The Cambridge University Collection of Aerial Photography (CUCAP).
- 25cm orthophotography supplied through the Pan Government Agreement (PGA).
- Google Earth vertical air photograph mosaics.
- Environment Agency lidar (1m and 2m resolution).

Monument datasets

- Cumbria HER.
- Lancashire HER.
- Lake District HER.
- National Record of the Historic Environment (NRHE) database (AMIE).

Other sources

- Ordnance Survey modern and historical mapping.
- Existing NMP data.
- NSRI soilscapes.
- Administrative boundaries.
- Scheduled Monument data, including the NHLE database and Registry files.
- Existing field surveys.
- Published and internal reports.
- External websites.

Photographic sources

All available vertical and oblique air photographs held by the English Heritage Archive in Swindon were consulted; the coversearch was carried out on 29 Nov 2012 (loan refs 74665 and 74666). A total of 2,535 vertical and 1,170 specialist oblique prints were examined. The vertical photography ranged in date from 1945 to 2000 and the obliques from 1932 to 2010. In addition to this, 231 oblique photographs dating from 2012 were provided as digital images. Further digital oblique photographs, dating from 02 Feb 2013, were made available locally as they were not accessioned into the English Heritage Archive at the start of the project.

Prints were loaned to the project by the Cambridge University Collection of Aerial Photography (CUCAP) administered by the Department of Geography.

Digital copies of photographs held by Lancashire HER were supplied to the project. The photographic collection of the Cumbria HER was accessed at the county offices in Kendal in May 2013 and selected photographs were scanned for rectification and mapping.

Orthorectified vertical photographs were supplied to English Heritage by Next Perspectives™ through the Pan Government Agreement (PGA) as 1sq km tiles in TIFF format, covering the entire project area. Additional vertical photography hosted on Google Earth was also routinely consulted.

Vertical photographs

Vertical photographs ranged in date from 1945 to 2000 and the vertical cover on Google Earth was as recent as 2011 in places. Factors influencing the visibility of features on vertical photographs include the quality of the negative and/or print, the scale of the image, cloud cover, the time of year, vegetation cover and the state of the crop or pasture but the principal factor for earthwork visibility is the angle and direction of the sun. Ideal lighting conditions are with the sun low on the horizon, usually in winter, to give strong shadows and highlights. Because none of the verticals assessed was taken for archaeological purposes, the lighting conditions were not necessarily optimal.

To adequately interpret and map earthwork or stonework sites they should ideally have been photographed on a number of different dates and at different times of the year. In general terms, the probability of identifying a site can also increase with the number of runs because there is a higher chance that there will be a run where conditions (lighting, vegetation cover, etc) were conducive to the site being visible.

Figure 37 shows the density and distribution of vertical frames per square kilometre based on the centre point of each frame. Although this is not an exact calculation of coverage (the area covered by a single frame will depend on the size of the negative and the scale of the photograph) it is indicative of the general density of photography. The highest densities of vertical photographs were in the south-west of the project area and to the west of Kendal. The lowest densities were in the Lyth valley and the areas to the east of the M6. The implications of this potential bias are discussed elsewhere in the report.

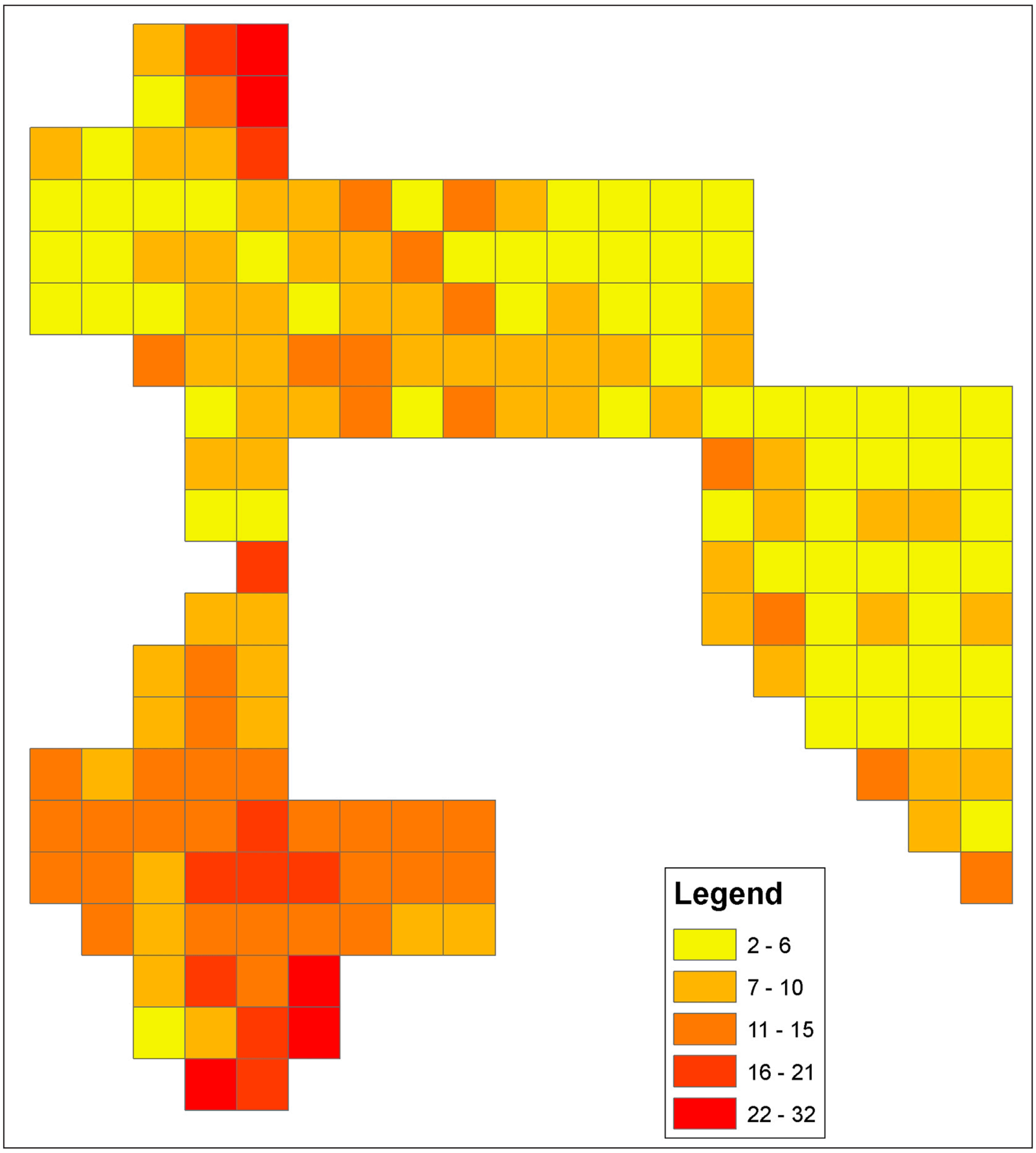


Fig 37: Number of vertical frames per square kilometre.

Without systematic reassessment of each run, it is difficult to make a qualitative judgement of the vertical photography but observations made during mapping indicate that the quality varied. Vertical photographs were generally considered to be the least useful of the image sources assessed by the project. This is partly due to a lack of runs that were taken in good lighting conditions for earthwork identification but also a reflection on the availability of lidar (see below). This has not been the case in other projects where well-lit vertical coverage has been invaluable, particularly in areas that underwent post-war arable intensification.

Vertical photographs were valuable, however, in identifying features where no lidar was available or where features such as Second World War military remains were no longer extant. Assessment of vertical photographs alongside lidar is also considered to be essential as they gave information on texture and tone and the ability to view in 3D. For example, colour orthophotography provided via the PGA was used to map sheep folds in the Pennine uplands where stonework contrasted well with the moorland vegetation.

Oblique photographs

Compared to some other parts of the country, the project area contains a relatively small number of specialist oblique photographs (Fig 38). The densest concentrations of photographs reflect areas with well-known earthwork remains to the east of the Lune (notably around High Park) and Levens Park. It is probable that the distribution and number of oblique photographs in the area is partly a consequence of poor conditions for cropmark formation. Regions that are conducive to cropmarks tend to be revisited on regular occasions but this is not always the case for other areas.

The distance from the airfield at Sherburn in Elmet used by English Heritage (previously RCHME) reconnaissance teams has meant that the region has received fewer regular flights than other areas of the country. At a local level, the project area has also tended to be covered by *ad hoc* flights rather than regular systematic programmes of reconnaissance from locally based flyers.

The oblique photographs ranged in date from 1932 to 2012 and varied in quality. Some images, particularly those dating from the 1970s and 1980s, were of insufficient quality to map from due to problems such as the graininess of the image or lack of control for rectification. Other images were not taken in appropriate conditions which, for earthwork sites, would be with the sun low in the sky to give good highlight and shadow. More recent photography, particularly the 2012 digital images from English Heritage (eg Fig 13) and those taken of High Park by Tim Gates, were more useful because they were taken in good conditions.

Oblique photographs available from CUCAP varied in subject matter and usefulness. Most of the photographs in the east and central parts of the project area were taken for archaeological purposes but rarely contained information not visible from other sources. The majority of the images in the west were taken for non-archaeological survey and no additional features were mapped from these. For other projects, images from the CUCAP collection can be a valuable source of information, particularly in cropmark landscapes.

Although lidar, where available, was commonly chosen over oblique photographs to map sites from, the additional detail the air photographs provided was useful. This was particularly so for very small or slight features which were not modelled with sufficient detail on 1m resolution lidar (Fig 12). Where it existed, oblique photography complemented the lidar very well, showing colour, tone and texture that are lacking in lidar data. These are particularly important for distinguishing details such as whether a feature is of stonework or earthwork construction.

Recent reconnaissance undertaken in optimal conditions provided good results, including details at known sites and some previously unrecorded sites (eg Fig 13). Continued reconnaissance may reveal some additional detail to sites recorded from lidar but the

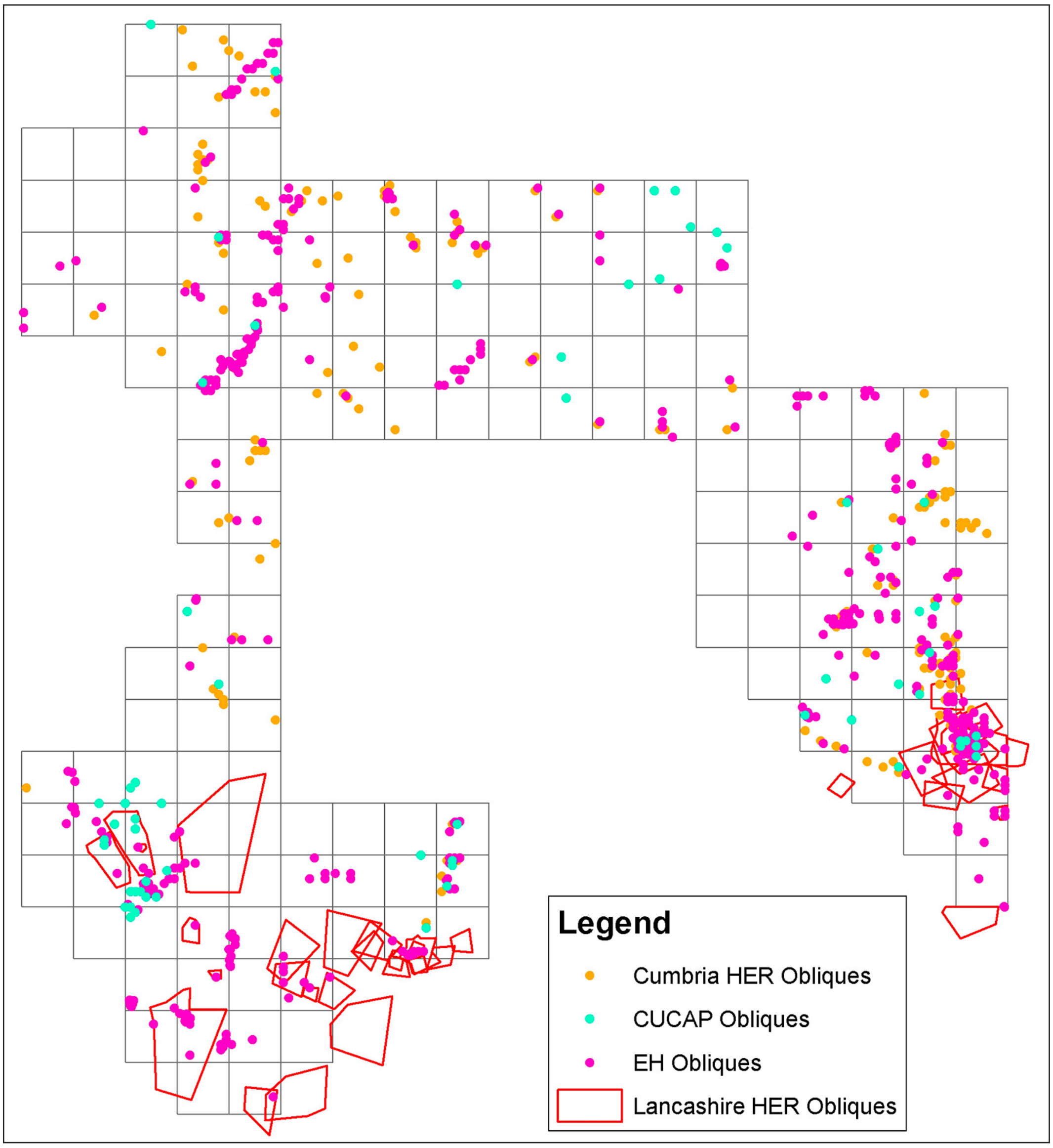


Fig 38: Distribution of oblique photographs.

probability of identifying new earthwork sites is now relatively low. The presence of a small number of cropmark sites demonstrated the potential for new discoveries in particularly dry years so further reconnaissance under the correct conditions is recommended.

Lidar

Lidar data were supplied to the project by the Environment Agency as 1m resolution gridded ASCII files and this covered 124sq km (71%) of the project area (Fig 39). Data were processed in house by Simon Crutchley using 16 direction hillshade and Principal Component Analysis (PCA) to produce 2D GeoTIFF images which were used in AutoCAD Map. These processing techniques create a composite image from the same data lit from 16 different angles. To achieve comparable results from conventional photography would require a site to be photographed in different light conditions at several different times of the day and year. There are also some angles from which the landscape would never naturally be lit.

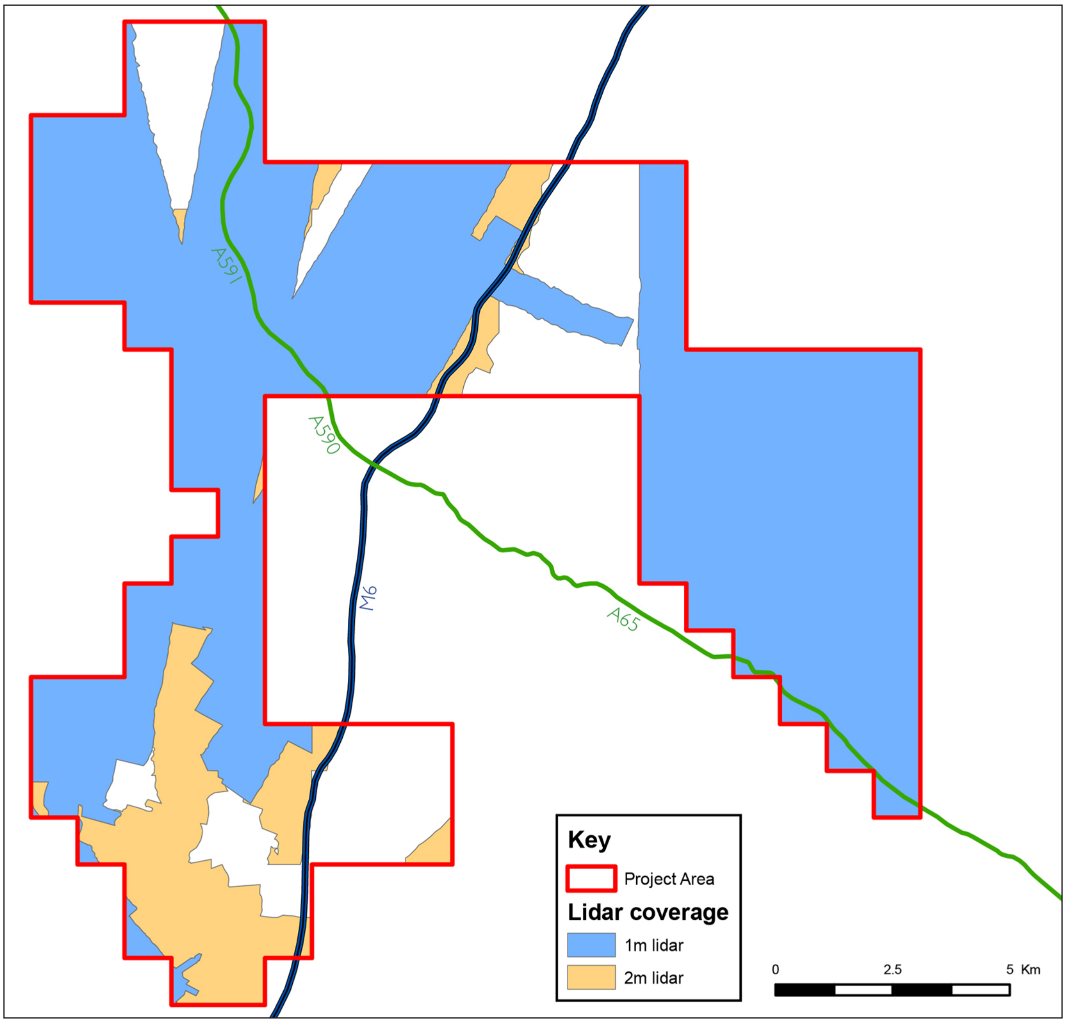


Fig 39: Coverage of Environment Agency lidar.

Additional coverage was available at 2m resolution. For these areas the single lit hillshade JPEG images supplied by the Environment Agency were used to supplement the 1m resolution lidar. Because of the lower resolution, only more substantial earthwork features were visible.

Over 80% of features were mapped from lidar and this figure rises even further if areas with no lidar coverage are excluded. The fact that a feature was not mapped from air photographs cannot, of course, be taken as an indication that it was not visible. This pattern will partially reflect the ease of using a georeferenced dataset compared to scanning and rectifying individual air photographs. However, lidar was generally found to be very effective at identifying earthwork remains and was considered to be the most valuable source in this particular landscape. This contrasts with areas such as the Hull Valley where post-war plough levelling of archaeology meant that historic photography was much more valuable than lidar (Evans *et al* 2012, 70–1).

Many features were only visible on lidar or were recorded with greater definition and detail than on air photographs. The resolution of the 1m lidar was generally found to be adequate for identification and mapping of archaeological features but in those instances where good quality oblique photography existed, additional detail was sometimes visible on the photographs. This was particularly the case with very slight or small earthworks that were not always modelled with sufficient detail on lidar (Fig 12). The resolution of the 2m lidar meant that only the more substantial remains were visible.

The survey of High Park undertaken by RCHME was used during mapping to inform interpretation and dating and provides a good control sample for the lidar. It was found that features identified through analytical field survey were generally visible on the lidar and some additional features that were not identified through field survey were mapped. This indicates that we can have quite a high degree of confidence that lidar will show features where they exist as surface remains. Conversely, in those areas where there is no lidar coverage the probability that features have not been identified increases. The definition and clarity of features was generally adequate for large-scale landscape survey although additional detail could be gained from targeted analytical field survey on appropriate sites.

As has been the case with previous projects, the use of air photographs alongside lidar was considered to be essential during the interpretation and mapping process. It is also probable that continued reconnaissance in the appropriate conditions will continue to reveal additional features. Some difficulties were encountered with the interpretation of lidar, particularly because no contemporary photography was available. Distinguishing between ridge and furrow and other linear marks caused by recent drainage for land improvement or other agricultural practices was particularly problematic.

Higher resolution lidar (50cm or 25cm) would give additional detail and possibly reveal further features. However, experience of using 50cm resolution lidar in the North Pennines indicated that this would be unlikely to significantly alter our understanding of the general morphology of a site and the extra time needed for interpretation and mapping could outweigh the benefits in most cases (Oakey *et al* 2012, 75). Additional lidar coverage to fill the current gaps would prove beneficial, particularly in the wooded areas of the Arnside & Silverdale AONB where higher resolution digital terrain data could yield further results.

Evaluation

Where appropriate, air photographs were examined under magnification and stereoscopically. Digital images, where no print was provided, and lidar data were viewed on a computer screen.

Rectification

Oblique and vertical photographs were scanned and then rectified using the specialist AERIAL 5.29 software. Control was derived from either the 25cm resolution PGA orthophotography or Ordnance Survey 1:2,500 scale MasterMap® vector data. Digital terrain models derived from 5m interval contour data supplied by Next Perspectives were used to improve the accuracy of the rectification.

The accuracy of rectified images is normally to within ±2m of the source used for control but this error may be larger in areas with large topographic variation. The accuracy of the PGA orthophotography and Environment Agency lidar is within 10–15cm. Consequently the accuracy of mapped features, relative to their true ground position, will depend on the source used for mapping. This may be in the range of ±5–15m for images rectified using an OS base map but will be sub-metre accurate for those features mapped from orthophotography and lidar. Subsequent field inspection of many of the sites using a survey-grade GNSS (sub-metre accurate) device to locate them suggested that the positional accuracy achieved from aerial imagery was on the whole extremely good.

Mapping

Rectified and georeferenced imagery (lidar and PGA orthophotography) were loaded into AutoCAD using a world (TFW) file. If required for mapping, Google Earth images were aligned to the 1:2500 Ordnance Survey map base.

All archaeological features were mapped as closed polygons in AutoCAD. Features such as scarps or large platforms were mapped using a schematic T hachure convention. The extents of a contiguous block of ridge and furrow were mapped as a closed polygon and a single polyline, in the form of an arrow, indicated the form and direction of ploughing.

An object data table was attached to all features which included the following information:

Attribute	Description	Sample data
MONARCH*	NRHE Unique Identifier (UID)	44125
PERIOD	Date of feature (EH Thesaurus). Single or dual indexed terms	IRON AGE/ROMAN
NARROW_TYPE	Monument Type (EH Thesaurus). Specific monument type for individual features	HUT CIRCLE
BROAD_TYPE	Monument Type (EH Thesaurus). Broader monument type to enable grouping of individual features	SETTLEMENT

EVIDENCE_1	Form of remains (EH Thesaurus) as seen on PHOTO_1	EARTHWORK
PHOTO_1	Source feature was mapped from (air photograph or lidar)	LIDAR SD6383 DSM 12-20-MAY-2009
EVIDENCE_2	Form of remains (EH Thesaurus) as seen on PHOTO_2	EARTHWORK
PHOTO_2	Latest available source (air photograph or lidar) to give indication of current state of preservation. Not applicable for cropmark sites	NMR 28365_015 11-DEC-2012

**MONARCH is a former name of the National Monuments database re-named AMIE, and now known under the umbrella term NRHE. The table retains the former name to facilitate download into the English Heritage GIS and for delivery and use by the relevant HER.*

Where ground-based stages enhanced our understanding of the date and/or function of sites, the AutoCAD object data were amended to reflect this.

Recording

New records were created and existing records enhanced in the NRHE database to English Heritage Data Standards. Where possible, records were concorded with the relevant HER data.

Additional sources

Datasets held on the English Heritage GIS (eg historic maps) as well as HER data were used to inform interpretation, mapping and recording. Where higher level surveys existed, these were used to aid interpretation.

Quality Assurance

Quality Assurance was undertaken by AIM team members on a representative sample of mapping and NRHE records. This was undertaken both within and between the York and Swindon offices to ensure consistency.

Data archive and dissemination

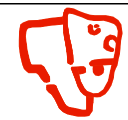
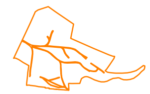
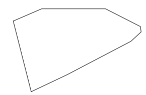
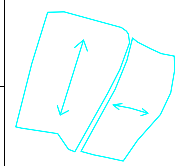
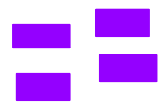
Copies of the AutoCAD drawing file are deposited with the Historic England Archive in Swindon (MD001344). Copies will also be retained by the Aerial Investigation & Mapping team for day-to-day access.

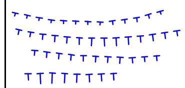
Data is also shared with project stakeholders (the Arnside & Silverdale AONB and relevant HERs) for incorporation into their GIS systems.

NRHE records created and amended by the project are available to professionals and the general public via PastScape (http://www.pastscape.org.uk) and signposted via Heritage Gateway (http://www.heritagegateway.org.uk).

Digital mapping is also incorporated into Historic England's corporate GIS where it can be displayed against other archaeological and non-archaeological datasets. This is available to Historic England and English Heritage staff via DeskGIS or WebGIS.

AutoCAD map layer content and drawing conventions

Layer Name	Layer content	Attached data table	Layer colour	Linetype	
0	None – AutoCAD standard	NONE	7 (white)	CONTINUOUS	
BANK	Closed polygons for features such as banks, platforms, mounds and spoil heaps	MONARCH	1 (red)	CONTINUOUS	
DITCH	Closed polygons for cut features such as ditches, ponds, pits or hollow ways	MONARCH	3 (green)	CONTINUOUS	
EXTENT_OF_FEATURE	Closed polygons outlining a feature or group of features such as an industrial complex	MONARCH	30 (orange)	CONTINUOUS	
MONUMENT _POLYGON	Closed polygons encompassing features recorded within a single NRHE record	MONARCH	7 (white)	CONTINUOUS	
RIG_AND_FURROW_ALIGNMENT	Polyline showing the direction and form of ploughing in areas of ridge and furrow	MONARCH	4 (cyan)	CONTINUOUS	
RIG_AND_FURROW_AREA	Closed polygon defining the extent of ridge and furrow	MONARCH	4 (cyan)	CONTINUOUS	
STRUCTURE	Closed polygon for built features including stone, concrete, metal and timber constructions				

THACHURE	Polyline t-hachure convention to schematise sloped features indicating the top of slope and direction of slope	MONARCH	5 (blue)	CONTINUOUS	

APPENDIX 2. GEOPHYSICAL SURVEY METHODOLOGY AND SCOPE

Archaeological scope

The results of the aerial mapping and analytical field surveys were reviewed by the entire project team and a 'long list' of sites was drawn up where ground-based geophysical survey could provide further information to answer unresolved questions. This long list was then prioritised in consultation with colleagues in Designation Team and at the local Historic Environment Record to determine those sites where additional survey would be most valuable. Four sites, all situated within NCA 19, were targeted based on these discussions:

Millbeck Farm

This site produced the only cropmark noted in the aerial mapping suggesting further subsurface remains may be present. As a new discovery by the project, there was a strong case for further ground-based investigation and, given that the types of remains expected might well have no surface expression, it was deemed a strong candidate for geophysical survey.

Kitridding Hill

The earthwork enclosure on Kitridding Hill showed morphological similarities with the scheduled enclosure at Castle Hill. Topographic features suggested there had been activity on the hilltop both within and outside the enclosure and geophysical survey to detect any additional subsurface remains was considered a valuable next step to improve understanding of the monument.

Howerigg Settlement

Although already scheduled, this settlement is poorly understood and its date uncertain. HER records show activity extending beyond the scheduled area and a Roman road runs close by the site although there is little clear evidence of its course in the immediate vicinity of the monument. It was therefore hoped that geophysical survey might help determine the relationship of the settlement with the Roman road and any additional remains outside the scheduled area.

Gowrey Farm

Situated on the eastern slopes of the Lune Valley, no aerial evidence for archaeological remains had been detected at Gowrey Farm but further up slope at High Park extensive Iron Age/Roman coaxial field systems had been mapped. There was a question as to whether these field systems might have extended down to the Lune Valley floor but had been levelled by more recent field improvement. Should the coaxial field system boundaries have a magnetic signature, it was hoped that an extensive survey of the fields at Gowrey Farm would detect evidence for their continuation into the valley.

Methodology

A defining feature of the NAIS methodology is to carry out a rapid assessment of the area in question with minimal resource investment. For this reason geophysical survey was largely restricted to use of magnetometry which can cover large areas quickly and responds to a wide range of buried archaeological remains. The predominately Silurian geologies of the region have seen comparatively little archaeological geophysical survey in the past but are believed to be relatively unresponsive to magnetometer survey. Hence, it was decided to trial a prototype towed array of high sensitivity caesium magnetometer sensors to gather the magnetic data for the project as this promised high speed data acquisition at high resolution.

Although the constraints of the project did not allow much scope for testing other techniques, a trial area of vehicle towed ground penetrating radar coverage was measured at Kitridding Hill over the earthwork remains of the enclosure. All geophysical survey was carried out in accordance with the guidelines for best practice set out by English Heritage (2008) and technical details of instrumentation and systems employed are described below.

Magnetic survey

Magnetometer data was collected using an array of six high sensitivity Geometrics G862 caesium vapour magnetometer sensors, capable of detecting anomalies of the order of 0.01 nT, mounted on a non-magnetic sledge. The sledge was towed behind a low impact, all-terrain vehicle (ATV) which also provided the power supply and housed the data logging electronics. Five of the sensors were mounted in a linear array transverse to the direction of travel 0.5m apart and, vertically, ~0.2m above the ground surface. The sixth was fixed 1.0m directly above the central magnetometer in the array to act as a gradient sensor. The sensors were set to sample at a rate of 16Hz based on the typical average travel speed of the ATV (3.2m/s) giving a sampling density of ~0.2m by 0.5m along successive swaths. Each swath was separated from the last by approximately 2.5m, navigation and positional control being achieved using a Trimble 4700 series GPS receiver mounted on the sensor platform 1.75m in front of the central sensor. Sensor output and survey location was monitored during acquisition to ensure data quality and minimise the risk of gaps in the coverage due to the use of a grid-less system.

After data collection the corresponding readings from the gradient sensor were subtracted from the measurements made by the other five magnetometers to remove any transient magnetic field effects caused by the towing ATV. The median value of each instrument traverse was then adjusted to zero by subtracting a running median value calculated over a 60m 1D window. This operation corrects for slight biases added to the measurements owing to the diurnal variation of the Earth's magnetic field and any slight directional sensitivity of the system.

Ground Penetrating Radar survey

Ground Penetrating Radar (GPR) data was collected using a Sensors and Software Pulse Ekko PE1000 console with a 450MHz centre frequency ground coupled antenna, to record reflections through a 50ns window. The antenna was mounted in a small sledge towed behind a four wheel drive vehicle together with a Trimble 4700 series GPS receiver to provide positional data. Individual GPR traces were collected at 0.05m intervals along profiles separated by approximately 0.5m, although the cross-line spacing was varied due to the topography and vegetation cover at the site.

Post-acquisition processing involved the adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. The broad bandwidth of an impulse GPR signal results in a range of frequencies to either side of the centre frequency which, in practice, will record significant near-surface reflections closer to the ground surface. Such reflections are often emphasised by presenting the data as amplitude time slices and these were created from the entire data set, after applying a 2D-migration algorithm, by averaging data within successive 2ns (two-way travel time) windows (Linford 2004).

Data archive and dissemination

Digital datasets of the survey measurements along with the CAD and PDF interpretation plans are held by the team on the Fort Cumberland file server.

Interim reports describing the surveys of each site have been circulated amongst the project team and stakeholders and provided to the regional HER (Linford, *et al* 2013a-c; Linford *et al* 2013d). These have been signposted using the Archaeology Data Service's OASIS database and summary details digital copies can be accessed by querying the online Geophysical Survey Database (http://archaeologydataservice.ac.uk/archives/view/ehgsdb_eh_2011//) or from Historic England's Research Reports database (http://research.historicengland.org.uk/). The NHRE records made during the aerial mapping phase of the project have also been updated to signpost the subsequent geophysical surveys.

APPENDIX 3. EXCAVATION METHODOLOGY AND SCOPE

Barbon

At this site, charcoal burning platforms (CBPs) were the subject of investigation. Two groups of platforms were investigated; one group on slopes to the east of Barbon Wood (AMIE 1574919) and the other on open parkland to the west of Barbon Wood (AMIE 1575141). The main aim of the work was to undertake small-scale, rapid excavations in order to:

a) first confirm that the aerially mapped features were CPBs, and then

b) to recover remains suitable for radiocarbon dating and for wood charcoal analysis with the aim of:

- identifying past vegetation types found within the area.
- identifying the preferred wood types used here for charcoal production.
- investigating whether there was evidence for any woodland management regimes, eg coppicing, and
- investigating whether there was any indication as to the subsequent use of the charcoal.

Given the short time available for fieldwork, investigating the form and character of the CBPs themselves in detail was not possible, and therefore out of scope.

Preliminary site visit

Prior to any works taking place, a day's reconnaissance visit to the site was carried out (September 2013) to visit some of the features and establish: i) their character and form (size and shape), ii) any surface indication of burning (ie charcoal fragments) and iii) the accessibility and suitability of individual features for further investigation (excavation, or sediment coring).

Site selection

Following the visit, it was decided that the most suitable CBPs were those: i) on the open slopes (and not within the woodland), ii) that were more-easily accessible (ie close to access paths), iii) with a stronger GPS signal (for site surveying), and iv) that had clearer, better defined shape and form. During the excavation phase of work, restrictions from estate staff also determined which could be used.

Archaeological excavation

Excavations took place in October 2013. Previous advice from T. Gledhill (pers comm) was that the front, downslope 'apron' of a platform would be the most likely place from which to recover charcoal; between burns charcoal makers would have scraped out any charcoal waste left within the platform, out and down over the front slope. Therefore, this was tested over the course of the excavation.

All data management followed English Heritage procedures.

Eastern group

From the group of CBPs to the east of Barbon Wood, three platforms (9013 (=E13), 9014 (=E14) and 9015 (=E15)) were investigated, with almost one completed each day.

Before any excavations began, rapid topographical survey of each of the three CBPs was carried out. This involved recording the overall shape of each CBP by mapping i) the highest point of the rim of the circular remains, ii) any obvious break in slope at the base of this ridge (inside and out) and iii) two perpendicular straight line transects across the feature intersecting in the middle recording the cross section profiles.

In order to establish the best place/s for recovering charcoal from a CBP (see above), some early trials were used to inform the locations of subsequent test pits. The total area of permitted excavation was *c* 2sq m per feature, so the number, size and shape of the test pits changed over the course of the excavation informed by the presence/absence and amount of charcoal recovered previously. Where it became clear on removal of the turfs that there was unlikely to be any charcoal recovered (ie an absence of black/darkened soil), the test pit was not excavated and the turfs were replaced.

Platform 9013 was the first platform to be excavated, and charcoal was recovered and sampled from the inner front edge of the platform itself (part of a 0.5x3m test pit extending downslope out and over the front lip of the platform); on platform 9014 a 0.5x2.6m test pit was excavated downslope (charcoal was recovered from the downslope 'apron' deposits); lastly, platform 9015 was excavated with a 0.5x3m test pit (and charcoal was recovered from the 'apron' sediments, as before).

All the bulk samples (for flotation) were between 2–40 litres. No sampling in spits was carried out, because the charcoal deposits were thin, and no stratigraphical layering was discernible within them. In addition to the flotation samples, single charcoal fragments for radiocarbon dating were sampled from other (non charcoal concentrated) contexts and from the ground surface from eroding sediments of non-excavated platforms.

All features, contexts and samples were surveyed in using a Leica CS09 differential GPS.

Western group

Two platforms (W2 and W3) were investigated here, selected on their shape and form and the apparent lack of associated features/disturbance within them. Three short cores were taken across both platforms using the Dutch auger on an approximately straight-line transect from front to back, located i) just at the inside break of slope at the back of the platform, ii) on the inside at the front of the platform, just inside the lip, and iii) just on the outside of the front downslope. Sediments were examined (mainly for the presence/absence of charcoal fragments), described and recorded on-site.

All coring locations were surveyed in using a hand-held mapping-grade Trimble GeoXT GPS.

Kitridding Farm and High Park

The main aim of these investigations was to attempt to scientifically date a series of earthwork features (settlement and field boundaries), using Optically-stimulated luminescence (OSL) dating and then compare the results to the purported ages based on the morphology of the mapped features. Firstly, sediments at each site were assessed for their suitability and application of OSL dating, and then, only where appropriate, OSL was used to produce ages for the features. Additional dating methods were to be used where appropriate (ie radiocarbon dating plant remains).

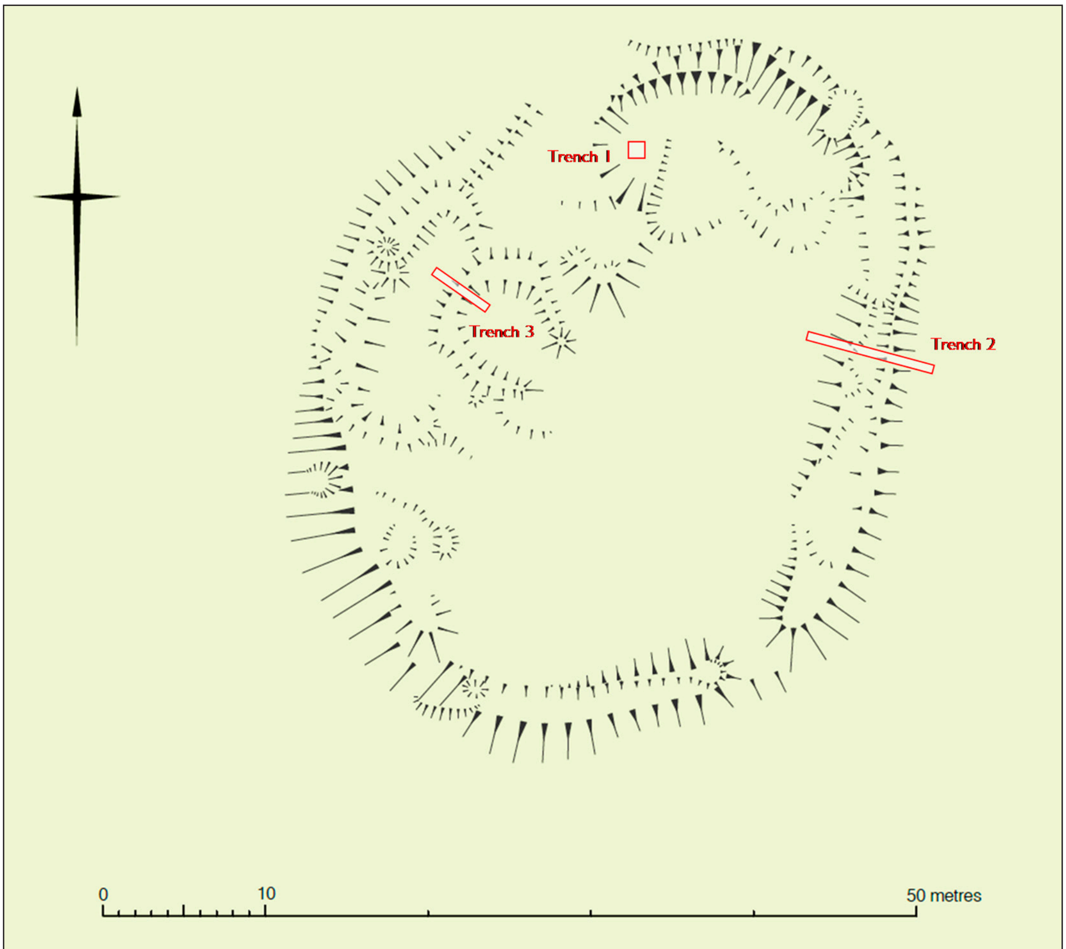


Fig 40: The locations of the excavation trenches over Ian Hardwick's Level 3 survey of the scooped enclosure at Kitridding Farm. After discussions with the Assessment team it was decided not to open Trench 1 due to the high probability that this was the location of later stone quarrying.

Site and feature selection

Following advice from English Heritage's Assessment Team, a selection of earthwork features (settlement and field boundaries) were identified as targets of particular interest for further investigation – in particular to determine their character, stratigraphic relationships and ages.

High Park

High Park was chosen due to the detailed survey results undertaken by Jecock (1998) and the archaeological importance of this site (it is a Scheduled Ancient Monument). A range of feature-types (field boundaries and settlements) were selected: i) an intersecting settlement complex and coaxial boundary, ii) an intersecting coaxial boundary and curvilinear paddock, and iii) a rectangular building.

Kitridding

At Kitridding Farm, settlement features (a scooped enclosure and a hut platform) were investigated. This site was selected for investigation for a combination of reasons:

- it is a well-defined and well preserved example of this kind of feature in the region; dated typologically, rather than scientifically.
- it had been selected for a detailed Level 3 survey to be carried out.
- it has an adjacent wetland site with waterlogged organic deposits that may be able to provide information on the activities and surrounding landscape at the time of the settlement's occupation.
- the site itself had ease of access (close to a public road).

Preliminary site visits

Before any excavations took place, a preliminary visit to both sites was carried out (May 2014). This involved sediment coring to determine i) the make-up and form of the features, ii) recover sediment for an assessment of the OSL potential ie to assess its suitability for this particular dating technique.

Given the low height of the features (all less than 1m) and the importance of recovering stratigraphically secure samples, it was necessary to recover intact cores using an Eijkelkamp percussion auger. Only 1–2 cores were taken at each feature, and all were less than 1m long. The sediments within each core were photographed and described according to English Heritage's Recording Manual and using a Munsell soil colour chart. Where appropriate, sub-samples of the fine-grained sediment were taken for laboratory analysis to assess their suitability for OSL dating. There was no attempt to establish stratigraphic relationships between features at this stage of the project.

Samples and *in situ* gamma spec readings were taken by Dr Phil Toms (University of Gloucester) who then carried out a laboratory-based assessment of their potential for OSL dating.

All spatial data (core/sample locations) were recorded using a Leica CS09 GPS.

High Park

At High Park, a total of four sediment cores were recovered, from three locations of interest. The raised earthwork remains targeted consisted of stone and soil banks, some of exposed stone and some turf-covered. Initially, the banks themselves were cored, but this proved difficult due to the stony components, and so at the final feature investigated at this site (the rectangular building) the sampling strategy targeted infill sediments that were easier to retrieve, and in theory could provide a post-abandonment age.

Kitridding Farm

At Kitridding Farm three cores were recovered from the settlement features and five cores from Kitridding Mire (see later). The settlement features were in fields used as pasture, and so were all turf-covered.

Two cores were recovered from the scooped enclosure feature: one from just inside the front edge, and one within the middle of the feature in order to recover its infill (and therefore possibly date the time of its abandonment).

Following the success of recovering fine infill sediment from the middle of the scooped enclosure, the middle of the hut platform feature was also targeted for sampling, and a single core was recovered.

Archaeological excavation

Excavations (October 2014) only took place at Kitridding Farm's scooped enclosure because, based on the results of the OSL assessment, the sediments from this site only were deemed suitable for OSL dating. The specialist advice was that no further luminescence work should be carried out at High Park.

The main aim of the excavation at Kitridding Farm was to obtain sediments that could be sampled for OSL dating and thereby provide ages for the construction, occupation and/or abandonment of the site. Two slot trenches were excavated (Fig 40): one across the outer enclosure bank (Trench 2: 1.2x10.4m) and the other across the bank of a hut within the enclosure (Trench 3: 1.2x4m). The locations of the trenches were informed by the results of the Level 3 Survey undertaken by HLF/IfA-funded HEP, Ian Hardwick (Fig 40) as well as from the preliminary site visit. Full details of methods and results will be presented in a Research Department Report when the work is complete. In the meantime, for more detail, see the Site Archive Completion report by Crosby and Hazell (in progress).

Palaeoenvironmental studies (Kitridding Farm) – methods and scope

Preliminary visit

The waterlogged organic deposits were sampled using an open-chambered gouge corer. A series of cores were taken along two transects perpendicular to each other, in order to determine the depth of the organic deposits across the site. For each core the main sediment characteristics were recorded (including Munsell colour, changes between predominantly organic and mineral deposits, and the degree of decomposition of the organics). Sub-samples were recovered from the main stratigraphical layers in order to examine them in the laboratory and assess their level of preservation and thereby their suitability for palaeoenvironmental investigation (in particular for pollen, plant macrofossils and radiocarbon dating).

Final coring

In total, two replicate cores were recovered from the organic sediments at Kitridding Mire using a 5cm diameter, D-shaped ('Russian') corer. They were taken 0.5m apart, and two were needed to ensure that sufficient sediment was recovered for both palaeoecological analyses and radiocarbon dating. They were taken from the area of wetland with the deepest organic remains (as determined from the preliminary coring).

Both cores consist of four core sections, and all eight sections are stored in half drain pipes and wrapped in clingfilm, in the cold store (<4°C) at Fort Cumberland.

A brief description of the cores was done on-site, but the cores still require full recording in the laboratory (sediment components and colour description, and photographing) prior to any subsampling. Work on these cores is to prioritise the selection of suitable remains for radiocarbon dating, in order to determine whether the wetland deposits are contemporaneous with the activities on the adjacent scooped settlement enclosure. Therefore, any assessment of micro/macrofossils must wait until the age of the sediments has been determined.

APPENDIX 4. SCIENTIFIC DATING METHODOLOGY AND SCOPE

Barbon

The main aims of radiocarbon dating the charcoal burning platforms were to: provide a date for the use of the platforms, determine whether there was evidence of multiple phases of use, and whether the use of the platforms were coincident/coeval, and to see if the charcoal produced was used to fuel a medieval iron bloomery that may have been present nearby in Barbon. It was hoped that their age/s could have helped inform the use of the charcoal (in particular given that there is a record (currently not validated) of an iron smelting site in the locality (Cumbria HER ref. 15986)).

Radiocarbon dating

Samples for radiocarbon dating were only submitted from the Eastern group of CBPs. Predominantly, these came from the three excavated platforms (two separate fragments of charcoal from each platform were submitted), however, an additional fragment recovered from the eroding front slope of platform 9007 was also radiocarbon dated.

Four samples were dated at the Scottish Universities Environmental Research Centre. These samples were pre-treated as described by Stenhouse and Baxter (1983). CO_2 obtained from the pre-treated samples was combusted in pre-cleaned sealed quartz tubes (Vandeputte *et al* 1996) and then converted to graphite (Slota *et al* 1987). The samples were dated by Accelerator Mass Spectrometry (AMS) as described by Freeman *et al* (2010). The ^{14}CHRONO Centre, The Queen's University, Belfast processed a further four samples using methods described by Reimer *et al.* (2015).

Kitridding Farm

The principal aims driving the scientific dating strategy at this site were to derive ages for i) the scooped settlement enclosure, and ii) waterlogged organic deposits from the adjacent area (Kitridding Mire). During the excavation, charred deposits were recovered from multiple contexts, particularly in the case of charcoal from a hearth feature. At that same feature, samples were also recovered by the OSL-specialist for luminescence dating.

OSL dating

Seven sets of samples were recovered from deposits associated with the scooped settlement enclosure, namely the outer enclosure bank (three samples), and the bank of a hut feature within the enclosure (three samples). One additional sample was taken from the burnt oven/hearth feature, and luminescence dating of the hearth deposits could provide information regarding the timing of its last (ie most recent) use.

All sampling was undertaken by the contracted project expert P. Toms (University of Gloucestershire). The processing for luminescence dating is in progress at the University of Gloucestershire.

Radiocarbon dating

Kitridding Farm Enclosure

Radiocarbon dating charred remains from the hearth (charred plant remains and/or charcoal) could provide an age estimate of a burning event during the hearth's use. The results can then be compared with those produced from OSL dating.

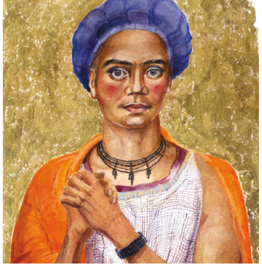
In addition, other samples with the potential for radiocarbon dating were collected – both bulk and specialist (individual charcoal fragments).

The samples have yet to be submitted.

Kitridding Mire

The initial aim of dating the organic waterlogged remains was to produce 'range-finder' ages (from the top, middle and bottom of the core) in order to determine whether the deposits are contemporaneous with the period of the settlement's occupation. If so, then the deposits have the potential to provide palaeoenvironmental information about the landscape at the time of the enclosure's occupation, and of its inhabitants' past activities.

The samples were submitted in December 2015.



ENGLISH HERITAGE RESEARCH DEPARTMENT

English Heritage undertakes and commissions research into the historic environment, and the issues that affect its condition and survival, in order to provide the understanding necessary for informed policy and decision making, for sustainable management, and to promote the widest access, appreciation and enjoyment of our heritage.

The Research Department provides English Heritage with this capacity in the fields of buildings history, archaeology, and landscape history. It brings together seven teams with complementary investigative and analytical skills to provide integrated research expertise across the range of the historic environment. These are:

- *Aerial Survey and Investigation*
- *Archaeological Projects (excavation)*
- *Archaeological Science*
- *Archaeological Survey and Investigation (landscape analysis)*
- *Architectural Investigation*
- *Imaging, Graphics and Survey (including measured and metric survey, and photography)*
- *Survey of London*

The Research Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support outreach and education activities and build these in to our projects and programmes wherever possible.

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ENGLISH HERITAGE