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The Legacy of Development-led Archaeology

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CONTENTS

The Irish Mesolithic and Developer-led Archaeology

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When it comes to finding sites, the Mesolithic is often very different from other periods. Aside from some shell middens, they frequently have no visible presence in the landscape; therefore many of the best known Mesolithic sites in Ireland have been found by chance. While some sites are discovered through the intervention of nature, such as those found as a result of coastal erosion at Ferriter's Cove in Kerry (Woodman *et al*. 1999) and Belderrig in Mayo (Warren 2009), other sites were first discovered through some form of development. These were not necessarily found during extensive industrial or housing development or the activities of the National Roads Authority. Newferry in Antrim was found during diatomite cutting (Woodman 1977) while Lough Boora in Offaly (Ryan 1980) was found through peat extraction. Major infrastructural developments have, however, added to our knowledge of the Irish Mesolithic. These include Mesolithic cremations at Hermitage in Limerick (water pipeline), fish traps at Clowanstown in Meath (road development) and Spenser Docks in Dublin (dockland development). These sites were all included in the 'current research' section of *Mesolithic Horizons* (McCartan *et al*. 2009). There are also other sites, such as the Port of Larne in Antrim, whose contribution to our understanding of how the lithic technology of the Irish Mesolithic developed is immense (see Woodman 2012), while the 350m long excavation on the Toome Bypass (Dunlop and Woodman 2015) provided numerous traces of Mesolithic settlement, including an enigmatic rectangular structure.

Aside from these high profile sites, we also have to ask whether or not, in the case of a period such the Irish Mesolithic, the "Celtic Tiger" has made a difference? There is no doubt that the intervention of IAI[2] in helping ensure that archaeological monitoring became an integral part of major developments was of crucial significance. 'Developer-led archaeology' has provided opportunities to examine several broader issues and in particular those associated with the location of Mesolithic activities across the landscape. Naturally it has not answered all the questions. One persistent query has been whether the intensive concentration of Mesolithic

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artefacts and sites near the coastline, river valleys and lakeshores is a product of research bias, i.e. we go back to locations where there is a reasonable chance of finding artefacts? Developer-led archaeology obviously provided possibilities for the discovery of traces of Mesolithic settlement away from the concentrations of known sites and find spots.

A fortunate combination of being in the final, anguished throes of preparing a book for publication and bringing work on a database for the Mesolithic to a conclusion provides this opportunity to take a look at how the Mesolithic has changed. At this stage the database contains nearly 1000 entries but is always going to be a work in progress, with missed or forgotten locations and new sites constantly being added.

In examining the long history of Mesolithic research in Ireland, which stretches back over 100 years, there have been a number of significant changes. When we started gathering information for the database the nature of site discovery was very different. Without doubt, 20 years ago most Mesolithic artefacts were chance finds often only recorded to the nearest townlands. While significant numbers were recovered from surface collection in fields, lake-shores, etc., excavated material only formed roughly 5% of the total. Now nearly 25% of the datasets available are based on excavated assemblages (Figure 1).

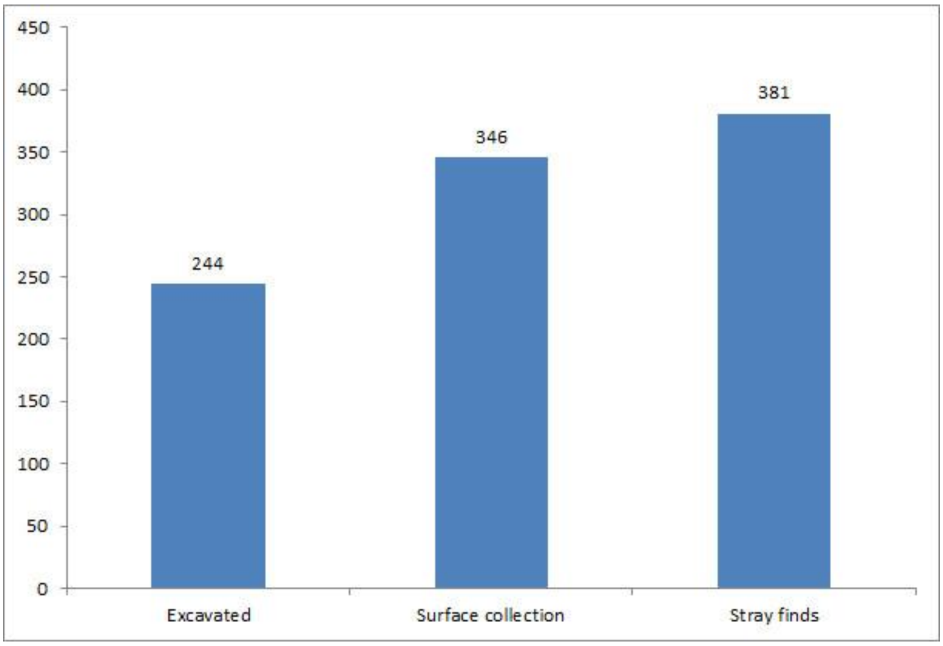


Figure 1: Methods of discovery of Mesolithic artefacts and sites.

Within the 25 years between 1985 and 2009 the number of archaeological licenses issued exceeded 25,000 (Edward Bourke pers. comm.). These figures can be used in a number of different ways. Many were monitoring licenses where nothing was found but there was also the introduction of Ministerial Direction licenses that covered large areas, including the excavation of a number of separate sites. One can assume, however, that at least 10,000 excavations have also taken place within this timeframe.

In the 50 years preceding 1985, before there was a significant rise in developer-led excavations, there had been probably less than 1,000 excavations, of which 75 produced Mesolithic material (indeed, I have cheated by making it 52 years to include the work of the Harvard Mission!). If we examine the excavations that paid significant attention to matters associated with the Mesolithic then we can define them as a) research excavations, i.e. those where there was an intention of researching the Mesolithic, or b) sites where roughly six weeks were given to the exploration of a Mesolithic component. Thus 20 sites of significance to the study of the Mesolithic were examined in over 50 years, while at the same time roughly 55 sites had also inadvertently produced some traces of Mesolithic activity (Table 1).

Table 1: Numbers of excavated sites and Mesolithic discoveries.

Excavations	**1932–1959**	**1960–1984**	**1985–2009**
Total Number	250	750	10,000 +(?)
Mesolithic Presence	27	28	176
Significant excavation	10	10	15

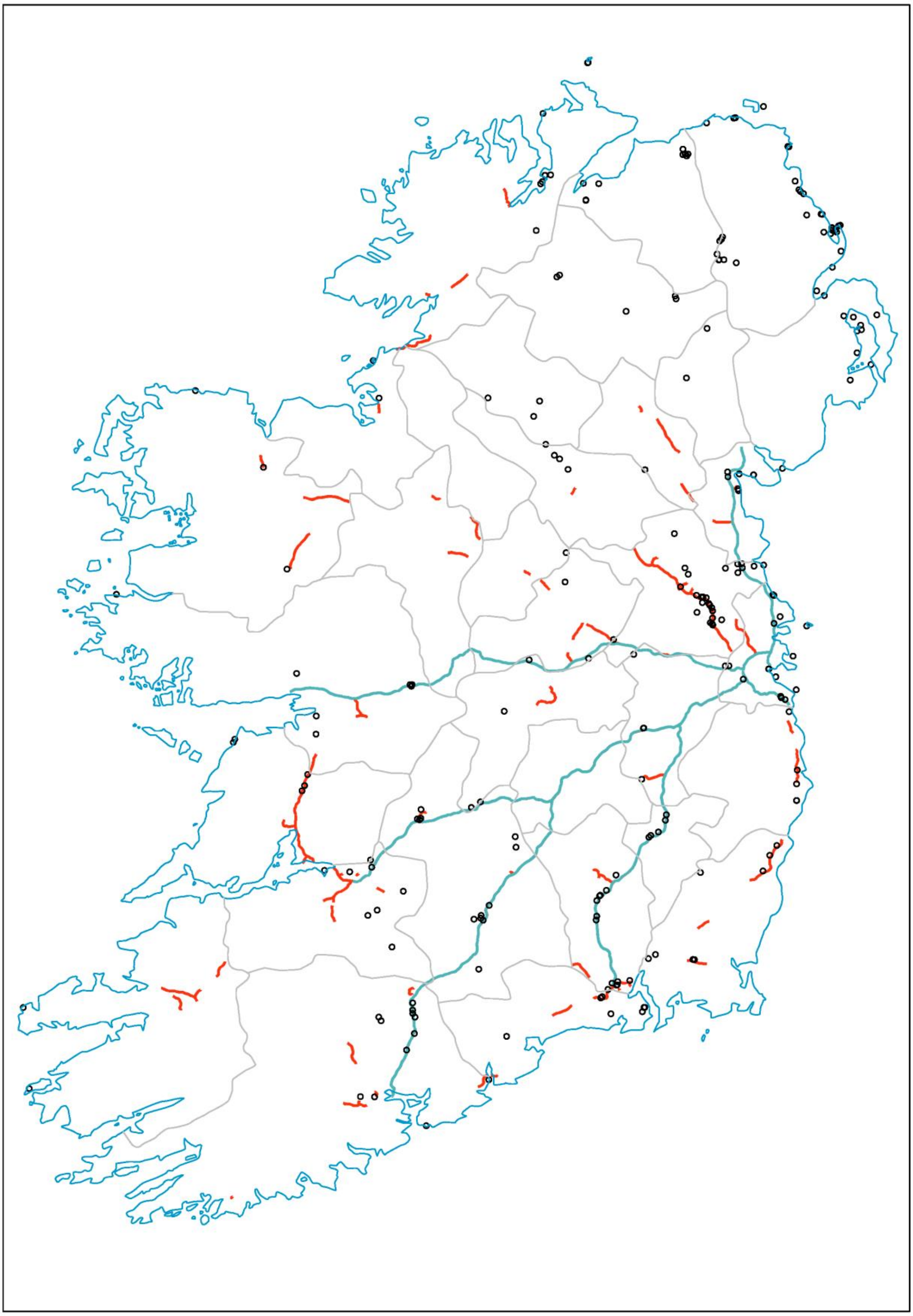
In contrast, in the last 25 years while the numbers of inadvertent finds increased in absolute numbers there was a drop in the percentage of sites producing Mesolithic material of any description (Table 1). The number of significant sites is only 15 although the number of sites producing any Mesolithic material did increase to 176. As a proportion of the total number of sites excavated during that time, there has been a very significant decrease in discoveries. Less than 2% of the total excavations have produced any trace of the Mesolithic, while in the preceding 50 years the figure would have been roughly 7.5%. Although there has been this proportionate drop in the number of sites with associated Mesolithic activity, the total number is still quite large. As noted at the beginning, there are obviously a number of sites of exceptional importance but it is also the overall pattern of discovery that is worth considering in more detail.

The results of the excavations were not always what might have been expected. In particular, there has always been the question of the “uplands”, but major roads tend to be between significant centres of population that are usually in the lowlands. In Ireland, unlike areas such as the Pennines in England, there is virtually no trace of Mesolithic activity above 300 metres. However, new road developments in Ireland also have not reached 300 metres above sea level! Not surprisingly therefore the presence or absence of an “upland” Mesolithic still remains a matter of debate (Woodman *et al*. 2006, chapter 7).

Along the east coast there have been a striking number of discoveries, especially in places such as County Meath (Figure 2). Indeed in many eastern counties, Mesolithic find spots had previously been confined to the immediate vicinity of the coast. Discoveries from developer-led excavation, especially infrastructural developments such as road schemes and gas pipelines, can also lead to linear distribution patterns, not just for the Mesolithic but also other periods and artefact types. This is very apparent in certain areas, such as County Meath. In parts of the Barrow Valley around Carlow the road schemes have revealed very significant numbers of locations that have produced Mesolithic artefacts. These can be added to those already known from the Barrow Valley Project (Zvelibil *et al*. 1996). In general, one can see clearly that while the major concentration of artefacts and sites still lie in coastal and riverine locations there is, as was apparent in the north-east as far back as the 1970s (Woodman 1978), a thin scatter of material across much of the lowlands.

Traces of the Mesolithic have not been found everywhere. The major concentration of locations containing Mesolithic and Neolithic activities along the N25 Waterford Bypass (Eogan and Shee Twohig 2011) provides an interesting contrast with another nearby area along the N25 at Kilmacthomas. In the latter case no trace of Mesolithic activity was recovered while only small quantities of Neolithic material were found. Other areas also appear to lack any trace of Mesolithic activity, these include the Ennis to Gort scheme. In spite of some significant discoveries on the M8 in the area of the River Funshion, just north of Fermoy, there is a remarkable paucity of early finds from Mitchelstown to Cashel.

Figure 2: Location of excavations with traces of Mesolithic activity.



If one looks at overall patterns, however, there is no doubt that archaeological monitoring and excavations in advance of development has added immensely to our knowledge of the Irish Mesolithic.

In retrospect one can also ask whether, in the context of developer-led archaeology during the last 25 years, certain aspects of the Irish Mesolithic have also been missed:

a) There are few sites in Ireland that have ever produced more than 15 microliths (in fact probably less than ten sites), but while diagnostic cores, groups of blades and even the occasional axe has been recovered within this 25 year time span, it is hard to find evidence of the discovery on excavations of even 15 microliths in total. One crucial question is whether the rarity of microliths is an artefact of field methodologies; have we simply missed them? Alternatively, is there a relatively rapid shift away from a technology that relies heavily on composite tools? Has developer-led archaeology contributed to this issue?
b) The vast majority of Later Mesolithic assemblages contain five or less diagnostic artefacts. Woodman and Anderson (1990) raised the issue of the nature of Later Mesolithic settlement sites. It has been apparent for a very long time that large concentrations of artefacts at key points are likely to be accumulations created during visits to persistent places. In contrast, it is difficult to interpret the thin scatters of artefacts from elsewhere.
c) In spite of the large areas of landscape that have been carefully excavated, while occasional stake- and post-holes have been noted, few traces of clearly defined structures have been recorded. Toome Bypass is one exception where numerous stake- and post-holes were recovered. Interestingly, this is one site where the topsoil was not machine stripped. While there is a scatter of small pits elsewhere, little evidence is known of the large deep pits such as those from Mount Sandel in Derry (Woodman 1985). Or have they been found but in the absence of diagnostic finds are presumed to be much later in date? It is very difficult to determine the significance of the occasional small pit, such as those found at Dowdalshall in Louth. As hunter-gatherer habitation structures are often very flimsy will their traces survive? Will their presence only be determined by artefact scatters?

It is highly probable that much of the finer elements of the Earlier Mesolithic would be missed in the topsoil, though one also has to note that it is probable that much of the distribution of Later Mesolithic elements will probably be as a result of loss or caching of small groups of larger Later Mesolithic tools.

One has to ask once again, whether in Ireland much of the original subsoil surface has been ploughed away? While this may not be as drastic as in some other parts of Europe it could have resulted in a significant portion of the artefactual record being transferred into the topsoil. Stripping of topsoil, including the careful trenching at early stages of environmental impact surveys, does not take into consideration the simple fact that few artefacts will be recovered from fresh soil, whether ploughed or trenched. Even making allowances for deterioration of ceramics, during early stages of archaeological investigation how many sites such as Neolithic or Bronze Age houses were noted through artefactual recoveries from the topsoil?

It would be Utopian to ask that extensive and detailed 'test pitting', and/or magnetic susceptibility surveys be carried out along a 20 km stretch of a proposed road. However if one is to look for ephemeral scatters of settlement traces from the Mesolithic, are we not getting to a point where one could begin to formulate templates based on criteria that would prioritise certain smaller landscapes? Indeed, while it is the overall patterns that are important there is also a need to be sensitive to localities where sites might have remained virtually intact. This should include locations not subject to intensive agriculture. These could be locations under permanent grassland where farming was limited. Windy Ridge in Antrim, which lies several hundred metres above sea level, is a good example of a site where just below the surface lithic and ceramic scatters still lay intact (Woodman *et al*. 1991–2). In many cases later quaternary deposits have helped preserve sites. If Ferriter's Cove, which fortunately lay buried under more than 2 metres depth of sand, had instead been a ploughed field site, virtually nothing would have survived. Even if buried beneath layers of alluvium or similar deposits, these locations should be a priority. At Tagerup in Sweden a linear area of 23,000 m² was explored; roughly twice the area of the Toome Bypass investigation. Here, below up to 2 metres of marine deposits, the excavators uncovered a series of huts, dumps, organic remains and burials (Karsten and Knarrström 2003); an example of what could be out there.

On the one hand there has to be awareness that in particular areas traces of early settlement might survive, while on the other hand there must be an appreciation that some large features/pits such as those found at Mount Sandel could have been created by our first settlers. In other words, “it’s attitude that matters”!

References

Dunlop, C. and Woodman, P. C. 2015. *Excavations of prehistoric settlement at Toomebridge, Co. Antrim, Northern Ireland 2003*. BAR British Series 609. Archaeopress, Oxford.

Eogan, J. and Shee Twohig, E. 2011. *Cois tSiúre – nine thousand years of human activity in the Lower Suir Valley: Archaeological excavations on the N25 Waterford City Bypass*. NRA Scheme Monographs 8, The National Roads Authority, Dublin.

Johnston, P., Kiely, J. and Tierney J. 2008. *Near the Bend in the River: the archaeology of the N25 Kilmacthomas realignment*. NRA Scheme Monographs 3, The National Roads Authority, Dublin.

Karsten, P. and Knarrström, B. 2003. *The Tågerup Excavations*. National Heritage Board Sweden, Lund.

McCartan, S., Schulting, R., Warren, G. and Woodman, P. (eds). 2009. *Mesolithic Horizons: Papers presented at the Seventh international conference on the Mesolithic in Europe, Belfast 2005*. Oxbow Books, Oxford.

Warren, G. 2009. Belderrig, a new Later Mesolithic and Neolithic Landscape in North West Ireland. In N. Finlay, S. McCartan, N. Milner and C. Wickham-Jones (eds.), *From Bann Flakes to Bushmills*, 143–152. Prehistoric Society Research Paper 1, Oxbow Books, Oxford.

Woodman, P. C. 1977. Recent excavations at Newferry, Co. Antrim. *Proceedings of the Prehistoric Society* 43, 155–199.

Woodman, P. C. 1978. *The Mesolithic in Ireland*. BAR British Series 58, British Archaeological Reports, Oxford.

Woodman, P. C. 1985. *Excavations at Mount Sandel, 1973–77*. Northern Ireland Archaeological Monographs 2, HMSO, Belfast.

Woodman, P. C. 2012. Making yourself at home on an island: the first thousand years (+?) of the Irish Mesolithic. *Proceedings of the Prehistoric Society* 78, 1–34.

Woodman, P. C. and Anderson, E. 1990. The Irish Later Mesolithic: a partial picture. In M. P. Vermersch and P. van Peer (eds), *Contributions to the Mesolithic in Europe*, 377–387. Leuven University Press, Leuven.

Woodman, P. C., Anderson, E. and Finlay, N. 1999. *Excavations at Ferriter's Cove 1983–1995: Last foragers, first farmers in the Dingle Peninsula*. Wordwell, Dublin.

Woodman, P. C., Doggart, R. and Mallory, J. 1991–92. Excavations at Windy Ridge, Co. Antrim, 1981–82. *Ulster Journal of Archaeology* 54–55, 13–35.

Woodman, P. C., Finlay, N. and Anderson, E. 2006. *The Archaeology of a Collection: The Keiller-Knowles Collection of the National Museum of Ireland*. National Museum of Ireland Monograph Series 2, Wordwell, Bray.

Zvelebil, M., Mackiln, M. G., Passmore, D. G. and Ramsden, P. 1996. Alluvial archaeology in the Barrow Valley, south-east Ireland: the Riverford Culture revisited. *Journal of Irish Archaeology* 7, 1–11.

The Legacy of Development-led Archaeology: Ten years of the extractive industries.

Charles Mount[3]

The peat and aggregate extraction industries are both concerned with the harvesting of natural resources over large areas of Ireland's landscape. Both industries have agreed Codes of Practice with government relating to archaeology (DEHLG 2009; DAHG 2012). In the last decade development in these industries has led to the excavation of a wide-range of archaeological sites from trackways to barrows, corn-drying kilns, ringforts and prehistoric settlements. The two industries are, however, different in their organisation and approach to archaeology and have fared differently in the post-boom period. Bord na Móna is a single company, while the aggregates industry is composed of competing firms that vary in scale from multi-national to regional firms. Bord na Móna deals with archaeology centrally through multi-annual contracts involving a single consultancy. In contrast the aggregates industry deals with archaeology at the quarry specific level on a seasonal basis and involves a wide-range of consultants. Development and archaeological excavation has continued in the peat industry uninterrupted by the end of the economic boom, whereas in the aggregates industry, because of the decline in construction, archaeological excavation has declined.

Bord na Móna

Bord na Móna is responsible for over 86,000 hectares of peatlands. Operating under a set of archaeological principles for the protection of archaeology agreed in 1998, 157 sites have been excavated in Bord na Móna bogs over the last decade, ranging from platforms and post rows, to toghers of wood and gravel and habitation sites. The work is part of an integrated programme that also involves scientific dating and palaeoenvironmental analysis.

Under its new *Contract with Nature* Bord na Móna no longer drains or opens new bogs and to reduce carbon dioxide emissions is reducing its harvesting activities and focussing on new sustainable energy producing activities, such as biomass and wind energy. The medium-term aim is to have a 70:30 peat to biomass use by 2016. Over time the companies' impact on

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archaeology will also reduce and new developments, such as wind farms, are not covered by the Archaeological Code and are dealt with through the normal planning process.

Some of the highlights of the Bord na Móna work carried out over the last decade by Archaeological Development Services Ltd. have included the Early Medieval habitation in Ballykean bog Co. Offaly, near Geashill, which was first identified in 2003 and excavated in 2007 and 2009. The site is radiocarbon dated to cal. AD 440–620 and 580–780 and is a sub-circular palisade enclosing an oval post and wattle house with a diameter of 8 m x 9.6 m with a timber floor surrounding a hearth (Figure 1). The enclosed area was completely surfaced with hurdling or planked walkways. Intermittent rows of posts around the inside of the palisade appear to have been structures with hurdle floors. The site has produced a large number of organic finds that are currently undergoing conservation and analysis. The nearby prehistoric square limestone enclosure at Ballybeg Site B, Co. Offaly measures 6.4 m x 5.8 m internally and encloses a charcoal spread and some chert and flint debitage. This site has been preserved *in situ*.

Figure 1: The enclosure at Ballykean, Co. Offaly (courtesy of Jane Whitaker ADS).

At Longfordpass, Co. Tipperary a number of Bronze Age trackways were investigated in 2010. Site 1 was a Late Bronze Age plank trackway over half a kilometre long which dates to about 986 cal. BC (Figure 2). The trackway appears to have had two main construction phases and a number of repairs. At Killeen bog, Co. Tipperary, which contains the ecclesiastical site of Derrynaflan, two prehistoric and an Iron Age trackway were investigated (Figure 3). In 2012 in Co Longford an Early Medieval gravel road over 600 m long, complete with potholes, that crossed Edera Bog was investigated.

Figure 2: The Late Bronze Age trackway at Longfordpass, Co. Tipperary.

Figure 3: Killeen Bog, Co. Tipperary, the Site 2 Iron Age track dated to cal. AD 150–430 heading for Derrynaflan Island in the background.

Quarries

In 2002, ICF quarries agreed an archaeological code with government which was updated and renewed in 2009. Since the code came into force in 2003 there have been 52 investigations carried out in ICF quarries. In contrast to Bord na Móna, the aggregates industry has gone into a major decline. In 2005 the overall industry produced products valued at €2.1 billion and employed over 12,000 people. Today the value of output has fallen by over 80% to just over €400 million and only 5,000 people are still employed.

Only a fraction of the 1,500 quarries in the state operate under planning consents that contain archaeological conditions. In 2008 the European Court Derrybrien decision 215/06 threw the planning status of hundreds of quarries into doubt. Under section 261A of the Planning and Development Act 2000, as inserted by section 75 of the Planning and Development (Amendment) Act 2010, over 700 quarries have now been identified by the Planning Authorities as requiring substitute planning consents. Once this process is complete the majority of quarries operating in the state will operate with archaeological planning conditions for the first time.

A notable aspect of the ICF work is the ability to avoid impacts on archaeology and preserve sites *in situ*. This meant that during the heady days of the Celtic Tiger it was possible to assess lands proposed for acquisition and recommend against purchase on archaeological grounds. This approach avoided impacts on a number of sensitive archaeological sites. In other cases, proposed quarry extensions were abandoned after geophysical investigations and/or archaeological testing identified archaeological remains.

One highlight of the quarry work has been the opportunity afforded to look in detail at whole landscapes, which has resulted in the identification of a number of multi-period sites in counties Cavan, Meath and Kildare. Near Swanlinbar, Co. Cavan work carried out by NIA, Aegis Archaeology Ltd., The Archaeology Company and Archer Heritage has uncovered a substantial number of archaeological features covering a period of over 4,000 years. The sites included Neolithic pits, some containing Middle Neolithic and Late Neolithic, Grooved Ware pottery, a Bronze Age ring-ditch containing a vase urn and the remains of a burnt mound. There was also an Iron Age structure measuring 16 m long by 3.5–6 m wide, a large Early Medieval enclosure that measured 65 m x 50 m with a surviving upstanding bank incorporated into a field boundary that dated from the sixth to eighth centuries AD. Further work identified a ringfort which was found to contain Bronze Age features and a Middle Bronze Age settlement associated with cordoned urns (Figure 4; Chapple 2010; 2011).

Figure 4: Middle Bronze Age house at Swanlinbar, Co. Cavan.

At Platin Co. Meath archaeological monitoring, geophysics and ten separate excavations over the last decade have been carried out by Arch-Tech, The Archaeology Company and Archer Heritage. The site has produced a range of settlement and burial evidence, including a rectangular Neolithic house, a circular barrow, a ring-ditch, a Medieval rectangular ditched enclosure and eight *fulachtaí fia*.

At Brownstown and Corbally, near Kilcullen in Co. Kildare, work undertaken by Margaret Gowen & Co. Ltd., Aegis Archaeology Ltd., The Archaeology Company, Archer Heritage and TVAS Ireland Ltd. has produced evidence from the Neolithic, Copper Age, Late Bronze Age, and Early and Later Medieval periods. There were six Neolithic houses, two beaker burials and a quantity of Bronze Age material. In the Later Iron Age and Early Medieval period a cemetery of five barrows developed at the site and one of the barrows was subsequently developed into an enclosed Medieval secular cemetery within a complex system of field division which contained 24 corn-drying kilns, some of which were enclosed by circular ditches (Figure 5; Purcell 2002; Tobin 2003; Coyne 2010; Mount 2013).

These projects have a great deal to tell us about the use and continuing re-use of the landscape over very long periods of time. While most of the post-excavation work has been completed on these excavations and the final reports have been completed, integrated publication of these excavations is a major challenge. The collapse of the construction industry has had a significant impact on the quarrying industry and the funding to pay for integrated publication in monograph form is simply not available. However, due to the professionalism and dedication of the archaeologists who carried out the work there has been considerable success in publishing these excavations on an individual basis. To date there have been three publications on different phases of Brownstown by Purcell (2002), Tobin (2003) and Coyne (2010). The Ballyburn Upper excavations have also been published by O'Neill (2010) and part of the Swanlinabr excavations have been published by Chapple (2010).

Figure 5: The Brownstown complex under excavation in 2004.

Development led-archaeology has undergone a roller-coaster ride over the last decade. A relatively small archaeological profession in just a few years rose to the challenge of undertaking over 2,000 archaeological investigations a year, as well as analysing and reporting on the work. This was a truly remarkable achievement. Today the profession is grappling with the challenges of operating during a time of austerity. Nevertheless the profession is rising to the challenge and is continuing to provide high quality services to developers, investigating and recording archaeology in a highly professional manner and producing the data and publications necessary to rewrite the story of the development of Ireland. This is an accomplishment to be proud of.

References

Chapple, R. M. 2010. One point throughout time: archaeological continuity at Gortlaunaght, Swanlnbar, Co. Cavan. *Archaeology Ireland* 24(1), 35–39.

Chapple, R. M. 2011. Cultural continuity and site use: excavations at Gortlaunaght, Swanlinbar, County Cavan. *Journal of Cumann Seanchais Bhreifne* XII, 162–202.

Coyne, F. 2010. Corbally, Co. Kildare: the results of the 2003–4 excavations of a secular cemetery. In C. Corlett and M. Potterton (eds), *Death and Burial in Early Medieval Ireland*. Wordwell Books Ltd., Dublin.

DAHG. 2012. *Code of Practice between the Department of Arts, Heritage and the Gaeltacht, the National Museum of Ireland and Bord na Móna.* http://www.archaeology.ie

DEHLG. 2009. *Code of Practice between the Department of the Environment, Heritage and Local Government and the Irish Concrete Federation.* http://www.archaeology.ie

Mount, C. 2013. A note on some beaker period pit burials in Ireland. *Journal of Irish Archaeology* XXI, 1–6.

O'Neill, N. 2010. Settlement and economy of an early medieval site in the vicinity of two newly discovered enclosure near the Carlow/Kildare border. *Journal of Irish Archaeology* XIX, 71–100.

Purcell, A. 2002. Excavation of three Neolithic houses at Corbally, Kilcullen, Co. Kildare. *Journal of Irish Archaeology* II, 31–75.

Tobin, R. 2003. Houses, enclosures and kilns: excavations at Corbally, Co. Kildare. *Archaeology Ireland* 17, 32–37.

Infrastructure archaeology and the origins of the burnt mound phenomenon: Ten years of *fulachtaí fia* excavations in Ireland[4]

Alan Hawkes[5]

Fulachtaí fia have become one of the best known prehistoric site types in Ireland. While previous estimates record at least 4,500 examples in the country (Power *et al*. 1994), recent discoveries during infrastructure and other development indicate that this is now closer to 7,000. They are generally recognised as crescent-shaped mounds of burnt stone, or are identified in plough-soil and during construction as levelled spreads of burnt stone mixed with high levels of charcoal-enriched soil. These can occur individually or in small clusters, and are generally located close to a water source. The burnt stone represents a waste-firing material associated with pyrolithic technology, where stones were heated and then rapidly cooled through immersion in cold water, although sites employing a dry heat are also known in the archaeological record.

Fulachtaí fia and infrastructure archaeology, 2000−2010

From 1992−2009, the construction of new roads led to the discovery of many unknown archaeological sites in Ireland. Of these, 92% were found during archaeological test-trenching in advance of development (McCarthy 2010, 41). The majority of these new sites were identified as *fulachtaí fia* (35%) or related pyrolithic deposits and most were previously unrecorded and had been levelled as a result of agricultural works in the nineteenth or early twentieth century. This has led to a distorted distribution across the landscape where linear patterns reflect major road and pipeline schemes traversing the country (Figure 1).

By 2010 an estimated 1200 burnt stone sites have been excavated in Ireland, with some 900 of these as a direct consequence of road and pipeline development, making this the most frequent site encountered during such projects. This large body of data has the potential to address many long-standing research questions, particularly relating to site function and chronology, areas where there has been much controversy. The latter theme will be briefly addressed here, particularly in relation to the early development of pyrolithic technology in prehistoric Ireland.

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[4] The topics dealt with in this paper are explored further by the author in a recently published article submitted to the Proceedings of the Royal Irish Academy.
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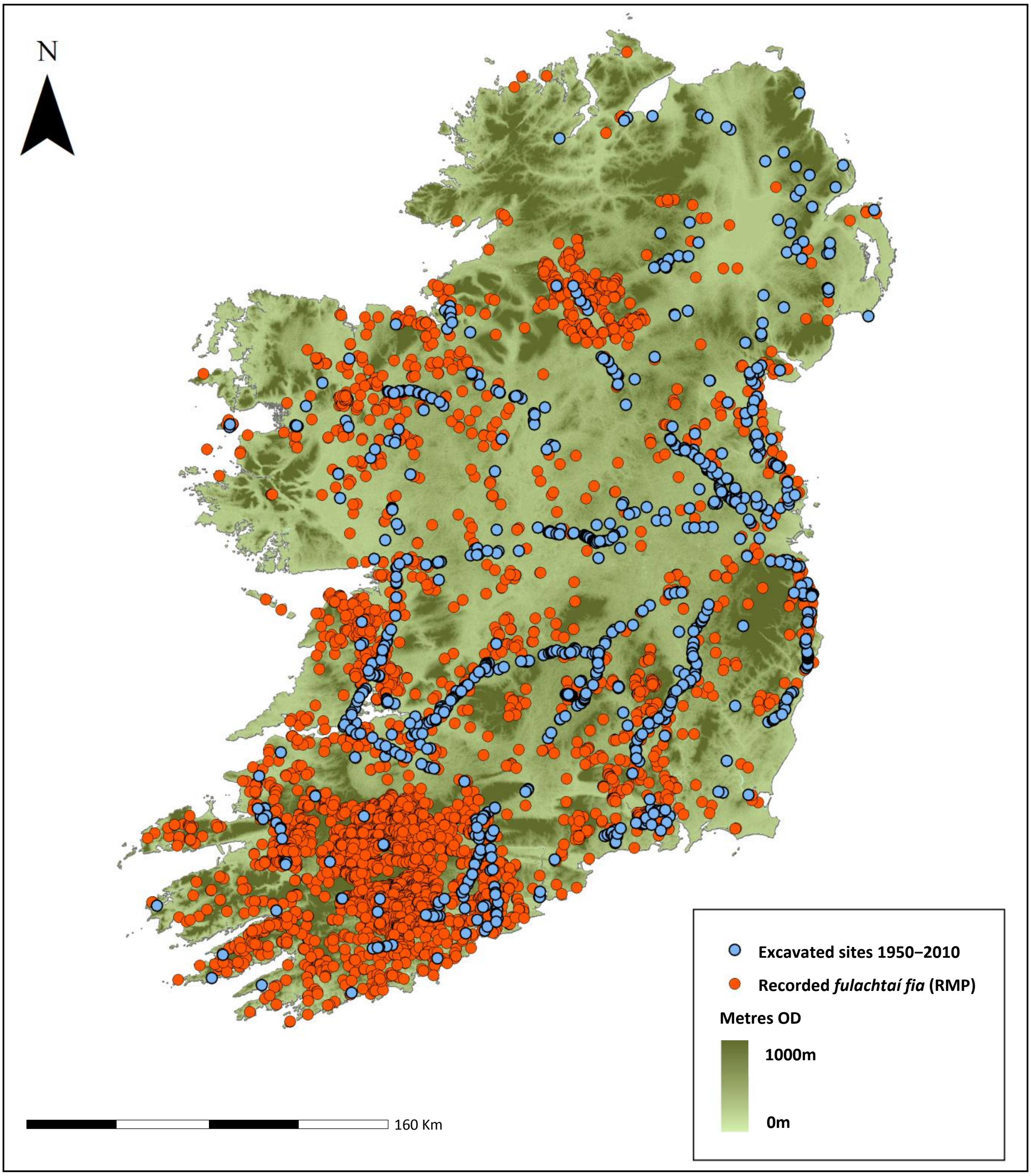
Figure 1: Distribution map of recorded and excavated *fulachtaí fia* (1950−2010).



While radiocarbon evidence suggests that the majority of these sites are Bronze Age in date (Brindley *et al.* 1989−90; Ó Néill 2009; Hawkes 2012), there are now numerous examples of pyrolithic-type processes in earlier contexts. This short paper explores some of this new dating evidence and highlights the possible origins of this technology in early Ireland. The evidence suggests that considerable caution should be exercised with regard to certain single radiometric dates and the inherent need to examine critically the sample context. This is also evident at a number of sites that have returned early medieval and modern dates (Hawkes 2012). A broader synthesis of the material is published elsewhere (Hawkes 2014).

Pyrolithic technology in early prehistoric Ireland

By the mid-1990s the earliest and most securely dated *fulacht fia* in Ireland was the site at Ballynoe in Co. Cork. A timber fragment from one of the internal side planks is radiocarbon dated to the Chalcolithic, 2459−2206 cal. BC[6] (3850±30BP; GrN-11803; Lehane 1988). It was later suggested that the emergence and popularity of these sites at that time may have been connected with a greater awareness of the power of heat in relation to mining and metallurgical processes (Brindley 1995). Traditionally seen as a Bronze Age practice in Ireland, there are now examples of *fulachtaí fia*-type processes in fully Neolithic societies, considerably earlier than the beginnings of metallurgy. Fourteen sites have been dated to the Early to Middle Neolithic period (*c.*4000/3800−3000 BC), with a further 28 sites dating to the Late Neolithic (*c.*3000−2500 BC) (Table 1).

Table 1: Mesolithic and Neolithic radiocarbon dates from *fulachtaí fia* and burnt stone deposits in Ireland (calibration after Oxcal v. 4.2). * Numerous dates available ♦ Dendrochronology date.

	Site Name	County	Context dated	Cal BC (2 sigma)
1	Ballycahane Lower	Limerick	Peat Layer (wood fragments)	7029–6604 BC
			Peat Layer (wood fragments)	5036–4798 BC
2	Ballyvass	Kildare	Burnt Mound (wood)	4583–4401 BC
3	Coolderry 2	Tipperary	Trough (wood)	4364–4263 BC
4	Flemby	Kerry	Burnt Spread (charcoal)	4230–3799 BC
5	Cherryville 7	Kildare	Burnt Spread (charcoal)	4219–3714 BC
			Burnt Spread (bone)	3634–3366 BC
6	Moorechurch 1	Meath	Burnt Mound (charcoal)	3971–3667 BC
			Pit Fill (charcoal)	3637–3120 BC
7	Clowanstown 1*	Meath	Trough Fill (charcoal)	3960–3780 BC
8	Ballintotty	Tipperary	Burnt Mound (charcoal)	3780−3641 BC
9	Carriganard	Waterford	Burnt Mound (charcoal)	3793−3649 BC
10	Pottlebane 3	Meath	Trough Fill (charcoal)	3770–3637 BC
11	Ballykilmore 5.1	Westmeath	Burnt Mound (charcoal)	3695–3530 BC
			Burnt Mound (charcoal)	3324–2927 BC

[6] All radiocarbon dates in this paper are given as calibrated dates, expressed at two sigma (95.4%) levels of confidence using Oxcal 4.2 software (After Bronk Ramsey 2013).

12	Cappanrush 1	Westmeath	Trough Fill (charcoal)	3640–3384 BC
13	Fermoy 2	Cork	Pit Fill (charcoal)	3517–3027 BC
14	Clowanstown 2	Meath	Pit Fill (charcoal)	3496–3103 BC
15	Ballyglass West	Mayo	Burnt Mound (charcoal)	3494–2920 BC
16	Cloghaclocka	Limerick	Trough (timber)	3485–3110 BC
17	Cherryville 6	Kildare	Peat Layer (bone)	3356–2936 BC
18	Annaholty 5	Tipperary	Pit Fill (charcoal)	3352–3102 BC
19	Islands	Kilkenny	Trough Timber	3011−2761 BC
			Trough Fill (charcoal)	2886−2500 BC
20	Gortybrigane	Tipperary	Burnt Mound (charcoal)	2880−2620 BC
21	Corraun	Laois	Pit Fill (charcoal)	2872−2579 BC
22	Ballinter 2	Meath	Pit Fill (charcoal)	2875−2500 BC
23	Sonnagh	Mayo	Burnt Mound (charcoal)	2871−2498 BC
24	Enniscoffey	Westmeath	Trough Timber	2873−2496 BC
25	Newdown	Westmeath	Burnt Mound (charcoal)	2876−2492 BC
26	Gortaroe	Mayo	Trough Fill (charcoal)	2860−2498 BC
27	Ballymount	Kildare	Post-Hole (charcoal)	2859−2497 BC
28	Doughiska	Galway	Wood (natural)	2861−2492 BC
29	Gortaroe	Mayo	Trough Fill (charcoal)	2858−2496 BC
30	Aghmacart	Laois	Spread (charcoal)	2861−2492 BC
31	Kilbeg	Westmeath	Pit (charcoal)	2859−2486 BC
32	Richill site B	Limerick	Pit (charcoal)	2836−2493 BC
33	Smuttanagh	Mayo	Trough Fill (charcoal)	2852−2476 BC
34	Springfield 3	Laois	Pit Fill (charcoal)	2866−2469 BC
35	Kennastown	Meath	Spread (charcoal)	2852−2476 BC
36	Boyerstown 8	Meath	Trough Fill (charcoal)	2851−2472 BC
37	Coolderry 2	Tipperary	Trough Timber	2828−2480 BC
38	Deerpark East	Mayo	Trough Fill (charcoal	2840−2469 BC
39	Gainstown 1B	Meath	Pit Fill (charcoal)	2833−2466 BC
40	Blundelstown	Meath	Trough Fill (charcoal)	2832−2462 BC
41	Tomboholla	Mayo	Burnt Mound (charcoal)	2834−2300 BC
42	Scratenagh	Wicklow	Post-Hole (charcoal)	2849−2145 BC
43	Ballinaspig More 7	Cork	Burnt Mound (charcoal)	2866−2493 BC
44	Jamestown♦	Dublin	Trough Timber	2859±9 BC
45	Magheraboy	Sligo	Pit Fill (charcoal)	2857−2467 BC
46	Gortaroe Area 4	Mayo	Trough Timber	2577−2479 BC

A critical review of these radiocarbon dates was undertaken using a grading system outlined by Mook and Waterbolk in 1985, and which was successfully used elsewhere in relation to other dated burnt stone deposits (Hawkes 2012). This is based on the degree of certainty of the dated sample and its association with pyrolithic activity. An analysis of 51 early prehistoric radiocarbon dates from 46 sites (Table 1) revealed that 18 samples can be securely connected with the type of pyrolithic/water-boiling process known from *fulachtaí fia*, with a further 18 dates possibly associated with a similar activity. The remaining ten dates have no association with the use of pyrolithic technology and include five Mesolithic radiocarbon dates from four sites.

The study confirms there was no burnt mound tradition in Mesolithic Ireland comparable to later prehistoric examples. Where Mesolithic radiocarbon dates are recorded from *fulachtaí fia* sites, these can be shown to have no association with the use of a pyrolithic technology and probably represent contaminated samples or earlier activity. Mesolithic artefacts, consisting entirely of lithic material, have been recovered from 15 *fulachtaí fia*, however none of these are from secure contexts. While an archaic version of the technology may have been employed for dry roasting/baking during the fifth millennium BC, it is likely that the use of pyrolithic water-boiling technology did not become widespread in Ireland until the Neolithic. This is based on the identification of trough pits and domesticated faunal remains in excavated burnt mound/spread sites dating from the early fourth millennium BC. This suggests that new cooking techniques emerged as a clear consequence of the adoption of animal husbandry.

Pyrolithic technology in Neolithic Ireland (*c.* 4000−2500 BC)

A total of 50 early radiocarbon dates and one sample dated by dendrochronology have been obtained from over 1,000 excavated *fulachtaí fia* and burnt stone deposits in Ireland (Table 1). Of the potential Neolithic sites, this study has revealed that five sites can be positively dated to 4000−3000 BC, with a further 24 dating to 3000−2500 BC. Seven sites cannot be securely related to a pyrolithic boiling process as no troughs were encountered, however, the site records indicate an activity possibly associated with roasting or steaming. The radiocarbon samples from a further five sites have no association with the use of pyrolithic technology, being either intrusive elements to the site or representing activity pre-dating the formation of the burnt mound. Diagnostic material culture has also been retrieved from some of these Neolithic *fulachtaí fia* in support of the radiocarbon evidence. Early Neolithic carinated pottery from Clowanstown 1, Co. Meath and Cherryville 7, Co. Kildare places these sites firmly in the early fourth millennium BC.

Troughs found at three sites can be securely dated to the Early Neolithic period (*c*.4000/3800−3500 BC) and all produced substantial deposits of heat-shattered stone. This suggests that the heating of water using hot stones was practiced at this early stage in Ireland, although there is no evidence that troughs were lined with wood or stone. This seems to have first occurred during the Late Neolithic period in Ireland, supported by radiocarbon dating of four trough timbers to the period 2800−2500 BC. It had previously been suggested that troughs began to be lined sometime after 2000 BC (Ó Néill 2000), however this now seems to have occurred at an earlier date.

If one accepts that cooking was the primary activity at these early pyrolithic water-boiling sites, what role did it play in the wider social structure of early farming communities? Although it is difficult to assess the significance of the earliest pyrolithic sites due to the small excavation sample, it is possible that the migration of farming groups into Ireland at this time, along with the introduction of domesticated cattle, created a new medium for exchange and new opportunities for feasting (Cummings and Harris 2011, 372). The animal bone recovered from early pyrolithic sites such as Clowanstown 1, Co. Meath, Moorechurch, Co. Meath and Cherryville 7, Co. Kildare, was dominated by cattle remains. This supports a possible cooking function associated with the beginnings of this technology in Ireland. Furthermore, the crushed calcined bone identified at Clowanstown 1, Co. Meath is thought to be consistent with butchery waste associated with the jointing of meat (Coles 2008). Mossop (2008) has tentatively suggested that marrow extraction may have also taken place at the site. This pyrolithic cooking process was possibly brought about by the introduction of new animal species, which would have created the potential for new notions of wealth and status (Cummings and Harris 2011, 376). There is no denying that these animals were a significant food supply, with meat and milk an important part of diet in the Neolithic. What may also be important is how people conceptualised these animals and how it impacted on their use within social relations (*ibid*., 367). Ethnographic accounts confirm that in many indigenous societies cattle symbolise wealth, power and prestige, and their meat was only consumed during feasting rituals (Jiménez and Montón-Subías 2011, 143). Pollard (2006, 135) observed that ‘animals are woven into the fabric of social life through their ubiquitous presence and involvement in the creation and maintenance of social relations as a medium of exchange, feasting and offering’. Such occasions may have warranted communal gatherings for the slaughter, butchery and cooking of animals using pyrolithic processes. The importance of such events is supported by the deliberate wooden deposits noted in both burnt mounds at Clowanstown 1, Co. Meath (Plate 1) and Cherryville 7, Co Kildare.

Plate 1: Burnt mound 'A' at Clowanstown 1, Co. Meath (courtesy of Matt Mossop).

Hayden (2001, 28) observed that feasting can be broadly defined as 'the sharing of special food on special occasions', while Twiss (2008, 419) defines feasts as 'occasions consciously distinguished from everyday meals, often by a greater number of participants and a larger supply of food'. Furthermore, she suggests that the modes of preparation, the discarding of food waste and the location setting of the event may also have distinguished feasting occasions (*ibid*.). Certainly, *fulachtaí fia* would have been prime locations for such activities as they were situated at least some distance from contemporary settlements, while the method of cooking employs a unique application, notably the use of a pyrolithic technology using an indirect heat rather than a direct one. This open-air process would have required a small labour force for the construction of timber troughs, the gathering of fuel and stone and for the constant maintenance of the hearth or fire. The size of some excavated troughs (up to 5 m in length), indicates intensive boiling episodes for the cooking of large amounts of meat. Large amounts of meat provided by a single animal had to be consumed rapidly by groups, as techniques of meat preservation were not known until the Late Bronze Age (Serjeantson 2006).

Conclusion

It is evident that pyrolithic water-boiling technology was not used to the same extent in early prehistoric Ireland as in later periods. This is supported by the dating of 36 sites from the large excavation sample in Ireland which surely would have accounted for a greater number if the technology was widely practiced during the Neolithic. This could suggests that the boiling of meat played a special-purpose role during this early farming period, possibly associated with communal feasting, not as an everyday activity, but a special event.

The dating of burnt stone deposits to the Neolithic has only been possible by recent large-scale archaeology projects connected to infrastructural developments. While the number of Neolithic burnt mound sites is small relative to the size of the excavation sample, it does confirm that pyrolithic technology was employed on a small-scale during the early farming period in Ireland.

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References

Brindley, A. L., Lanting, J. N. and Mook, W. G. 1989−90. Radiocarbon dates from Irish *fulachta fiadh* and other burnt mounds. *The Journal of Irish Archaeology* 5, 25−33.

Brindley, A. 1995. Radiocarbon, chronology and the Bronze Age. In J. Waddell and E. Shee Twohig (eds), *Ireland in the Bronze Age: Proceedings of the Dublin Conference*, 4−13. Stationary Office, Dublin.

Bronk Ramsey, C. 2013. Oxford Radiocarbon Accellerator Unit. Available at: http://c14.arch.ox.ac.uk/embed.php?File=ocal.html (accessed 16 July 2013).

Coles, C. 2008. Faunal report, Clowanstown I, Co. Meath. Unpublished specialist report for Archaeological Consultancy Services Ltd.

Cummings, V. and Harris, O. 2011. Animals, people and places: the continuity of hunting and gathering practices across the Mesolithic-Neolithic transition in Britain. *European Journal of Archaeology* 14(3), 361−382.

Hayden, B. 2001. Fabulous feasts: a prolegomenon to the importance of feasting. In M. Dietler and B. Hayden (eds), *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, 23−64. Smithsonian Institution Press, Washington, D.C.

Hawkes, A. 2012. Medieval *fulachtaí fia* in Ireland? An archaeological assessment. *The Journal of Irish Archaeology* 20, 77−100.

Hawkes, A. 2014. The beginnings and evolution of the *fulacht fia* tradition in early prehistoric Ireland. *Proceedings of the Royal Irish Academy* 114C, 89−139.

Jiménez, G. A. and Montón-Subías, S. 2011. Feasting death: funerary rituals in the Bronze Age societies of south-eastern Iberia. In G. A. Jiménez, S. Montón-Subías and R. Sánchez, *Guess Who's Coming to Dinner: Feasting Rituals in the Prehistoric Societies of Europe and the Near East*. Oxbow Books, Oxford.

Lehane, J. 1988. Excavations at Ballyclogh, Fermoy, Co. Cork. *Journal of the Cork Historical and Archaeological Society* 93, 83−92.

McCarthy, D. 2010. Digging, data and dissemination. *Seanda* [National Roads Authority Archaeological Magazine] 5, 41.

Mossop, M. 2008. Archaeological excavations at Clowanstown 1, Co. Meath. Unpublished excavation report for Archaeological Consultancy Services Ltd.

Mook, W.G and Waterbolk, H.T. 1985. *Handbook for Archaeologists, No. 3: Radiocarbon Dating*. Strasbourg.

Ó Néill, J. 2000. Just another *fulachta fiadh* story. *Archaeology Ireland* 14(2), 19.

Ó Néill, J. 2009. *Burnt Mounds in Northern and Western Europe: a Study of Prehistoric Technology and Society*. VDM Verlag, Saarbrucken.

Pollard, J. 2006. A community of beings: animals and people in the Neolithic of southern Britain. In D. Serjeantson and D. Field (eds), *Animals in the Neolithic of Britain and Europe*. Neolithic Studies Group Seminar Papers 7, 135−48. Oxbow Books. Oxford.

Power, D., Byrne, E., Ursula, E., Lane, S. and M. Sleeman. 1994. *Archaeological Inventory of County Cork, Vol. II: East and South Cork.* Stationary Office, Dublin.

Serjeantson, D. 2006. Food or feast at Neolithic Runnymede? In D. Serjeantson and D. Field (eds), *Animals in the Neolithic of Britain and Europe*, 113−134. Neolithic Studies Group Seminar Papers 7. Oxbow Books, Oxford.

Twiss, K. 2008. Transformations in an early agricultural society: feasting in the southern Levantine pre-pottery Neolithic. *Journal of Anthropological Science* 27, 418−442.

Charcoal and pollen research along the M6 road scheme – new research and methodological studies towards the advancement of guidelines and best practice

Ellen OCarroll and Fraser Mitchell[7]

PhD research completed under the direction of Fraser Mitchell at TCD and funded by the NRA examined charcoal methods in relation to archaeological sites and woodland resource usage using a variety of anthracological (charcoal) and palaeoecological (including pollen) approaches as well as literary evidence at different spatial and temporal scales. The ultimate aim of the research was to produce a set of guidelines on the use and applicability of both charcoal and pollen in relation to archaeological sampling and research. These guidelines are to be used by the NRA to ensure that on-site palaeoenvironmental sampling strategies and post-excavation analysis and reporting conform to the best standard and is focused on achieving high-quality and scientifically meaningful results. Changes in woodland composition and woodland dynamics was also observed using a multidisciplinary approach through the analysis of charcoal samples as well as pollen data from a local and regional core are being investigated. These changes in woodland resource usage are not discussed in this paper but can be read in the NRA National Archaeology Seminar publication 2012, Futures and Pasts, Archaeological Science on Irish Road schemes.

Introduction

The reconstruction of past landscapes and landscape dynamics using archaeological wood and charcoal has been demonstrated through a variety of studies (Smart and Hoffman 1988; Heinz and Barbaza 1998; Asouti 2001; 2003; Dufraisse 2002; Nelle 2003; Marguerie and Hunot 2007; O'Donnell 2007; 2011; Veal 2009). Charcoal is the most frequent of the plant remains recovered during archaeological excavations and it is present in almost every archaeological feature and site type excavated. Analysis of charcoal remains can provide functional evidence for various activities at a site, as well as insights into cultural, ecological and economic variables. Certain wood species may have been selected for particular uses, such as structural posts, firewood, pyre fuel and wattle – it is known, for example, that oak was often selected as fuel for prehistoric cremation pyres; oak was also the preferred species for manufacturing charcoal for use in industrial activities such as metalworking (O'Donnell 2007). However, charcoal identifications with regards quantity of fragments and samples

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analysed varies hugely in Ireland and elsewhere and is led by many different factors such as budgetary constrains, time limits, specific research objectives and the analysts preferred methodologies. This leads to inconsistencies and bias with regards interpretations and reconstructions. Environmental reconstructions as well as woodland resource usage based on two or three samples containing very few charcoal fragments is not valid and scientifically flawed. It is thus important to analyse and quantify the data produced from charcoal identifications using consistent and reliable methods, especially when site types and dates vary (Asouti and Austin 2005).

This paper uses data from the analyses of hundreds of charcoal samples to address two fundamental issues facing archaeologists and sampling procedures. The first is the optimal number of samples that should be analysed from a site and the second is the optimal number of charcoal fragments that should be analysed from each sample. These two aims are addressed by analysing numerous samples from a range of site types covering several archaeological time periods.

Pollen analysis is used for reconstructing woodland succession as well as the scale and type of vegetation that was present in proximity to archaeological remains (Bradshaw 2007a; 2007b). Analysis can also reveal the impact that both humans and climate had on that vegetation in the past. Methodologies used in reconstructing woodland successions from pollen analysis are well researched. Therefore by combining the analysis of wood selection and use, which is intrinsically linked to human influence, with a record of pollen data from sediment cores which are well dated, it is possible to re-create past landscapes at different spatial scales. The validity of using charcoal to reconstruct past landscapes is often questioned as charcoal excavated from archaeological sites can be related to human selection and much taphonomy (Théry-Parisot *et al*. 2010). The mean pollen and charcoal percentage datasets were therefore cross compared. This determined whether the proportions of charcoal of varying taxa identified correspond to arboreal vegetation close to the study area across nine time periods during the mid to late Holocene.

Results and Data Analysis

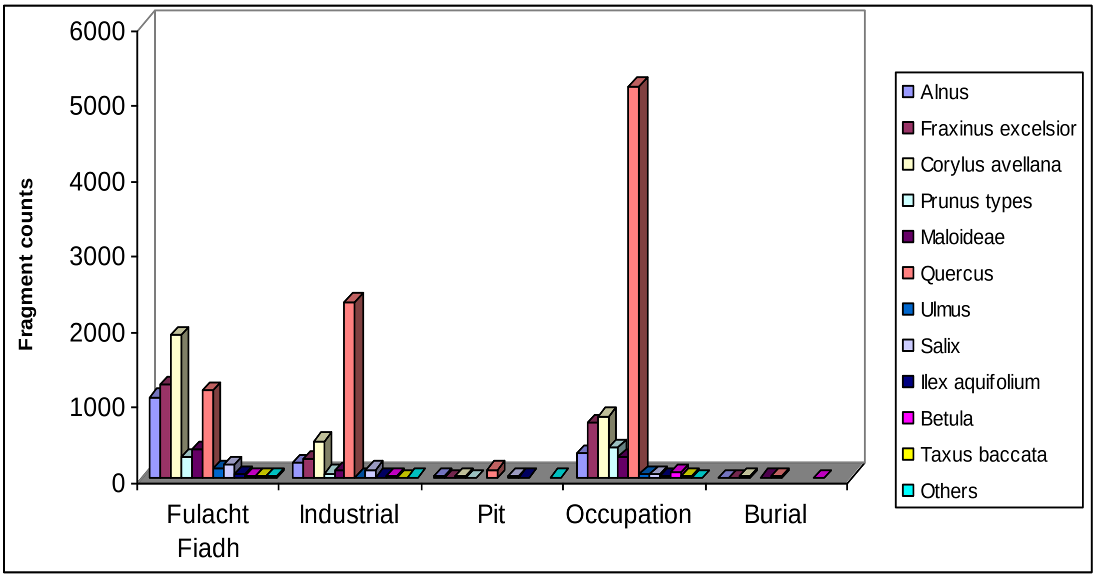
Archaeological excavations associated with the construction of the M6 across the midlands of Ireland provided a range of archaeological sites of varying ages. The study area is defined by a 61 km stretch of the M6 roadway between the towns of Kinnegad and Athlone (Egan 2007).

A data set of over 17,000 charcoal fragments from 56 archaeological excavations is used to develop recommended sampling protocols for archaeological charcoal analysis. Charcoal and pollen data are then cross compared to check the validity of using charcoal for vegetation reconstruction.

Charcoal data

The overall results from the data set are divided into five site types and graphed below (Figure 1). These include *fulachtaí fia*, industrial sites, pits, occupation sites and burials. Industrial sites include cereal-drying kilns, charcoal production pits and metalworking activity, while occupation sites include both Bronze Age habitation sites and Medieval ringforts. Overall charcoal identification results from the whole data set show that *Quercus*, *Corylus avellana*, *Fraxinus excelsior* and *Alnus* are represented most frequently at all sites investigated, although variation in dominant types can be ascertained between site types.

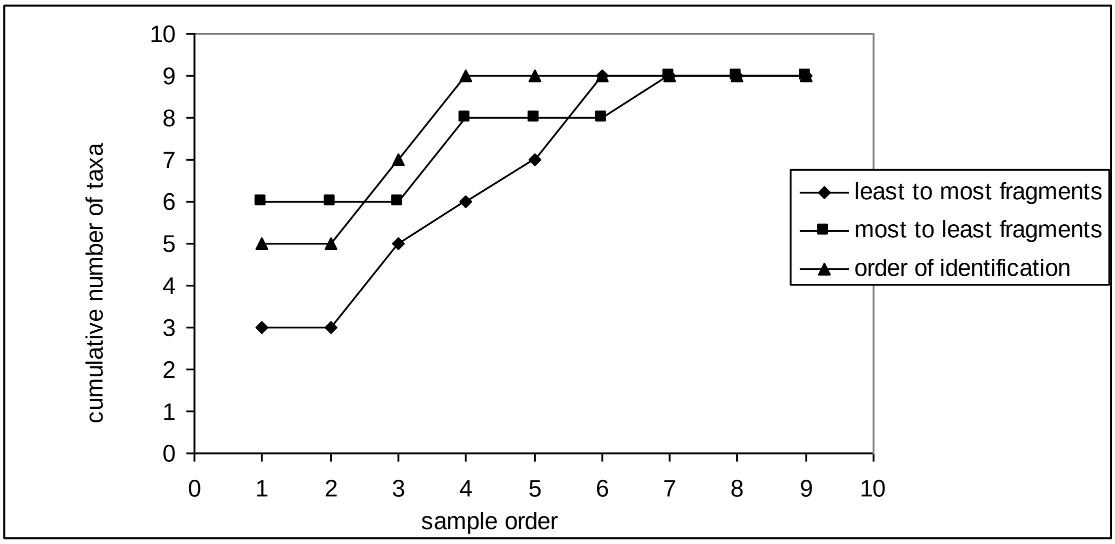
Figure 1: Total charcoal identifications per site type. N=17,997 fragments and 'Others' = *Sambucus*, *Ulex*, *Euonymus*, *Viburnum*, *Cornus*, *Hedera*.



Cumulative saturation curves were constructed by adding successive samples or charcoal fragments cumulatively to determine whether the information provided by new samples or fragments is unique or redundant compared to information provided by earlier samples (Lymana and Amesb 2007). When no new information is obtained by the addition of more samples or fragments (i.e. taxon) the curve levels off and is said to be saturated.

The cumulative saturation curves for the optimal number of samples records the relationship between the number of samples identified per site and taxa diversity/recovery. The shape of the saturation curve can vary depending on the order of identification of samples and the number of fragments per sample, therefore the data is displayed along three different curves. The samples were ordered either by: 1) ascending order of the number of fragments in each sample, 2) descending order of the number of fragments in each sample, or 3) the order in which they were identified (Figure 2).

Figure 2: Example of a number of samples saturation curve, data from a Bronze Age *fulacht fia*.



Three hundred and six charcoal samples from 20 sites covering an age range from the Early Bronze Age to the Medieval were analysed to address the first aim of the number of samples to analyse per site (Table 1). In this paper we focus on the three most common site types excavated: *fulachtaí fia*, industrial and occupation sites.

Table 1: Summary of site types, sample numbers and fragment numbers used to complete the cumulative saturation curves used to quantify optimal number of samples per site type.

Site type	No. Sites	Mean no. samples (range)	Mean fragment count (range)	Mean Saturation point (±SE)
Fulachtaí fia	8	9 (4–16)	367 (141–645)	5.4 ±0.9
Industrial	6	8 (5–12)	507 (221–959)	5.7±1.2
Occupation	6	29 (4–72)	1317 (126–3463)	23.4±6.1

The saturation curves illustrate that for both *fulachtaí fia* and industrial sites at least six samples should be analysed but for occupation sites at least 24 samples should be analysed (Table 1).

A total of 5,138 identified charcoal fragments from 61 samples were analysed to address the second aim of how many fragments should be analysed per sample (Table 2). One hundred fragments of charcoal were identified from samples used to create the saturation curve profiles. Saturation curves were drawn in the archaeological wood and charcoal database—WODAN (www.wodan.ie). The saturation point illustrates the point at which all new taxa have been identified from a sample so the levelling off of the curves can be used to determine the minimum number of fragments to identify to ascertain the taxa present in the sample (Figure 3).

Table 2: Summary of site types, sample numbers and fragment numbers used to complete the cumulative saturation curves used to quantify optimal number of fragments to identify per sample.

Site type	No. Sites	Mean no. Samples (range)	Mean fragment count (range)	Mean Saturation point (±SE)
Fulachtaí fia	10	3 (1–6)	311 (102–467)	24.2 ±4.78
Industrial	3	4 (4–4)	740 (600–945)	23.9±5.7
Occupation	3	5 (1–8)	215 (100–329)	16.6±5.8

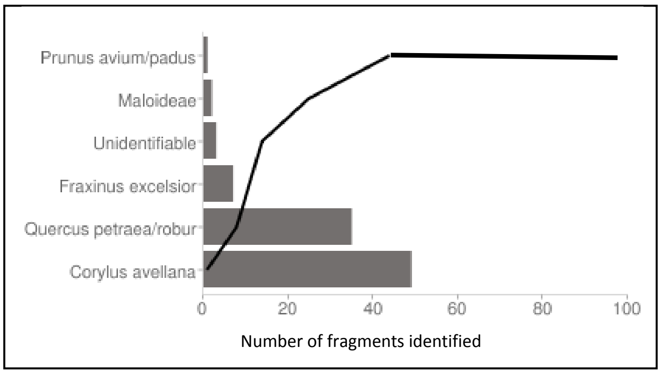


Figure 3: Example of a saturation curve for taxa occurrence within one sample (Early Bronze Age fulachtaí fia). The line registers the fragment number from which a taxon was first recorded.

Saturation points tended to increase with the number of taxa identified but overall, fragment counts from *fulachtaí fia* and industrial sites reached similar saturation points at around 25 fragments with occupation sites reaching saturation point by 17 fragments (Table 2).

The precision of estimates of the proportions of taxa from the subset of fragments identified was determined using standard equations (Moore and McCabe 2006). This reveals fragment counts in excess of 500 are required to achieve a 95% confidence of deriving taxon proportion estimates with a margin of error below 2.5% (Table 3).

Table 3: Precision of taxon proportions derived from subsets of charcoal fragments.

Fragment counts required to achieve 95% confidence in taxon proportions for a range of margins of error					
Margin of error (%)	1	2	3	4	5
Fragment count	2401	600	267	150	96
Precision of determining taxon proportions at 95% confidence for a range of fragment counts					
Fragment count	30	50	100	200	500
Margin of error (%)	8.9	6.9	4.9	3.5	2.2

Pollen data

Comparing the pollen and charcoal data over time can answer the two following research questions. Can the relative proportions of different taxa in charcoal data from archaeological settings be used to reconstruct the proportions of trees in the adjacent woodland? Are relative proportions of different taxa in charcoal data from archaeological settings influenced by preferential selection of certain taxa within the adjacent woodland resource?

The archaeological charcoal data and pollen profiles are compared directly by percentage proportion graphs for each period under discussion (Figures 4 and 5). Cornaher Lough, Co. Meath pollen diagram is used for the purpose of this paper.

On a very basic level it is possible to infer the presence of certain tree types in the surrounding landscapes from the charcoal and wood identifications and these compare well to the pollen data sets. Charcoal from the earlier prehistoric periods show more congruence with the pollen data when compared with the same proxy in the Medieval periods. This is also shown in statistical analysis using similar pollen data and completed for this project where temporal clusters are more evident in the earlier periods and more spread out in later periods. Although the charcoal and pollen data are showing differences in the range of taxa types in the later periods they are both effects of human interventions on the woodland landscape and selection of woodland types. The proportions of pollen taxa and charcoal data are not similar. The charcoal data presents a *Quercus* dominated landscape, due to the high selection of this wood for various purposes. The convergence of the charcoal data set with the pollen data can be linked with the rise in human activities. One can determine very clearly that the Later Bronze Age shows an increased selection in wood types (*Quercus*) which can also be seen by increased activities in the archaeological resource in the area.

One important outcome from this analysis is that charcoal can be used to indicate patterns of change in the woodland resource. For example an increase in *Fraxinus* charcoal is also detected in the earlier Bronze Age periods in pollen, highlighting the opening up of the landscape. *Ulmus* and *Taxus* are similarly matched and indicators of anthropogenic activity.

Figure 4: Mean percentage pollen proportions of arboreal taxa through time at Cornaher Lough.

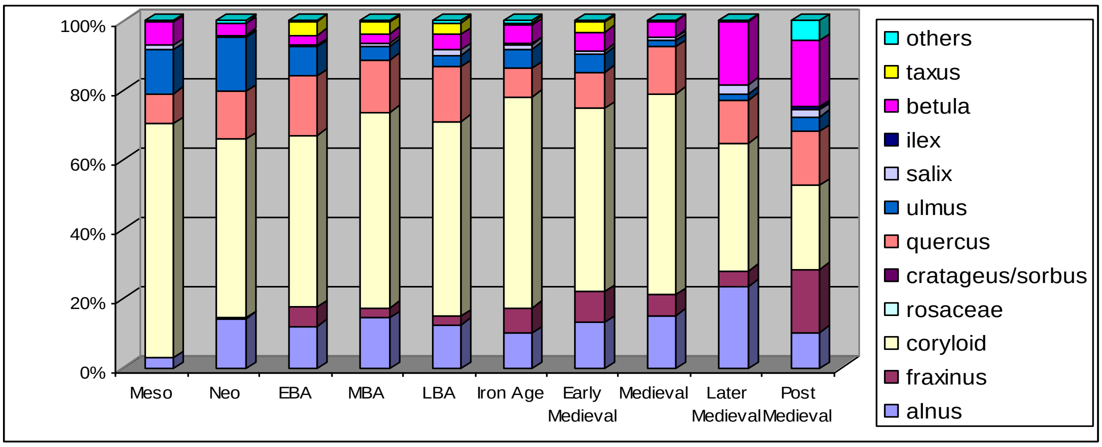
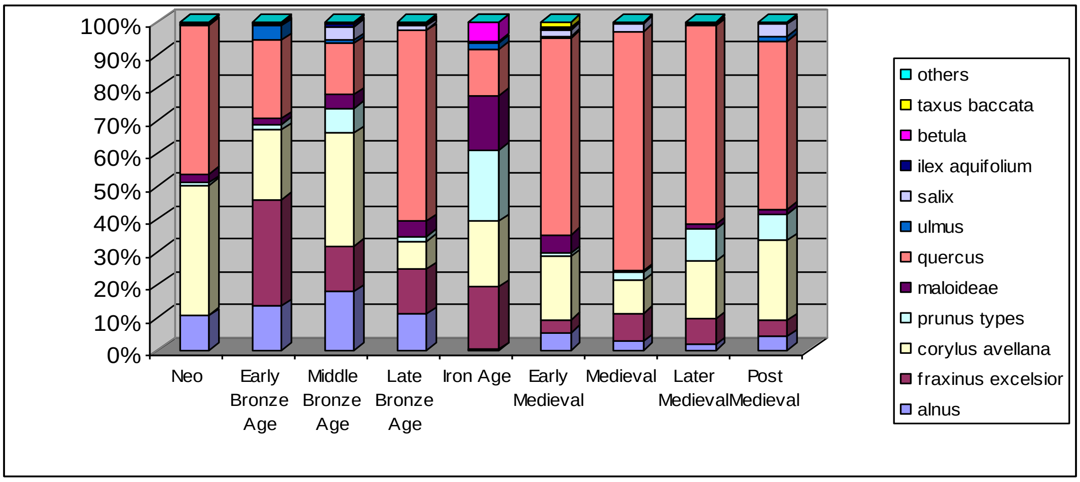


Figure 5: Mean percentage charcoal proportions of arboreal taxa through time in relation to the archaeological charcoal data.



Summary and Conclusions

The saturation curves illustrate important differences between site types. For both *fulachtaí fia* and industrial sites the results are similar and suggest that minimum sampling should aim to analyse at least 25 charcoal fragments from at least six samples per site. For occupation sites a minimum of 17 fragments should be analysed from at least 24 samples. These recommendations are intended to provide **minimum** sampling and analysis requirements to capture the range of taxa that are represented within the charcoal excavated from archaeological sites, but the precision of proportion estimates of these taxa is also dependent to fragment counts, which will need to be much higher if margins of error below 2.5% are desired. These analyses were confined to three site types that were commonly found in the study area. Due to their rarity other distinctive site types, for example, cremation/burial sites, were not included and thus do not fall within these recommendations.

Similarities between the pollen and archaeological charcoal data sets can be determined through certain taxa and not through others. These similarities are not represented by taxa proportion sizes, however, but instead are shown through similar trends in fluctuating patterns and also through the absence/presence of certain taxa during specific time periods. Presence and absence of certain tree types in the charcoal data set such as *Ulmus*, *Pinus*, *Fraxinus excelsior* and *Corylus* can indicate patterns of woodland change, but do not directly relate to vegetation proportions in the associated landscapes. Graphing results suggest alterations in the proportions and densities of vegetation types as well as variance in wood selection across certain site types and periods. Following on from this, the presence and absence of certain tree types in the archaeological record can indicate patterns of woodland change but do not directly relate to vegetation proportions in the associated landscapes.

The results from this research have been incorporated and are currently in use by archaeologists managing and undertaking archaeological excavations funded by the National Roads Authority (McClatchie and OCarroll 2013). Their purpose is to ensure that a standardised approach is adopted to palaeoenvironmental sampling, analysis and reporting. The guidelines are intended to be used in the context of the Department of Finance approved Standard Conditions of Engagement for Consultancy Services (Archaeological).

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References

Asouti, E. 2001. Charcoal analysis from Catalhoyuk and Pinarbasi, two Neolithic sites in the Konya Plain, South Cental Anatolia, Turkey. Unpublished PhD thesis, University College London.

Asouti, E. 2003. Woodland vegetation and fuel exploitation at the prehistoric campsite of Pinarbasi, south central Anatolia, Turkey: the evidence from the wood and charcoal macro-remains. *Journal of Archaeological Science* 30, 1185–1201.

Asouti, E. and Austin, P. 2005. Reconstructing Woodland Vegetation and its exploitation by Past Societies, based on the Analysis and Interpretation of Archaeological Wood Charcoal Macro-Remains. *Environmental Archaeology* 10, 1–18.

Bradshaw, R. 2007a. Paleobotany: Overview. In S. Elias (ed.), E*ncyclopaedia of Quaternary Science*, 1567–1574. Elsevier, Amsterdam.

Bradshaw, R. 2007b. Stand-scale palynology. In S. Elias (ed.), *Encyclopaedia of Quaternary Science*, 2535–2543. Elsevier, Amsterdam.

Dufraisse, A. (ed.). 2002. *Charcoal analysis in a lake dwelling site:a sampling model for lacustrine contexts*: BAR International Series 1063. Archaeopress, Oxford.

Egan, O. 2007. Past Lives in the Midlands: archaeology unearthed on the N6 Kilbeggan–Athlone road scheme. *Seanda* [National Roads Authority Archaeological Magazine] 2, 12–13.

Heinz, C. and Barbaza, M. 1998. Environmental changes during the Late Glacial and Post-Glacial in the central Pyrenees (France): new charcoal analysis and archaeological data. *Review of Palaeobotany and Palynology* 104, 1–17.

Lymana, R. L. and Amesb, K. M. 2007. On the use of species-area curves to detect the effects of sample size. *Journal of Archaeological Science* 34, 1985–1990.

Marguerie, D. and Hunot, J. Y. 2007. Charcoal analysis and dendrology: data from archaeological sites in north-western France. *Journal of Archaeological Science* 34, 1417–1433.

McClatchie and OCarroll, E. 2013. NRA Palaeo-environmental Sampling Guidelines. Retrieval, analysis and reporting of plant macro-remains, wood, charcoal, insects and pollen from archaeological excavations. Unpublished report.

Moore, D. and McCabe, G. P. 2006. *Introduction to the Practice of Statistics*. Freeman and Company, New York.

Nelle, O. 2003. Woodland history of the last 500 years revealed by anthracological studies of charcoal kiln sites in the Bavarian Forest, Germany. *Phytocoenologia* 33, 667–682.

O'Donnell, L. 2007. Environmental Archaeology: identifying patterns of exploitation in the Bronze Age. In . Grogan, L. O'Donnell, and P. Johnson (eds), *The Bronze Age Landscapes of the Pipeline to the West: An integrated archaeological and environmental assessment.* Wordwell Ltd., Bray.

O'Donnell, L. 2011. People and Woodlands: an investigation of charcoal remains as indicators of cultural selection and local environment in Bronze Age Ireland. Unpublished PhD thesis, University College Dublin.

Smart, T. L. and Hoffman, E. 1988. Environmental Interpretation of Archaeological Charcoal. In C. Hastorf and V. S. Popper (eds), *Current paleoethnbotany; analytical methods and cultural interpretations of archaeological plant remains.*University of Chicago Press, Chicago/London.

Théry-Parisot, I., Chabal, L., Chrzavzez, J., 2010. Anthracology and taphonomy, from wood gathering to charcoal analysis. A review of the taphonomic processes modifying charcoal assemblages in archaeological contexts. *Palaeogeography, Palaeoclimatology, Palaeoecology* 291(1–2), 142–153.

Veal, R. 2009. The Wood Fuel Supply to Pompeii Third century BC to AD79: an environmental, historical and economic study based on charcoal analysis, Unpublished PhD thesis, University of Sydney.

I would walk Ten Thousand Miles: What have we learnt from Geophysical Legacy Data collected on road schemes?

James Bonsall, Christopher Gaffney and Ian Armit[8]

Large-scale Irish archaeological geophysical surveys have, historically, translated methods and techniques that worked well in the UK and applied them here. Following the boom in excavations on road schemes during the 2000s, anecdotal evidence suggested that the degree of success experienced by geophysicists in the UK did not similarly translate to the Irish experience. A three-year study of historic geophysical surveys on Irish road schemes has examined this situation to understand how and where different survey methods work across the country and how and where they should be applied in the future.

Geophysical Survey Frequency

Ireland is one of the few countries that record or regulate the use of archaeological geophysical surveys. Annual Detection Licence statistics supplied by the National Monuments Service indicate that the frequency of all surveys (terrestrial, marine and metal detection) increased from 1997 onwards until peaking in 2008 at 392 licences, and immediately falling off (following the recession) down to 201 licences in 2011 (comparable to the number of licences issued each year between 2002 and 2005). Terrestrial (archaeological geophysical) Detection Licences peaked in 2007 (at 199) and fell off to 106 in 2011 (an annual level not seen since 2005). During the period from which National Roads Authority (NRA) Legacy Data is available (2001–2010), 1,173 Detection Licences were issued, for which 193 were used on NRA-funded projects (16.5% or 1 in 6), These generated 170 geophysical reports with the frequency of NRA Detection Licences peaking in 2005. Statistics are rarely available for geophysical surveys in most countries; however estimates suggest that Ireland has the second highest rate of geophysical survey use in Europe, after the UK. The 193 Detection Licences issued to NRA funded projects between 2001 and 2010 is higher than the total number of archaeological geophysical surveys carried out for the same period in

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Norway (98), the Netherlands (159) or Sweden (165 between 2001–2008); thus the NRA Legacy Data archive is a considerable resource, not just for Ireland but for wider Europe.

The NRA Legacy Data is recorded in a database using 129 different fields that include details on administrative areas and units, instrumentation, survey environment, data collection and processing, report details and the quality of the archived data. The 170 geophysical reports identified 735 isolated survey areas (e.g. on known monuments or at areas of archaeological potential) and 26 road schemes that were surveyed from 'end-to-end'. In total 73 different road schemes were assessed (either wholly or partially) by geophysical surveys. A number of the reports were found to omit some details which included Detection Licence numbers, soil, weather and land use conditions as well as instruments used, resolution of data capture and method of data processing. A professional geophysical report would not commonly omit such details.

Nineteen geophysical consultancies carried out the surveys. The earliest work depended on UK contractors coming to Ireland but this quickly changed and since 2002 Irish contractors have undertaken most of the work, sometimes in conjunction with UK organisations. The last UK contractor to work on an NRA road scheme was in 2008.

Survey Techniques Used

Sixty-six per cent of projects used only a magnetometer survey – magnetometry was responsible for covering 82% of the 1755.8 ha of survey areas in the Legacy Data archive. This mirrors to some extent the reliance upon magnetometry in England (Table 1), but there is certainly not a universal commitment to the technique; the Netherlands prefers earth resistance (followed equally by GPR and magnetometry), Norway and Sweden both prefer GPR (followed by magnetometry). The NRA's second preferred technique is earth resistance, followed by magnetic susceptibility and magnetometer scanning, whereas the English experience prefers magnetometer scanning as its second technique, followed by earth resistance and magnetic susceptibility.

Table 1: Use of geophysical surveys by the National Roads Authority compared to other countries.

Technique	**Ireland (NRA Projects, *n=170*)**	**England (*n=2,666*)**	**Netherlands (*n=159*)**	**Norway (*n=98*)**	**Sweden (*n=165*)**
Magnetometry	**1** (160 = 94%)	**1**	2 (joint)	2	2
Earth Resistance	2 (38 = 22%)	3	**1**	3	-
Magnetic Susceptibility	3 (35 = 21%)	4	-	-	-
Mag. Scanning	4 (9 = 5%)	2	-	-	-
Electromagnetics	5 (2 = 1%)	-	4	-	-
GPR	6 (1 = <1%)	5	2 (joint)	**1**	**1**

Geophysical Survey Success

Geology plays a very important role in the success or otherwise of geophysical surveys. Near surface igneous geology can strongly influence magnetometer data to the extent that no archaeological anomalies can be seen, whereas deeper igneous deposits covered by thick layers of surface geology may not impede the quality of the archaeological response at all. Most surveys however occurred over sedimentary rock, which dominates Irish geology and is generally well suited for magnetometry. Extensive GIS assessments of ground-observed geophysical data from NRA excavations have shown very high correlations between interpretations and excavated features on sedimentary rocks.

Feedback from excavations is traditionally very poor and interpretations can be improved if archaeologists send their geophysical consultants a copy of testing or resolution reports. In many cases the excavation report can be enhanced by a consulting geophysicist, relaying important soil information that is not visible to the naked eye. The majority of excavated site types on Irish road schemes (burnt mounds of stone, burnt spreads, industrial deposits and hearths) are thermoremanent features that have been burnt and leave characteristic anomalies that can be identified via magnetometry on a favourable sedimentary geology. Less commonly excavated site types, including ringforts and large enclosures, can be found via magnetometry depending on the geology and the local soils – alluvium, peats and gleys are very unsuitable for the identification of such features via magnetometry. In some cases a high resolution survey (0.5m x 0.25m) can improve the responses on those soils, however under some circumstances only a limited magnetic contrast or none at all may exist. In these cases, alternative techniques must be sought and Irish surveys should not obliging follow the English model of magnetometer reliance but should adapt archaeological geophysical methods and techniques to suit its needs. Earth resistance and modern electromagnetic surveys, for example, have both demonstrated an ability to identify archaeological features on challenging gley soils and near surface igneous deposits, despite an absence of those features in magnetometer data.

Conclusions

Comparisons between geophysical interpretations and subsequent ground truthed excavations have shown that the UK model is not appropriate for most soils and geologies in Ireland. The frequent chalky soils of the UK that are particularly suited to magnetometer surveys are not found in Ireland, where carboniferous limestone presents some challenges to such a survey. A new approach, based on the known successes/failures experienced on Irish soils and taking advantage of new methods of prospection, should be adopted in the future.

The research has shown that high resolution magnetometer surveys are required for the assessment of some soils and geologies, rather than ‘standard’ methods previously adopted. Detailed surveys that provide full coverage of a survey area (rather than a scanning/reconnaissance sample) are not only more effective at identifying archaeological features, but are, with the latest instruments, an affordable alternative. In areas of challenging soils or geology (such as igneous deposits found around counties Donegal, Wicklow and Dundalk), magnetometer surveys are inappropriate, but alternatives such as electromagnetic surveys can be used instead to rapidly identify archaeological features.

The outcomes and the lessons learnt from the research will be used to inform future policies on road scheme prospection. In the past, rigorous specifications were issued for geophysical surveys on road schemes and these will continue to be implemented based on the outcomes of this research; the use of specifications could also have applications in the wider commercial world beyond road scheme infrastructure, where some procurement practices are often less rigorous.

Access to the NRA Archaeological Geophysical Survey Database

All geophysical reports in the NRA Legacy Data Archive (2001-2010) are now available to members of the public to download freely for the purposes of research. They may be currently accessed on the NRA Archaeological Geophysical Survey Database www.Field2Archive.org/nra/, officially launched by James Bonsall and NRA Head of Archaeology, Ronan Swan, at the IAI Seminar on the 6th April 2013.

Excavation reports as primary source material

Paul Rondelez [9]

The ideas presented here arose during my PhD research into late medieval ironworking in Ireland. This topic has had a convoluted history, with many of the sites excavated early on being designated as smelting sites based on the occurrence of 'furnace bottoms' and/or 'bowl furnaces'. The former are now generally seen as the result of smithing activities, while the latter as technically non-viable (e.g. Crew and Rehren 2002, 96). We now know that, until the end of the early medieval period, iron in Ireland was almost exclusively produced in slag-pit furnaces (Young 2003), with other furnace-types becoming dominant after that period (Rondelez 2014). Iron smithing was carried out in bowl-shaped hollows and is characterised by smithing hearth cakes (the former 'furnace bottoms') and hammerscale. It was therefore of great importance for my research to be able to get past the various interpretations and as close to the original findings as possible. In some cases, the residues themselves could be studied, but mostly the information concerning the ironworking activities on the various sites was recorded in the written sources.

Traditionally, the formal publication of an excavation is seen as the main source of information in the archaeological profession. In the majority of the cases, however, these publications do not provide the necessary information allowing for critical (re-)appraisal of the findings. Rarely are full descriptions of all the contexts provided, not only in journal articles, but even in some of the large excavation monographs. It is frequently impossible to deduce the archaeological context of the finds and samples. The solution lay nearly always in going back to the excavation reports. Some, such as those published in the *Eachtra Journal*, were available online, while others were obtained after simple email queries resulting in the reports being sent directly or permission granted to take notes from those deposited with the National Monuments Service in Dublin. A large number of reports were also obtained directly from the National Roads Authority.

Checking and re-compiling the data in these reports was often revealing. Not only could additional information be obtained about the metalworking processes, but it was frequently found that features could be re-interpreted and chronological sequences reassessed. This was

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in contrast to most of the formally published material, which relied heavily on interpretation, without providing the means for this to be checked. Slowly, it became clear that these excavation reports, together with the preserved finds and samples, made up what amounted to the primary source material for our profession. This is not exactly correct, of course, as the original plans, registers, photographs, diaries, etc., are the real primary sources, while the excavation reports are, or at least should be, the accessible materialisation of that same information. As such, they are comparable to the transcriptions of the manuscript sources for the historian, or the printed observation results for the biologist. This is not to say that the published secondary information has no value; the translation of this primary data by archaeologists for a wider public and other archaeologists is essential for the distribution of our current knowledge. Undoubtedly in many decades or even centuries to come, it will be our excavation reports and the preserved remains that will be scrutinised again and again, while only some exceptional publications will remain relevant beyond their historical value.

One of the main issues with these excavation reports was the enormous volume of data to be processed. Some consisted of multi-volume works covering many hundreds of contexts, with the relevant information for late medieval ironworking spread over many chapters. Thankfully, most of the reports had been converted from text documents into PDF-format and were readily text-searchable. Others, either photographed or hand-typed, could be converted to computer-readable text through Optical Character Recognition (OCR) software. The free versions of these all proved to be rather disappointing and the best results were obtained through the OCR option in various Adobe Acrobat editions, but the effectiveness of the latter was highly dependent on the quality of the original file. Another very helpful tool, especially after receiving several gigabytes of NRA reports, was a Desktop Search Engine. This type of programme allows for the searching of large batches of computer-readable texts in one go, sometimes giving previews of the 'hits'. When searching for the term 'furnace', for example, this means that when a report contains the sentence 'this feature was not a furnace', it can be discarded without opening. The most efficient of these batch-search programmes found, and freely downloadable, was the Copernic Desktop Search software, but even here instances were found where certain 'hits' were missed in texts converted directly to PDF.

But the reports are not perfect. Only on rare occasions were those with many, say more than a hundred, contexts found to be without mistakes. And this observation is based solely on searching for information relating to the ironworking activities and associated information such as types of pottery, radiocarbon dates, etc. The errors were varied: context numbers assigned to samples which did not appear elsewhere in the report; double use of the same context number; incorrect dimensions of features; discrepancies between dimensions in the text and on the plans; wrongly calibrated radiocarbon dates. Apart from some frustrating exceptions, most of these could be corrected, but often only after elaborate detective-work. My main issue with these errors is that, after all the efforts expended to find out the correct information, they were still there and the next person consulting the same report would have to repeat the same steps. In an ideal world, these mistakes would not be in the reports in the first place, but the sheer volume and complexity of the data may mean that errors are almost inevitable.

Because of the high value of the excavation reports as information repositories for current and future research, avoiding and correcting the above errors is of the utmost importance. Tighter editing should help limit errors in future reports, together with more automated report-writing. Another possible solution would be to make the text of the report available for crowd-sourced editing before submission. This could be done in a controlled fashion, i.e. with a designated group of volunteers, or suggestions could be welcomed from a larger audience. With some additional technological input, something similar could be done for the reports already finalised. My favourite futuristic solution would be a so-called 'edit-button' that would come attached to the digital report. When clicked this would send a message containing the correction to whoever is responsible for amending the report. The original author of the report could be the editor or could have given permission for the report to be updated.

We could go one step further. If these reports were made publicly available, for example online in text-searchable PDF-format, digital versions of our knowledge could be connected directly to this primary source material. Again this could be subjected to crowd-sourced editing. Bundled together, this could become a body of knowledge similar to Wikipedia, but with all the information linked to its primary data. To avoid the obvious downfalls of open editing that Wikipedia sometimes experiences, it is envisioned that an editing body could act as a filter between the suggestions for correction and the revisions in the text. We would then possess a body of information that could be updated as new data becomes available and which would be, slowly but unstoppably, purged of errors.

In summary, this is a plea for the recognition of the exceptional value of our excavation reports for current and future archaeological research. They constitute the most user-friendly version of our primary sources and should be the basis for our research. Errors in these reports can be minimised, for example by improved pre-production, and even crowd-sourced post-production, editing. If made readily available on a large-scale and in a digital format, a process which is currently under-way in many different forms, the reports could become the information base of our archaeological knowledge, verifiable by the click of a button. This will, however, only be possible through enhanced cooperation, which would not only mean people dedicating time to checking the work of others but, especially, opening up 'our' information so it can be scrutinised by others.

References

Crew, P. and Rehren, T. 2002. Appendix 1: High-temperature workshop residues from Tara: iron, bronze and glass. In H. Roche (ed.), *Excavations at Ráith na Ríg, Tara, Co. Meath*, 83–102. Discovery Programme Monographs 6. Royal Irish Academy, Dublin.

Rondelez P. 2014. Ironworking in late medieval Ireland, c. AD 1200 to 1600. Unpublished PhD thesis, University College Cork, Department of Archaeology.

Young, T. 2003. Is the Irish iron-smelting bowl furnace a myth? A discussion of new evidence for Irish bloomery iron making. GeoArch Report 2003/09. Unpublished Specialist Report, GeoArch Ltd.

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