Understanding the spatial patterning of English archaeology: modelling mass data, 1500 BC to AD 1086

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Variation in the density of archaeological evidence is caused by a multitude of interacting factors, some of which reinforce each other and some of which act to disguise genuine patterns of past practice. This paper initially presents a set of density models for England constructed by the members of the English Landscape and Identities (EngLaId) project and then goes on to discuss three possible explanations for the variation seen: modern affordance, variability in past usage of material culture, and past population density. The various members of the project team (with the aid of Andrew Lowerre) then provide their thoughts on the models and ideas presented from their own specific period specialist perspectives. The article is presented in this discursive format to reflect the differing opinions and approaches across an unusual multi-period project, in the spirit of multi-vocality and healthy debate.

INTRODUCTION <mark>H1</mark>

Archaeology's current phase of collating and analysing mass data sets raises questions about the sorts of broad patterns discernible in our evidence and what these might represent. In this article we present differences in the density and type of archaeological evidence across

England and discuss three possibilities for interpretation: (i) the ease with which we can find and investigate various archaeological phenomena; (ii) variations in past practices and the use of material culture; (iii) change in relative population densities.

In the English Landscape and Identities (EngLaId) project we are concerned with the distribution of settlements, cemeteries, field systems and finds across the English landscape from the Middle Bronze Age (*c.* 1500 BC) to the survey of England recorded in the Domesday Book of AD 1086. Differential densities in these distributions are of initial interest, identifying where features are most and least common, and how broad variations correlate with differences in landscape creation and use. In addition, we are interested in continuities across the *c.* 2500 years covered by the project. We have been influenced by a rich tradition of research exploring variation in England's landscape history, notably the influential study of Roberts and Wrathmell (2000) who defined three zones of settlement across England from the nineteenth century and traced these zones back into the medieval period, each with their own character of nucleation or dispersal of settlement. In the context of the EngLaId project, we aimed to investigate whether such a characterization, based on map regressions, would compare to a detailed consideration of the archaeological evidence from the early medieval period and, if it did, whether similar distributions of settlement might be found in the distribution of archaeological evidence from earlier periods. There were also methodological issues central to this undertaking: working with a mass of data raises questions of how far it is possible to say anything about differences in population levels, modes of settlement, and the use of material culture on the basis of broad sets of evidence.

The EngLaId team has collected an extremely large number of records (over 900,000) of English archaeological sites and finds for the period of interest from as many different sources

as possible (including almost all local government Historic Environment Records [HERs], from Historic England, and from the Portable Antiquities Scheme, amongst several others, listed below) and built these into a large database. This database is the main resource used to pursue the aims and objectives of the EngLaId project. Domesday was chosen as the end point for EngLaId because it formed the first national survey of the English people (although it was not principally concerned with people, but with taxable income), albeit not all of modern England as the Domesday surveyors did not venture far into the north and north-west of the country as it is defined today. In some ways EngLaId is an attempt to read backwards from Domesday into the deeper past of the area covered by this modern country of England (which includes areas not conventionally seen as settled by the 'English'). Although 'England' did not exist as an entity through much of our period of interest, it forms a convenient limit for the purposes of analysis, within which there is a reasonable degree of coherence across the datasets used. The research agenda of the project has been organized according to six overarching themes:

1. Identity: considering community, settlement hierarchy, social identity, and the relationship of the preceding factors to landscape;

2. Temporal patterning: considering the past in the past, 'continuity' and 'change' (and the usefulness or not of these concepts), and long timescales crossing traditional period boundaries;

3. Morphology and the definition of space: considering enclosure, the definition and nature of boundaries, and the relationship between morphology/topology and past human practice;

4. Agency of landscape/landscape force: reconsidering the relationship between the environment and past human activity;

5. Relating datasets: understanding the relationships between the multitude of data repositories in English archaeology and what different datasets can be used for as part of academic endeavour;

6. Mobility: considering patterns of movement and mobility of people and things in the past.

This article is primarily concerned with themes 1, 2, 5 and 6. In particular, the origins of this specific work derive from our desire to try to understand changes and continuities in past relative population density: were there particular parts of the country that held more people than others across the long term? Or did centres of high population density shift?

We are one of a number of recent large dataset analysis projects including: *The Fields of Britannia Project* (Rippon et al. 2015), the *Roman Rural Settlement Project* (Allen et al. 2015) and *People and Places in the Anglo-Saxon Landscape* (Blair 2014). These all broadly concentrate on published material or grey literature, providing somewhat smaller but more detailed databases with more information on artefacts, faunal and plant material, including pollen. Once all these projects are completed it will be of interest to compare and contrast the strengths and weaknesses of various approaches, particularly from the perspective of the much greater timespan encompassed by the EngLaId project (the other projects each only cover one traditional time period or the transition between two).

Patterns in very large datasets, almost by definition, are so complex that they cannot be understood on a purely empirical basis: different observers pick out and emphasize various elements of pattern. Interpretations on a broad scale partly depend on what individuals think possible for archaeology and archaeological data more generally. In what follows, two of the EngLaId team (Gosden and Green) present possible interpretations of the data and the other

members give their opinions: Ten Harkel and Lowerre (Historic England who have carried out pioneering work towards creating a detailed GIS of Domesday Book (Lowerre forthcoming); and Franconi, and Cooper. Gosden and Green tend to be more optimistic about the possibilities of, for instance, understanding past population densities than the rest of the group. We hope both the data themselves and the debates around them will be useful in promoting broader debate about interpreting archaeological information on a broad scale.

PATTERNS IN THE DATA <mark>H1</mark>

To undertake our analyses, the EngLaId team developed a set of 119 types of monument and twenty-two broad types of finds, further simplified into eight broad interpretative classes (all based on the Historic England monument thesaurus: Historic England 2014). The broad classes are:

1. Agriculture and subsistence;

2. Religious, ritual and funerary;

3. Domestic and civil;

4. Architectural forms;

5. Industrial;

6. Communication and transport;

7. Defensive;

8. Other.

The datasets combined in the EngLaId database that were used for this analysis were:

- HER databases from most of England's HERs (excluding North Somerset, Bath and North East Somerset, and some urban databases);

- Historic England's National Record of the Historic Environment (the former National Monuments Record);

- Portable Antiquities Scheme database;

- Fitzwilliam Museum's *Corpus of Early Medieval Coin Finds*;

- Data from the Archaeological Investigations Project at the University of Bournemouth;

- Data from Yates 2007 (prehistoric field systems), Palmer 2010 (Domesday Book), and Kinory 2012 (Iron Age and Roman salt processing evidence).

Monuments and finds were then collated on a presence/absence basis across a series of different spatial bins (a regular division of space into polygonal units of equal area and shape, e.g. a grid of squares or hexagons), the smallest of which were 1 km by 1 km (Green 2013). This size of square was taken as the smallest unit of analysis because a significant minority of our data (such as all records from Palmer 2010 or from the Fitzwilliam Museum's Corpus) are only recorded to this level of spatial precision (a much less significant minority might be recorded to a lesser level of precision). For the purposes of this analysis, we also filtered out records based purely upon place-name interpretation or documentary sources (where an evidence type was recorded by the HER), to minimize the effect of different policies in regard to such evidence types across the country (being particularly widely incorporated in Cornwall, but less so elsewhere).

We took the presence/absence maps of the broad monument classes and types as collated by 1 km by 1 km square and created kernel density estimate (KDE) plots of the results (using the centroids (i.e. the centre point) of each grid cell as point inputs). The concept of KDE modelling is that a spatial pattern has density between recorded locations, which is estimated by summing the number of events (multiplied by a numeric variable – the 'population') within a region (the 'kernel') around each point. The result of this is a continuous density

surface showing the variation in the 'population' across space and between the known recorded points. A KDE plot allows the discovery of higher ('hotspot') and lower areas of 'population' and is one of the most useful ways of moving from a point pattern to a more realistic surface model of a variable (O'Sullivan and Unwin 2010, 68–71). Because of the 1km horizontal/vertical spacing of the data points (being derived from the 1 km by 1 km grid) and due to the nationwide scale and relative coarseness of analysis, a 10 km kernel was used in the generation of the density plots (such a kernel also concords with the lowest level of spatial precision seen in a small minority of our data). As the 'population' field for the density model, we used a measure of the variety of different monument types recorded within each cell (essentially a count of the number of monument types per cell per period), no matter what type of monument was represented. Finds were included as a single monument type, and so were only counted once per cell (if present). It would be possible to create models based upon any particular category or type of site, but that was not deemed fruitful for this exercise as we wished to look at overall densities of evidence: where relevant, such work will appear in our final project publications.

KDE plots were created for our data for each of four broad periods: early medieval, Roman, Iron Age, and Bronze Age. Unspecific 'prehistoric' material was split across the Bronze and Iron Age models at a 50:50 weighting. To facilitate comparison, the results for each KDE surface were normalized by, for each pixel, subtracting the mean value for the surface as a whole and dividing by the surface's standard deviation (this is known in statistics as a z-score or standard score). As a result, in the following maps the positive values (pale (low value) through to bright red (high value)) are above the mean average (white) and the negative values (pale (low value) through to dark blue (high value)) are below the mean average, with numeric values being the number of standard deviations above/below. Due to the spatial

binning method used to collate the data, the results are more smoothed out (i.e. lower peaks and shallower troughs) than if every individual record location had been input into the model. This helps produce an output less influenced by modern recording practices (e.g. the degree to which different recording bodies lump or split 'sites' across more or less records which gives a false impression of the number of 'sites' present, but this is minimized by only counting each monument category once per square). Records with multiple types would feed into the presence of multiple site categories within a grid square, but this is a genuine reflection of the complexity of the archaeological record in said grid square.

Naturally, there are other methods by which we might have approached this data. There is potential for enhancing the HER record for Britain using methods borrowed from Big Data analytics: natural language processing (the extraction of data via computer algorithm from human-written text), for example, might be used to extract monument types or events that have been omitted from their relevant tables from descriptive text fields (see Jeffrey et al. 2009 for an example of such work). On the whole, however, the HER record is very well curated, so this would probably make only a minor difference to the results of broad scale analyses such as those undertaken here. We might also have taken a more spatial statistical approach, defining sizes of spatial bins and kernels based upon the statistical spatial structure of the data: instead, however, we based our bin and kernel sizes upon our knowledge of the spatial precision of the records contained in our database, which is an equally valid method.

Illus 1-4 here

We first sought differences in the density of features and finds across England through the data we have. Once broad patterns were recognized we then discussed possible reasons for the

differences. Illus. 1 shows the relative densities of archaeological evidence for the early medieval period using EngLaId data. There is a broad division either side of a line roughly from Torquay to Whitby, with higher levels of evidence to the east and south. East Anglia has the highest values, with a swathe of denser evidence through the Midlands to the Humber and into the Yorkshire Wolds. Areas of less dense evidence exist within this area, especially in the Weald. The main high values outside this area are found in Cornwall, possibly due to practices of categorizing sites and evidence there, although sites only known through place-name or documentary evidence were filtered out (see above and below), or possibly due to the long and rich fieldwork tradition in that area (Herring 2011; Herring et al. 2011). Similar patterns are found in earlier periods.

Illus. 2 shows Roman evidence. It might seem surprising that the model indicates much lower peaks than the succeeding early medieval model, but each model is presented as variation from its own average. The Roman model is not suggesting lesser activity, but a more consistent level of evidence across the broad band of central, southern and eastern England. The Iron Age evidence is broadly similar to the succeeding Roman model, but with a somewhat restricted area of higher relative density and with stronger peaks (Illus. 3). Iron Age activity in England might have been more closely clustered around fewer large central places than in the succeeding Roman period. The Bronze Age model shows greater evidence in upland areas compared with later periods (Illus. 4). This could reflect preservation factors: the upland zones of Britain became less favourable for settlement after the Bronze Age and, as such, were subject to later less destruction than lowland areas (Taylor 1972, 109–10).

Certain continuities consistently occur across these models. In particular, the southern and eastern half of England always seems to possess a higher relative density of settlement and

finds than the northern and western half, much like Fox's (1932) old model which divided the long-term prehistory and early history of the island between a highland zone from Cornwall to Scotland of successive cultural assimilation (a tendency towards continuity) and a lowland zone across central, southern and eastern England of successive cultural replacement (a tendency towards change). Within the south and east, one gap is apparent throughout all periods: the Weald in Kent. This may be due to less archaeological fieldwork in this area, or it may be a true historical pattern of long-term dispersed settlement in its wooded hills. With the exception of the Roman period, East Anglia and Cornwall both appear particularly high, although again this might be down to modern archaeological practice. The period that looks most different from the others is the Bronze Age where activity is more evident in upland areas such as the Derbyshire Peak and Dartmoor, while appearing to be sparser in some parts of the Midlands compared to later periods.

Having identified broad differences in the density of evidence across some 2500 years, we now discuss the key factors that lie behind such variations. We see three broad possibilities considered in turn: first, that the patterns seen may be due to the effects of the differing complexity of the archaeological record across England caused by variations in modern practice and recording – these we call 'affordances'; second, that differential densities of evidence derive from varying patterns of practice in the use of the landscape and of material culture, whereby people in the north and west may have used less (or less durable) material culture and/or lived more mobile lives, consequently generating lower levels of evidence; third, that the patterns derive from variations in population density in the past, using a general assumption that more people (in particular, more densely clustered people) should have produced more evidence, if one were to assume broadly similar lifestyles (contra the previous assumption). We selected these three factors as they seemed to us the most likely to have a

strong structuring effect on the nature of the English archaeological record on a national level. Other factors undoubtedly come into play with various levels of effect (most importantly site formation processes), but these would often only be possible to analyse on a site by site basis.

POSSIBILITY 1: MODERN ARCHAEOLOGICAL AFFORDANCES H1

The concept of affordance was introduced into landscape archaeology by Ingold (1992) and helpfully summarized by Gillings (2007, 38–9). Affordances are opportunities provided to people by their environment during practical activity. Affordance is primarily used in archaeology as a way of understanding interactions between people and their environment in the past. We have altered its usage to understand the interaction between the archaeological resource (as buried evidence) and its recovery in the present day by archaeologists (and others). There is a primary affordance of the presence of archaeological material in the ground, which is mediated through a series of other interrelated affordances in its preservation (taking into account site formation processes), discovery and recording. We prefer the term 'affordance' for modelling this relationship between potential and recovery over terms such as 'constraint' or 'bias' due to the more positive relationship envisaged between potential and recovery: using affordance makes this model into a consideration of opportunity rather than conceiving it as a problem. The records in the EngLaId database can be divided into two broad categories: find-spots and sites. Find-spots have their own set of structuring affordances relating primarily to metal detecting practice (discussed as biases in Robbins 2012; 2013; 2014; to be discussed in Cooper and Green forthcoming). We shall explore factors affecting the discovery and recording of sites.

Key differences exist in archaeological complexity between areas in the north and the south of England and we use the example of the EngLaId data from Cumbria to explore these.

Archaeological evidence from Cumbria is characterized by 'shyness' (in the sense of possessing a less detailed record), in contrast to the bolder data more typical of southern England (in the sense of possessing a more detailed record); a problem caused, in large part, by the nature of the Cumbrian evidence, which predominantly consists of earthworks that are difficult to date purely based upon their morphology and which yield few finds when excavated (a relatively rare event). For instance, the miscellaneous 'Other' category is the most dominant category in Cumbria, with a large number of undated enclosures. When creating archaeological maps by period, up to 28% of the dataset (2816 monument records) is forced to be excluded as it remains undated, meaning that maps of this region are missing nearly the equivalent of the Bronze Age, Iron Age and prehistoric datasets combined (2875 monument records). Uncertain boundaries and land divisions make up 51% of the dataset for Cumbria. This has ramifications for any understanding of change in enclosure, land division and mobility in Cumbria over time.

Investigation types also influence our understanding of the archaeology of Cumbria. The main bulk of events (44%) are aerial photographic surveys, due to a long history of aerial photography in the area. There is a lack of excavation in Cumbria, compounded by the paucity of datable material produced by excavations. It is striking that over sixty excavations produced no datable material found – it is hard to imagine a similar situation in southern England. Overall, there are considerable numbers of archaeological sites in Cumbria, but their high level of chronological uncertainty means that sites do not fit easily into traditional periods, with ramifications on how this area appears when comparing relative densities of sites from one traditional period to another. Part of the lack of strong concentrations of data across the north and west of England must be due to similar factors to those found in Cumbria. Unfortunately, the vast majority of our data has temporal precision only to the level

of broad time period at best (the PAS being an obvious exception) and so any probabilistic/aoristic treatment of time (for more on these methods, see Johnson 2004; Green 2011; Crema 2015) in our models would not have been fruitful.

Returning to the English evidence more broadly, the main intermediate affordances relevant to the sites and monuments are due to the main methods by which sites are discovered and recorded: aerial survey and excavation. Aerial survey is governed by a series of potential affordances, including the visibility of the ground surface, the type of land usage and the susceptibility of soils to show crop-marks. Since the later twentieth century, excavation is governed primarily by where development takes place, but also by other more intangible affordances such as local authority planning practice/policy. Antiquarian activity is another original source for English archaeological data, but many of these sites will have been re-examined at a later time by archaeologists (whether on the ground or via aerial survey) and, in any event, mapping the activities of antiquarians to understand their spatial patterning would be too immense a project to undertake here (albeit a worthy one). Of the records in our database, less than a thousand appear to explicitly record the former presence of an antiquarian (unless only referred to by name).

When attempting to map these affordances, understanding aerial survey is fairly straightforward. Areas of arable and grazing land are derived from the Centre for Ecology and Hydrology's Land Cover Map 2007 (Morton et al. 2014) and obscuring features can be derived from Ordnance Survey thematic mapping data (Ordnance Survey 2015). Soils that do not show crop-marks were defined by Evans (1990) and can be mapped using the National Soil Map of England and Wales (Cranfield University 2015). We have created an affordance map for aerial photographic prospection in England by combining grazing land minus

obscuration (representing potential to show earthworks or parch-marks) with arable land

minus obscuration and poor crop-mark soils (representing potential to show crop-marks)

(Illus. 5). This shows areas of high and low potential for (visual) aerial survey. A different

affordance map would be needed for LiDAR data that left woodland out of the obscuration

data: LiDAR was not considered as part of this exercise as it had resulted in very few new site

records for English archaeology at the time of data gathering, although that has surely been

changing since.

Quantifying affordances for excavation is more problematic as this is primarily determined by

planning processes that are not well recorded in any accessible way. National planning

statistics are plagued by changing local authority boundaries, as well as the lack of

information on planning applications that were approved and those that went ahead. In the

absence of reliable statistics, we have had to use data regarding the density of archaeological

fieldwork events instead (based upon Historic England's NRHE Excavation Index). This is

problematic, as the model becomes somewhat self-referential, but we have mitigated this by

looking at excavation events that found material of any (or no) period rather than just events

that found material of our period of interest.

Combining these two affordance models allowed us to understand the percentage of records

in our database that originated from fieldwork events. The combined affordance map for

sites/monuments (Illus. 6), is inevitably imperfect (as all models are), but useful. We can

begin to understand variation in the archaeological record as an artefact of modern

archaeological opportunity and practice. The most interesting areas are those with an apparent high affordance but with a low number of sites or those with an apparent low affordance and a high number of sites. More fundamentally, analysing distributions against affordance measures in a multitude of ways (e.g. linear regression of affordance ranking against density of evidence, see Illus. 10 below) can allow us to begin to tease out the degree of structuring influence that modern practice has had on our understanding of the archaeological past and the degree to which patterns in our data reflect genuine patterns of past practice.

POSSIBILITY 2: DIFFERENCES IN PAST SETTLEMENT TYPE AND USE OF MATERIAL CULTURE H1

As a second possibility, ways of life in the south and east show more evidence of larger and more complex settlements and field systems, as well as a greater emphasis on material culture compared to the north and west. We shall consider here variations in the amounts of pottery deposited/recovered across the country as an indication of the use of material culture more broadly. Pottery has been settled on for modelling here as it remains the primary source by which most archaeological contexts are dated in England (especially from the Roman period onwards). Certain styles of building may also be hard or impossible to discern when excavated (e.g. Anglo-Saxon buildings, see below and Blair 2013), but the people building such structures often left behind more tangible remains (e.g. cemeteries). Where pottery was not used (or used sparsely), however, it often becomes very difficult to obtain precise dates for an archaeological site (unless material for scientific dating is recovered), especially at a context level (due to the relatively high expense of scientific dating methods). These factors result in sites being less visible in the archaeological record for a particular period (see above), but we also suggest that using less pottery hints at less settled ways of life.

Illus. 7 here

To understand and, potentially, quantify the use of ceramics across the country, we collected several existing sources of data, as our main database contains little detailed information on finds from sites (naturally the finds datasets do (e.g. the PAS), but there is little pottery recorded in those). For the later prehistoric period, the most complete data source was that archived at the Archaeology Data Service (ADS) by Earl et al. (2007) covering collections of pottery dating between the later Bronze Age and the Roman conquest for all of England, collected between 1996 and 1998. The database is around twenty years out-of-date, but we assume (in the absence of any evidence to the contrary) that the general structure of the distribution will not have changed fundamentally. The overall distribution (Illus. 7) shows a distinctly higher density of pottery finds across a broad swathe of southern and eastern England (with a notable gap across the Weald in Kent and Sussex) than across western and northern England.

Illus. 8 here

The only existing national source of Roman pottery data is the excellent website maintained by Paul Tyers (1996–2014). This consists of maps of different pottery fabrics plotted on a presence/absence basis by 10 x 10 km grid square for all of Great Britain. The maps all carry a 2004 date, indicating the data is around ten years old. Again, it is assumed that the broad-brush distribution will not have changed immensely in recent years. Through image manipulation in GIS it is possible to create a composite map of the variety in pottery fabric across England through the Roman period (Illus. 8). The image processing involved saving the images from the website, rectifying them to a map of the UK, reclassifying the images to just retain the blue and red elements, then extracting values using a 10 x 10 km vector grid. Any grid cells containing data in the results were counted as featuring the presence of that particular pottery fabric, each of which could then be summed to produce a count of fabric

types per square. Compared to the later prehistoric map above, this is less a measure of record density and more of record variability. Essentially, this map shows diversity of pottery supply, indicating (relatively) aceramic zones in the southwest and in large areas of the north (away from military sites). Tyers does not record reduced ware products without easily defined fabric types (Paul Booth pers. comm.), but the ninety-two ware types recorded by Tyers (of a variety of types including finewares, coarsewares, amphorae, mortaria, etc.) provide a representative sample of pottery supply in Roman Britain.

Collating data on pottery distributions for the early medieval period becomes much more complex, as there is no comprehensive catalogue for the entire early medieval period because the earlier handmade and later wheel-turned industries are not usually studied together. For the earlier half of the period, the best source of evidence remains that of Myres (1969, map 1), which is several decades out-of-date. For the latter half of the period, the best evidence is a single map created by Vince (1993, fig. 1), alongside an updated map for Ipswich Ware only by Blinkhorn (2012, fig. 36): that being the first type of wheel-turned pottery to be produced in England (in Ipswich) since the end of the Roman industries, in the middle Anglo-Saxon period (AD 650–850). These datasets are problematic for our purposes in that they only refer to so-called 'Anglo-Saxon' material and leave out the 'British' west of England. This was rectified to some extent with the aid of two maps (respectively earlier and later early medieval) produced by Wood on early medieval pottery from south-west England (2011, figs 4.1 and 4.15; also summarized in Herring et al. 2011).

Combining these into a model, the distributions from Vince were given a lower weighting than the other sources due to their coarse character (being simply lines drawn around regions of supply). To try to bring the model more up to date, we also included (again, at a lower

weighting) a density map of early Anglo-Saxon cemeteries based upon data collected and kindly provided by Martin (2011), as most of these sites have produced ceramic finds, although this provides a rather coarse proxy. The combined model of early medieval pottery usage produced was thus (with the first half of the equation being the earlier material and the second half the later):

$$(Myres + 0.5\ Martin + Wood\_early) + (Blinkhorn + 0.5\ Vince + Wood\_late)$$

Illus. 9 shows a broad pattern of pottery usage in early medieval England with a ceramic eastern half of the country and a largely aceramic west and north, with some material in the far south-west. We need to be cautious, however, as the sources fed into the model are less comprehensive and more out-of-date than those used for the later prehistoric and Roman periods. This is the best model that we could hope to produce, given the material available to us, and it is hoped that the inclusion of more modern but fragmentary/secondary sources has minimized the risk of compounding past errors. It would undoubtedly be a worthwhile future project to collate pottery data for all of our time periods (and beyond), but an immense one.

The three maps indicate a consistently aceramic north and west and a much more actively ceramic-using south and east (with the exception of the Weald). This picture is reinforced by the lack of pottery from excavations in areas such as Cumbria. During the Roman period, there is more pottery usage in the north of England, but this tends to cluster around the sites occupied by the Roman military and the few larger towns (York, Wroxeter). South-west England appears to have less pottery usage in this period than in prehistory. In the early medieval period, the western and northern half of England uses even less pottery than in

earlier periods, albeit with the Humber/Trent basin possibly showing a greater intensity of ceramic usage than before.

All of these data sources need updating and, as such, are certainly not exhaustive or fully accurate in charting pottery usage in past. Collating up-to-date data on ceramic finds from excavations would be an immense undertaking and is far beyond the possible remit of the current project. However, it seems reasonable to assume that the broad-brush picture painted by these varied data sources should remain fundamentally the same, with any changes being either local in effect or purely of a general increase in intensity. Furthermore, these data remain subject to the same structuring affordances as all other excavation-derived material, which will undoubtedly have introduced a degree of positive bias towards the south-eastern half of England.

<mark>Illus. 10 here</mark>

Illus. 10 shows the results from testing the period density maps against the affordance model and pottery models, sampled using 10 x 10 km grid squares (mean values). Linear least square regression lines have been added: the degree of correlation between the variables was low for the Bronze Age and not particularly high for any of the other time periods, the strongest correlation being between the Roman density of evidence and the monument affordance model. This is a good result for us as archaeologists as it suggests that it is not just the multiple modern structuring affordances or variations in past usage of material culture that determine the distribution of archaeological evidence.

POSSIBILITY 3: PAST POPULATION DENSITIES <mark>H1</mark>

by CHRIS GOSDEN AND CHRIS GREEN

As David Hinton (2013, 147) recently and succinctly states: 'The starting-point for British population studies is shadowy'. Differential densities of archaeological remains may be due to varying population densities: following the general proposition that more evidence equals more people, or at least more densely clustered people living more settled lifestyles. It could be argued that burial evidence would form a more obvious starting point for modelling past populations, but across the temporal and spatial scales approached by EngLaId there are too many gaps caused by poor preservation and by less archaeologically visible practices for the treatment of human remains. Also, even where burial practices are visible in the archaeological record, we can never be certain that burials capture the entirety of the past population.

Demographic work on early historic and prehistoric populations forms a complex and confusing area of study, with a variety of approaches based on incomplete or dubious data. Arguments have concentrated on absolute numbers and the archaeological or historical evidence for such numbers. In Britain, demographic data from cemeteries have been used (Mays et al. 2007), as well as settlement densities (Hamerow 2005) and isotopic analyses that might inform on population movements (Hedges 2011). For the early medieval period a recent thorough-going review of the first major historical account of (parts of) the English countryside, the Domesday Book (written in AD 1086 – on which much more below) and antecedent forms of evidence, such as the Tribal and Burghal Hideages, have been used to give an estimate of around 2.5 million people in AD 1086 (Hinton 2013), possibly representing a drop of around 1 million from the peak of the Roman population (Millett 1990, 181–6). For the prehistoric period, there is greater circumspection in population estimates (Fowler 2002 being a slight exception; Sealey 2016 is an interesting recent regional experiment on Iron Age demography, which shied away from turning relative population

measures into head counts). However, most assume that Bronze and Iron Age populations were radically lower than the Roman period.

The Domesday evidence is problematical but useful. The issues involved in modelling Domesday populations are not insurmountable given appropriate care and caveats. We used the Electronic Edition of Domesday Book (Palmer 2010), which is easily accessible online for academic use, for our model. There is uncertainty over how many persons make up a recorded household in Domesday and slaves are recorded inconsistently (Darby 1986, chapter 3; see also Hinton 2013). If we are only modelling the 'free' population and counting households rather than individual people we are able to consider relative population levels within each individual period. As such, it is perfectly reasonable for us to simply model relative 'free' population for Domesday.

Illus. 11 here

Illus. 11 shows the population centres recorded in the Palmer edition of Domesday (2010), where geographic locations are recorded. The geographic coverage outside of the north and west is reasonably complete, with the exception of certain holes: most notably the North York Moors, the Peak District, Dartmoor, and the Weald. There were some data points running along valleys (primarily the rivers Lune, Ribble, Tees, and Wyre, and in the region of Furness) into the otherwise empty north-west, but as the Domesday survey was not carried out in this region to the same extent as further south, these data points were removed as they were too few to make density modelling sensible (also see below, section 2). The point-based nature of these data means that they take no account of the spatial extent of the relevant locations (the manors), so to make the data more cross-comparable, we have built in this factor through calculating the density of points weighted by the numerical (population) value.

Illus. 12 shows the kernel density estimate (KDE) of the points shown in Illus. 11 (again using a 10 km kernel for consistency), normalized by the mean and standard deviation. There are clear peaks in Leicestershire, East Anglia, east Kent, Lincolnshire and through Herefordshire/Gloucestershire/Shropshire which might indicate relatively high levels of population, providing a picture of the relative 'free' population of England in AD 1086, although the model is somewhat flawed due to the reasons discussed above.

Referring back to Illus. 1, this shows different densities of archaeological evidence for the early medieval period and compares reasonably with the Domesday results presented above (Illus. 12), but with obvious differences. The greatest difference is the much higher level of activity in the southwest. This could be accounted for through a greater intensity of modern archaeological activity in Cornwall or it might suggest that the Domesday surveyors were less thorough or less able to achieve good results in this region (due to its relative remoteness from the core of the Norman realm). The truth is more complex than a single answer could suggest, with both suggested factors probably being relevant (amongst others). The other obvious difference is the lack of peaks seen in Herefordshire/Gloucestershire/Shropshire in Domesday in our model. The opposite arguments to Cornwall might account for this, with lower intensities of modern archaeological activity but easier access for the Domesday surveyors in the eleventh century. However, the overall broad similarity to the Domesday population map suggests our model provides a fairly reliable proxy for past population, with differences being due largely to the different size of time-slice represented (Domesday being a snapshot compared to the entire early medieval period) and due to the fundamentally different nature of the evidence (documentary vs. archaeological).

High levels of evidence are found for the Roman period. The early medieval people of England may have been living in much greater densities in East Anglia and Cornwall compared to the rest of the country, whereas the Roman high-density areas of population were much more widespread across the south and east of England, with relatively large numbers of people living in most of lowland England. Within the broad period from the Middle Bronze Age to the early medieval period, the Roman phase probably represented the highest absolute population and the period with the most widespread higher densities of settlement.

Moving forward from the Bronze Age, Illus 1–4 can be read as showing a picture of an expanding population spreading into new areas over time, abandoning upland areas at the end of the Bronze Age, peaking in the Roman period and then retreating somewhat in the early medieval. We feel that relative differences of population in any one broad period and across time has a considerable influence on the nature of our evidence. The three possibilities discussed in this article each partially explain the variation seen in the spatial distribution of archaeology in England, with no one factor being more important than any other. Undoubtedly there were other factors at play, but those discussed do explain much on a coarse spatial and temporal scale.

Overall, we feel there are good grounds for positing variations in ways of life in different parts of England. Differences in affordances created extra visibility for archaeology in the south and east. For instance, where sites are excavated in the north and west, material culture occurs in lower amounts than in the south and east indicating various attitudes towards material culture; a difference reinforced by the nature of the landscape evidence. However, there were probably also generally higher population levels in these areas in the past, together with a greater use of material culture.

EARLY MEDIEVAL PERSPECTIVES <mark>H1</mark>

by LETTY TEN HARKEL AND ANDREW LOWERRE

For the early medieval period (*c.* AD 400–1100), we suggest all three factors identified above contribute to generating the patterns visible in Illus 1, 11 and 12. It is precisely the interaction between past lifestyles and subsequent archaeological survival and recovery that is reflected in the EngLaId database, and the strength of the project lies in the explicit acknowledgement of this complexity.

First, affordances and issues of archaeological visibility certainly affect emerging patterns. In general terms, sites in the north of England are harder to characterize and date as a result of a dominance of non-intrusive investigations and a lack of dating evidence. This is especially pertinent in relation to early medieval architecture. Although *Grubenhäuser* (sunken-featured buildings) may be readily identified as crop-marks where affordances are good, post-built or beam-slot structures are notoriously hard to recognize, even through excavation. A single, well-executed open area excavation can dramatically improve the state of knowledge. For example, investigations prior to quarrying in the Milfield Basin in northern Northumberland revealed several post-built structures and doubled the number of excavated *Grubenhäuser* in the county (Stafford 2007, 149–50; Waddington 2009).

<mark>Illus. 13 here</mark>

The notion of affordance may also explain why there is little evidence of the three broad settlement provinces identified by Roberts and Wrathmell (2000) in Figures 1 and 13a. Roberts and Wrathmell's methodology was based on retrogressive analysis of nineteenth-century 1st-edition OS maps, and the assumption that some of these patterns can be traced

back to the early medieval period was based on the distribution of deserted medieval villages, Domesday Book, and place-name evidence. Thus the basis of analysis is very different from that of the EngLaId project, which focuses predominantly on archaeological evidence, filtering out records based purely upon place-name interpretation or documentary sources. Different data lead to different answers, and unsurprisingly, Illus 12 and 13c – Domesday Book population densities – are a much better fit with Roberts and Wrathmell's (2000) model (and with Beresford and Hurst's (1971) map of deserted medieval villages) than Illus 1 and 13a, predominantly based on archaeological evidence. Here, we see clear excavation affordances, in particular the importance of urban excavation for the early medieval period (London, Norwich, Southampton (*Hamwic*) and Lincoln being particularly visible). We also recognize the enormous contribution made by individual researchers with medieval interests in specific counties, such as Northamptonshire, Cornwall and the Vale of Pickering.

The second possibility raised is that the maps reflect regional differences in the use of (portable) material culture. It is clear that such differences did indeed exist. Peaks in East Anglia and east Kent correspond to the region of furnished early Anglo-Saxon burials (Bayliss et al. 2013: 2, fig. 1.1; Martin 2015). For the middle Anglo-Saxon period onwards, results from Blair's *People and Places in the Anglo-Saxon Landscape* project — involving a detailed survey of grey literature for this period from across the entire country — are revealing. Based on high numbers of records in the Humber/Wash area, Blair (2013, 36, fig. 9) identifies an 'Anglo-Saxon building culture province'. According to Blair (2013, 13), the explanation for the relatively low density of early medieval activity elsewhere is *not* that 'the settlements never existed', but 'that they existed but are invisible to us'. In other words, relative archaeological visibility does not necessarily equate to relative population density.

It is worth drawing attention to the fact that the north of England is relatively empty on both Illus. 1 (mapping archaeological evidence for the early medieval period) and Illus. 12 (mapping recorded Domesday populations). Are these empty spaces on these maps then perhaps *both* indicative of archaeological invisibility, or the relative engagement with 'material culture' in the broadest sense of the word (also including documents)? That would be a useful conclusion in its own right.

Given the possible absence of correlation between archaeological evidence and past population, for the early medieval period population density is best approached through Domesday Book, which provides detailed counts of certain population categories. Darby's *Domesday Geography* series presents the most comprehensive investigation of early medieval population density so far, but numerous issues remain. As Gosden and Green also acknowledge, slaves (serfs) are recorded inconsistently, so at best Domesday Book provides us with a picture of the 'free' population of England at the end point of the EngLaId timespan. At worst, the situation is less straightforward.

The creation history of Domesday Book is complex, and despite more than two centuries of scholarly attention, there is no single, universally acknowledged explanation of how the text came to be. One important distinction is between the Domesday Inquest and the Domesday Book. The former is seen as a communal effort intended to redefine the relationship between King William I and his magnates in the context of taxation (*geld*) and personal service, and the latter composed as an administrative tool, possibly following William's death (Roffe 2000): two different historical processes that distance the text from the historical 'reality' that underlies it. Two issues emerge: first, the administrative apparatus of the late Anglo-Saxon state that underpinned the Inquest had not yet fully developed in large parts of northern

England (Loyn 1987, 7), and second, it may be that unquantifiable amounts of property and population were excluded from the survey because they were not subject to tax and therefore not considered relevant (Roffe 2000, 47–8; 2007, 133). Rather than modelling relative population densities *per se*, we can therefore only model relative population densities *as recorded in Domesday Book*.

That there was a discrepancy between 'real' population densities and those recorded in Domesday Book is beyond dispute. The rationale behind the compilation of Domesday Book was taxation, and its accuracy depended on the efficacy of the surveyors, and the relative numbers of tax-owing inhabitants in different parts of the country (Fox 2003; Faith 2004). On a more positive note, however, Lowerre (forthcoming) argues that for those parts of England with sufficient Domesday coverage, the amount of excluded property may not be so great as to discount Darby's (1986, 14) qualified assessment of Domesday's completeness and accuracy. Mapping *relative* population densities therefore still provides a reliable enough picture of population variability across space in some parts of England, especially – as Oosthuizen (2014) has aptly demonstrated for the Cambridgeshire Fens – if other factors such as physical geography are given a more prominent role in modelling exercises.

Another issue relates to the specific source used to generate Illus 11 and 12. Analysis of Palmer's dataset shows that the same coordinates are sometimes used for more than one place: 885 out of 12,395 National Grid References have two or more places assigned to them. This means that the KDE plots may be substantially skewed in a number of locations. When comparing Illus. 1 and Illus. 12, there is a further problem of mapping only the 'free' population as recorded in Domesday Book, but mapping *all* the likely archaeological proxies for early medieval population, without acknowledging the legal status of the people behind

the proxies. Put simply, some of the houses, settlements and artefact find spots used to generate Illus. 1 were created, used, abandoned and discarded by people who were slaves. Of course, there is effectively no way, working with archaeological data at a national scale, to tell the remains left by free people from those left by the unfree. Having said that, as both maps compare reasonably well – except in Cornwall, and isolated peaks in Herefordshire / Gloucestershire/Shropshire – it is possible that, generally speaking, the number of slaves compared to the number of 'free' peasants was broadly consistent.

In sum, understanding maps based on a combination of archaeological and historical source material is no mean feat. The pictures we can paint of late-eleventh-century England based on Domesday evidence are intrinsically related to the specifics of the creation of Domesday Book as an artefact, but underlying this may be 'real' patterns that shed light on relative population densities. Comparing these patterns to archaeological data from the EngLaId database brings up additional complexities. The maps in Illus 1–4 and 12 are of admirably high spatial resolution, given that the data presented in them are national in scope. Temporally, however, the picture they present is, arguably by necessity, extremely broad-brush. Have they been painted with so broad a brush as to make the pictures too smeared or generalized to allow us to draw meaningful insight? The maps depict recorded archaeological and textual traces of myriad processes operating at different spatial and temporal scales. It is far from certain that the nature of those processes can reliably be discerned from the sum total of their recorded traces. Having said that, we think this this modelling exercise constitutes a useful, if necessarily tentative, first step in the right direction.

ROMAN PERSPECTIVE <mark>H1</mark>

by TYLER FRANCONI

The proposals outlined come at a critical juncture of archaeological studies, emphasizing the need to collate and analyse existing data to push the boundaries of current thinking. As a single archaeological database, the EngLaId dataset is largely unmatched in its size and complexity, and the authors present a nuanced approach to the research possibilities afforded by its careful consideration. No dataset of comparable size yet exists in Roman studies that allows such a thorough study of a regional landscape, so the methodology outlined in this paper has the potential to inform future studies of other areas once similar data become available.

The EngLaId database covers a huge swath of time, 2600 years in total, of which the Roman period accounts for only some 14% of this time span. It is truly remarkable, therefore, that such a relatively short amount of time should account for 40% of the total number of database records. From a long-term perspective, this demonstrates just how unusual those 367 years of Roman rule were. From a methodological perspective, as the number of dots on maps increase, it is important to understand the factors that shape the patterns visible in the distribution of material. The issues of affordance, as outlined above, are therefore key to this discussion.

In light of the discussion of the factors that influence the discoverability of archaeological remains, I think two important features need to be emphasized for the Roman period, and in order to do this the material needs to be presented in the context of major Roman settlements and road networks (Illus. 13d). Put against this backdrop, the distribution of Roman material in the south and east of the country begins to make more sense, as we can see that many, but not all, of the 'peaks' visible in the data relate to major urban and military centres: the major colonies and civitas capitals, legionary fortresses, and Hadrian's Wall. These sites have, in many cases, been extensively investigated through excavation for over a century, and while knowledge of these centres has certainly been advanced by developer-led archaeology (Willis

2016), they were already foci of attention. Much like the biases of antiquarian researchers mentioned above, the bias of Roman archaeologists towards the urban and military centres of England have directly contributed to the shape of this map in many ways.

The second observation is that more recent work emphasizing the importance of smaller towns and rural settlement — both categories that have been substantially influenced by developer-funded work — has helped to counteract this urban-centric view and fill in the gaps. This is particularly noticeable along the Upper Thames, upstream of Water Newton on the Nene, and along the Roman road between Tadcaster and Longthorpe in western Yorkshire. These results have not only been generated by excavation, but also by aerial survey, and the difference in data is clearly shown when the density and distribution of EngLaId data is compared to that of the Roman Rural Settlement Project (Illus. 13f). This project's emphasis on excavated, rural material results in a very different map (see Allen et al. 2015), with many more individual peaks that are less focused on major centres. The general distribution of records is similar, with the southern and eastern regions being the densest, yet the regional clusters along rivers and roads are less obvious. Both maps emphasize the importance of nodal points within the provincial transport infrastructure, regardless of their size, and there is no doubt that careful consideration of each dataset with their individual strengths and weaknesses will produce a more complete view of Roman-period England than either individually.

These observations about the underlying archaeological methods that structure current understanding of the modern country of England in the Roman-period directly contribute to the second issue raised in this paper regarding differential usage of material culture across the country through time. Again, the map of Roman pottery supply has been augmented by the addition of major settlements and roads (Illus. 13e), and again this makes it very clear that much

of our data for Roman ceramic assemblage is still dictated by published reports from major urban and military centres, especially around London and the Thames Estuary, York, and Hadrian's Wall. Most, but not all, of the other major centres in the province are at the centre of glowing points of pottery diversification. This surely has much to do with the way that Tyers collected the data for his website that underlies this model, and one must wonder if an increased contribution from grey literature reports might help brighten the countryside. That said, the general model is unlikely to change so much, as quantities of pottery, both in raw counts and in the variety of types, is probably higher in major settlements than in the countryside. The research of one of the EngLaId project's doctoral students will undoubtedly help shine some light on this issue (see Stansbie and Mallet 2015 for initial results), as he focuses on pottery usage in southern England using the extensive databases of Oxford Archaeology and the Museum of London Archaeological Service. We must also be mindful of the usage of non-ceramic vessels and containers, as pottery was certainly not the only option available: glass, metal, barrels and other wooden vessels also played important parts that cannot be shown here.

The third interpretation raised, that of demographic distribution, is more complicated. Because the EngLaId data is only reliably resolved to very broad historical periods, the evidence shown in a single map is basically a flattening of some three and a half centuries of life under the Roman Empire. This gives an overall impression of the sum total of Roman life, but does not allow for the representation of any fluctuations within this period. However, even at the very coarse level discussed here, a comparison between the maps of the Iron Age (Illus. 3) and the Roman period (Illus. 2) show broad continuities in the density of records in Wessex, along the Nene, and in Yorkshire. There are spatial differences, notably in eastern Yorkshire and in the southwest of the country, and also clear differences in settlement nucleation with the advent of towns and military fortifications but, generally speaking, it looks like Roman things turn up in

about the same places where Iron Age things turn up. This is less true when we compare the Roman period to the Early Medieval period (Illus. 1), with notable increases in Essex and Cornwall, and decreases in density just about everywhere else.

It would be useful to be able to understand better if this spatial distribution corresponded to growth or decline in real population numbers. While there are varying estimates for total population at the peak of the imperial period of ranging from 2–2.5 million (Frere 1967, 311; Jones 2004; Mattingly 2006), to as high as 3.7 million (Millett 1990) or even 5–6 million (Salway 1981, 544), it is not easy to translate these numbers into spatial distributions or densities. We are less well-informed about the early Roman or late Roman periods, though perhaps a combination of the EngLaId and the Roman Rural Settlement Project data would be able to produce a more complex model of change through time.

These very general observations and thoughts are meant to highlight both the potential and drawbacks of large datasets to furthering research into Roman life in England. The issues raised above are only three of many that must be accounted for when interrogating these data, but it is clear that archaeologists are well positioned to make substantial new contributions to individual periods as well as the long-term view of English settlement history.

PREHISTORIC PERSPECTIVE<mark>H1</mark>

by ANWEN COOPER

It is worth stressing at the outset that I believe strongly it is vital to ask what *can* be said on the basis of EngLaId's large and complex dataset, rather than dwelling on the difficulties involved in using it analytically (Cooper and Green 2016). Regarding the interpretative suggestions made above, of course, all three possibilities are involved to a certain degree. It is

much more difficult, however, to determine how much weight to place on each of these interpretative options, and to identify what sorts of theoretical issues need to be addressed in order to better understand the evidence under consideration.

The suggestion that basic patterning in the EngLaId evidence relates to archaeological 'affordance' seems reasonable. It is also unsurprising that evidence throughout our study period is focused on lower-lying ground in southern and eastern England. These findings should perhaps channel our analytical interest towards patterns that do not fit this general rule (e.g. the distinctive upland distribution of Bronze Age material). There is clearly scope for honing the affordance maps in future; for instance, by adding in details generated locally (e.g. the position of gravel islands within the East Anglian fens which offer zones of high archaeological affordance within a broader matrix of low affordance). Oosthuizen (2014) illustrates very effectively how it is possible to substantially revise estimates of Domesday population levels (and of activity levels more broadly) in the fens if only land that was actually accessible in the late Anglo-Saxon period (areas that were not inundated) is considered in analytical models. I also find Gosden and Green's staging of archaeological affordance as an interpretative *outcome* slightly confusing. Obviously archaeological affordance can be seen as an interpretative endpoint. However, it is arguably more productive (and more interesting) to view key measurable elements that shape archaeological patterning as stepping-stones in the interpretative process as they bolster our sense of confidence in particular interpretative directions.

Regarding the second interpretative possibility, I believe very strongly that differences in past life-ways have a role to play in shaping basic patterns in our evidence. I also think that there are tangible ways of exploring the relationship between past peoples' lives, and their

archaeological outcomes. In this context, I find Gosden and Green's attempt to build a long-term model of peoples' use and deposition of pottery important and intriguing. While limited by the availability of relevant information, these models do offer a rare insight into pottery use and deposition over an extended period and at a national level. Unfortunately, it does seem likely – especially given the intensity of developer-funded archaeology over the past 30 years – that these models are highly partial, particularly for prehistory and the early medieval periods. While at one level, British archaeology has experienced a recent 'material turn',involving a more empirical research emphasis and a theorization of archaeological materials (e.g. Alberti et al. 2013), this has clearly not been extended to include the synthesis of ceramic evidence at a wide scale. In relation to this issue, the pottery distribution models presented above are perhaps best viewed as a significant starting point for further work.

I find Gosden and Green's third assertion – that coarse-grained patterning in the distribution of English archaeological records relates closely to past population dynamics – more challenging. On a positive note, it is certainly interesting and important to consider densities and movements of past populations, and to imagine how such factors relate to past practices and to the archaeological outcomes available to us. Historical accounts that consider the shifting interrelationships between populations of various kinds (people, materials, microorganisms and so on) can undoubtedly also be engaging and persuasive (e.g. De Landa 1997). Concentrations and movements of people clearly do contribute at some level to the evidence that forms the basis of the models offered above. It is also possible that over much of later prehistory and, subsequently, lowland England was more densely populated overall than the north and west.

More specifically, Gosden and Green's comparison of the distribution of population as recorded in the Domesday survey with the distribution of archaeological evidence for the early medieval period is useful. These two datasets overlap in the time period they represent and offer different perspectives (material and documentary) on the matter of population. The model presented here also provides an interesting counterpart to Bevan's (2012) recent attempt in a similar vein. Bevan compared a hypothetical population model based on Domesday records with one based on the distribution of single coin finds for the period AD 1066–1158 recorded in the Corpus of Early Medieval Coin Finds (EMC). Following Blackburn (2005), Bevan suggested that evidence from the EMC provided a useful comparison with the Domesday survey, since single coin finds (in contrast to coins from hoards) are likely to result from accidental loss, and thus likely to express general demographic and economic trends. Bevan's selection of only single coin finds that were broadly contemporary with the Domesday Survey obviously also enhances the compatibility of these evidence sets. Gosden and Green's model, by contrast, incorporates evidence covering a much broader timespan (the entire early medieval period): a quality that might be seen as problematic. On the other hand, it also includes a much broader range of archaeological evidence, making it, in some ways, much more representative of past human activity at a wide level.

My main difficulty with reading the models as proxies for relative population is that this skims over the important fact that it is extremely difficult to build a useful understanding of how past population dynamics relate to the occurrence of material remains. This is particularly the case for British prehistory, when people are likely still to have lived relatively mobile lifestyles (e.g. Giles 2012, 47). It is for this reason that previous studies which have commented on the sharp distinction that exists in prehistory between the materially rich south

and east of England, compared to the materially impoverished north and west, have stopped short of attributing this pattern directly to differences in population (Cunliffe 2009, 82; see also Piggott 1949). It is also worth noting that sensitivity to the 'pathways of inference' involved in modelling proxy populations has, for a long time, been a feature of prehistoric population studies (e.g. Rick 1987). Thus my critique of this issue covers well-trodden ground (see also Thomas 2014; 219; Sheridan and Pétrequin 2014, 373).

Other difficulties with using the models as proxies for relative populations can be broached usefully by considering recent approaches to prehistoric population dynamics (Chamberlain 2009; Zimmerman et al. 2009; Williams 2012). As Franconi has mentioned already, one key problem with modelling relative population levels within traditional period boundaries is that it precludes the development of understandings of population (and material) dynamics within these limits. To give a prehistoric example, these models are insensitive to the ebb and flow of material densities over the duration of the Bronze Age that Wilkin (2014) is revealing in his ongoing interrogation of Fox's (1932) postulated highland/lowland cultural divide in Britain. This seems a particularly important theme to address in this context given the EngLaId project's central aim to develop long-term histories that *defy* the dominance of period boundaries. One way that prehistoric population studies have approached this issue is through the use of summed radiocarbon date probability plots (also known as temporal distribution frequencies or tdfs). Both proponents (e.g. Rick 1987; Shennan and Edinborough 2007; Ashton et al. 2011; Williams 2012) and critics (e.g. Thomas 2014; Sheridan and Pétrequin 2014) of this method have rightly raised flaws with its application, and such an approach is clearly not directly relevant for the EngLaId dataset. One advantage of this method, however, is that the results are not necessarily lumped together within traditional

period boundaries (e.g. Collard et al. 2010; Armit et al. 2013). It seems important that other ways of exploring population dynamics are developed that seek to transcend these limits.

Two further issues with reading the models presented here as proxies for long-term shifts in relative population are, firstly, their reliance on patterning in one specific evidence set (overall settlement and/or material densities) and secondly, that the interpretative benefits are abstract and thus somewhat intangible. Many recent prehistoric population studies have emphasised the need to compare models derived from different evidence bases, for example juxtaposing tdf models with those produced via material and settlement densities (e.g. Chamberlain 2009; Tallavaara et al. 2010; Williams 2012). Additionally, it is definitely interesting to consider, at a general level, long-term shifts in relative population based on Gosden and Green's models. However, the resulting interpretative vagaries can be contrasted with the more tangible findings of prehistoric population studies that interrogate specifically the relationship between major shifts in the evidence base (e.g. the appearance of farming) and population dynamics.

Overall, Gosden and Green's models provide a useful starting point for considering the interpretative capacities of large, complex legacy datasets in archaeology – a pressing current concern (e.g. Kintigh 2006; Allison 2008; Atici et al. 2013; Bevan 2012; 2015; Bradbury et al. 2016). The findings may not be immediately satisfying for researchers used to working at a detailed contextual level. However, they do offer vital pointers for future work that might ultimately strengthen the interpretative purchase of coarse-grained models. In particular, they highlight key bodies of data (pottery) that are in urgent need of synthesis, and reveal continuing ambiguities in our understanding of past life-ways in the north and west of England, particularly in prehistory and early medieval times.

A BRIEF RESPONSE <mark>H1</mark>

by CHRIS GOSDEN AND CHRIS GREEN

As a project we have been trying to understand the processes by which archaeological evidence was generated by those living in the past; the processes in the present by which these are discovered, investigated, recorded and published and (most importantly) what the evidence will allow us to say of human history, either over long sweeps of time and space or through more detailed happenings in particular locales and periods. Our starting point here has been empirical, rather than theoretical, but many theoretical issues are involved. Our colleagues have raised a set of key points that confront us in our attempts to understand the English landscape from the Middle Bronze Age to the Norman invasion, but also are relevant to all archaeological endeavours. Due to the conventional broad time periods used by most of our data providers, extending beyond AD 1066 would have caused us to capture data for the entire high medieval period, which simply would have stretched us beyond our data processing limits. There are key questions of spatial scale: how can the broad patterns we claim to have recognized link into finer grained case studies? Conversely, there are also uncertainties of periodization: have we become too stuck in broad period divisions and should we use other means (such as radiocarbon and other absolute dates) of generating understanding of time and sequence? There is obviously no single best scale or temporal resolution and our prime aim has been to look at the evidence broadly to see what, if anything, it can tell us.

We are generally convinced that there is a very long-term difference in ways of life and probably population density between the north and west of England and the south and east. There are lesser amounts of material culture in circulation and probably greater mobility in

the former area than in the latter (e.g. pastoral herding as opposed to settled arable agriculture with paddocked animals) over most of our time period. There are biases in the writing of prehistory and history that tend to emphasize the south and east as a norm; this may also be true of the ways in which data are recorded. Such broad conclusions can only be investigated through more detailed case studies. Even if case studies broadly support such generalizations, they will show life to have been more complicated, less contrasting, and not linear in terms of history. It is also very obvious that the modern political division of England is unhelpful. Many of the patterns we have recognized can only be fully understood through looking at Scotland, Wales and Ireland. Likewise, in all periods, but especially in Roman and the Anglo-Saxon times, what was happening across the channel and North Sea were major influences on these islands (Bradley et al. 2015; Soulat 2011). We have a large amount of data, but have set geographical and temporal limits to it, which allows us to investigate it within a five-year time span (ending December 2016; further major outputs of the project will include a monograph, an atlas, and a GIS-based website). Having said that, England (and Britain as a whole) is one of the best-understood parts of the world in archaeological terms. The fact that we, as an archaeological community, are just getting to grips with data at a mass scale is salutary, as is the fact that many basic questions remain to be answered concerning what our evidence means.

ACKNOWLEDGEMENTS <mark>H1</mark>

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Illus. 1   Density of evidence (10 km KDE) – early medieval. Values are expressed in standard deviations above (red) or below (blue) the mean average (white)

Illus. 2   Density of evidence (10 km KDE) – Roman. Values are expressed in standard deviations above (red) or below (blue) the mean average (white)

Illus. 3   Density of evidence (10 km KDE) – Iron Age. Values are expressed in standard deviations above (red) or below (blue) the mean average (white)

Illus. 4   Density of evidence (10 km KDE) – Bronze Age. Values are expressed in standard deviations above (red) or below (blue) the mean average (white)

Illus. 5   Affordance map of aerial photographic discovery potential. Green areas are un-obscured grassland (liable to show earthworks or parch-marks), yellow areas are un-obscured arable land (liable to show crop-marks), and black areas are largely obscured for aerial photography (either above or below ground)

Illus. 6   Affordance map for site/monument discovery in England. Values are expressed as a decimal from 0 (lowest) to (potentially) 1 (highest)

Illus. 7   Map of density of later prehistoric pottery records (based upon Earl et al. 2007). Values are expressed as a decimal from 0 (lowest) to 1 (highest)

Illus. 8   Map of variety of Roman pottery fabrics (based upon Tyers 2014). Values are expressed as a decimal from 0 (lowest) to 1 (highest)

Illus. 9   Map of distributions of early medieval pottery records / industries (based upon Myres 1969, map 1; Vince 1993, fig 1; Martin 2011; Wood 2011, figs 4.1 and 4.15; Blinkhorn 2012, fig 36). Values are expressed as a decimal from 0 (lowest) to 1 (highest)

Illus. 10   Scatter plots with linear least squares regression lines (in red) comparing period density of data evidence against monument affordance and (relevant) pottery models. Correlation values for the affordance plots are: Bronze Age – 0.32; Iron Age – 0.51; Roman – 0.64; early medieval – 0.56. Correlation values for the pottery models are: Bronze Age – 0.38; Iron Age – 0.49; Roman – 0.46; early medieval – 0.47

Illus. 11   Domesday population centres (based on Palmer 2010)

Illus. 12   Domesday relative 'free' population density (based on Palmer 2010). Values are expressed in standard deviations above (red) or below (blue) the mean average (white)

Illus. 13   Roberts and Wrathmell's settlement provinces (2000), towns in 1086 (Reynolds 1977, 35), and Roman roads plotted over (a) early medieval evidence density model, (b) early medieval pottery supply model and (c) Domesday relative population density model. Roman major towns and Roman roads plotted over (d) Roman evidence density model, (e) Roman pottery supply model and (f) density of sites recorded by the Roman Rural Settlement Project (Allen et al. 2015)