The Irish Iron Age "Lull" Reframed: A Hypothesis of Woodland-Based Economies and Aceramic Culture

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Abstract

The Irish Late Iron Age has long been characterised as a period of demographic contraction and agricultural decline, based on sparse settlement evidence, an aceramic material record, and palynological signals commonly interpreted as woodland regeneration. This apparent “Late Iron Age Lull” has been widely framed as socio-economic stagnation or collapse. This paper re-evaluates that interpretation and argues that the perceived lull is better understood as a problem of archaeological and palaeoecological visibility rather than a genuine reduction in activity.

It proposes that the widespread availability of iron and early steel tools enabled a fundamental reorganisation of material culture and land use centred on intensive woodworking, managed woodland, and hedgerow-based agricultural systems. Steel-edged tools facilitated efficient timber felling, joinery, vessel production, and boundary maintenance, allowing wood to function as a near-total material system for domestic, agricultural, and infrastructural needs. This shift provides a coherent explanation for the aceramic character of the Irish Iron Age, the scarcity of metal artefacts due to curation and recycling, and the ephemeral nature of settlement remains in corrosive soils.

At the landscape scale, the paper argues that dense networks of high, managed hedgerows, coppice, and small enclosed fields would have profoundly altered pollen dispersal, fire signatures, and sediment dynamics. Such landscapes are expected to suppress cereal pollen, enhance arboreal representation, and reduce macro-charcoal deposition despite continued farming, fuel use, and metallurgical activity. Consequently, conventional pollen-based interpretations may systematically under-represent agricultural intensity in highly enclosed and actively managed environments.

To address this interpretative problem, the paper advances a functional palaeoecological framework integrated with multi-proxy evidence, including microcharcoal, phytoliths, non-pollen palynomorphs, and sedimentary ancient DNA. This approach allows explicit testing of alternative land-use scenarios and reframes the Late Iron Age not as a period of decline, but as one of adaptive reorganisation characterised by high productivity and low archaeological visibility.

1. Introduction

The Irish Iron Age (c. 700 BC - 400 AD) has long puzzled archaeologists due to an apparent reduction in settlement activity, arable agriculture, and artefact production, especially ceramics (Raftery 1994; Mallory and McNeill 1991). This 'invisibility' (Raftery, 1994) of the Irish Iron Age is matched at many sites by a change in pollen profiles that

suggest a dropping off of agriculture that has been termed the “Late Iron Age Lull” (Mitchell, 1986). This interval is thus commonly viewed as one of socio-economic decline. Yet academic studies question whether the perceived lull reflects genuine inactivity or rather a transformation in material culture that is archaeologically less visible (Armit, 2007; Coyle McClung and Plunkett, 2020).

This article re-examines that interpretation, proposing that the “lull” represents not collapse but adaptation: a reorganisation of land use and material culture grounded in the expanded use of wood as a sustainable, renewable resource. This change was made possible by the development and widespread availability of iron and steel tools.

When contextualised within broader European developments in ironworking, environmental management, and resource use (Pleiner 2000; Tylecote 1986; Cunliffe 2004), this model provides a coherent explanation for Ireland’s aceramic Iron Age. It situates the “lull” and "invisible" nature within a continuum of technological and ecological adaptation rather than decline.

2. Background and Current Interpretations

Data from conventional palynological studies from across Ireland consistently indicate a decline in cereal pollen and an increase in arboreal taxa during the Late Iron Age (Jeličić and O’Connell 1992; Weir 1995; Molloy 2005; Molloy and O’Connell 1991, 2004; O’Connell and Molloy 2005; O'Connell and Molloy. 2001; Feeser and O'Connell 2010; Coyle McClung 2012; Chique *et al*. 2017; O'Carroll and Mitchell 2017). Although the timing, extent, and degree of these changes in pollen spectra varies from site to site (Coyle McClung, 2012; 2013), the pattern has been interpreted as landscape rewilding following a decline in human activity (Chique *et al*. 2017; O'Connell and Molloy 2001).

Excavated sites that have been dated to the Iron Age have consistently shown a dearth of clear settlement structures and burials. They principally comprise post holes, trenches, hearths, and pits. These ephemeral traces contrast strongly with stone buildings, monuments and burials from the preceding Bronze Age (Becker *et al*, 2009). The succeeding Early Medieval period saw an explosion of ringfort construction (Stout, 1997).

During the Iron Age in Ireland, ceramic artefacts become scarce compared with Bronze Age and Early Medieval assemblages, reinforcing perceptions of regression or abandonment. Barry Raftery (1994) highlighted this aceramic character, yet its causes remain contested.

Proposed explanations for this apparent decline include population collapse (Weir 1995) or a shift toward mobile, pastoral societies (Armit 2007). Some attribute it to climatic deterioration (Weir 1993), perhaps linked to volcanic activity (Baillie 1992, 1993), while others emphasise socio-political factors (Coyle McClung 2012; Coyle McClung and Plunkett 2020).

However, these interpretations may conflate a reduction in archaeological visibility with an actual reduction in activity. As Dowling (2014) notes, Ireland’s limited integration with Roman Britain likely permitted indigenous systems to evolve independently, without

adopting Roman material culture. The continuation of local traditions—coupled with new iron and steel technologies—could have fostered a materially distinct but economically vigorous society.

Re-examining the “lull” through the lens of technological change, woodcraft, and landscape management provides an alternative explanation for the archaeological and palynological record.

3. The Development of Iron and Steel Tools

A central element of this hypothesis is that advances in iron and early steel availability and technology transformed everyday labour. Bronze, although durable, was scarce in Ireland because local copper deposits lacked nearby tin sources (O’Brien 2014). Copper sources were limited and largely concentrated in the south-west, while tin was not locally available and had to be imported, most likely from Cornwall. Control over these resources and their circulation implies social constraints on production and access. Although bronze tools were effective and durable, their manufacture required the melting and casting of alloyed metals followed by work-hardening. The economic and technical costs associated with this process likely limited the availability of bronze tools to higher-status individuals and specialised contexts. For many rural households, stone tools may have remained the primary means of cutting and shaping materials until ironworking matured (Sheridan *et al* 1992; Humphrey, 2007). By the late bronze age it appears that Irish copper reserves were exhausted and copper, like tin, had to be imported, even though Irish bronze production continued (Bottaini & Brandherm, 2024).

Iron, by contrast, is both more widely available and technologically flexible. Iron ore occurs across large areas of Ireland, and its reduction does not require alloying materials (Dolan, 2012; Scott, 1977). Crucially, the use of charcoal as fuel in early smelting and forging introduces carbon into the metal, often producing material that behaves as steel. Even relatively small carbon contents dramatically improve hardness, edge retention, and overall performance (Scott, 1990). This process does not require a conceptual understanding of steel as a discrete material; it emerges naturally from bloomery or hearth-based ironworking. Iron and steel production introduced a revolution in tool capability. The forging of steel and iron in solid state resulted in thinner and finer bladed tools than was generally achieved by casting bronze (Scott, 1977; Raftery, 1983).

The implications through the use of these new tools are profound. Unlike bronze tools, made from a more valuable and less widely available metal, iron tools occupied a different position in household economies. They were curated, maintained, resharpened, and recycled rather than discarded. Broken tools could be reforged, worn edges renewed, by local smiths using bloomery or hearth techniques (Harding 2004). This practice reduces the quantity of metal deposited in archaeological contexts and helps explain the relative scarcity of iron artefacts in Ireland despite their likely abundance in use.

Equally important is the social distribution of these tools. Ironworking, once established, is inherently decentralised. Local ore sources, small-scale smelting, and the recyclability of iron mean that tools can circulate widely through communities rather than remaining

concentrated among elites. These iron tools were valuable investments that enabled the production of a wide range of artefacts, containers, and structures from locally available wood.

The development of iron and early steel tools should be understood not simply as a chronological marker but as an enabling condition for wider economic and cultural change. As will be examined later, these tools underpinned the expansion of wood-based material culture, the intensification of wood management, the construction and maintenance of hedgerows, and the reorganisation of agricultural landscapes. In other words, iron does not merely replace bronze; it facilitates an entirely different relationship between people, materials, and land. In this context, technological innovation need not be spectacular or archaeologically conspicuous to be transformative. The widespread diffusion of practical, durable, and maintainable steel-edged tools is sufficient to explain the dramatic but archaeologically subtle changes observed in Late Iron Age Ireland.

The taphonomic environment further compounds the invisibility caused through curation and reuse. Ireland's maritime climate is highly corrosive to iron. Unless preserved in exceptional conditions, iron objects deteriorate rapidly and completely. The combined effects of curation, recycling, and poor preservation therefore produce a misleading impression of technological absence. The apparent scarcity of iron artefacts may be best interpreted not as evidence of limited technology, but as an artefact of how such technology was valued, used, and ultimately lost to preservation.

4. Wood as a Total Material System

Up until the Iron Age, stone tools—although effective and well understood (Mathieu and Meyer 1997; Tegel *et al.*, 2012; Rybníček *et al.*, 2018; Elburg *et al.*, 2015)—still limited large-scale woodworking. Stone and bronze implements were used to work chiefly along the grain, and cross-cutting was slow, wasteful, and labour-intensive (Elburg *et al.* 2015). Stone and bronze implements, while capable of performing many tasks, impose important constraints on woodworking (O'Sullivan, 1996). The production of thin, precise components—such as staves, boards, or fine joinery elements—was labour-intensive and often impractical. As a result, even where wood was used extensively in earlier periods, its range of applications was constrained.

Once steel tools became widely available, they enabled unprecedented efficiency in felling, shaping, and joinery, with chisels, adzes, drawknives, and saws enabling rapid, precise, and economical woodworking (O'Sullivan, 1996). Cross-cutting timber becomes efficient; controlled splitting and shaping become routine rather than exceptional; and the manufacture of items requiring accurate fitting—stave-built containers, framed structures, turned vessels—becomes feasible at the household scale. The use of pole and spindle lathes may have been widely practised, and with steel tools, farmers and craft workers could produce wooden containers locally and cheaply.

This technological autonomy reduced reliance on trade and led to an aceramic but materially rich household economy. The near-absence of ceramic artefacts in the Irish Iron Age has often been read as regression, yet it may instead represent a shift in

material strategy (Raftery 1994). This is one of the most persistent features cited in discussions of the 'invisible' Iron Age. Compared with the preceding 3,000 years in which pottery was widely used and frequently deposited (Raftery, 1995), the Iron Age appears strikingly aceramic, with ceramic vessels largely confined to metallurgical installations, or imported wares in the later period. This phenomenon has often been framed as anomalous, backward, or indicative of cultural isolation. However, when examined within the technological and environmental context of Iron Age Ireland, an alternative interpretation emerges: ceramics were not abandoned because of cultural loss, but because wood offered a superior, more flexible, and more sustainable material system.

In Ireland, the sources of clays suitable for pottery production has not been determined. In regions lacking good pottery clay, such as areas dominated by glacial boulder clay or thin upland soils, wooden vessels were a logical, adaptive solution (Mitchell 1986). Pottery requires resource access, skills in kiln design and build, knowledge of firing, and transport, and was thus costly and the end product fragile. The localisation of pottery making may have occurred as a result of a fall off in centralised pottery manufacture by skilled potters, resulting in the poorer quality of pots in the Late Bronze Age, as detailed by Raftery (1995).

The technological threshold required to transition from pottery to wood is not high, once appropriate tools exist. In contrast to clay, wood is ubiquitous, renewable, and geographically unconstrained. Once steel-edged tools were available, wooden vessels could be produced rapidly, repaired easily, and replaced at minimal cost. Pole lathes and related turning technologies were known long before the Iron Age. It has been shown that both flint and bronze work well with spindle and pole lathes (Woodworkers Institute, 2025), but tool efficiency depends critically on long, sharp cutting edges capable of controlled shaving and fine finishing. With even a small number of steel chisels, gouges, or knives, a household could produce bowls, plates, cups, and storage containers at a speed and consistency that rivals or exceeds ceramic manufacture. Modern turners using pole lathes, replicating the tools and methods that were available in the Irish iron age, produce large wooden bowls suitable for domestic or dairying use in under an hour using simple equipment.

Experimental archaeology has also shown that wooden vessels and structures, including stave-built containers, can fully replicate ceramic functions (Coles 1973). Stave-built containers and coopered vessels, requiring precise cutting and joining, would have flourished once steel tools became common (Kelly 2000).

The implications extend beyond domestic equipment. Agricultural infrastructure in a wood-based system can be almost entirely organic. Hurdles woven from coppiced hazel rods provide movable, reusable livestock enclosures. Fences, gates, and penning systems can be built from readily available poles. This “invisible” material culture extended to buildings and furnishings. Excavated post-built structures suggest wooden houses, fences, and enclosures (Becker *et al*. 2009; Becker 2019). Coles, Heal, and Orme (1978) list the wide array of wooden artefacts—domestic, agricultural, and transport-related—demonstrating the versatility of the various species of wood. Virtually every functional

item, from cups to carts, could be made in wood, given suitable tools. In such contexts, stone becomes a supplementary rather than primary building material, further reducing archaeologically visible residues.

The archaeological implications of this system are profound. In most Irish soils, wood decays rapidly and survives only in waterlogged, anaerobic, or exceptional conditions. Timber-built houses leave only fleeting traces—postholes, stains, shallow slots—easily missed, truncated, or erased by later activity. Wooden domestic artefacts vanish entirely, creating a false impression of material poverty where abundance had potentially existed. This preservation bias is compounded by patterns of deposition. Wooden objects are rarely deposited deliberately in the way ceramic vessels or bronze hoards may be. Instead, they are reused, repaired, and eventually recycled as fuel when their primary function ends. (The most obvious exception here is the trackways across bogs, which were situated in environments of preservation (Raftery, 1990; Gowen, 1997; Cross *et al*, 2005)). This final act of reuse leaves no recognisable artefact record. Thus, the very efficiency and sustainability of the system ensures its archaeological invisibility. Additionally, in Ireland dampness and acidic soils exaggerate this invisibility, making the Iron Age appear far poorer in material culture than it was in practice.

Recognising wood as a total material system reframes the problem of the 'invisible' Iron Age. What appears to be an absence of artefacts may instead reflect the dominance of a perishable material strategy that was both rational and resilient. In this sense, the Iron Age is not defined by what it lacks, but by what it chose to use—and how effectively that choice shaped everyday life while eluding archaeological detection.

5. Hedgerows as Agricultural Infrastructure and Resources

Importantly, the use of wood at this scale requires not merely access to trees but a cultural and practical commitment to their management. Coppicing, pollarding, and selective felling produce wood of predictable size, quality, and seasonality. The different species contributed differently to the material economy. The resulting landscape is neither wild woodland nor cleared farmland, but a managed mosaic of productive vegetation.

A crucial distinction must be made between unmanaged scrub boundaries and functioning hedgerows. Naturally regenerating shrubs or tree lines may act as visual markers, but they are not stockproof. Most hedgerows are based upon a bank and ditch principle (Hickie, 2004; Feehan, 2003), the ditch either acting as the source for the bank material, or if deeper, as a 'deer's leap' that makes the passage of animals more difficult. This can be seen in the internal ditches of the 'royal' sites of assembly. In either case the boundaries would be more effective if a hedge grew on the bank, and even more so if it was managed. To exclude livestock reliably, hedges must be deliberately laid: partially cut, bent, interwoven, and maintained as dense living barriers. Laid hedges sprout vertically from the horizontally laid stems. This process requires the woody elements of the hedgerow to be allowed to grow for several years, and thus to reach greater heights. It also requires sharp, controllable cutting tools capable of making precise incisions close

to ground level without killing the plant. Stone and bronze tools are less well suited to this task, both in efficiency and in control, partly because of their bulkiness, but also for their adverse effect on the remaining stool in reducing sprouting due to greater injury (Out *et al*, 2020). Steel-edged tools, by contrast, make hedge laying practical, repeatable, and sustainable.

The adoption of iron and early steel tools therefore has direct implications for boundary technology. Once hedge laying becomes feasible, hedgerows shift from marginal features to central components of the farming system. A laid hedge not only confines stock but regenerates valuable material. New shoots—"whips" and poles—can be harvested on rotational cycles determined by species, location, and intended use. All native Irish trees can be coppiced or pollarded, with the exception of *Pinus sylvestris* as well as those species that sucker (e.g. *Populus, Ulmus procera* type, and *Prunus*) (Rackham, 2003). Laid hawthorn, blackthorn, willow, and hazel in mixed-species hedges form dense barriers; pollards and standards of species such as wych elm, oak, and ash provide timber above the browsing line.

This continuous regeneration transforms hedgerows into linear woodlands with multiple functions and maximum access to light. Coppicing and pollarding ensures a renewable supply of straight, uniform wood of different species and size. Harvesting occurs largely in autumn and winter, when agricultural labour demands are lower and sap levels are reduced. The supply of firewood, poles, tool handles, basketry material, and repair timber, all lies within close proximity to farmsteads. Hedgerows thus act as a distributed resource store embedded within the agricultural landscape, minimising transport costs and travel time.

The presence of productive hedgerows enables smaller, enclosed field systems. Instead of large open fields vulnerable to grazing incursions, farmers can divide land into manageable units with clearly defined functions. Different crops can be spatially segregated; livestock can be grouped by age, gender, or purpose; hay meadows can be protected during the growing season; arable plots can be shielded from both domestic animals and wildlife; areas of coppice segregated from animals to allow unpredated shoot growth; and fields of pasture can be rested, mown, or grazed as required. Such subdivision improves efficiency without necessitating greater land clearance (Feehan, 2003).

This form of enclosure has further implications for land tenure and social organisation. Clearly bounded fields support more precise notions of ownership, responsibility, and inheritance. Indeed, the defining of boundaries, and thus of land ownership, appears to be a widespread phenomenon across the later Bronze Age and Iron Age in the UK and Europe as well as Ireland (Audouze and Büchsenschütz, 1991; Hill, 1995; Wells, 2007). The function of linear earthworks in Ireland has not been fully determined, but they undoubtedly represent a boundary of some kind (Raftery, 1994; Waddell, 2010; Armit, 2007).

Smaller enclosed field systems allow households to intensify management of their own resources. This reorganisation of space—driven by private management of hedged

boundaries and rotational coppice plots—could represent the formative stage of what later developed into the so-called 'Celtic' field systems. The enduring traces of these small, rectilinear enclosures, still visible in some upland landscapes of Ireland, and largely undated, may thus preserve the physical imprint of this Iron Age transition: a countryside shaped not by decline, but by innovation in both technology and land management. While this process need not imply fully privatised landholding in the modern sense, it does suggest a move away from extensive communal field systems towards more locally controlled agricultural units. This may even have been used as a move for individuals to enclose their own part of what was previously commonly held and worked land in large open field systems. Thus, individual land ownership may have become the norm, rather than land held in common, giving rise to a more organised rural landscape with greater emphasis perhaps on ownership, individuality, and possession (Cowley *et al.* 2019). This shift may represent an important precursor to the highly structured rural landscapes described in early medieval Irish law texts (Kelly, 2000). It is also entirely possible that some existing field boundaries have prehistoric origins.

Measured historic boundary networks in classic hedged landscapes (e.g. in Devon between 11–13 km/km² (Rees and Toogood, 2010); Brittany commonly between 2–10 km/km², locally higher (Aviron *et al*, 2016); and Ireland (hedgerows, stone walls, and banks) approximately 10 km/km² (Green *et al*, 2014)) are substantial, but still generally below the boundary densities implied by a fully enclosed network of 50–100 m long field boundaries, which would amount to between 22 and 42 km/km². Such field sizes are to be seen in the prehistoric field systems (mostly dated MBA to IA) in the Netherlands that were excavated in detail (Arnoldussen, 2018). If Late Prehistoric landscapes approached those enclosure scales, boundary effects on wind flow and pollen dispersal could be expected to be strong.

Such landscapes are labour-intensive, with hedgerows requiring continuous attention. Neglect leads quickly to gapping, browsing damage, and eventual failure as stock barriers. Their persistence therefore implies stable communities with sufficient labour, knowledge, and incentive to maintain them. The very presence of functioning hedgerows argues against depopulation and agricultural collapse.

When integrated with the wood-based material economy described above, hedgerows emerge as a central organising feature of Iron Age farming systems. They link tool technology to woodland management, woodland management to enclosure, and enclosure to productivity. At the same time, they play a critical role in shaping the palaeoecological record by filtering pollen and mediating the visibility of human activity.

In this sense, hedgerows help reconcile two strands of evidence that have often been treated separately: the archaeological scarcity of settlements and artefacts, and the palynological signals interpreted as reforestation or agricultural retreat. Rather than reading these signals as evidence for abandonment, they may reflect the success of a farming system that relied on managed woodlands, enclosed fields, and distributed resources—efficient in practice, but quiet in its material and ecological signatures.

6. Palynological Evidence and Interpretation

The traditional interpretation of Late Iron Age pollen records—declining cereal and open-ground species alongside an increased occurrence of woodland taxa such as hazel, oak, holly, and birch (O'Carroll and Mitchell 2017)—has long been read as evidence of agricultural decline. Yet this view may oversimplify the complexity of managed landscapes. Coppiced woods, managed hedgerows, and grazed pasture with scattered trees could all produce pollen signatures resembling natural regeneration (Mitchell 1986; Rasmussen, 1990; Chique *et al*. 2017).

From an ecological perspective, the proliferation of hedgerows alters landscape structure profoundly. Smaller fields bounded by woody barriers create a mosaic with a high edge-to-area ratio. Wind movement is disrupted, microclimates develop, and the dispersal of pollen is constrained (Auer *et al*, 2016). Hedgerows act as aerodynamic filters, capturing pollen locally and reducing long-distance transport. This effect will be greatest for grasses and cereals, whose pollen is produced later in the year when tree and shrub species are in full leaf, and even pastoral indicator taxa may be partially suppressed. The management of hedgerows further compounds this effect. Regular cutting, laying, or harvesting removes flowering material and affects pollen output in subsequent seasons (Rasmussen, 1990; Waller *et al*, 2012). Standards pollarded above browsing height continue to produce timber while limiting lower canopy flowering. The cumulative result is a landscape in which woody taxa may be well represented in pollen diagrams while the intensity of agricultural activity remains under-registered. A landscape of small hedge enclosed fields would affect hydrology giving rise to a reduction of runoff, and thus lower signals of sediment influx from lake catchments (Chique *et al,* 2017).

As a classic coppice species, the dominance of hazel (*Corylus*) in the pollen record may signal active woodland management rather than neglect. Increased oak (*Quercus*) and ash (*Fraxinus*) values could likewise indicate use in boundary planting or hedged enclosures (Kelly 2000). Thus, woodland indicators should be re-evaluated in terms of human-managed systems, especially when accompanied by low levels of cereal pollen, fungal spores associated with grazing, or microcharcoal.

Managed hedgerows and boundaries likely played a critical role in shaping the pollen signal. Allowing hedges to grow tall either as required for laying, for pollarding, or coppicing, would have reduced wind dispersal of cereal and grass pollen beyond field margins. As noted by Weir (1993), arboreal belts may act as filters, further reducing low-lying herb pollen on bog surfaces and in lake sediments. This effect, however, is unlikely to be selective as suggested by Chique *et al.* (2017). Most of the native Irish trees produce pollen in early spring when there are no leaves on the deciduous trees. Grass and cereals and other anthropogenic signal plants produce pollen later in the year, when trees and shrubs have leafed up, thereby providing effective barriers to widespread pollen dispersal. The resulting reduction in long-distance pollen transport would accentuate arboreal signals and diminish herb and cereal representation—creating an illusion of abandonment in regional diagrams despite continued agriculture.

As Coyle McClung and Plunkett (2021) showed, regional sequences often show broad woodland expansion, whereas local, high-resolution records adjacent to settlements reveal mixed economies combining grazing, tillage, and wood exploitation. These patterns support a model of ongoing land use under a regime of managed woodland and field-boundary systems—precisely the kind of environment that would accompany widespread wood utilisation and hedgerow cultivation.

7. Charcoal and Fire Use

Charcoal evidence is often used to infer land clearance and burning intensity, but its decline in Iron Age contexts has been taken too readily as a sign of reduced activity (O'Donnell, 2018). In reality, fire practices may have evolved from large-scale open burning to more controlled and localised uses—domestic hearths, small-scale clearance, and charcoal production in covered pits (Groenman-van Waateringe 1993; Chabot *et al*. 2021).

Charcoal making leaves only subtle archaeological traces. Indeed, the making of charcoal is likely to have been a suitable, if not essential, part of fuel gathering since the Neolithic period. The reduction of fallen timber in the woodlands to lengths suitable for burning indoors would have represented a major expenditure of energy. In addition, the storage of dry timber in quantities sufficient for cooking and heating would require large storage areas, probably roofed. A far more efficient way to manage fuel would be to make charcoal from long wood gathered in the woodlands, and store that. Not only does it take less space to store, but the heat generation is far more efficient with less smoke production.

If Iron Age communities increasingly relied on managed woodland for both fuel and craft, small-scale, sustainable charcoal production could have complemented coppicing systems. This approach aligns with a model of resource efficiency that also supports metallurgical work (Pleiner 2000; Tylecote 1986). It might also be that the distal areas of unmanaged woodland and forest, as opposed to more proximal sources of wood, were utilised for functions such as charcoal production, as well as hunting, and pannage. A significant quantity of charcoal was required to smelt iron ore (Crew, 1991).

The apparent reduction of charcoal layers in Iron Age deposits does not necessarily imply less burning. Microcharcoal analyses show that low-intensity, continuous fire use—typical of household maintenance or craft work—produces minimal macro-charcoal yet leaves consistent microscopic traces (Blackford 2000). Recent high-resolution sediment studies (Chique *et al*. 2017) demonstrate that such subtle fire signatures persist even where open burning declines.

Multidisciplinary work that has combined micromorphology, phytolith analysis, and charcoal fragment studies with experimental reconstructions of Iron Age fuel use, has clarified comparable low-intensity fire systems elsewhere in Europe and could do so in Irish contexts (Braadbaart *et al*, 2017).

8. Functional Palaeoecology and Multi-Proxy Approaches

If the Late Iron Age “lull” in Ireland reflects a reorganisation of land use and material practice rather than a decline in activity, then this proposition must be testable using appropriate methodological frameworks. The challenge lies not in a lack of evidence, but in extracting meaningful signals from landscapes structured in ways that suppress conventional archaeological and palynological visibility. Addressing this challenge requires a shift from species-based interpretation toward functional and landscape-scale approaches (Fyfe *et al*, 2025).

Functional palaeoecology provides a particularly appropriate framework for evaluating the model proposed here. Rather than treating pollen taxa simply as indicators of presence or absence, a functional approach characterises plants according to traits that influence how they are managed, harvested, and expressed in the pollen record. These traits include growth form, woodiness, shade tolerance, coppice or pollard response, pollen productivity, flowering phenology, grazing tolerance, and suitability for use in hedgerows or boundary planting.

By assigning such traits to taxa identified in pollen diagrams, it becomes possible to explore how different landscape organisations would be expected to express themselves palynologically. For example, a landscape dominated by unmanaged regenerating woodland would differ functionally from one composed of stock-proof hedgerows, coppice rotations, pollards, and enclosed grassland, even if the same tree species were present in both. The key distinction lies not in species composition alone but in structure, management intensity, and spatial configuration (Sugita, 2007; Gaillard *et al,* 2010) and crucially requires a consideration of landscape heterogeneity (Tonetti *et al*, 2023).

By using a functional framework pollen analysis can be approached in reverse. Rather than assuming a direct correspondence between pollen assemblages and land use, it is increasingly recognised that similar pollen signals can arise from very different landscape configurations, depending on structure, spatial patterning, and management intensity (Birks and Birks, 2006; Bunting and Middleton, 2009; Gaillard *et al*, 2010). This inversion enables explicit hypothesis testing. Certain landscape configurations—such as extensive abandonment or wholesale reforestation—can be modelled and compared against scenarios that incorporate intensive hedgerow management, small enclosed fields, seasonal harvesting, and suppressed flowering. Implausible scenarios can then be rejected, while consistent ones remain viable.

Phenology plays a critical role in this process, as does seasonal management practices, further modifying pollen production. Wood management with harvesting in the winter reduces spring pollen output; mowing of hay meadows (traditionally undertaken before flowering and lignification) prevents grass flowering altogether. Functional palaeoecology allows these processes to be incorporated explicitly rather than treated as noise or minor corrections.

Landscape scale must also be considered. Small, enclosed fields bounded by hedgerows increase edge density and reduce pollen dispersal distances. Field size, boundary length,

and the proportion of arable, pasture, and managed woodland interact to shape pollen spectra. These factors cannot be inferred directly from pollen percentages alone, but they can be explored through scenario modelling that integrates ecological theory, experimental data, and spatial assumptions. Archaeologically in Ireland, apart from examining pre-bog walls, few resources have been directed to the full understanding of prehistoric field systems - these have been analysed quite thoroughly in the Netherlands (Arnoldussen and van der Linden, 2017; Arnoldussen, 2018; 2021) - and this is an area that may contribute useful data.

Because pollen is only one proxy for plant presence, a multi-proxy approach is essential. Sedimentary ancient DNA (sedaDNA) is particularly valuable in contexts where pollen visibility is suppressed. Unlike pollen, sedaDNA can derive from plant tissues such as seeds, chaff, roots, straw, and leaves, allowing the detection of cereals and other cultivated plants even when flowering was limited or absent (Parducci *et al*. 2017; Giguet-Covex *et al*. 2019). In managed landscapes where harvesting and mowing prevent pollen release, sedaDNA may provide the most direct evidence for continued agricultural activity.

Additional proxies further strengthen interpretation. Microcharcoal analysis can distinguish between large-scale clearance fires and low-intensity, continuous burning associated with domestic hearths, craft activities, or controlled fuel use (Whitlock and Larsen, 2001). Phytolith analysis may capture grasses and cereals under-represented in pollen records (Ball *et* al, 2016; Hermans *et al*, 2025), while non-pollen palynomorphs, including coprophilous fungal spores, can provide independent indicators of grazing pressure and stock presence (Shumilovskikh and van Geel, 2020; Gauthier and Jouffroy-Bapicot, 2021). When integrated with high-resolution chronological frameworks, these proxies allow changes in land management to be tracked over sub-centennial timescales.

Importantly, the model outlined here is falsifiable. If Late Iron Age landscapes were genuinely characterised by agricultural abandonment or drastic population decline, then independent proxies should converge on that interpretation. SedaDNA should show diminished crop presence; functional trait assemblages should favour unmanaged woodland structures; charcoal records should indicate reduced fuel use; and evidence for systematic woodland management should be absent. Conversely, if agriculture persisted within enclosed, hedge-dominated landscapes, then functional signatures of management should be detectable even where pollen percentages remain low.

This approach reframes the role of palaeoecology in Iron Age studies. Rather than serving solely as a descriptive archive of vegetation change, palaeoecological data become tools for evaluating socio-ecological systems. By integrating functional traits, landscape modelling, and multiple proxies, it becomes possible to distinguish between genuine land-use decline and shifts toward low-visibility, intensively managed systems.

9. Discussion

The evidence reviewed in this paper invites a fundamental reassessment of how the Irish Iron Age landscape has been interpreted through both archaeological and palaeoecological records. Traditional readings of pollen decline, reduced cereal representation, diminished charcoal signals, and low artefact densities have tended to converge on explanations framed around demographic contraction, agricultural retreat, or socio-economic stagnation. What emerges from the synthesis presented here is a different picture: one in which visibility, rather than activity, is the variable that changes most profoundly.

Central to this reinterpretation is the recognition that technological change—specifically the widespread availability of iron and early steel tools—enabled a reorganisation of land use and material practice that left fewer durable traces. These developments provide a coherent explanation for the aceramic character of the Irish Iron Age, the scarcity of metal artefacts, and the ephemeral nature of settlement remains.

At the landscape scale, the consequences of this reorganisation are especially significant. It can be expected that not all the proposed factors applied together at every place, nor consistently through time. The variation within the archaeological, and more particularly the palaeoecological, records demonstrate how different aspects may or may not have been applied, both regionally and across time. Ireland has a wide range of geographies and topographies, and changes can be expected to have taken place at different rates in various places. Underpinning this is the principle that landscape management and organisation lies at the very heart of an agriculturally dependent society.

The proliferation of high hedgerows as functional agricultural infrastructure—rather than as incidental scrub or unmanaged woodland margins—would have produced a countryside characterised by high boundary density and small field units. Modelling suggests that small enclosed fields, as could be expected from small household managed farm holdings, would result in boundary densities that would have profound aerodynamic and ecological effects, reducing wind fetch, fragmenting pollen dispersal pathways, and increasing the local retention of pollen within field compartments. Management of coppice, hedges, and meadows would all reduce pollen production at source. The phenological separation between early-flowering arboreal taxa and later-flowering grasses and cereals further accentuates this effect, allowing woodland taxa to dominate pollen assemblages even in actively farmed landscapes.

Charcoal records tell a similar story. The apparent reduction in macro-charcoal during the Iron Age has been read as evidence for declining burning activity or reduced woodland exploitation. Yet experimental and microstratigraphic studies demonstrate that low-intensity, continuous fire use—typical of domestic hearths, craft production, and small-scale charcoal manufacture—produces minimal macro-charcoal while leaving consistent microcharcoal signatures. A shift away from large-scale clearance burning toward controlled fuel use within managed woodlands would therefore be expected to reduce the archaeological visibility of fire without diminishing its importance within

everyday life. In a system reliant on charcoal for both domestic heating and ironworking, such practices represent efficiency rather than decline.

The social implications of this model are important. A landscape structured around small, enclosed fields and managed boundaries implies a high degree of household-level control over production, labour, and resources. Such systems suggest communities capable of sustaining complex management regimes across generations. This could indicate a move away from extensive communal field systems toward more localised, clearly bounded units of use and responsibility. In this respect, the Iron Age landscape may represent an important precursor to the highly structured agricultural and legal frameworks documented in early medieval Ireland. Importantly, this reinterpretation does not deny change across the Iron Age–Early Medieval transition. Rather, it offers a mechanism that allows dramatic alteration of the visibility of agriculture without requiring abrupt changes in population or effort.

The model proposed here is deliberately framed as falsifiable. If Late Iron Age Ireland was characterised by genuine agricultural collapse or demographic contraction, then independent proxies should converge on that interpretation. Conversely, if farming persisted within enclosed, hedge-dominated landscapes, functional signatures of management should be detectable even where traditional pollen indicators remain muted. The methodological framework in combining functional palaeoecology with sedaDNA, microcharcoal, phytoliths, and non-pollen palynomorphs provides a pathway for testing these alternatives explicitly. Rather than asking whether agriculture was present or absent, future work can ask which landscape configurations are capable of producing the observed palaeoecological signals.

10. Conclusion

This paper has argued that the apparent “lull” in the Irish Late Iron Age is better understood as a problem of visibility rather than of lack of activity. The combined archaeological and palaeoecological record does not require an explanation rooted in demographic decline or agricultural regression if technological change, material choice, and landscape structure are treated as active mediators of what survives and what is detectable. When these factors are taken seriously, the Late Iron Age record appears consistent with continuity of farming and settlement organised in ways that produced fewer durable traces.

The model proposed here emphasises the consequences of iron-enabled woodworking, perishable material economies, and densely bounded agricultural landscapes. Together, these factors provide a coherent mechanism by which settlement evidence, artefacts, pollen, and charcoal could all appear attenuated without implying collapse. In this context, muted palaeoecological signals and ephemeral archaeological remains are not anomalous but expected outcomes of a land-use system optimised for local resilience and low material redundancy.

More broadly, this study highlights the need to distinguish between absence and invisibility in long-term landscape histories. It demonstrates that changes in how land is

organised and managed can profoundly reshape environmental and archaeological proxies, independent of changes in population or productivity. Recognising this distinction allows the Late Iron Age to be re-situated as a period of adaptive reorganisation rather than failure, and it underscores the value of integrating functional palaeoecology with archaeological interpretation when confronting similarly “quiet” periods elsewhere.

From this perspective, the so-called “Late Iron Age Lull” can be understood as an artefact of interpretative frameworks that assume relatively open landscapes and direct proportionality between activity and visibility. This paper highlights how technological change, material choice, and landscape organisation can conspire to render successful systems archaeologically quiet. By foregrounding wood as a total material system, and with landscape structure taken seriously as an intervening variable, the pollen record appears less as a straightforward indicator of land-use intensity and more as a reflection of how land was organised, bounded, and managed. Seen in this light, the Late Iron Age “lull” represents an opportunity rather than a problem. It highlights the limits of traditional interpretative frameworks and underscores the need for methodologies capable of detecting quiet, sustainable, and highly managed agricultural landscapes. Functional palaeoecology, combined with emerging molecular and microscopic techniques, offers a pathway toward resolving one of the most persistent interpretative challenges in Irish later prehistory.

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