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LITTLE HOUSE ON THE HILL: NEW CHRONOLOGIES FOR UPLAND SETTLEMENT AND LAND USE IN 2ND MILLENNIUM BC SCOTLAND

Thesis submitted for the degree of
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Abstract

This thesis uses Bayesian modelling and radiocarbon dating to develop refined, precise chronologies for upland settlement in Scotland north of the Forth/Clyde line in the 2nd millennium BC. In the course of this research, 73 new radiocarbon dates were produced, 32 from archival charcoal samples (sourced from the archive of the Lairg Project [1988–1996]), 41 from peat sampled from the Allt na Fearna quarry site, Achany Glen, Sutherland. Further chronological models for seven additional Bronze Age settlement sites were produced using published or publicly available dates.

The results of this research update current narratives for Bronze Age settlement in Scotland. It is generally held that settlement expansion or intensification in this period occurred notably in upland areas. The chronologies produced during the course of this research indicate that settlement expansion occurred at both upland and lowland sites after c.1700 cal BC, with a decline in settlement activity again seen at both upland and lowland sites in the late 2nd/early 1st millennium BC. Potential drivers behind settlement intensification and decline – climatic shifts and social and economic change – are explored. Individual roundhouses appear to have been in use for only a generation or so before being abandoned. This has implications for existing narratives for settlement in Scotland (and potentially further afield) in the Bronze Age.

Additionally, a potential old wood effect was observed in legacy dates from bulk charcoal samples, and potential issues were also identified with legacy palaeoenvironmental chronologies. Going forward it is suggested that archaeological and palaeoecological chronologies based on uncritically accepted legacy dates should be treated with caution.

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Chapter 1: Introduction

1.1 The research: broad context and key questions

The Bronze Age in Britain is often characterised as a time of change. In the course of the period (c.2200/2150–800 BC) there is a shift in the archaeological record from a landscape dominated by monumentality and mortuary archaeology, with relatively slight evidence for settlement or domestic activity, to one of highly visible settlement sites and agricultural remains, and with a corresponding decline in monuments and funerary sites.

Accompanying this narrative of intensification of settlement and agriculture from the Middle Bronze Age is the idea that settlement expansion was particularly notable in upland areas, far above the modern limit of settlement and cultivation. The remains of roundhouses and field systems can be seen across upland parts of Britain, from the Dartmoor reaves in south-west England, to sites across Highland Scotland. Explanations for the apparent proliferation of high-altitude settlement in the 2nd millennium BC often link this phenomenon to broader narratives of expansion of settlement and agriculture – settlement being 'pushed' uphill, to allow growing populations or emergent societal elites to maximise agricultural yields from fertile lowland areas.

However, chronologies for Bronze Age upland settlement, especially in Scotland, are heavily based on a handful of 'type-sites', some with substantial numbers of radiocarbon dates (e.g. Lairg, Sutherland [McCullagh & Tipping, 1998] and Tormore, Arran [Barber, 1997]), but also some with chronologies based on a limited number of radiocarbon determinations (e.g. Kilearnan Hill, Sutherland and Lintshie Gutter, Peebleshire). The majority of sites on which chronologies for upland settlement in Bronze Age Scotland are based were excavated in the later 20th century, prior to the routine practice of AMS dating of single-entity samples. Not only are these dates less precise than those produced through modern dating programmes, but as they are generally derived from bulk charcoal samples there is the potential issue of an old wood effect (Ashmore, 1999), potentially resulting in chronologies which are too early.

The often-large uncertainties associated with legacy radiocarbon dates have also resulted in 'fuzzy' chronologies for upland settlement, an issue common to prehistoric archaeology more generally. Elongated radiocarbon chronologies give the impression of a kind of timeless prehistory, with change occurring slowly, at a scale far beyond a human lifespan, removing any sense of the agency or actions of individual people in prehistory. Loose chronologies also lead to vague interpretations as to the drivers of the change seen in the archaeological record over the 2 course of the Bronze Age and make it difficult to understand the character of settlement in this period. The use of Bayesian statistical modelling to construct archaeological chronologies allows for the production of precise, generational-level chronologies. This facilitates the construction of nuanced narratives for archaeological phenomena and allows us to explore how sites were used at the level of an individual human lifetime.

This thesis uses Bayesian modelling of new and legacy dates from a key type-site for Bronze Age upland settlement in Scotland (Lairg, Sutherland, [McCullagh & Tipping, 1998]), with supporting information from new palaeoenvironmental reconstructions from Lairg and new chronological models for a selection of supplementary sites, to explore the timing, nature and possible causes behind the apparent expansion of settlement activity seen in upland areas in this period.

There are four considerations core to this research:

- When any intensification in upland settlement took place. Are there differences in the chronologies of upland and lowland sites? Has preservation bias in the archaeological record led to a skewed focus on upland areas?
- Why did any expansion/intensification of upland settlement occur? Can chronologies produced through Bayesian modelling of new and legacy radiocarbon dates allow us to correlate settlement activity with environmental or social phenomena?
- How were Bronze Age settlement sites used? How were individual buildings used, and what patterns of settlement and land-use did they constitute?
- How accurate are the legacy chronologies on which current narratives for Bronze Age settlement are based? Is there an old-wood effect inherent to dates from bulk charcoal samples? If so, what are the implications for prehistoric chronologies more widely?

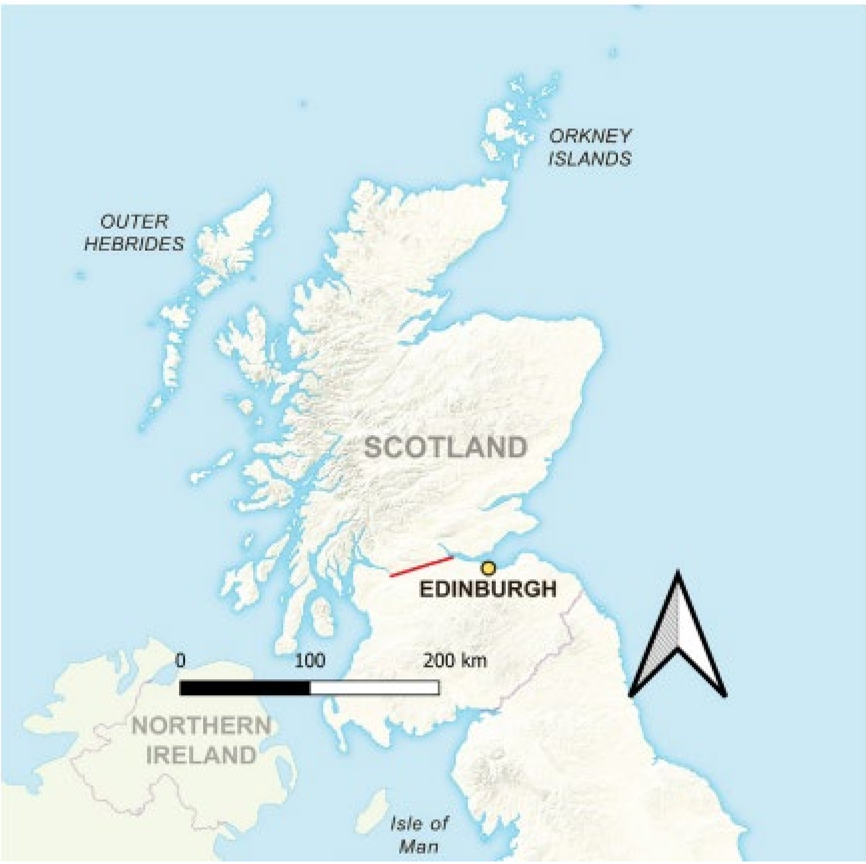

Figure 1: Map showing Scotland. Only sites north of the Clyde/Forth line (shown in red) were included in this research.

The study area for this research is mainland Scotland, north of the Clyde-Forth line (see Figure 1). Scotland is proportionally over-represented in terms of evidence for Bronze Age settlement (Caswell, 2020), and the range of landscape types present in this northern part of Scotland – low lying, fertile agricultural land and exposed upland sites – allow us to explore any differing dynamics between settlement at upland and lowland sites within a relatively tightly defined area.

1.2. Chapter breakdown

The chapters of this thesis address the key questions shown above, detailing strands of the research programme, before attempting synthesis of the results and literature, building a new narrative for Bronze Age upland settlement in Scotland.

- Chapter 2 constitutes a review of the archaeological literature pertaining to Bronze Age settlement, in Britain more widely and mainland Scotland specifically, expanding on the themes briefly outlined above. This chapter provides context for the research detailed in Chapters 4–7.

- Chapter 3 contains a brief review of the literature on radiocarbon dating and Bayesian chronological analysis, outlining the advantages of using Bayesian statistical modelling to construct archaeological chronologies.
- Chapter 4 details the overarching methodology of the research programme, as well as providing more granular detail of the various techniques used in the course of this research: archival research and sample selection for radiocarbon dating; radiocarbon dating of charcoal and peat samples; pollen analysis, and loss on ignition.
- Chapter 5 begins with an overview of the key case study site in this research: Lairg, Sutherland. The Lairg Project (1988–1996) was a large-scale programme of survey, excavation and palaeoenvironmental reconstruction, centring on the excavation of eight Bronze Age roundhouses at the Allt na Fearna quarry site, Achany Glen, Sutherland. The site was extremely well-dated for its time, and re-examination of the Lairg Project archive has been core to this research. Archival samples were used as the basis of a new dating programme, on which new chronologies for Bronze Age settlement at the Allt na Fearna site have been based. In this chapter, the new Bayesian chronologies for the roundhouses at the site are detailed and discussed. Analysis of legacy and new dates from the same contexts is used to test the reliability of chronologies based on legacy dates from bulk charcoal samples.
- Chapter 6 details new palaeoenvironmental reconstructions from the Allt na Fearna site, updating legacy palaeoenvironmental reconstructions and aiming to provide context for settlement activity at the site.
- Chapter 7 details and discusses newly developed Bayesian chronologies from seven additional supplementary sites, based on published/freely available radiocarbon dates. Three of these sites are in lowland locations, four in upland areas (>100m OD, after Pope [2015]). This allows for comparison of the timing of Bronze Age settlement expansion/intensification in upland and lowland areas – whether there any differences between uplands and lowlands, and if expansion/intensification was reserved to upland areas.
- Chapter 8 discusses the findings of Chapters 5–7 in the context of the literature, constructing a new narrative for Bronze Age settlement in Scotland and exploring potential drivers of settlement expansion/intensification in the 2nd millennium BC.
- Chapter 9 concludes the thesis, summarising the findings of this research, reflecting on challenges and setting an agenda for future research in this area.

Chapter 2: Archaeology Literature Review

2. 1 Introduction

This chapter outlines and discusses narratives of and factors germane to land use and settlement in Scotland in the 2nd millennium BC. This falls within the period generally defined in British archaeology as the Bronze Age (c.2200–800 BC). This period is often characterised as one of social and economic change, with a shift from a landscape defined by monuments and only ephemeral evidence for human settlement, to one where settlement, enclosure and agriculture were highly visible.

The focus of this section will be on mainland Scotland, although where appropriate evidence from or narratives for Britain more widely will be discussed. Although the focus of this thesis is on the Scottish mainland, some evidence from the Northern and Western Isles will be discussed in this section. The Northern and Western Isles have been the focus of sustained research into prehistoric settlement and monumentality (e.g. Card *et al.*, 2020; Parker Pearson, 2012), and archaeological record for these regions differs from that of the mainland in terms of the visibility of different periods.

In this chapter, and throughout this thesis, the chronological scheme laid out in the Scottish Archaeological Research Framework (ScARF) Bronze Age Panel Report (2012) is used (although the 'earliest Bronze Age' described therein is here subsumed into the Early Bronze Age). In that document, a Chalcolithic is defined as spanning the 25th–22nd centuries BC, the Early Bronze Age from the 22nd century BC to c.1700/1600 BC, the Middle Bronze Age from c.1700/1600 BC to the 12th century BC, and the Late Bronze Age lasting from the 12th century BC to the 8th century BC. Dates are reported as they have been published; in this chapter cal BC/AD, BC/AD and BP (before present, with 'present' being AD 1950) are all used. Where any of these expressions appears in lower case, this is in reference to an uncalibrated radiocarbon determination.

The chapter begins with an overview of climatic and environmental trends in Neolithic and Bronze Age Scotland as they are currently understood and considers potential links between climatic shifts and changes in settlement and land use, with a particular focus on the pollen record. The concept of resilience in the context of climate change is explored, with reference to examples in the archaeological and palaeoenvironmental records for these periods.

The chapter then moves on to discuss societal changes in the later 3rd millennium BC, by way of offering background information for discussion of the Bronze Age. The formation, from the Chalcolithic onwards, of wide-ranging exchange networks based on metal technology is touched upon.

The focus then shifts to the settlement record. First, settlement evidence from the Neolithic, Chalcolithic and Early Bronze Age is considered, before more in-depth discussion of narratives of settlement and land use in the Middle and Late Bronze Age, including a proposed retreat from upland areas at the very end of the Bronze Age. Finally, areas identified for further exploration are identified.

2.2 Climate and environment in the Neolithic and Bronze Age

2.2.1 Neolithic and Bronze Age climate change affecting Scotland: an overview

Scotland is well-served by palaeoenvironmental and palaeoclimatic proxies (Edwards, 2004; Edwards *et al.*, 2019; Tipping *et al.*, 2013). The archive provided by extensive peat bogs allows for the reconstruction of past landcover through pollen analysis, and for the exploration of climatic conditions through proxies such as testate amoeba, used to reconstruct water tables and therefore climatic shifts. Scotland's climatic and environmental conditions are closely linked to those of the north Atlantic (Bond *et al.*, 1997; Tipping *et al.*, 2013), and ocean circulation, along with solar activity, is a key factor behind climatic fluctuation (Brown, 2008). Additionally, the Irish Crag Cave speleothem provides an annually resolved climatic proxy for the wider region, and numerous paleoenvironmental and palaeoclimatic investigations have been carried out at peat bogs in mainland north-western Europe, a region also affected by conditions in the North Atlantic.

Climate change is often linked, in the archaeological literature, to socio-economic change. In British archaeology, this strand of thought has its roots in Parry's (1978) work on upland settlement and climate change in the uplands of southern Scotland. While narratives based on rather simplistic causal links between past climate change and human activity fell out of fashion during archaeology's post-processual turn, more recently research into the links between climate and societal changes has proliferated. There has been a particular focus on 'big data' studies using, for example, summed probability distributions of radiocarbon dates as a proxy for population, in order to explore issues of resilience and collapse (e.g. Bevan *et al.*, 2017; Colledge *et al.*, 2019; McLaughlin *et al.*, 2016; Stevens & Fuller, 2012; 2015; Stolze & Monecke, 2021; Woodbridge *et al.*, 2021; Whitehouse *et al.*, 2014).

While conditions in the early Neolithic are thought to have been relatively warm, dry and favourable to agriculture – Bonsall *et al.* (2002) have linked the uptake of agriculture to climatic amelioration – there is evidence for climatic downturn in the Middle/Late Neolithic. Several studies from across Europe (e.g. Magny, 2004; Magny & Haas, 2004; Mauquoy *et al.*, 2008), Ireland (Barber *et al.*, 2003; Caseldine *et al.*, 2005; Langdon *et al.*, 2012), and northern England (Barber *et al.*, 2003; Hughes *et al.*, 2000) indicate a shift to cooler/wetter conditions around the mid-4th millennium BC.

A '4.2ka event', a cooler/wetter phase immediately preceding the Bronze Age, with societal impacts across Europe and the Near East (Bond *et al.*, 2001; Kleijne *et al.*, 2020; Weiss, 2016), has been proposed. Analysis of multiple climate proxies from sites across the globe indicates a cooling trend at c.4200–3800 BP (Mayewski *et al.*, 2004), although evidence that this was experienced in Britain is disputed (Roland *et al.*, 2014). Proxy evidence from north Atlantic palaeoclimatic records is somewhat inconclusive (Bradley & Bakke, 2019; Moros *et al.*, 2004).

However, there is evidence for increased alluvial activity, suggesting flood events, c.4300–4000 BP (Johnstone *et al.*, 2006), and Crag Cave speleothem records indicate a cooling event at c.4200 BP (McDermott *et al.*, 2001). This is matched by proxy temperature records from Greenland ice core archives (based on ^{18}O measurements), showing cooler temperatures in the north Atlantic at around this point in time (Vinther *et al.*, 2009). Sediment cores from locations across the north Atlantic also show evidence of cooler temperatures (increased transport of sediment between locations, caused by 'ice rafting') at c.4200 BP (Bond *et al.*, 1997). At a more local level, records of bog surface wetness (BSW) from Cumbria (Barber *et al.*, 1994; Hughes *et al.*, 2000), Ireland and North Wales (Blackford, 2000) indicate wetter shifts at c.4000 BP/4100 BP. BSW records are essentially reconstructions of past water tables, indicating increased/reduced evapotranspiration linked to either temperature, precipitation, or both factors (Barber, 2007). In Scotland, there is evidence that water tables were relatively high at c.2500–2200 BC (discussed in Tipping *et al.*, 2013).

Analysis of the Irish Crag Cave speleothem records indicates increasing average temperatures through the 2nd millennium BC (by c.2°C) (McDermott *et al.*, 2001; discussed in Woodbridge *et al.*, 2021). Pollen-based temperature reconstructions from Finland, which, like Scotland, has a climate affected by conditions in the North Atlantic, also provide evidence for generally increasing summer temperatures through the 2nd millennium BC until a dramatic drop in the early centuries of the 1st millennium BC (Seppa & Birks, 2001). BSW proxies from British sites indicate stable or reduced water tables in roughly the first half of the 2nd millennium BC (Anderson *et al.*, 1998). There is some evidence that the mid-2nd millennium BC saw increasing BSW (Barber *et al.*, 1994; Charman, 2010; Tipping *et al.*, 2013), although proxies directly linked to temperature do not indicate a cooling trend around this time (Charman, 2010). Drier conditions are thought to have resumed at c.1200 BC (Brown, 2008), and Irish records potentially indicate that the final centuries of the 2nd millennium BC were relatively warm and dry (discussed in Gearey *et al.*, 2020; Swindles *et al.*, 2010).

A cooler/wetter shift at c.800 cal BC is well-attested to in the palaeoclimatic literature, thought to be linked to reduced solar activity (discussed in Brown, 2008; Martin-Puertas *et al.*, 2017; Mauquoy *et al.*, 2004; van Geel *et al.*, 1996). Reconstructions of solar irradiance based on ^{14}C measurements from the global tree ring record and ^{10}Be measurements derived from ice cores from Greenland and Antarctica support this, with a dramatic decline in solar irradiance observed at c.800 cal BC (Steinhilber *et al.*, 2012). This is mirrored in the Crag Cave speleothem data, with average temperatures declining in the early 1st millennium BC (McDermott *et al.*, 2001, discussed in Woodbridge *et al.*, 2021). A peak in north Atlantic ice rafting has been observed at c.2800 BP (Bond *et al.*, 1997), indicating cooler ocean temperatures. Increased BSW across wetland sites in the Netherlands has been dated to c.850–760 cal BC (Blaauw *et al.*, 2004; van Geel *et al.*, 1996; van Geel *et al.* 1998a; van Geel *et al.*, 1998b), interpreted as reflecting the onset of cooler, wetter conditions in north-west Europe. Similar shifts have been observed at sites across continental northern Europe (Barber *et al.*, 2004; Mauquoy *et al.*, 2004; Mauquoy & Yeloff, 2008), and also at sites in Ireland (Plunkett, 2006; 2009; Swindles *et al.*, 2007), northern England (Barber *et al.*, 1994; Hughes *et al.*, 2000; Yeloff *et al.*, 2007) and Scotland (Blundell & Barber, 2005; Chambers *et al.*, 1997; Charman, 1994a, 1994b, 1995). Chironomid-based temperature reconstructions from mires in Ireland (Taylor *et al.*, 2018) and northern England (Langdon *et al.*, 2004) indicate shifts towards cooler temperatures at c.800 cal BC.

2.2.2 The role of resilience

Although simplistic correlations between human behaviour and environmental conditions should not be drawn, the ways in which people are able to use and inhabit landscapes are inevitably affected by climatic conditions (c.f. Berglund, 2001). Correlations have been made between climatic shifts and widespread changes in archaeological and palaeoenvironmental records across north-west Europe (Berglund, 2001), and Scotland specifically (Tipping *et al.*, 2013).

In terms of the climatic shifts discussed above, the climatic decline observed in the mid-4th millennium BC has been linked to a corresponding agricultural decline. It has been suggested that, following an initial uptake of arable agriculture in Britain and Ireland in the Early Neolithic (seen in evidence for woodland clearance and cereal pollen in palaeoenvironmental records from this period), from c.3600 to c.2450 BC, evidence for cereal production declines and woodland regeneration took place, indicating a potential decrease in population (Bevan *et al.*, 2017; Bradley, 2007; 2019; Colledge *et al.*, 2019; McLaughlin *et al.*, 2016; Stevens & Fuller, 2012; 2015; Stolze & Monecke, 2021; Treasure *et al.*, 2019; Woodbridge *et al.,* 2014; Woodbridge *et al.*, 2021; Whitehouse *et al.*, 2014).

Several of the studies referenced above are based on summed probability distributions (SPDs) of radiocarbon dates. Stevens and Fuller (2012; 2015) based their analyses on dates from carbonised cereal grains from archaeological contexts. While SPDs of radiocarbon dates are commonly used as a demographic proxy, the potential issue of bias caused by the differing relative visibility of various practices at different points in the past; biases in research activity, and taphonomic processes have been raised (Torfing, 2015; Williams, 2012). Additionally, there is some evidence that the SPD trends can be influenced by the radiocarbon calibration curve (Bamforth & Grund, 2012; Williams, 2012). Griffiths (2022) has noted that this approach can obscure what she refers to as the 'warrants' – the contextual information underpinning the validity of a given chronological determination – of legacy datasets.

Beyond wider critiques of SPDs, studies based on large datasets have been criticised on the basis that they obscure more nuanced or localised trends. For example, while Stevens & Fuller (2012; 2015) argued for a decline in cereal production in Britain in the later Neolithic, Bishop (2015) noted that evidence from Scotland was not well-represented in Stevens & Fullers' analyses and disputed that a dramatic decline in later Neolithic cereal production occurred there. Instead, communities in areas marginal for cereal cultivation, such as northern Scotland, may have been insulated from the impacts of climatic deterioration by an existing reliance on barley (rather than wheat). Barley is more tolerant of cool, wet conditions than wheat, providing these communities with an inbuilt resilience in the context of climatic decline (Bevan *et al.*. 2017; Bishop *et al.*. 2009; Bishop 2015; Colledge *et al.*. 2019; McDonald *et al.*, 2021; Stevens and Fuller 2015). Recent palaeoenvironmental evidence from Lairg supports this hypothesis (see Chapter 6; McDonald *et al.*, 2021).

In a similar vein, the cooler/wetter shift observed in paleoclimatic proxies at c.800 BC has frequently been linked to a decline in upland settlement across Britain (Amesbury *et al.*, 2008; Barclay, 2005a; Barber, 1997; Barber and Brown, 1984; Burgess, 1984; 1985;

Champion, 2009; Cowley, 1998; Turney *et al.*, 2016) and to the restructuring of societies across north-west across Europe (van Geel *et al.*, 1996; van Geel *et al.* 1998a; van Geel *et al.*, 1998b; van Geel & Berglund, 2000). While changes in the archaeological record in the Late Bronze Age appear to indicate a shift in settlement patterns in Scotland (discussed further in Chapters 5, 7 and 8 of this thesis), there is little evidence from the pollen record for wholesale land abandonment of the sort discussed by authors such as Burgess (1984; 1985).

Instead, analyses of pollen records from this period from across Britain generally indicate that an open landscape persisted, with no widespread reforestation (Dark, 2006; Tipping, 2002 for discussion in a Scottish context). Pollen reconstructions from Rogart, Sutherland, indicate that a restructuring of land use, rather than abandonment, took place, with an increased focus on pastoral agriculture, particularly in the uplands (Tipping *et al.*, 2008a). This was interpreted as reflecting the resilience of local communities, adopting adaptive land use strategies (*ibid.*). Continuity of land use throughout the climatic decline of the Late Bronze Age was also observed in the 1990s pollen reconstructions from Lairg (McCullagh & Tipping, 1998; Smith, 1998).

Stevens & Fuller (2015) identify a Late Bronze Age population 'bust' around this point in mainland Britain (although the caveats outlined above regarding SPD studies stand). However, Armit *et al.* (2014) dispute a causal link with climatic deterioration, as according to their analyses populations in Ireland, at least, were in decline prior to the onset of cooler, wetter conditions. The chronological resolution of palaeoenvironmental and palaeoclimatic records generally offers less precision than that of the archaeological record, with chronologies based on a relatively limited number of dates. This problematises defining links or relationships between trends observed in either. Additionally, BSW is not a quantitative proxy – it offers an insight into changes in evapotranspiration, affected by both temperature and precipitation (discussed in e.g. Brown, 2008; Gearey *et al.*, 2020), and we cannot extrapolate information about possible changes to growing seasons, agricultural yields, or indeed the weather conditions experienced by contemporary populations from BSW records (c.f. Kleijne *et al.*, 2020; Gearey *et al.*, 2020). There are discrepancies between narratives of climate-change induced demographic crises and land abandonment, and pollen records indicating a more nuanced picture (e.g. Dark, 2006; Gearey *et al.*, 2020; Tipping *et al.*, 2008a).

Chronological issues notwithstanding, the archaeological and especially the palaeoenvironmental records for Neolithic and Bronze Age Scotland provide ample evidence of resilience in the face of climatic changes. Cooler, wetter shifts would have acted as an external stressor for communities, increasing their vulnerability to crop failures and making it less likely that they would be able to meet their own basic subsistence needs, let alone generate a surplus (Armit, 1998). Acknowledging the role of environmental conditions in defining the parameters of choices available to prehistoric societies is not necessarily deterministic; there is scope to look for evidence of agency and resilience in the relationship between people and their environments in the past (Tipping, 2002; Tipping *et al.,* 2013; Tipping & Tisdall, 2004).

The concept of resilience in archaeology (as outlined by Redman & Kinzig, 2003; Redman, 2005) allows us to explore this relationship in terms of societal adaptation, and can provide a counterpoint to narratives foregrounding environmental change as a driver of societal collapse (c.f. Butzer, 2012; Middleton 2012; 2017). Some socio-economic systems are more resilient than others – this can be seen in the examples described above, where a pre-existing reliance on barley over wheat may have functioned as an adaptive measure mitigating the impact of later Neolithic climatic deterioration. Flexibility has been suggested as a factor promoting resilience (Butzer, 2012; Kleijne *et al.*, 2020), seen in the preference for pastoral agriculture in the uplands of Sutherland in the context of cooler, wetter conditions in the Late Bronze Age (Tipping *et al.*, 2008a). Flexibility is also evidenced in Neolithic and Early Bronze Age middens and soils from Tofts Ness, Sanday, Orkney and Jarlshof, Shetland. Midden deposits indicated exploitation of a broad range of marine and terrestrial food sources, protecting against crop failure (Dockrill & Bond, 2009), while analysis of buried soils provided evidence for enrichment with midden material, replacing nutrients reducing the impacts of wind erosion (Dockrill & Bond, 2009; Simpson, 1998).

2.3 Bronze Age beginnings: social and economic change in the later 3rd and earlier 2nd millennium BC

2.3.1 Metal, migration and monumentality in the later 3rd millennium BC

The adoption of metal technology was relatively late in Britain. Unlike other parts of Europe which experienced a defined Chalcolithic (or Copper Age) between roughly the 5th and the 3rd millennium BC, copper was only adopted here 200–300 years before bronze (Heyd, 2012). The earliest copper used in Britain is likely to have originated from Irish sources (Rohl & Needham, 1998), such as Ross Island, where mining activity has been dated to c.2400 BC

(O'Brien, 2004). The onset of copper use is commonly associated with the introduction of Beaker-style pottery to Britain, as part of a cultural 'package' including single-inhumation graves with associated goods; archery equipment such as distinctive barbed and tanged arrowheads, and metal and metalworking (Armit & Reich, 2021; Sheridan, 2008; 2012). This Beaker 'package' is generally thought to have arrived in Britain c.2450 BC (Parker Pearson *et al.*, 2016), with the first dated use of Beaker pottery in a funerary context at c.2460–2330 cal BC (Parker Pearson, 2019; Parker Pearson *et al.*, 2019). Beaker pottery is most commonly found in contexts dated to broadly the 25th–23rd centuries BC (Parker Pearson *et al.*, 2019), with the latest use in a funerary context (taking into account issues around defining 'end points' for material culture phenomena) dated to c.1800–1650 cal BC (Parker Pearson, 2019; Parker Pearson *et al.*, 2019).

The utility of the concept of a 'Chalcolithic' in Britain has been subject to debate, and the term has not been widely used in discussions of British prehistory (Needham, 2012), at least until recently. A Chalcolithic can be defined as a period of exclusive copper use (Roberts & Frieman, 2012). Those who argue for the use of the term (e.g. Sheridan, 2012) argue that it defines the 3rd quarter of the 3rd millennium BC, defined by the introduction of metal objects and the rest of the Beaker 'package' discussed above, as distinct from the Late Neolithic and Early Bronze Age. However, any period of exclusive copper use in Britain is thought to have been very brief, only 200–300 years (Bray, 2012), and there are issues around the limitations of radiocarbon dating material to such a short period (Roberts & Frieman, 2012). Figure 2 shows simulated radiocarbon dates from the 25th–22nd centuries BC – with modern uncertainties of c.25 years, single calibrated dates in this period generally have ranges of c.100 years. The uncertainties attached to legacy dates are generally larger, and their calibrated ranges are longer. There is also little evidence for 3rd millennium BC copper production from Britain (as opposed to Ireland) (*ibid.*).

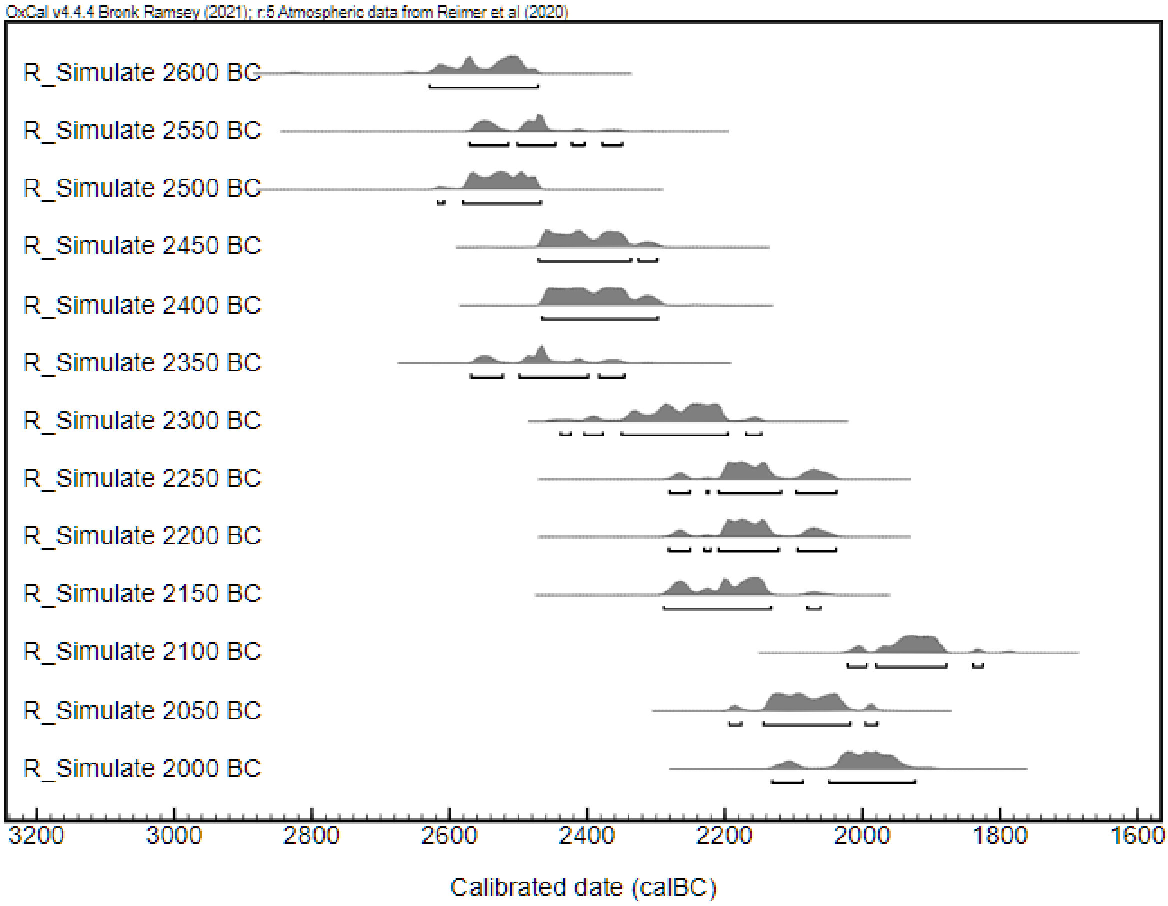

Figure 2: Simulated radiocarbon dates from the 25th–22nd centuries BC.

There is also the issue of foregrounding metal technology as a driver of cultural change (c.f. Needham, 2007; *contra* Vander Linden, 2012). Whether this was the case or not, there are clear changes in the archaeological record temporally associated with the introduction of Beaker-type pottery and its attendant phenomena.

Culture-historical narratives in archaeology promulgated the idea of the migration of the 'Beaker people' as being behind these changes, while processual and post-processual approaches sought to emphasise instead the importance of socio-cultural mechanisms (discussed in Armit & Reich, 2021). It has been argued that trade and exchange networks allowed for the movement of ideas, leading to social change (e.g. Fokkens, 2012), and that there was a lack of archaeological evidence for migration (Barber, 2003). Other authors have proposed small-scale migration (e.g. Needham, 2005; 2012), perhaps in the context of 'heroic journeys' of high-status individuals (Sheridan, 2008; 2012), bringing new ideas which then spread through local populations.

Isotope analysis of skeletons interred with Beaker-type pottery and grave goods support migration theories (Allentoft *et al.*, 2015; Haak *et al.*, 2014; Hervella *et al.*, 2015; Parker Pearson *et al.*, 2019; Price *et al.*, 2004). This includes migration into Britain, such as that of the well-known Amesbury Archer, thought to have had origins in Central Europe, most likely southern Germany (Chenery & Evans, 2011; Evans *et al.*, 2006; Sheridan, 2008: 63) and migration within Britain (Parker Pearson *et al.*, 2016; Parker Pearson *et al.*, 2019).

However, isotopic analysis of human remains has limitations as a technique, in that it can only identify first-generation migrants (Armit & Reich, 2021; Parker Pearson, 2019). Recent aDNA studies indicate significant migration into Britain in the late 3rd millennium BC (Booth, 2019; Brace *et al.*, 2019; Olalde *et al.*, 2018), a phenomenon not identified in continental Europe (Olalde *et al.*, 2018). Between the Late Neolithic and Early Bronze Age, 93% of the gene pool in Britain is thought to have been replaced, with changes in both mitochondrial and Y-chromosome-linked DNA indicating the movement of both male and female individuals with Steppe ancestry, likely to have come from continental Europe (Armit & Reich, 2021). There are potential confounding issues – a gap in the burial record in the late Neolithic (Bradley, 2019; Healy, 2012; Sheridan, 2012) could make it difficult to 'see' persistent populations of those with indigenous DNA (Armit & Reich, 2021). This also introduces bias; aDNA samples are taken from intact human remains from burial contexts, which during this period are likely to be associated with 'Beaker' material. A possibly diminished Late Neolithic population in Britain (discussed above) could mean that a relatively low-level migration of individuals with Steppe ancestry had a disproportionate effect on the genetic make-up of the region (Armit & Reich, 2021). It has been suggested that migration could have been at the level of hundreds, rather than thousands of individuals, taking place in a diasporic manner rather than as a single wave, mixing with local populations (Parker Pearson *et al.*, 2019).

While the settlement record for the Chalcolithic is thought to be, like that for the Neolithic, relatively ephemeral in much of Britain (see Section 2.4.5 of this chapter), clear change can be seen in monumentality in this period. Late Neolithic monumentality is thought to have been relatively uniform across Britain and Ireland, with similar monument forms (such as henges) appearing across both landmasses (Barclay, 2005b; Bradley, 2007; 2019), although Younger (2015) has highlighted a lack of evidence for Late Neolithic henge construction in Scotland. The later 3rd millennium BC is thought to have seen general decline in large-scale monumentality across much of Britain (Bradley, 2007; 2019; Needham, 2012; Parker Pearson, 2019). Despite this, some of the largest known henge monuments, such as the final stages of Stonehenge (Bayliss *et al.*, 1997; Darvill & Wainwright, 2008; Parker Pearson,

2009), are broadly contemporary with the arrival of the Beaker 'package'. This has been interpreted as a potential reaction to the arrival of Beaker-using migrant populations, asserting the norms of the insular culture in the face of change (Bradley, 2019).
Any decline in monumentality in the late 3rd millennium BC was not uniform across Britain. In north-east Scotland, the late 3rd millennium BC saw the development of new types of monument: Clava-type cairns, primarily located in the area around Inverness (Ashmore, 1996; Bradley, 2000) and Aberdeenshire's recumbent stone circles (Bradley, 2005; Curtis & Wilkin, 2012; Welfare, 2011). Stone rows, a feature of the archaeological record of northern Scotland, are also thought to be a phenomenon of the Bronze Age, although there is a lack of definitive dating evidence for this type of monument (Heald & Barber, 2015). Similarities have been observed between the distributions of recumbent stone circles and those of Beaker-type pottery (Curtis & Wilkin, 2012; Needham, 2004), and Beaker pottery deposits have been excavated at the recumbent stone circles of Tomnaverie and Berrybrae (Bradley, 2005; Welfare, 2011). Beaker burials are also found at other older monuments in Scotland, such as the cairns at Nether Largie South, in Kilmartin Glen (Ritchie & Harman, 1985) and South Yarrows North, Caithness (Heald & Barber, 2015) This re-use could represent a ritual 'closing' of these monuments (Wilkin, 2016).

The British Chalcolithic is thought to have drawn to a close in the 22nd millennium BC (Needham *et al.*, 2017; Parker Pearson, 2019), with the widespread, rapid uptake of bronze technology across Britain and Ireland (Needham, 1996). Britain is thought to have been the first part of Europe to move wholesale to using bronze, perhaps because of the rich tin deposits found throughout Britain and Ireland (Parker Pearson, 2009:103–105).

2.3.2 Metal in the 2nd millennium BC: long-distance connections

Although the settlement record indicates a society constituted of small, dispersed communities across much of Britain in the Bronze Age (as described below), artefactual evidence shows that complex, wide-ranging exchange networks were in place (Roberts, 2013). Whether the term 'trade' to describe exchange in this period is appropriate is disputed (Harding, 2013). Needham (2009) used the concept of 'maritories' to describe the development of cross-Channel zones of cultural interaction (e.g. between Wessex and northern France), identified on the basis of artefact distributions and similarities in monumentality, from the later 3rd millennium BC through into the 2nd millennium BC. New exchange and communication networks are thought to have developed across Europe during the Bronze Age, based on access to bronze goods and the raw materials for their creation as well as other goods such as gold and amber (see Kristiansen & Suchowska-Ducke, 2015; Sherratt, 1993).

This has been discussed in terms of a prehistoric example of ‘globalisation’, with socio-economic changes including the development of social stratification and inequality based on control of resources and exchange networks (e.g. Bradley, 2007; 2019; Brück, 2006:74; Champion, 2009; Parker Pearson, 2009:103 for discussion of this in a British context), across Eurasia and North Africa (Kristiansen, 2017; Kristiansen & Larsson, 2005; Vandkilde 2016; 2017a; 2017b; 2019). In this model, the period c.1600–1500 BC is seen as a watershed moment, with massively increased amounts of metal in circulation across Europe (Roberts, 2013; Vandkilde 2016; 2017a; 2017b; 2019) and a corresponding expansion in long-distance connections between production centres (Radivojević *et al.*, 2018). This has been linked, though without extended discussion of a defined causal mechanism, to the changes seen in the settlement record for Britain (e.g. Caswell, 2020; 2022; Radivojević *et al.*, 2018; Roberts, 2013; Williams & Le Carlier de Veslud, 2019) around the mid-2nd millennium BC discussed further in Chapter 8 of this thesis, and similar changes observed across Europe (Earle & Kristiansen, 2010).

While there is little evidence for 3rd millennium BC copper mining in mainland Britain (Roberts & Frieman, 2012), the early 2nd millennium BC is thought to have seen new copper mines opening up in England and Wales (O’Brien, 2015; Timberlake & Marshall, 2014), with copper production in Britain peaking c.1900–1500 BC (Timberlake, 2001:190). Despite mainland Britain’s extensive copper ore deposits (Barber, 2003), around 1600 BC copper production is thought to have contracted geographically, with only Great Orme, Clwyd, continuing as a key source of British copper, with evidence for distribution across Europe (Ling *et al.*, 2019; Timberlake, 2001; 2017; Timberlake & Marshall, 2014; Williams, 2017; Williams & Le Carlier de Veslud, 2019). Copper production at Great Orme is thought to have reduced from c.1400 BC (Timberlake & Marshall, 2014; Williams & Le Carlier de Veslud, 2019). It has been suggested that copper from continental sources was dominant in artefacts recovered across northern Europe (including Britain from c.1400 BC) from c.1500 BC onwards (Ling *et al.*, 2019; Melheim *et al.*, 2018; Timberlake & Marshall, 2014).

2.4 Settlement and land use in Scotland from the Neolithic to the Late Bronze Age

2.4.5 Late Neolithic and Chalcolithic settlement in Scotland: a brief overview

The Early Neolithic saw a 'house horizon' in Scotland and Ireland (Sheridan, 2013), with sites such as Balbridie (Fairweather & Ralston, 1993), Warren Field (Murray *et al.*, 2009) and Claish (Barclay *et al.*, 2002) dating to the early 4th millennium BC (Bradley, 2019; Brophy, 2007). These substantial, rectangular structures have mainly been excavated in lowland areas (Brophy, 2007), and environmental evidence suggests an association with arable farming (Sheridan, 2013; Tipping, 2009), potentially indicating a degree of permanence in their habitation or use (Sheridan, 2013). Parallels between the ground plans of these structures and contemporary monuments have been drawn, and it has been suggested that they may have had a monumental or ritual function (discussed in Bradley, 2019; Brophy, 2007). Houses dating to the 4th millennium BC are also represented in the archaeological record from Orkney (papers in Richards & Jones, 2016), and settlement activity at the islet site of Eilean Domhnuill, North Uist has been dated to the mid-4th millennium BC (Armit, 2003).

However, from roughly the second half of the 4th millennium BC, there is a decline in direct settlement evidence across mainland Britain (Bradley, 1997; 2007; 2019). Evidence for Neolithic settlement in Britain has widely been characterised in the archaeological literature as ephemeral, interpreted as reflecting mobile (e.g. Barrett, 1999; Pollard, 1999; Thomas, 1999; 2013; Thomas & Renfrew, 1991) or semi-mobile (e.g. Brophy, 2006) settlement patterns. A paucity of Middle/Late Neolithic settlement evidence has also been observed across north-west Europe (Gibson, 2003; 2019a; 2019b).

Most evidence for Late Neolithic domestic activity across Britain (see papers in Anderson-Whymark & Thomas, 2012) is in the form of pits, widely thought to represent the structured deposition of domestic material (e.g. Barclay, 2003a; 2003b; discussed in a Scottish context in Brophy & Noble, 2012; Noble *et al.*, 2016). Settlement sites consisting of more easily identifiable houses dating to the Late Neolithic have been excavated at Durrington Walls, Wiltshire (Parker Pearson & Larsson, 2007) and in Orkney, at the Ness of Brodgar (Card *et al.*, 2018; Card *et al.*, 2020); Barnhouse (Richards *et al.*, 2016); Skara Brae (Clarke, 1976) and numerous other sites (see papers in Richards & Jones, 2016). In the Western Isles, some evidence for Middle Neolithic settlement is thought to have been preserved beneath coastal machair and 'blacklands' in this region (Hamilton & Sharples, 2012; Parker Pearson, 2012). It has also been suggested that 'four-poster' remains excavated at Neolithic sites such as Greenbogs, Aberdeenshire could represent the remains of domestic buildings, with a central four-post setting acting as the support for the roof of a circular superstructure (Noble *et al.*, 2012; discussed in Bradley, 2019).

Although it has been argued that ideas of a lack of Neolithic domestic structures are based heavily on evidence from southern England, and are therefore inappropriate for other parts of Britain and Ireland (Cooney, 2003; Clarke, 2004; Sheridan, 2003; 2013), there is not a great deal of evidence for Late Neolithic buildings in mainland Scotland (Barclay, 2003b). Sharples (2009) has also suggested a Late Neolithic ‘gap’ in the settlement record for the Western Isles.
Evidence for Late Neolithic settlement could have been missed, and gone unrecorded during the excavation process (Barclay, 2003b); taphonomic processes or later activity could have destroyed or obscured evidence (Barclay, 2003b; Gibson, 2003), or settlement activity may have been reduced in this period (*ibid.*). Reasons for caution regarding studies based on SPDs have been rehearsed in Section 2.2 of this chapter, as have issues of differing chronological resolution in the palaeoenvironmental and archaeological records, but any apparent decline in Late Neolithic settlement evidence (Bradley, 2008; 2019; discussed in Thomas, 2013) correlates roughly with reductions in palaeoenvironmental evidence for arable agriculture and anthropogenic activity identified by Stevens and Fuller (2012; 2015), Woodbridge *et al.* (2014), and other studies referenced in Section 2.2.2 of this chapter. This has been linked to the period of proposed Late Neolithic climatic deterioration discussed in Section 2.2.1.
Although there has been an assumption that the advent of full-time, sedentary farming came in the latter part of the 3rd millennium BC, progressing from a mobile/semi-mobile Late Neolithic (Allen & Maltby, 2012), Chalcolithic settlement evidence is also rare across Britain and north-west Europe (Allen, 2005; Bradley, 2007; 2019; Gibson, 2019a; 2019b). The archaeological record from this period is dominated by funerary assemblages (Parker Pearson, 2019) and across Britain, the settlement record again consists primarily of pits (Allen & Maltby, 2012; Parker Pearson, 2019). There are gaps in our understanding of Beaker-period subsistence bases in Britain (Sheridan, 2012; Parker Pearson, 2019), although the later 3rd millennium BC sees increasing palaeoenvironmental evidence for woodland clearance (Stevens & Fuller, 2012; Woodbridge *et al.*, 2014), often associated in the literature with increased anthropogenic activity (Farrell *et al.*, 2020: 273).

Multiple buildings dating to the mid-3rd millennium BC have been excavated in the Western Isles, where the use of stone to build foundations and the accumulation of sand dunes have prevented later destruction or degradation (Parker Pearson, 2019), for example at Northton, Harris (Simpson *et al.*, 2006); Dalmore, Lewis (Sharples, 2009) and Cil Donnain, South Uist (Hamilton & Sharples, 2012; Zvelebil & Parker Pearson, 2014). Indeed, more than half of all excavated Chalcolithic and Early Bronze Age in Britain are located in the Western Isles (Parker Pearson, 2012). Excavations of stone-walled buildings at Ness of Gruting and Scord of Brouster, Shetland have also produced Chalcolithic and Early Bronze Age dates (discussed in Sheridan, 2014). Unlike earlier rectilinear settlement forms, these were circular or oval buildings. The existence of similar architectural forms from this period in Atlantic Europe have been used as evidence that this change came about as a result of broader cultural changes associated with the arrival of Beaker-style pottery in Britain (Parker Pearson, 2019).

Construction techniques leaving little archaeological trace, such as the use of mud brick as a building material (Bradley, 2019) or shallow foundations (Parker Pearson, 2019), could account for a lack of more widespread Chalcolithic settlement evidence. It is also likely that at least some of the lack of evidence for both late Neolithic and Beaker-period settlement is due to its being obscured by later activity, as was observed at Machrie Moor (Barber, 1997) and recent excavations at Must Farm (McFadyen, 2021).

2.4.6 Settlement in the 2nd millennium BC in Scotland: increasingly visible?

There is evidence for the continued importance of monuments into the Middle and Late Bronze Age in Scotland (e.g. Barclay, 2005b; Bradley & Sheridan, 2005). Henges were returned to, re-used and rebuilt into the 2nd millennium BC and beyond (Younger, 2015), and Bradley (2011) has proposed a ‘second wave’ of henge construction, in the Early–Middle Bronze Age, based on dates from sites such as Achinduich, Sutherland, near Lairg. However, it is a widespread theme in the archaeological literature that as the Bronze Age progressed, settlement became the defining feature of landscapes across Britain (Ashmore, 1996; Brück, 2000; Champion, 2009; Darvill, 2013; Evans *et al.*, 2006; Parker Pearson, 2009). It has been suggested that the focus of cosmologies and ritual activities shifted from the wider landscape and more dispersed communities to the domestic sphere, encapsulated in the house and household (e.g. Bradley; 1997; Brück, 2000; Cavers; 2006; Parker Pearson, 2009): a move from a ‘landscape of the dead’, defined by burial monuments such as cairns and barrows, to a ‘landscape of the living’ where houses, settlements and field systems were dominant (Parker Pearson *et al.*, 2005).

As is discussed above (in Section 2.4.5), settlement in the Neolithic in Britain has been characterised as largely ephemeral, although whether this model applies to Scotland has been subject to challenge and debate (Barclay, 1996, 2003b, 2004; Bishop *et al.*, 2009; Brophy, 2006; 2016; Sheridan, 2010; 2013; 2017). The rarity of Chalcolithic settlement evidence has also been noted (Allen, 2005; Bradley, 2007; 2019; Gibson, 2019a; 2019b). It has been proposed that from the Middle Bronze Age onwards, a mobile settlement pattern gave way to more settled lifeways (Ashmore, 1996; Barrett, 1999; Brück, 2000), with increased evidence for settlement, agriculture, and land division in the archaeological record from this point onwards (Barrett, 1999; Bradley, 2007; 2019; Champion, 2009; Cowie & Shepherd, 1997).

For later British prehistory, a key feature of settlement sites is the roundhouse. Roundhouses, in British archaeology, are generally understood as a feature of 'the Metal Ages' (Ralston, 2003:2), and they were the dominant architectural style from the Bronze Age through to the early medieval period in Scotland. Until the mid-20th century, it was widely believed that hut circle sites in Scotland, and their associated agricultural remains, were an Iron Age phenomenon. Key excavations in the 1980s and 1990s, like those on Arran (Barber, 1997) and at Lairg (McCullagh & Tipping, 1998), pushed the chronologies of these sites back to the 2nd millennium BC (Halliday, 2015; 2021).
From late 19th century ideas of prehistoric people dwelling in semi-subterranean 'pit-houses' (Halliday, 2015), thousands of roundhouse sites are now recognised throughout Britain (despite a longstanding bias in research excavations towards monumental sites [Hingley, 1992]). Scotland is likely to be over-represented in the record due to demographic and topographic factors (Caswell, 2020). Various types of roundhouses are recognised, with structures categorised based on the presence of features such as ring-ditches, ring-banks and post-rings (see Pope, 2003 and 2015 for detailed discussion). The majority of roundhouses were likely to have been primarily domestic sites, although a strand of the literature ascribes a ritual aspect to them (e.g. Wait, 1985; Boast & Evans, 1986). This is in line with ideas of a shift from a Neolithic and Early Bronze Age defined by public ritual to cosmologies centred on the domestic sphere from the Middle Bronze Age onwards.

The Middle and Late Bronze Age (c.1600 BC onwards) do appear to see a move away from large-scale burial monuments and archaeologically visible funerary activity across Britain (Caswell & Roberts, 2018; Bradley, 2019; Parker Pearson *et al.*, 2005; Roberts, 2013). There is a lack of evidence of burial activity from the latter part of the Bronze Age (Ashmore, 2001). Ritual activity may have moved to the domestic sphere (Cavers, 2006), linked to the new importance of the household as the main structuring unit in society (Hingley, 1992). The deposition of human remains, such as the Cladh Hallan mummies (Parker Pearson *et al.*, 2005), and material culture linked to agriculture and fertility in domestic buildings (Cavers, 2006) provides supporting evidence for this model. Patterns of erosion and artefact deposition in roundhouses from the Middle Bronze Age onwards have also been ascribed to ritualised use of these spaces (e.g. Fitzpatrick, 1994). Division between the uses of central and annular space in buildings is a common theme (Harding, 2009), as is the idea that daytime activities primarily took place in the southern parts of roundhouses, while the north was reserved for sleeping (e.g. Hill, 1996; Parker Pearson & Richards,1994).

However, this cosmological model of roundhouse use is based on a geographically and numerically limited dataset (Pope, 2007; Webley, 2007). Any spatial patterning in use may have been a response to the differential availability of light (Pope, 2007; Musson, 1970; Harding, 1974), as many roundhouses have south/east facing entrances (presumably to maximise daylight). Additionally, evidence from truncated structures can be ambiguous (Romanciewicz, 2018), and artefacts recovered from excavated buildings may represent abandonment practices rather than patterns of domestic use (Webley, 2007). Ritual and routine are difficult concepts to disentangle on the basis of archaeological evidence (Bradley, 2003; 2005; Brück, 1999). It is difficult to tell whether habit, belief or a mixture of the two was behind any evidence we see for uniformity of use or deposition in these structures.

An increase in settlement evidence in the archaeological record across Britain has been observed beginning at c.1700 BC (Caswell, 2020), and the Middle Bronze Age is thought to have been a key period of expansion and intensification of settlement activity across mainland Britain (Halsted 2007, 167–8). The earliest dates for Bronze Age domestic structures in Scotland can be found at Kilearnan Hill, Sutherland, with material from one structure dated to 1950–1400 BC (McIntyre *et al.*, 1999) and at Lintshie Gutter in Peebleshire, where a date of 2580–2200 cal BC was produced from non-species-identified charcoal from a roundhouse ring-groove (Ashmore, 1996; Pope, 2015; Terry, 1995; Terry *et al.*, 1996). Dates from Green Knowe, (Jobey, 1980) have calibrated ranges beginning in the very early 2nd millennium BC, although in several cases these ranges span the better part of a millennium. The settlement site at Tormore, on Arran, also produced early 2nd millennium BC dates (Ashmore, 1996; Barber, 1997). Pope (2015) has suggested, based on analysis of radiocarbon dates from 58 sites across northern Britain, that roundhouse settlements became established from c.1880 BC, with this happening earlier in the uplands than the lowlands. However, this chronology is based on interpretation of dates with calibrated ranges, in some cases, spanning 400–600 years, rather than formal statistical analysis. At Lairg, most settlement activity was thought to date to the mid-2nd millennium BC (Ashmore, 2001; McCullagh, 1993; McCullagh & Tipping, 1998). Ashmore (2001; 2004) has highlighted the small number of and inherent weaknesses in the radiocarbon determinations used to produce accepted chronologies for Bronze Age settlement.

Taphonomic processes could play a part in the relative lack of visibility of earlier settlement evidence compared to that of the Middle Bronze Age onwards (discussed in Halliday, 2015; Halliday, 2021). Adoption of more substantial building materials and changes in building techniques (as suggested by Bradley, 2019) could have increased both the likelihood of a building's survival and the visibility of its remains. There is also evidence, from excavations on Arran, for the ploughing of Bronze Age house sites when they fell out of use (Barber, 1997; discussed in Bradley, 2019). At Lairg, where the majority of buildings were dated to the Middle Bronze Age, there was evidence for cycles of occupation and cultivation of the same sites (McCullagh & Tipping, 1998) – enriched occupation soils would be particularly fertile (Bradley, 2019).

2.4.7 Upland expansion in the 2nd millennium BC

Expansion of settlement into upland areas is a key feature of narratives for the Scottish Bronze Age (Burgess,1984; 1985; Parker Pearson 1993; Ashmore 1996; 2001; Cowley 1998; Fleming 1988; Tipping 2002; 2010; Tipping *et al*., 2013). However, proposed chronologies for this phenomenon lack precision. As early as the 1990s, attention was drawn to the lack of a cohesive pattern of occupation dates for upland hut circle sites in Scotland (McCullagh, 1993). There are only 316 dated Bronze Age settlement sites across the whole of Britain (Caswell, 2020), and dates from upland sites range from the early 2nd to the 1st millennium BC.

Upland settlement in northern Britain is thought to have become more prevalent from c.1800 BC onwards (Pope, 2015), and a general proliferation of settlement sites in the record has been noted at c.1700 BC at both upland and lowland sites across Britain (Caswell, 2020). There is evidence for use of upland soils in Scotland from as early as the mid-3rd millennium BC (Davidson & Carter, 1997). This may have been part of a process of 'experimentation' in the use of upland areas in the Late Neolithic and Early Bronze Age – Bradley (2019) has noted an expansion of monument distribution into moorlands, heath, and upland areas in the Early Bronze Age. Land use and settlement in these areas may have intensified after c.1400–1500 BC (Ashmore, 1996; Bradley, 2001; 2019; Brück, 2000; Champion, 2009; Cowie & Shepherd, 1997; Parker Pearson, 2009). Intensification and formalisation of land use in upland areas as the 2nd millennium BC progressed could have been a continuation of increasing intake of land from the Neolithic onwards, as characterised by Bradley (2001;

2007; 2019), or part of a process of infilling of settlement and agriculture in landscapes already in use (Cowie & Shepherd, 1997). Evidence for Neolithic cultivation underlies Bronze Age remains at a number of sites across Scotland: at Tormore, on Arran (Barber, 1997); at Skaill, Caithness (Cavers *et al.*, 2016), and at Lairg, where the remains of Bronze Age activity overlay earlier cultivation evidence (McCullagh, 1993; McCullagh & Tipping, 1998). Cavers *et al.* (2016) suggested that this earlier cultivation made upland areas attractive places to settle in the Bronze Age, as populations were drawn to soils improved by these activities.

It has been suggested that environmental factors such as warm summers could have facilitated the expansion of settlement and agriculture into upland areas in the Bronze Age (e.g. Burgess, 1985; discussed in Tipping *et al.,* 2013), in accordance with models for marginal land use proposed by Parry (1978). The impact of climatic factors on any upland expansion depends on the timing of that phenomenon. It is thought that the centuries around 2000 BC were likely to have been a period of climatic downturn (Anderson *et al.*, 1998; Coles & Mills, 1998; Davies, 2007; Tipping, 2015; Tipping & Tisdall, 2004), an event that for authors such as Burgess (1984; 1985) should discourage upland agriculture and settlement. However, it has also been suggested that cooler, wetter conditions may have in fact led to more favourable conditions for upland agriculture, by reducing upland pine populations and creating a more open landscape suitable for pasture (Davies, 2007; Tipping, 2015; Tipping & Tisdall, 2004).

Beyond environmental drivers, expanding populations have been suggested as a reason for 2nd millennium BC upland expansion. Population growth, attributed by Burgess (1985) to favourable climatic conditions in the early 2nd millennium BC, could have led to intensification of land use throughout the landscape, with shortages in the most fertile, low-lying areas pushing activity into more marginal upland zones (Barclay, 2005a; Cowie & Shepherd, 1997; Halliday, 2015). Evidence for increased settlement activity at all altitudes across mainland Britain from c.1700 BC (Caswell, 2020) could support this hypothesis. It may also be the case that in the context of population expansion, settlement moved into areas unsuitable for arable agriculture to maximise production in lower-lying, more productive areas (Barber, 1997). This interpretation, though, is firmly grounded in modern, western concepts of economically rational behaviour (Coles & Mills, 1998; Johnston, 2005). Estimating the size of past populations is notoriously difficult (Edwards & Ralston, 1997), and issues with SPD estimations of past population are discussed in Section 2.2.2 of this chapter.

Social and cultural factors could also have played a part in an expansion of upland land use in the Bronze Age, linked to changing concepts of land ownership, territory and tenure (Davies, 2007). Increasing social stratification and the development, from the Early Bronze

Age, of an elite class whose power was based on the control of surplus goods, has also been proposed as a driver of agricultural intensification in the uplands as pressure on agricultural production increased (Brück, 2000; Cowie & Shepherd, 1997), potentially part of wider changes in societies and settlement patterns across northern Europe in the Bronze Age attributed to similar factors (e.g. Earle & Kristiansen, 2010). It is also possible that there was no one overarching explanation behind upland expansion in the 2nd millennium BC (Coles & Mills, 1998) – altitudinal settlement limits may have fluctuated based on local environmental, social and economic factors. The results of survey work in the Strath of Kildonan, Sutherland suggest that the limit of settlement fluctuated over time, perhaps on a seasonal or opportunistic basis. Larger settlements with greater evidence for lengthy occupation were predominantly found on the lower slopes of the valley, and higher-altitude settlements tended to be smaller in size (Cowley, 1998).
Any proposed shift or expansion of settlement into upland areas in the 2nd millennium BC could be an artefact of biases in preservation and research interest (see Halliday, 2021; Thoms & Halliday, 2014). As noted above, Caswell's recent (2020) study of Bronze Age settlement across mainland Britain identified an increase in settlement evidence in both upland and lowland areas beginning at c.1700 cal BC, and increasingly, commercial excavations reveal evidence for Bronze Age settlement at a range of altitudes (Halliday, 2021), such as Kintore, Aberdeenshire, and Meadowend Farm, Stirling, discussed in Chapter 7. The increasing visibility of upland settlement in the 2nd millennium BC could well be part of wider changes in settlement and land use.

2.4.8 Bronze Age agriculture

Early farming in Scotland was probably small-scale, based on a system of garden-like plots (Barclay, 2003a; Guttman, 2005; Guttman *et al.*, 2006; Tipping, 2019). It has been suggested that farming in the Neolithic, and into the Early Bronze Age comprised a pattern of shifting, short-term cultivation (and occupation) of sites, becoming more settled from the Middle Bronze Age onwards (Barrett, 1999). As has been discussed elsewhere in this thesis, it has been proposed that from the Middle Bronze Age onwards, the archaeological record in Britain reflects increasing sedentism (see Ashmore, 1996; Brück, 2000), with more evidence for settlement, agriculture and land division in the archaeological record from this point onwards (Champion, 2009). The small, intensively cultivated garden plots of the Neolithic and earlier Bronze Age have been described as giving way to larger fields, with a growing focus on arable crops and a decreased reliance on wild foodstuffs (based on evidence for granaries and storage pits) (Stevens & Fuller, 2012). Pollen evidence suggests increasing evidence for arable farming across Britain in the 2nd millennium BC (Bradley, 2019), after the proposed agricultural recession of the later 3rd millennium BC discussed in above. In upland areas, there is evidence that Bronze Age agriculture in Britain was primarily pastoral (see Gearey *et al.*, 2000; Fyfe, 2012; Fyfe *et al.*, 2008). However, there is both archaeological and palaeoenvironmental evidence for cultivation (potentially of cereal crops) in Scotland's uplands during this period, in the form of repeated layers of ard-marked soils on Arran (Barber, 1997), at Lairg (McCullagh, 1993), and in Caithness (Cavers *et al.*, 2016), as well as evidence in the pollen record (Davies, 2007; Tipping, 2015).

Field boundaries are thought to have been well-established across much of Britain by the mid-2nd millennium BC (Bradley, 2001; Parker Pearson, 2009), accompanied by nucleation of settlement (Rathbone, 2013). It has been proposed that this shift to a landscape of fixed, bounded places of occupation is representative of a new sense of identity bound closely to territory (Parker Pearson, 2009). Deposits of pottery and metal items found in boundary ditches indicate the importance of these boundaries (Brück, 2000). A move from tilled, but open land to enclosed units of farmland from the earlier to later 2nd millennium BC was also observed during excavations at Lairg (Tipping, 1993).
Boundaries can be interpreted as a means by which new levels of control and organisation of the landscape were made manifest (Ashmore, 1996; Cowie and Shepherd, 1997; c.f. Earle & Kristiansen, 2010). It has been suggested that the development of field boundaries was associated with land shortages (Barclay, 2005a), potentially linked to an increasing population from the Middle Bronze Age onwards, increasing pressure on resources. Increased pressure on resources, as well as forcing the population to begin to exploit less preferable soils in marginal, upland areas, could have led to a need to manage the boundaries of and demonstrate control over farmland, in the form of physical barriers (Ashmore, 1996; Champion, 2009; Halliday, 2015; also see Farrell, 2015).

However, the development of large-scale field systems was not uniform across Britain. This model is heavily based on evidence from the south of England, such as the Dartmoor reaves, and applications beyond this region may not be appropriate (Bradley, 2007; Halliday, 2015). In upland parts of northern Britain, agriculture may have been predominantly practised in small plots and fields (e.g. Barber, 1997; Johnston, 2005; Cavers *et al.*, 2016). There is very little evidence for Bronze Age field systems in mainland Scotland (Davies, 2007; Halliday, 2021), although Bronze Age field systems are a feature of the archaeological landscape in Shetland (e.g. Christie, 2019; 2021; Turner, 2011). A lack of field systems could reflect differing socio-political structures around land use, less focused on formalised ownership of or attachment to discrete parcels of land (e.g. Halliday, 2015; 2021).

2.4.9 2nd millennium BC settlement dynamics

A lack of formal field systems in the Bronze Age in Scotland could reflect somewhat transient patterns of settlement and land use (Halliday, 2021). Extensive, shifting settlement patterns have been suggested for Bronze Age land use in Scotland, with intermittently occupied roundhouses and associated cultivated plots forming relatively short-lived 'core' areas, with pastoral activities taking place in the wider landscape; cores could shift around a given landscape or territory at intervals, with 'abandoned' settlement sites taking on new functions rather than going completely out of use (see Halliday, 2007; 2015; 2021; c.f. Roymans & Fokkens, 1991).
This model is supported by evidence from sites like Lairg, where roundhouses were superimposed, with intervening layers of cultivation evidence (McCullagh & Tipping, 1993). Although some superficially similar aspects of Middle and Late Bronze Age landscapes (the field boundaries of southern England, for example, and the grouped remains of roundhouses resembling hamlets or villages) make it easy to assume parallels between lifeways in these societies and those of more recent historical periods (discussed in Champion, 2009), this can lead to a projection of permanence or longevity onto 2nd millennium BC settlement which is unlikely to have actually existed (Halliday, 2021). In Scotland, pollen evidence supports a model based on farmers doing 'much the same thing everywhere' (Tipping, 2015:109) – farming landscapes without defined core/peripheral arable/pastoral divisions. Although it is not possible to state definitively why populations would have chosen this shifting, wide-ranging model of settlement and agriculture (see Tipping, 2015), it has been suggested that it would have allowed for the maximisation of the agricultural potential of a given landscape (Halliday, 2021).

The use-lives of individual roundhouses have been estimated at anywhere from 10–100 years (Pope, 2003), with a tendency in the later 20th century to propose long use-lives for these structures (at the level of centuries). This was based on analogies with medieval timber-framed buildings and work at Butser Ancient Farm (Reynolds, 1977), and also on interpretations of the long spans of radiocarbon date ranges from excavations such as those on Arran in the 1980s (Barber, 1997; discussed in Halliday, 2021) and at An Sithean, Islay (Barber & Brown, 1984). This can be linked, conceptually, to pervasive ideas in British archaeology around a 'timeless prehistory' (see Whittle *et al.*, 2011), a past imbued with a sense of timelessness and continuity (Barber & Crone, 2001). Deep sediment layers in roundhouses (although rare in British archaeology [Barber & Crone, 2001]) were taken as evidence of longevity of occupation, as was evidence of erosion in building interiors (Barber, 1984; Pope, 2003).

In the early 2000s, this model was called into question (Pope, 2003). Now it is generally thought that later prehistoric roundhouses were likely to have had use-lives at the level of decades rather than centuries. Buildings may have been used by just a single generation, an extension of the idea that the house's life cycle was tied to those of its occupants (Brück, 1999; 2000). This link between the life cycles of buildings and their occupants has also been suggested for Iron Age settlement sites in the Netherlands (Gerritsen, 1999). Evidence from experimental work, dendrochronological dating of roundhouse timbers, and increasingly, from the construction of Bayesian chronologies for excavated sites indicate that later prehistoric roundhouses were probably in use for only a generation or so (Crone *et al.*, 2018).

Experimental work indicates that the timbers used to construct many roundhouses would have begun to decay after less than 15 years (Harding *et al.*, 1993), and that structures would have had a maximum lifespan of around 30 years (Reynolds,1994). At Butser Ancient Farm, a reconstructed roundhouse based on plans from the Iron Age settlement site of Pimperne, Dorset was left in place for 14 years – on investigation, the unseasoned oak posts making up the building's structure had decayed significantly where they met with the ground surface, leaving only a stump of heartwood. It was estimated that replacement of timbers or the total reconstruction of the building would have been necessary in a further five to ten years, based on this decay rate (Harding *et al.*, 1993).

Dendrochronological dating of Scottish sites with well-preserved timbers supports this, with the use-lives of the majority of such sites across all prehistoric periods estimated at less than c.40 years (Barber & Crone, 2001; Crone *et al.*, 2018). Preliminary results of recent dating and chronological modelling of crannog use-lives indicates that individual structures were unlikely to have been used for more than 100–150 years, with evidence for refurbishment of structural timbers every decade or so (Hamilton, pers. comm., 2022). Continental pile-dwelling sites with well-preserved timbers also provide evidence for short building use-lives in the Bronze Age (although longer durations of settlement activity are evidenced at some sites) (Jennings, 2012) and repairs to structures (Martinelli, 2014). Re-use of settlement sites is a feature of the Bronze Age settlement record in Scotland (Barber, 1997; Barrett, 1999; McCullagh & Tipping, 1998; Cavers *et al.*, 2016), with cycles of roundhouse building/occupation, abandonment and cultivation of the abandoned house site observed at Lairg (McCullagh & Tipping, 1998) and multiple successive floor surfaces excavated at the Late Bronze Age site of Cladh Hallan, South Uist (Parker Pearson *et al.*, 2004). Multiple phases of construction were also a feature of the archaeological record at Tormore, Arran (Barber, 1997); Cnoc Stanger, Caithness (Mercer, 1996). Successive episodes of construction should not necessarily be taken as evidence of lengthy, ongoing settlement at a given site (discussed in Halliday, 2021) – at Lairg, evidence for intervening periods of tillage, as well as the updated chronologies for the site discussed in Chapter 5, are evidence against this. Episodic settlement at a given site, rather than a continuous succession of occupations, may have been the norm in 2nd millennium BC Scotland (Barber and Crone 2001; Halliday 1999; 2007; Thoms & Halliday, 2014).

While evidence for a ritual aspect in the use of roundhouses is not definitive, there is evidence for ritualised abandonment of these buildings. Structured abandonment, defined by deliberate or partial destruction of the building (Webley, 2007), along with deposition of material such as household objects, can be observed at several sites including Lairg (McCullagh & Tipping, 1998). It has been hypothesised that the lifecycles of houses from the Middle Bronze Age onwards were linked to those of their inhabitants, again drawing on the idea of settlements as a site of ideological investment from this period onwards (Brück, 2000). Deposition of objects such as querns (linked to agriculture [Williams, 2003; Cavers, 2006]) and the eventual, deliberate process of abandonment of a roundhouse may have been part of this process (Brück, 1999; 2000; Pope, 2003). Planned abandonment of settlements/structures has ethnographic parallels (e.g. Brooks, 1993), and although evidence for the process at later prehistoric settlement sites is by no means ubiquitous (Webley, 2007), both structured deposition and planned abandonment were thought to have occurred at Lairg (McCullagh & Tipping, 1998). Evidence for the practice is more commonly observed at Middle Bronze Age, rather than Late Bronze Age or Iron Age sites (Webley, 2007). The apparently short use-lives of later prehistoric roundhouses may have been due to both practical limitations and wider social or cosmological factors.

Although some Bronze Age settlement sites from across Britain have been discussed in terms of ‘villages’, there is little dating evidence for contemporary use of buildings at sites where multiple roundhouses have been excavated (see Brück & Fokkens, 2013; Rathbone, 2013:47-48; Roberts, 2013). Occupation of multiple buildings, resulting in populations larger than that of a single-family unit, has been suggested at the sites of Green Knowe (Jobey, 1980) and Lintshie Gutter (Terry, 1995; Terry *et al.*, 1996), although this is based on interpretation of a limited number of radiocarbon dates with substantial uncertainties. Authors such as Cavers (2016) and Tipping (2015) have noted a lack of evidence for contemporary use of adjacent roundhouses at Scottish sites, although again this is based on dates from a limited number of sites, with Lairg, Sutherland held up as the archetypical example of this phenomenon. However, evidence from the Late Bronze Age wetland site of Must Farm, Cambridgeshire, uncovered evidence of at least five structures, apparently all in use at the point of the settlement’s destruction (see Knight *et al.*, 2019) and at Bestwall Quarry, Dorset, chronological models indicated that use of some Late Bronze Age roundhouses at the site could have been contemporaneous (Bayliss *et al.*, 2009).

2.4.10 The end of the Bronze Age: climate change and crisis?

Widespread abandonment of upland settlement across Britain is thought to have occurred c.800 BC, at the very end of the Bronze Age (Ashmore, 1996: 102; Barclay, 2005a: 59; McCullagh & Tipping, 1998). A common theme in the literature is that Late Bronze Age settlement decline in upland areas can be attributed to climatic deterioration (Amesbury *et al.*, 2008; Barclay, 2005a; Barber, 1997; Barber and Brown, 1984; Burgess, 1984; 1985; Champion, 2009; Cowley, 1998; Turney *et al.*, 2016), and potentially to related population decline (Armit *et al.*, 2014; Bevan *et al.*, 2017; discussed in Tipping *et al.*, 2008a). This is discussed in more detail in Section 2.2.1 of this chapter.

Late Bronze Age upland abandonment has also been attributed to other environmental factors. The Hekla 3 eruption in Iceland in 1087–1006 BC (Plunkett & Pilcher, 2018) and an associated climatic downturn has been cited as a possible driver (Baillie, 1989; Burgess, 1989; Blackford *et al.* al, 1992 for discussion of climate change), as have volatile compounds transported in ash clouds, leading to fluoride poisoning of livestock and soil acidification (Grattan, 1998). Volcanic activity has been linked to to cooler climates (Bethke *et al.*, 2017), however, there is not clear evidence for Hekla 3 tephra in Britain (Dugmore *et al.*, 1995; *contra* Baker *et al.*, 1995), and any ash deposition may have been minimal in impact (Buckland *et al.*, 1997).

Soil exhaustion, linked to intensive agricultural activity, may have also been a factor in upland abandonment (see Acott, 1998), and there is evidence for improvement of soils with midden material, potentially to counter this, at Late Bronze Age sites in the Northern Isles (Dockrill & Bond, 2009; Simpson, 1998). Other pedogenic processes may also have played a part. Blanket peat inception is thought to have been taking place across Scotland since c.9000 BP (Edwards, 2004). Wet, cool conditions facilitate its formation (Moore, 1987; 1989), although the role of human activity in its spread has been the subject of debate (Edwards, 2004; Moore, 1987; Piggot, 1972). Although peat has been framed as limiting human settlement and agriculture (e.g. Armit, 1998; Barber, 1984; discussion in Tipping, 2008), it is likely that peat inception was already underway at sites across Scotland during the period of proposed settlement expansion into marginal areas in the 2nd millennium BC (Tipping, 2008). Agricultural activity may have played a part in abating peat spread, and it is possible that peat deposits were actively managed by later prehistoric communities (Edwards, 2004). Peat deposits were already in existence at Lairg, Sutherland during the proposed floruit of settlement activity at the site in the mid-2nd millennium BC (McCullagh & Tipping, 1998; McDonald *et al.*, 2021).

While there is good evidence for cooler, wetter conditions affecting Britain and Scotland in the early 1st millennium BC (see Section 2.2.1 of this chapter; Blaauw *et al.*, 2004; van Geel *et al.*, 1996; van Geel *et al.*, 1998a; van Geel *et al.*, 1998b; Martin-Puertas *et al.*, 2017; Mauquoy *et al.*, 2008; Mayewski *et al.*, 2004), socio-economic changes were also taking place during the Late Bronze Age/Early Iron Age transition. The period between c.800–400 BC can be discussed in terms of unknowns. There is a perceived relative lack of burial and settlement evidence (at all altitudes) from this period (Haselgrove & Pope, 2007; Pope, 2003), although taphonomic factors, biases in research and misattribution of Early Iron Age sites to earlier or later periods may play a part in this (Haselgrove, 2015; Haselgrove & Pope, 2007; Ralston & Ashmore, 2007).

The Early Iron Age saw changes in the settlement record: the development of, for example, the substantial Atlantic roundhouses found in north-west Scotland (Armit, 2015; Ralston & Ashmore, 2007; Romanciewicz, 2009) and crannogs (Cavers, 2006; Crone, 2012; Ralston & Ashmore, 2007; Stratigos & Noble, 2015; 2018). Hillforts also became a prominent feature of the landscape, with the majority of dated examples across Britain assigned to the 800–400 BC period (Lock & Ralston, 2022). The role of the Hallstatt plateau in spreading chronologies for individual sites or phenomena more generally across this period bears consideration. There is also some evidence – with the caveat that these studies are based on interpretations of SPDs, potential pitfalls of which are discussed above – of a generally reduced population across Britain and Ireland in the Early Iron Age (Armit *et al.*, 2014; Bevan *et al.*, 2017).
Other changes thought to have occurred in this period include an increasing reliance on pastoral rather than arable agriculture (Haselgrove, 2015; Haselgrove & Pope, 2007), although pollen records from Scotland indicate a more complex picture at local scales (Dark, 2006; Davies, 2007; Tipping, 2002; Tipping *et al.*, 2008a; Tipping *et al.*, 2008b). There is increasing evidence in the archaeological record for salt production and grain storage underground, indicating an increased interest in food preservation (Cunliffe, 2015; Needham, 2007). Deposition of bronze metalwork in hoards is thought to have reached a peak in the century leading up to c.800 BC, after which both this behaviour and the quantity of metalwork in circulation dramatically reduced (Haselgrove & Pope, 2007; Needham, 2007).

This broadly correlates with the introduction of iron technology (the raw materials for which have a far wider geographic spread than copper and tin ores [Armit *et al.*, 2014]), and could have been a sign of a reduction in the need for, or the redundancy of, bronze (Cunliffe, 2015). It could also be the case that the introduction of new technologies precipitated a change in the social role of bronze (see Cunliffe, 2015; Needham, 2007): as the metal became less valuable (whether due to overproduction or redundancy), the political, social, and economic structures based on its value went into decline (Needham, 2007). The collapse of long-distance, bronze-based trade networks may have led to the development of societies with a greater focus on the control of the domestic and agricultural spheres (Cunliffe, 2015; Henderson, 2007; Needham, 2007). Armit *et al.* (2014) have suggested that the upheaval of socio-economic structures during the Late Bronze Age/Early Iron Age transition could have played a part in population reduction and accompanying changes in the archaeological record, including a reduction in evidence for settlement activity.

2.5 Implications and directions for future research

Creating a cohesive narrative for Bronze Age agriculture and settlement evidence, with a focus on upland areas, is not easy. Chronologies are often vague, based on interpretation of a limited number of imprecise radiocarbon dates, and establishing clear narratives can be challenging. There are certain key themes that can be drawn out for further exploration:

- When was upland settlement/expansion taking place, and when did it end? As noted in Sections 2.4.7 and 2.4.9, our current understandings of this are largely based on legacy radiocarbon dates, which can have large uncertainties and long calibrated ranges.
- What were the main drivers behind this phenomenon? Can we link any expansion of settlement in the 2nd millennium BC to wider socio-economic or environmental trends?
- Was the timing and nature of settlement expansion geographically uniform? Based on the evidence outlined above, especially Section 2.4.9, it can be argued that current chronologies are not precise enough to map any significant regional differences in 2nd millennium BC settlement. The skewed concentration of radiocarbon dated settlement sites, favouring the east of Scotland, is also a confounding factor (see maps in Caswell, 2020; Pope, 2015).
- Was this expansion real in the first place, or has the visibility of Bronze Age settlement remains obscured a narrative of continuity of occupation from at least the Neolithic onwards? Is the idea of a preference for upland settlement in the 2nd millennium BC an artefact of biases in preservation?
- How were 2nd millennium BC roundhouses used, and from this what can we infer about wider patterns of settlement and land use? Current understandings of roundhouse use-lives are largely based on Iron Age sites.

- Can a widespread decline in settlement at the end of the 2nd millennium BC be identified? Can we link this, as for earlier settlement expansion, to climatic or socio-economic shifts? Is there evidence for resilience in the archaeological or palaeoenvironmental records from this period?

While recent research has been undertaken in building a chronology for Bronze Age settlement across Britain (Caswell, 2020), until very recently understandings of upland settlement and land use in the Bronze Age in Scotland have largely been informed by analogy with evidence from England, in particular sites such as the Dartmoor reaves and their associated settlement remains (e.g. Amesbury *et al.*, 2008; Fleming, 1988; Fyfe *et al.*, 2008) and a very few Scottish 'type-sites' such as Tormore, Arran (Barber, 1997) and Lairg, Sutherland (McCullagh & Tipping, 1998). Chronologies from individual sites have been used to make arguments at regional or national levels, often based on (sometimes very few) radiocarbon dates from before the advent of routine AMS dating with, in some cases, measurement uncertainties of over a century.

Additionally, the answers to questions regarding the dynamics of upland settlement – how long buildings were in use for, and whether nearby buildings were commonly occupied at the same time – can only be guessed at without precise chronologies at a site level. Chronology is key to understanding the drivers behind upland settlement in the Bronze Age. Robust chronologies across sites and regions are necessary to assess, for example, the temporal relationship between climatic events and patterns of upland settlement and land use. There is recent and ongoing research into the relationship between later prehistoric settlement, agriculture and climate change (e.g. Bevan *et al.*, 2017; Colledge *et al.*, 2019; Shennan *et al.*, 2013; Stevens and Fuller, 2012, 2015; Woodbridge *et al.*, 2014; Woodbridge *et al.*, 2020) and the proposed decline in upland settlement across Britain towards the end of the Bronze Age has frequently been linked to a corresponding climatic downturn (Amesbury *et al.*, 2008; Burgess, 1984; 1985; 1989; Fleming, 1988; Parker Pearson, 1993 – for arguments against see Davies, 2007; Young, 2000; Young & Simmonds, 1995).

The resolution of archaeological and palaeoecological chronologies is often mismatched, and a number of recent studies of later prehistoric settlement and land use are based on the reanalysis of legacy data from sites with few or imprecise dates for both archaeological and palaeoenvironmental sequences (see McDonald *et al.*, 2021). Palaeoenvironmental sequences can be a means by which to fill in gaps in archaeological evidence, and improved chronologies for palaeoenvironmental records from upland sites offer an opportunity to explore this. As stated previously, narratives for upland settlement in Scotland are largely based on excavations at a limited number of ‘type-sites’ which, although well-dated for the period in which they were excavated, have chronologies which are imprecise by modern standards. The advent of routine AMS dating, negating the need to date bulk samples (and therefore avoiding old wood effects), and Bayesian modelling allow for far more precise site chronologies, and also for comparison across sites. Comparison of chronologies from sites in different parts of Scotland could allow for the identification of regional patterns in upland land use and settlement in the Bronze Age. Additionally, comparisons of chronologies from both upland and lowland sites will shed light on whether there are any similarities or differences in when and how upland and lowland sites were being used.

Chapter 3: Bayesian Analysis and Radiocarbon Dating Literature Review

3.1 Introduction

This chapter outlines the theory behind both radiocarbon dating and Bayesian analysis of radiocarbon dates. It goes on to discuss the advantages, applications, and potential disadvantages of Bayesian analysis of radiocarbon dates.

3.2 Radiocarbon dating in archaeology

Chronology has been a key concern for archaeologists since the inception of the discipline, and methodologies and schemes geared towards dating sites, artefacts and monuments have been introduced with varying degrees of success (Lucas, 2015). Radiocarbon dating was first introduced into archaeology in the 1950s (van Strydonk, 2017). Initially, the technique was not embraced by all members of the archaeological community. Accepted chronologies already existed, based on typologies for lithic and ceramic artefacts (Lucas, 2015; van Strydonck, 2017).

Initially, ^{14}C dating was applied predominantly to date artefacts with organic components, but as the technique developed, applications expanded. Radiocarbon dating is used now not only to ascertain the ages of the materials used to make artefacts, but to date contexts and define phases of activity at archaeological sites (van Strydonk, 2017), and to date environmental phenomena (Hajdas, 2008; 2009). Radiocarbon dating techniques have become increasingly sophisticated since their introduction, and accurate radiocarbon dates are key to accurate archaeological interpretations (McCormack & Bayliss, 2004).

The use and continual refinement of radiocarbon dating in archaeology can be discussed in terms of 'revolutions'. The first of these can be seen as the invention of the method itself, the second the introduction of methods for calibrating ^{14}C dates, and the third being either the introduction of AMS dating (now routinely used) (van Strydonck, 2017) or of Bayesian approaches to radiocarbon dating (Bayliss, 2009).

That the introduction of radiocarbon dating was revolutionary is almost an understatement. Upon the technique's introduction, accepted chronologies based on artefact typologies such as those constructed by Childe were 'stretched', with events once thought to be contemporary being demonstrated to be 500 years or more apart (Lucas, 2015). This had a far-reaching impact on archaeologists' understanding of the past, particularly around ideas of cultural change through diffusionism (*ibid.*). Radiocarbon dating has also had an impact on how we make archaeological interpretations and indeed how we think about the discipline itself, with both the first and second radiocarbon revolutions occurring at the point of disjuncture between culture-historical approaches and the birth of New (processual) Archaeology, predicated on the establishment of archaeology as a scientific endeavour (Griffiths, 2017).

Bayesian analysis of radiocarbon dates has been widely practised since the 1990s, and allows for the production of more precise, more accurate chronologies. The remainder of this chapter will go on to discuss the underlying science behind radiocarbon dating, an outline of Bayesian analysis, and the advantages and potential pitfalls of its application to archaeological radiocarbon dates.

3.3 Radiocarbon dating: the underlying science

^{14}C is a naturally occurring, radioactive isotope of carbon, produced in the Earth's upper atmosphere through the interaction of nitrogen atoms with cosmic radiation. The exact amount produced in the upper atmosphere fluctuates over time. The half-life of ^{14}C is 5730 ± 40 years (Godwin, 1962), although in archaeological and palaeoenvironmental radiocarbon dating, the older 'Libby half-life' is used, which is 5568 ± 30 years, in order to ensure consistency between new and legacy dates (Bronk Ramsey, 2008; McCormack & Bayliss, 2004).

What archaeologists refer to as radiocarbon dates are based on this half-life. Essentially, the degree to which the ^{14}C contained in organic material (for example, parts of plant or animal organisms) has decayed is used as the basis for radiocarbon ages. This is estimated in terms of the ratio between the radioactive isotope ^{14}C, and the stable isotopes ^{12}C and ^{13}C. While the amount of ^{14}C on Earth fluctuates, due primarily to solar activity and variations in the Earth's magnetic field, the amount of the stable forms of carbon do not change, and thus the ratio of ^{14}C to either ^{13}C or ^{12}C changes over time as well. It is not necessary to know the past rate of production to accurately estimate the ratio of ^{14}C to ^{12}C and ^{13}C at a given point in the past (Bronk Ramsey, 2008). Instead, dates are calibrated using information about past ^{14}C concentrations in the atmosphere primarily gleaned from known-age wood. The carbon incorporated into tree rings provides a record of the atmospheric concentration going back to the beginning of the Holocene and even into the Late Glacial period. Earlier calibration curves spaced points at multi-year intervals (e.g. Reimer *et al.*, 2013; Wood, 2015), however for parts of the IntCal 2020 curve single-year resolution has been achieved (Reimer *et al.*, 2020).

^{14}C becomes fixed in organisms during their lifespan, entering the food chain through photosynthesis (Bronk Ramsey, 2008; McCormack & Bayliss, 2004). Plants take in ^{14}C in their uptake of CO_2 directly from air and water, and animals ingest these plants either directly (herbivores and omnivores) or indirectly (omnivores and carnivores), and therefore the ^{14}C contained within them. This carbon becomes part of these animals' bodies and remains in relative equilibrium with the atmosphere while the plant or animal is alive. ^{14}C uptake ceases upon an organism's death, therefore the decay rate of ^{14}C in an organism's remains can be used to calculate its age at death.

3.4 Calibration of radiocarbon dates

Calibrating radiocarbon ages involves linking the concentration of ^{14}C, represented by the ^{14}C age, with calendar ages, through the use of a reference curve (Maspero *et al.*, 2016; Reimer *et al.*, 2020). The former is usually expressed in radiocarbon years bp, and the latter expressed in calendar timescales such as cal BP/cal BC/cal AD. The need for calibration of radiocarbon dates was first recognised in the late 1950s, with the understanding that rates of ^{14}C production in the upper atmosphere, and exchange rates with various reservoirs, have varied over time (de Vries, 1958a; 1958b; Millard, 2014; Stuiver & Suess, 1966; Suess, 1965; 1968). This production rate fluctuates for a variety of reasons, including solar activity and variations in the earth's magnetic field (Bronk Ramsey, 2008; Houtermans *et al.*, 1973; Suess, 1965; 1968; 1971).

The introduction of calibration in the 1960s and 1970s led to new understandings of archaeological chronologies, altering them by centuries in some instances and leading to new interpretations of various phenomena (Bayliss, 2009a; Bronk Ramsey, 2008; e.g. Renfrew 1973; 1974). Calibration is generally undertaken using one of a suite of available software options, such as OxCal (Bronk Ramsey, 1995; 2001) or BCal (Buck *et al.*, 1999), and using one of the internationally agreed calibration curves (Millard, 2014).
The 'turnover' of carbon varies between types of organism and tissue: in non-wood plants, which have short lifespans, the lifecycle is approximately annual, and most herbivores are likely to be ingesting plant growth from a single given year. For trees, which lay down tissue annually, the outermost ring will provide the date closest to the tree's death, while the tree's heartwood will provide dates for the beginning of its life.

Archaeologically, the soft tissues of animals and humans are very rarely recovered. Therefore, the degree of ^{14}C 'turnover' in the tissues more likely to survive – bone, hair, teeth and nails – needs to be taken into account. Adult teeth are formed in infancy and early childhood, and their enamel and dentine are not replaced throughout an organism's life, while teeth and nails are subject to constant new growth. This should be considered when selecting samples (Bronk Ramsey, 2008). Additionally, for non-herbivore animals, dietary composition must be accounted for. 'Reservoir effects', found in marine and freshwater environments, can affect radiocarbon ages, making dated material appear to be older than it actually is (Bronk Ramsey, 2008; Wood, 2015).

Reservoir effects need to be taken into consideration when calibrating radiocarbon dates. The ocean reservoir effect occurs because the oceans provide a larger carbon reservoir than the earth's atmosphere, with uptake of atmospheric carbon occurring only at the ocean's surface (Ascough *et al.*, 2005). ^{14}C mixes through the oceans more slowly than it does through the atmosphere – in deep ocean waters carbon has a residence time of c.1000 years (Sigman & Boyle, 2000). This results in a depletion level of ^{14}C at the ocean's surface of around 5%, correlating to a radiocarbon age roughly 400 years older than the reality. This effect is transferred to organisms whose carbon uptake comes predominantly from marine sources, and the terrestrial animals that consume those organisms, with varying degrees of severity (Cook *et al.*, 2015; Hamilton and Sayle, 2017).
A reservoir effect also exists in freshwater contexts (Ascough *et al.*, 2011; Bronk Ramsey, 2008; Hamilton and Sayle, 2017; Philippsen, 2013; Sayle *et al.*, 2016), where ^{14}C from both atmospheric and geological sources is incorporated. The picture is further complicated by seasonality and weather conditions in river systems (Bronk Ramsey, 2008). An internationally ratified calibration curve is available for what is known as the Marine Reservoir Effect (MRE) (see Cook *et al.*, 2015) while efforts are being made to correct for the Freshwater Reservoir Effect, which can offset radiocarbon ages by millennia (Hamilton and Sayle, 2017; Philippsen, 2013; Sayle *et al.*, 2016). The marine calibration curve is based on global averages, and the MRE varies somewhat both geographically and temporally (Ascough *et al.* 2004; Ascough *et al.*, 2006; Ascough *et al.* 2007; Russell *et al.*, 2010; Russell *et al.*, 2015).

3.5 Sample selection in radiocarbon dating

Sample selection is decided on the basis of the event that we wish to date. For example, the event of building a structure may relate to the date at which the timbers used in its construction were felled (although this is not always the case) while charcoal in a hearth deposit could well be related to occupation activity. It is generally recommended that the sample used to obtain a date is taken from an identifiable single organism – single-entity dating (Ashmore, 1999; Bronk Ramsey, 2008). It is important that the entity being dated is demonstrably a single part of a given organism and not several different parts of what we think was once a single entity (Ashmore, 1999): a single half of a broken piece of charcoal rather than both halves.

Single-entity dating can be used to construct highly developed chronologies. For example, at Verrebroek, a prehistoric site in Belgium, single-entity dating showed not only that there had been a gap in the order of centuries between the deposition of charcoal and hazelnuts in a hearth context, but that the hazelnuts themselves also dated to different periods (van Strydonk, 2017:1246).

Some single-entity samples, such as cereal grains or fragments of charcoal, are very small. In the past, this was an issue, as the radiometric dating technique used required large sample sizes, meaning that material from the same context would generally be analysed together as a 'bulk' sample. These bulk samples, often containing material from more than one entity, could contain material of different ages within them, potentially leading to errors (Ashmore, 1999).

At present, AMS (accelerator mass spectrometry) dating (Nelson *et al.*, 1977), which only became widely affordable in the mid-1990s, is routinely used. This technique allows for the dating of very small samples (Bayliss, 2009a; Jull, 2006). AMS dating works by directly detecting (i.e., counting) the carbon atoms by their different masses, unlike methods such as liquid scintillation or gas proportional counters which count the decay of the ^{14}C atoms in the sample (Bronk Ramsey, 2008; Povinec *et al.*, 2009).

3.6 Bayesian analysis and radiocarbon dating

Bayesian statistics is a way of using prior knowledge to inform statistical models. The field is based on the 18th century work of the Reverend Thomas Bayes, but it has only really been possible to apply in the field of archaeology (due to limitations on computing power) since the 1980s (Buck, 1998). Bayesian analysis of radiocarbon dates has the potential for a transformative effect on archaeological chronologies as we currently understand them, as 'usher[ing] in an entirely new kind of (pre)history' (Bayliss, 2009: 123).

Bayesian models are useful in archaeology as they allow us to include sources of uncertainty, something which, to one degree or another, is always present in archaeological data. Traditional models for radiocarbon age determination assume that there is no known prior information about the calendar date when the organism we are sampling the remains of stopped respiring. However, we often do have information regarding this, either in the form of historical narratives or stratigraphic information (which tells us that certain events must pre- or post-date each other). As archaeologists, we frequently use a wide range of sources to inform our interpretations, and a Bayesian framework allows us to combine information from various sources to obtain interpretations which reflect as much of our current knowledge as possible (Buck, 1998).

When constructing Bayesian chronologies in archaeology, generally the results of the scientific dating process (known as the 'standardized likelihood') and the relative dating evidence (our archaeological knowledge, usually about a site's stratigraphy - our 'prior beliefs') are combined to provide quantitative estimates of the date we are interested in, or 'posterior beliefs' (Bayliss *et al.*, 2007:5). The difference between Bayesian and traditional approaches to statistical inference is the use of a priori information in data interpretation; combining archaeological knowledge with probabilistic modelling can provide us with better estimates for dates and more precise chronologies (Overhöltzer, 2015).
Calibrated radiocarbon dates are non-normal distributions, which can make their interpretation difficult (Maspero *et al.*, 2016; Wood, 2015). There is no single, impartial way to analyse the results of radiocarbon dating of samples, which can lead to subjective and sometimes conflicting interpretations produced by archaeologists based on how they have understood the archaeology in question. Using a Bayesian statistical approach to analyse radiocarbon dates allows us formally to include prior knowledge about the archaeology we are trying to understand in a mathematical form, combining them with the scientific results (Maspero *et al.*, 2016).

3.7 Constructing Bayesian chronological models

To create Bayesian chronological models, we must assume that our chronology can be broken down into events, whether with phases of activity bounded by start and end events or in a continuous series, and that these events occurred on a well-defined timeline (for example, calendar years before present, BC or AD) (Bronk Ramsey, 2009a). Archaeological information about relative chronology – stratigraphy, phasing, artefactual or historical evidence – expressed mathematically as the 'informative prior' in Bayes' theorem, introduces constraints on the order of events in chronological models.

Bayes' theorem has three key components. The first is the likelihood: how likely the observed data values are given the values of the unknown parameters. The second is the informative prior (as mentioned above): how much belief we have in the values of the unknown parameters *before* we observe the data. The third is the posterior: what we want to obtain, the belief we attach to the specified values of the unknown parameters *after* observing the data. As analyses proceed, the models produced can be built on – today's posterior becomes tomorrow's prior – as chronologies are continually refined. This approach results in much tighter chronologies than traditional radiocarbon age determination models. For the Bronze Age site of St Veit-Klingberg, Austria, for example, including stratigraphic information in Bayesian models of radiocarbon ages led to a calibrated date range for a sample from one context which was 200 years shorter than that produced through traditional approaches (Buck, 1998).

Generally, Bayesian analysis is used to produce chronological models for individual sites, although it can also be used to produce models for the chronologies of artefact typologies (Bayliss, 2015), studies of the environment in the past (Blaauw *et al.*, 2005; Blockley *et al.*, 2007; Bronk Ramsey, 2008; Christen *et al.*, 1995; Bayliss, 2015; Contreras, 2017) and even chronologies for groups of different sites (Bayliss *et al.*, 2007a; Bayliss *et al.*, 2007b; Whittle & Bayliss, 2007; Whittle *et al.*, 2007; Whittle *et al.*, 2011).

Archaeological applications of Bayesian analysis are numerous and widespread. The technique has been used in studies as diverse as producing an absolute (as opposed to typological) chronology for the beginnings of the ancient Egyptian state (Dee *et al.*, 2013); creating models for the human colonisation of Polynesia (Burley *et al.*, 2015); determining the age of the earliest excavated levels of Çatalhöyük (Bayliss *et al.*, 2015) and timing the disappearance of Neanderthals in Europe (Higham *et al.*, 2014). Bayesian models can also be used to construct chronologies for artefact types (Binder *et al.*, 2017; Pesonen, 2021; Raczky & Siklósi, 2013). In terms of research into British prehistory, since the 1990s, several

Bayesian chronological models based on radiocarbon dates have been produced for Stonehenge (Darvill *et al.*, 2012); models for the earliest and latest known uses of Bell Beakers in British burial contexts (Parker Pearson *et al.*, 2016; Parker Pearson *et al.*, 2019); models for patterns of use of southern English Early Neolithic long barrows and long cairns which challenged assumptions about the long use-lives of these monuments (Whittle *et al.*, 2011); and the results of Bayesian modelling have been used to call existing chrono-typologies for the British Iron Age into question (Hamilton *et al.*, 2015).

3.8 Advantages of applying Bayesian analysis to radiocarbon dates

Bayesian analysis of radiocarbon dates has become increasingly popular in the last decade or so, although it was developed in the late 20th century and since the mid-1990s, has been routinely carried out on dates obtained during excavations funded by English Heritage, and is becoming increasingly routine in other parts of the UK (Bayliss, 2009; Whittle *et al.*, 2011; Bayliss, 2015; Hamilton *et al.*, 2015; Hamilton & Krus, 2018). The technique is also growing in popularity in the USA (Hamilton & Krus, 2018).

One key advantage of Bayesian analysis of radiocarbon dates is that it offers a means to combine formally archaeological knowledge with the results of scientific dating techniques. This is an iterative process, and models can and should be updated as new information comes to light. The concept behind this process – interpreting information in light of our existing knowledge – is intuitive, especially to archaeologists familiar with Ian Hodder's concept of the hermeneutic spiral, where the interpretations are constantly updated as new knowledge arises (Bayliss *et al.*, 2007). This ability to update conclusions easily in the light of new evidence is a key advantage of adopting a Bayesian approach (Otárola-Castillo & Torquato, 2018). Bayesian analysis of radiocarbon dates is also congruent with accepted archaeological theory in that multiple, differing, non-definitive models are produced. In this sense, undertaking Bayesian analysis of radiocarbon dates is another way of creating multiple pasts, a concept put forward during the post-modern turn in archaeology of the 1990s (Bayliss & Bronk Ramsey, 2004). Additionally, unlike classical statistical analysis, which is suited to testing hypotheses, Bayesian analysis allows us to choose the most likely possibilities from an almost infinite range of outcomes. This makes it particularly well-suited to analysing the results of archaeological dating projects (Bronk Ramsey, 2000).

Bayesian analysis allows archaeologists to combine the results of scientific dating programmes with prior knowledge about the age (potentially relative) of the context being sampled. This information can come in many forms, including knowledge about the sample's position in a stratigraphic matrix, dendrochronological, artefactual and historical evidence (Steier & Rom, 2000; Otárola-Castillo & Torquato, 2018; Bayliss *et al.*, 2007; Buck & Juarez 2017; Whittle *et al.*, 2011; Bronk Ramsey, 2015). Chronologies based on all available evidence are more likely to be reliable than those based on only one strand of data (Bayliss, 2009). Archaeologists commonly use a wide range of sources of information about the past, and using a Bayesian framework means that we can obtain interpretations reflecting as much of our current knowledge as possible (Buck, 1998).

Through applying Bayesian analysis to archaeological radiocarbon dates, more precise chronologies can be achieved. Dates which have been simply calibrated (using an intercept or a classical statistical method) rarely provide date ranges of less than a century. Using a Bayesian approach can provide date ranges of under a century, in the order of >50 years (Whittle & Bayliss, 2007). Dates produced through Bayesian analysis are also more likely to be more accurate than those analysed by either visual inspection or summing sets of calibrated dates (Bayliss *et al.*, 2007; Bronk Ramsey, 2015). Visual inspection has generally been the most common way in which radiocarbon dates are interpreted, and involves taking the widest limits of the distribution range as the limits of the activity or event being dated. Interpretations based on visual assessment of dates do not have to be inaccurate – it would be correct, for example, to state that the event dated occurred at some point between the earliest and latest limits of the date range, and that it was of unknown duration. However, what this visual inspection cannot be used to do is to determine start and end points (and therefore, to calculate the duration of) activities. Oftentimes it is used in this way, creating the impression that the dated event was of a far longer duration than may have actually been the case and causing events which were not necessarily contemporary to be interpreted as such. Summing sets of calibrated dates often also leads to overestimates of event duration (Bayliss *et al.*, 2007).

Constructing chronologies is a means of imposing order on the past, long a goal of archaeologists (Wood, 2015), with an emphasis on increasing precision (Lucas, 2015). Bayesian analysis can be used to produce far more precise chronologies than is possible through visual inspection (Whittle *et al.*, 2011; Otárola-Castillo & Torquato, 2018). The results of Bayesian analysis for groups of radiocarbon dates can be, at >95% confidence, at a decadal resolution (Bronk Ramsey, 2008). However, it should be noted that the chronologies produced are models, simplified representations of reality based on a limited sample of data. By definition, all models are incorrect. It is the degree to which they are incorrect which is important. As long as the informative prior beliefs (the archaeological information) are correct, date estimates produced through Bayesian analysis are unlikely to be ‘importantly’ wrong (Bayliss *et al.*, 2007). Outliers and errors are often the result of misinterpretations of the contexts from where samples were obtained (Bronk Ramsey, 2009). Additionally, in a Bayesian framework, prior beliefs about the data being analysed are explicitly and formally included in the process of analysis (Otárola-Castillo & Torquato, 2018; Waddington *et al.*, 2018) meaning that the assumptions and potential biases of researchers can easily be seen and if necessary, remedied.

Bayesian analysis of radiocarbon dates has clear practical advantages. It is a cost-effective means by which to improve the chronological resolution of scientific dates (Bronk Ramsey, 2008). The technique also allows us to make new interpretations of existing archaeological data. It has been pointed out that the visual inspection of dates leads to the over-estimation of the duration of the events being dated. For British prehistory, this has had the effect of eliding events centuries apart, equivalent to being unable to meaningfully separate the Black Death, the introduction of enclosure laws and the establishment of the Church of England in time (Whittle *et al.*, 2011). Given the resolution of current chronologies, we can only look at change in the archaeological record on a long-term basis, with events ‘smeared’ over periods of uncertainty (Bayliss, 2009: 142).

Using the more precise chronological models produced through Bayesian analysis of radiocarbon dates allows us to understand the tempo of archaeological phenomena better (Hamilton *et al.*, 2015): changes may well have happened over short, as opposed to extended, periods of time (Whittle *et al.*, 2011). More precise chronologies mean that we can start to look at change at the level of individuals and generations, and in the context of their agency and choices (Bronk Ramsey, 2008; Overhöltzer, 2015; Whittle *et al.*, 2008; Whittle *et al.*, 2011). We can begin to see that prehistoric societies were more dynamic than perhaps once thought, with some changes happening rapidly, and with shorter occupation periods for settlements (Bayliss, 2009).
Bayesian approaches are therefore particularly useful when considering past human agency. While researchers studying British prehistory have constructed theories regarding personhood, worldviews and agency working within a coarse chronological framework (Whittle *et al.*, 2008), it is only really when working at the resolution of individual human lifetimes and generations that we can begin to understand how events were experienced at the time of their occurrence. Human agency is relational, based on contextual memories and knowledge, and as such is situated in specific points in time – it is not timeless (Whittle &

Bayliss, 2007). Archaeology is set apart by the ability it offers to study change in human societies over the long term (potentially forced by a lack of refined chronologies [see Whittle *et al.*, 2008]). The more precise chronologies afforded by Bayesian analysis offers a greater degree of choice in the interpretations that we as archaeologists make. Precise chronologies allow us to better understand events as they were experienced at the level of individual lifetimes and agents, to explore short term changes or more long term economic or environmental processes (Whittle & Bayliss, 2007; Whittle *et al.*, 2008; Whittle *et al.*, 2011).

3.9 Critiques

Despite the advantages outlined in sections 3.7 and 3.8, Bayesian analysis has been criticised on the basis of a perceived lack of scientific objectivity. This critique is based on the idea that researchers can pick and choose aspects of their analyses to suit their own preconceptions. Some subjectivity is inherent in the prior beliefs used to create Bayesian models, but transparency about the choices made during the construction of models can mitigate against this possibility (Hamilton and Krus, 2018). Some critics of the method have gone as far as to state that Bayesian approaches in general are entirely unscientific (Steel, 2001).

Accuracy of the chronologies produced through Bayesian modelling of radiocarbon dates has also been cited as a concern (Steier & Rom, 2000). Assumptions about prior probabilities can create artefacts in data, resulting in calibrated dates that are more precise, but less accurate than results produced by classical statistical analyses (*ibid.*).

However, the inclusion of agreement indices in OxCal, software commonly used to carry out Bayesian analysis, can highlight where there are inconsistencies between the data and the prior. The need to choose prior information carefully and the fact that the results of Bayesian analysis are models was noted; there is no one single correct answer, only a model that helps best interpret the data. Best practice, it is suggested, is to apply several models, each with different priors, to the same data. If the results are similar, this would demonstrate that the conclusions are not sensitive to the priors (Bronk Ramsey, 2000). Choice of priors can have a marked impact on interpretations. For example, while the initial results of the Beaker People project (Parker Pearson *et al.*, 2016) supported the idea of diffusion of Beaker material culture and cultural practices from an initial core area, changes in model choices led to final results indicating that this process was diasporic (Parker Pearson *et al.*, 2019).

Issues around the strength of the connections between analysed samples and the activity being dated have also been raised in the context of Bayesian analysis of radiocarbon dates (Reece, 1994). However, issues of residuality, intrusivity and 'old wood' effects are not unique to samples being analysed in a Bayesian framework, and if taking into account agreed best practice around using single-entity samples from secure contexts (see Ashmore, 1999), they can be mitigated against. Ensuring a strong link between the material being dated and the event we, as researchers, are interested in dating is of key importance (e.g. Waterbolk, 1971).

In the past decade or so, the popularity of Bayesian analysis in archaeology has increased massively, although the quality of some of these studies is in doubt, with issues regarding sample selection and reporting of results (Bayliss, 2015; Pettit & Zilhão, 2015).
Because the chronological models produced through Bayesian analysis are interpretative constructions based on an understanding of data at a particular point in time (Bayliss, 2015; Bronk Ramsey, 2000), they can, and should be, updated as new information comes to light (Bayliss, 2015). Therefore it is important that published studies 'show their workings' – that they make their choices at each stage in the modelling process, from sample and prior selection to modelling choices clear. Key details regarding samples and their selection, laboratory processes and model construction are often missing from published studies where Bayesian analysis has been applied. Detailed reporting in all these areas would mean that researchers can verify the quality of these studies and therefore how readily to accept their results (*ibid.*).
Archaeologists are not generally trained in statistics or mathematics and can view Bayesian analysis as a 'black box': as the available software becomes more sophisticated and user-friendly, less of an appreciation of the technique's mathematical and philosophical underpinnings are required to produce analyses (Buck and Meson, 2015). Flawed or poorly informed applications of Bayesian methods consequently lead to flawed results, and Bayesian analysis software should not be treated as a 'black box' (see Bronk Ramsey, 2008), into which information is fed and from which results are obtained - it is important for archaeologists using these techniques to have a grounding in the theory behind Bayesian analysis (Pettit & Zilhão, 2015; Hamilton & Krus, 2018).

3.10 Conclusion

Bayesian analysis is the most recent of a series of revolutionary changes in how archaeologists build chronologies using radiocarbon dates. Although it has been in use in archaeology since the 1990s, it is only from the 2000s onwards that its application to archaeological research questions has become widespread, and the technique has become increasingly popular.

Using Bayesian analysis to produce archaeological chronologies has several distinct advantages. The principle of the technique can easily be grasped by archaeologists, given its similarity to Hodder's (1997) hermeneutic spiral, and its emphasis on the iterative process of building models of multiple possible pasts based on the evidence as we understand it at a given point in time. Intuitively, interpretations built on multiple strands of evidence are more secure than those based on a single strand, and Bayesian analysis offers a means to combine our archaeological knowledge with scientific information, aligning both traditional archaeological methods and the scientific turn ongoing in the discipline.

The prominent role of researchers' choices in creating Bayesian chronological models has, understandably been a key critique of their application in archaeology and other disciplines. When carrying out Bayesian analysis while adhering to best practice, researchers' decisions are explicitly and transparently included for the reader. Ensuring the quality of models is key (Bayliss, 2015), and if archaeologists are to use Bayesian analysis as a tool for interpreting the past, the underlying principles and theory need to be well understood (Bayliss, 2015; Buck & Meson, 2015; Hamilton *et al.*, 2015).

The key advantage of applying Bayesian analysis to build archaeological chronologies is the degree of precision that can be achieved, allowing us to answer ever more sophisticated and nuanced questions about the past. Previous methods of building chronologies, including traditional methods for interpreting radiocarbon dates, had led to a version of prehistory where social, cultural and economic changes were smeared across centuries of uncertainty, their true timing, tempo and duration obscured (Whittle *et al.*, 2008; Whittle *et al.*, 2011). In this framework, interpretations of the motives and experiences of people in the past can only ever be somewhat broad and vague. Using Bayesian analysis to interpret radiocarbon dates means we can begin to produce a more individualised prehistory, answering with greater nuance and confidence questions about the experiences of the people whose monuments, possessions, homes and remains we are studying

Chapter 4: Methodology

4.1 Introduction

This section outlines the methodology used to reconstruct the chronology of the Bronze Age settlement sites at Lairg, Sutherland, the key case study for this project. The methodology can be split into two main strands: the dating and modelling of archival charcoal samples (including sample identification, retrieval, species identification and radiocarbon dating), and palaeoenvironmental reconstruction (including sample retrieval, dating, pollen analysis and loss on ignition). Here, they are each discussed separately, with reference to relevant literature.

4.2 Charcoal

4.2.1 Sample identification and retrieval

The first step of the entire project was to take stock of the available material. As is generally the case in Scottish archaeology, the paper part of the Lairg archive (including administrative and financial documents, field excavation and survey records, and items as diverse as payslips and accommodation brochures), is kept separately from the artefacts and ecofacts recovered from the excavation, with the paper archive held as part of the National Record of the Historic Environment (NRHE), by Historic Environment Scotland in Edinburgh. The artefacts and environmental samples (the physical archive) were stored at the Inverness Museum, Inverness, now part of High Life Highland.

The paper archive comprises over 100 cardboard boxes, labelled from MS 1139/1 to MS 1139/106. The collection was viewed in its entirety, and the contents of each box were catalogued as part of this process. The whole physical archive was not catalogued, as only the charcoal samples were relevant to this project. However, all charcoal samples from the structures identified as prehistoric settlement evidence were viewed, and information including the context number and a brief description of each sample was recorded. In all, 1055 samples from six structures were recorded. A catalogue of this material has been included as Appendix 2.

The next key step was to link the physical samples with their paper records, in order both to identify samples of interest for re-dating, and to reconstruct (as far as possible) the stratigraphy of the samples selected. This involved working systematically through the context records in the paper archive, looking for contexts with the potential to provide strong dating evidence. All contexts with corresponding charcoal samples were noted, and a description of each of these contexts and their stratigraphic relationships was recorded.

Contexts were identified as being of interest based on their function (as described in the archived context records) and the taphonomy of any charcoal found within them. It was important that charcoal sampled was not intrusive, and that it could be linked to a specific activity during the site's use. Hearth features, internal post-holes and filled gulley features were prioritised for sampling. Hearths were desirable as the deposition of charcoal within them is likely linked to their use, and therefore the use of the structure within which they were located. Internal post-holes and gulley features were also identified as potentially providing strong dating evidence, as charcoal found within them is likely to have been produced through everyday activities related to the use of each site, periodically swept in, for example, as the building was cleaned (Reynolds, 1995). It was also important to exclude contexts where there was evidence for disturbance, either by animal activity (e.g. burrowing, which can result in intrusive, later material being pulled down through the soil matrix), later agriculture, or other means. Charcoal from 'soil layers' or tillage-related contexts was avoided on the basis that a secure relationship between any dated material and the activity that material represented could not be established.

Sample selection focused primarily on material related to the construction and use of the roundhouses at Lairg, rather than any pre-roundhouse activity (aside from SUERC-92838, derived from a Beaker burial context below House 2, which was used as a *tempus post quem* for that building). This was because the focus of this research was explicitly on Bronze Age settlement activity in upland areas.
Charcoal from contexts identified as being of interest for dating was then retrieved from the physical archive in Inverness, in the form of sub-samples decanted from the larger bags kept in the archive. These were taken to SUERC for wood species identification and radiocarbon dating.

4.2.2 Wood species identification

A key consideration in radiocarbon dating is that the sample being dated relates as directly as possible to the event we are trying to date. This impacts not only on considerations of sample taphonomy, but on considerations of inbuilt age in the samples themselves. Charcoal samples for dating were selected from contexts identified as of interest to this project (as described above). Single-entity samples were preferred, avoiding potential offsets (eg the 'old wood' effect [Ashmore, 1999]) caused by the incorporation or use of heartwood, particularly from long-lived species (Brock *et al.*, 2010). Species identification was carried out on all dated samples. For the first five dated samples, wood species identification was carried out by Dr Anne Crone (AOC Archaeology). For all other samples, wood species identification was carried out at SUERC, by the author (with reference to Schweingruber, 1990). Charcoal samples from short-lived species such as alder, hazel and willow were selected for dating, as the age at death of the sample is unlikely to be far removed from the time that the context from which they were retrieved was formed – all of these species have average lifespans of <100 years.

4.2.3 Dating

Charcoal samples were treated following an acid-base-acid protocol, as outlined in Dunbar *et al.* (2016). Samples were weighed, and 100 ml of 0.5M hydrochloric acid (HCl) was added to each. Samples were then covered and placed on the hotplate at c.80 ˚C for two hours, to remove carbonates and acid-insoluble contaminants. Samples were removed from the hotplate, and once cool, the solution was decanted and disposed of. Next, 100 ml of 0.5M sodium hydroxide (NaOH) was added to each sample, and samples were again covered and returned to the hotplate at c.80 ˚C for two hours, to remove alkali-soluble contaminants. As in the previous step, the solution was cooled and decanted, and a final acid step was repeated, neutralising any excess NaOH. Samples were then rinsed with ultrapure MilliQ® water and left to dry (uncovered) overnight. Once dry, samples were weighed into small glass tubes, ready for graphitisation.

For graphitisation, 10–20mg of each sample was weighed into clean quartz inserts, then placed into precleaned quartz combustion tubes. The tubes contained copper oxide (providing oxygen for the combustion reaction) and silver foil (in order to remove any gaseous impurities). Samples were converted to graphite, which was then pressed into aluminium cathodes for AMS (Accelerator Mass Spectrometry) analysis. For AMS measurement, samples were divided into groups, and natural graphite standards are included with each group. This is to measure background 14C activity. 14C/13C ratios were calculated and the average background value determined, and 14C results calculated as outlined in Dunbar *et al.* (2016). All chronological models were constructed in OxCal 4.4.2 (Bronk Ramsey, 2020) using the IntCal20 calibration curve (Reimer *et al.*, 2020). OxCal commands and modelled determinations are shown in italics.

4.3 Palaeoenvironmental reconstruction

4.3.1 Sample Retrieval

Originally, it was intended to sample peat cores from two sites previously sampled as part of the Lairg Project (1988–1996). Reconstructing the landscape through time, and understanding the relationship between settlement and the environment, was an important aspect of that project, and three peat cores were taken from sites in the vicinity of the excavation area.

Two of these sites were selected for inclusion in this programme of sampling: AG3, directly adjacent to a cluster of hut circles, and AG1, on the shores of Lochan nam Peathraichean. This was decided on the basis that data from AG3 (a small peat basin, likely to have a local pollen catchment) would directly reflect events at the Bronze Age settlement site, while AG1 would provide evidence for activity in the wider landscape. It is widely accepted that both empirical and theoretical modelling approaches indicate that the relevant source area for pollen (RSAP) changes according to the size of the sediment basin sampled, from c.50–100m for small basins to c.600–800m for medium lakes (Sugita, 1994; Calcote, 1995; Bunting *et al.*, 2005).

The sample sites were located using maps included in the Lairg Project monograph (Tipping, 1998) and descriptions from personal communication and meetings with the authors. These maps were approximate, and site locations had not been recorded with a GPS. A series of exploratory transects in the parts of the landscape fitting the described locations was undertaken, and initially it was difficult to identify a suitably deep deposit for sampling near the AG3 site; the original core taken here was c.2.7m in depth. The peat in the area was thought to be largely topogenous, rather than blanket peat, as it had previously been described.

A suitable location near the AG3 site was eventually identified, directly below the Allt na Fearna quarry escarpment, above which the Lairg Project excavations took place. While attempts were made to retrieve samples from the AG1 site, the ground here was too dry to extract cores. Coring was undertaken by the author, along with Dr Ben Gearey and Dr Kevin Kearney (University College Cork).

4.3.2 Dating

Initially, eight depths from the AG3/19 core were sampled to obtain rangefinder 14C dates. Samples were sent from University College Cork to SUERC and pre-treated using a modified acid-base-acid approach, as outlined in Dunbar *et al.* (2016). Both humic acid and humin fractions were dated, and preliminary age-depth models were constructed, providing oldest and youngest possible models for the palaeoenvironmental data.
Following examination of the models produced using the rangefinder dates, it was decided to take further dating samples at 5cm intervals, again from core AG3/19A. These, like the earlier samples, were processed according to the following description.

Radiocarbon dating is one of the most commonly used methods to construct chronologies for peat deposition (Piotrowska *et al.*, 2011), as peat develops from organic material. Under the right (anaerobic and/or acidic) conditions, dead plant matter does not fully decay, and instead builds up, forming peat deposits. As with the dating of other types of samples, taphonomy is a key consideration when selecting peat for radiocarbon dating, and for selecting the fraction to be dated. Species identifiable plant macrofossils (e.g. non-root parts of mosses such as Sphagnum, or dwarf shrubs such as Calluna or Ericacaea) are the most likely type of sample to reflect the time at which the plants forming the peat died, and are generally preferred for dating. However, in well humified samples this is not always possible, and in these instances either the whole ('bulk') sample, the humic acid, or the humin fraction can be radiocarbon dated (Hamilton *et al.*, 2007; Piotrowska *et al.*, 2011; Dunbar *et al.*, 2016). The humic acid fraction is produced through the in situ decay of the plant material making up the peat, while the humin fraction is other, alkali and acid-insoluble organic material. Of these, the humic acid fraction is preferred. This is because peat generally forms in acidic environments, and as humic acid is acid-insoluble, it is less likely to be mobile with groundwater fluctuations, while the humin fraction can contain intrusive material, either inwashed, producing a date older than the context, or introduced through bioturbation or wet-dry cycles, resulting in a date that is too young. There is also the possibility that the humin fraction could be contaminated by geological-age carbon (Hamilton *et al.*, 2007). Generally, both the humic acid and humin fractions are dated, as agreement between the two can provide confidence in the results (Dunbar *et al.*, 2016).

Peat samples were pre-treated broadly as outlined in Dunbar *et al.* (2016), using a modified acid-base-acid approach. This approach is designed to remove sedimentary/contaminant carbonates, any acid contaminants, then any dissolved atmospheric CO2 which may have been absorbed by the sample during the base/alkali wash step (Brock *et al.*, 2010).
Samples were weighed and placed into large glass beakers (generally used for samples >5g). 600ml of 0.5M HCl was added, and the beakers were covered and placed on a hotplate for 2 hours. The acid was decanted from the samples, and 600ml of 0.5M NaOH was added. The beakers were covered again and returned to the hotplate for another 2 hours.
Once the samples had been removed from the hotplate, the extract (the humic acid) was decanted into fresh beakers, labelled with the relevant identifying GU numbers. The residual material (the humin fraction) was retained. Around 40ml of concentrated (in excess of 4M) HCl was added to the beakers containing humic acid, and they were placed on the hotplate until a precipitate formed. They were then removed from the hotplate, and the precipitate was allowed to settle. 100ml of 0.5M HCl was added to the beakers containing the humin fraction, which were then placed onto the hotplate for c.1 hour, before also being removed, allowing the residue to settle.
Once cooled, the liquid was decanted from all samples (both humic acid and humin fractions), and the solid material remaining in the beakers was transferred to centrifuge tubes, labelled with the corresponding GU numbers. Samples were rinsed with distilled water on three-minute cycles of the centrifuge, until the supernatant appeared clear. This was then decanted from the samples, and they were placed (still in the labelled centrifuge tubes) into the freezer. Once frozen, the tube lids were replaced with glass paper covers, and samples were placed into the freeze dryer for at least 24 hours. Once the freeze-drying process was complete, the samples were transferred to labelled glass vials. The post-treatment weight of the samples was recorded. Samples were then graphitised and submitted for AMS analysis.

4.3.3 Loss on ignition

Samples for loss on ignition (LOI) were taken from every 2cm from 10–200cm in the AG3/19B core, and measured approximately 1cm3. Samples were placed, in batches of 12, into an oven set to 100°C to dry overnight. They were then placed into crucibles (the empty weight of which had been recorded), weighed, and left in a furnace set to 550˚C for four hours. Once cool enough to handle, the crucibles containing the samples were removed into a desiccator until they could be weighed for a second time. They were then weighed again, and discarded. The difference between the pre- and post-ignition weights was used to determine the percentage of organic material the sample had contained (Heiri *et al.*, 2001).

4.3.4 Pollen analysis

Samples of approximately 1cm^3 were taken from core AG3/19 at 2cm intervals, taking care to sample from the central part of the core to avoid possible contamination. 1g sub-samples were then taken and placed in polyethylene centrifuge tubes. One tablet containing *Lycopodium clavatum* spores was added to each tube. A series of steps including washing, sieving, gravity separation and acetylosis (Magri & Di Rita, 2015) was then carried out, beginning with the addition of 10ml 10% HCl to each tube. Tubes were then placed in a bath of boiling water for 20 minutes, removing calcium carbonate ($CaCO_3$), and 2ml of methanol (CH_3OH) was added to each tube, reducing the sample's specific gravity. Samples were centrifuged, washed twice with deionised water (with 2ml of methanol added each time), centrifuged and decanted again.

To remove humic acid, 10ml of 10% NaOH was added to each sample, before they were placed in a bath of boiling water for 2–3 minutes. Samples were then sieved through a 60 μm mesh, removing larger mineral material and organic matter. Samples were washed a further five times with deionised water, again with 2ml of methanol added, and then centrifuged until the supernatant appeared clear. After this, samples were examined under a microscope, to ensure that inorganic material had been removed. If inorganic material was still visible, samples were transferred to labelled HF tubes (50ml polyethylene centrifuge tubes with caps), before being washed with 10ml 10% HCl to remove remaining calcium carbonate, centrifuged again and decanted. Then, if necessary, hydrofluoric acid (HF) treatment was carried out. In these instances, 10ml of 60% HF was added to samples, inside a fume cupboard. They were placed in a bath of boiling water for 25-30 minutes, stirred every five minutes with a polyethylene rod. After this, tubes were filled with methanol, reducing the specific gravity of the samples, then centrifuged and decanted into a calcium carbonate solution. This process also took place within the fume cupboard. Once the HF had been decanted, 10ml 10% HCl was added to each sample. Samples were then placed in a bath of boiling water for 20 minutes, removing colloidal silicates and silico-fluorides. 2ml of methanol was then added to each sample. They were centrifuged, and then decanted.

Following this, samples were again washed with deionised water and 2ml of methanol, centrifuged and decanted, before acetolysis digestion was carried out, removing all non-pollen organic material. Samples were twice washed in glacial acetic acid (CH_3COOH), centrifuged and decanted, removing all water in order to avoid a reaction with the acetolysis solution (comprising 9ml acetic anhydride [$(CH_3CO)_2O$] and 1ml concentrated sulphuric acid (H_2SO_4). The solution was added to each sample, which were then placed in a water bath at

100˚C for two minutes, stirred after one minute. They were the removed from the water bath, 42 and 10ml of glacial acetic acid was added to each sample, they were centrifuged and decanted.
Samples were again washed in deionised water and 2ml of methanol, centrifuged and decanted. Deionised water and drops of 10% NaOH were added to each sample until they had reached a pH of around seven (to allow for staining). They were then centrifuged and decanted again, and a drop of aqueous safranin and 50ml deionised water was added to each tube to stain the samples, assisting identification of pollen and other microfossils. Samples were centrifuged and decanted again, before 10ml of tertiary butyl alcohol (TBA) was added to each sample, centrifuged and decanted. TBA was then used to wash the samples into labelled glass vials, and silicone oil was added to each vial. The samples were left uncovered for at least 24 hours to allow the TBA to evaporate (adapted from Kearney, 2019, pers. comm.).

Small drops of the samples were placed onto labelled microscope slides and covered with coverslips. Pollen was counted (at least 500 grains per slide, excluding non-terrestrial plants, spores and Lycopodium clavatum, to ensure counts were representative), noting the species/type of each grain, and results were analysed in Tilia (Grimm, 2010) software to produce relative percentage pollen diagrams.

4.4 Conclusion

There were diverse strands to this project, and the above description is a simplified outline of what were sometimes iterative processes. The lab-based aspects of this research used established procedures and analytical techniques. There is also a well-established practice of using archived excavation material and other items from museum collections as part of radiocarbon dating programmes (e.g. Garrow *et al.*, 2009; Needham *et al.*, 1997; Whittle *et al.*, 2011; Whittle, 2018), although over the past decade or so studies exploring chronologies for Bronze Age society in Britain and Ireland have tended to focus on the use of published or existing radiocarbon dates as a form of 'Big Data' (e.g. Armit *et al.*, 2014; Caswell & Roberts, 2018; McLaughlin *et al.*, 2016; Turney *et al.*, 2016). New dates from carefully selected archival samples allow for greater control of the various sources of uncertainty inherent in radiocarbon determinations (outlined in Hamilton & Krus, 2018; Wylie, 2020).

Chapter 5: Settlement Chronologies from Lairg

5.1 Introduction

This chapter details the archaeology and chronology of prehistoric settlement at the Allt na Fearna quarry, Lairg. A series of roundhouses, the majority of which were radiocarbon dated to the 2nd millennium BC, were excavated here in the 1990s as part of the Lairg Project, and the site has since been something of a 'type-site' for narratives of Bronze Age upland settlement in Scotland. This is primarily because of the total number of radiocarbon dates (139) that were produced during the course of the Lairg Project, including dates from both environmental and archaeological contexts (McCullagh & Tipping, 1998).

Because Lairg has been such an influential site in narratives for Bronze Age upland settlement in Scotland, it is all the more important to ensure that the chronology for the site is as accurate and precise as possible. Continuing progress in methods for producing and interpreting radiocarbon dates (discussed in Chapter 4) means that modern chronologies are far more precise than was possible at the time the Allt na Fearna site was excavated, and the routine use of AMS dating of single-entity samples mitigates against the possibility for any old wood effects (see Ashmore, 1999). This project provided an opportunity to update the accepted chronology for prehistoric settlement at Lairg, with new dates being produced (as outlined in Chapters 1 and 4), and new chronologies defined through the use of Bayesian statistical analysis.

5.2 Lairg: an overview

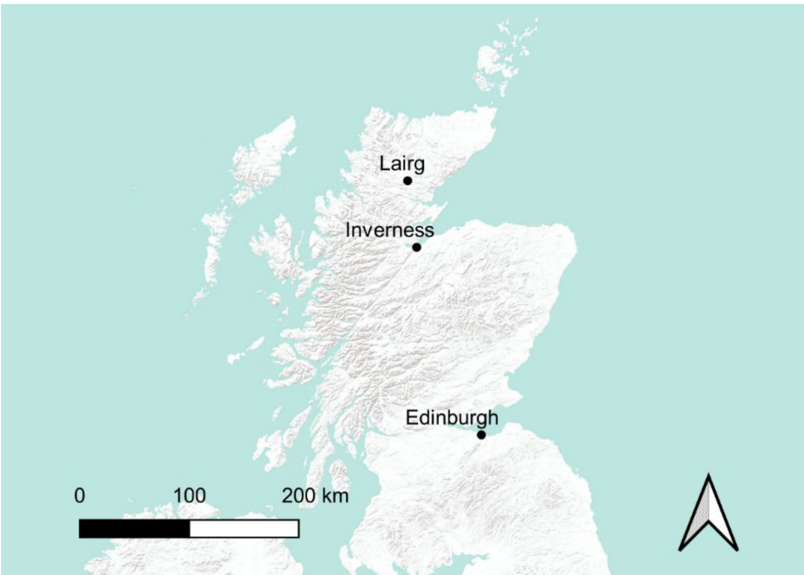

Figure 3: Map showing Lairg.

A desk-based assessment of Lairg and its environs was undertaken, using Canmore, the online catalogue for Scotland's National Record of the Historic Environment, local authority historic environment records, historic maps that were primarily accessed through the National Library of Scotland's website, and the Edina DigiMap historic mapping function. Academic literature and historic sources were also consulted.

The landscape around the village of Lairg, Sutherland (Figure 3), contains the remains of millennia of agricultural activity. A review of available data shows that within c.140 km^2 of Lairg Station (the nearest consistently identifiable point to the site excavated as part of the 1990s Lairg project) there are over 500 sites of archaeological interest, ranging from prehistoric hut circles, burnt mounds and monuments to rig and furrow, the remains of townships and a modern hydroelectric power station. One hundred and forty of these sites are recorded by Canmore as being prehistoric, and a further 10 have been assigned Neolithic or Neolithic/Bronze Age dates. There are also 11 scheduled monuments in the area.
Sutherland, the historic county in which Lairg is located, lies north of the Moray Firth. The archaeology of the region has had diverse cultural influences, from Scandinavia and Orkney to its north, from the rest of Scotland and continental Europe, to which it is connected by the North Sea. Most of the region's archaeology is concentrated in its south and east, along river valleys such as that of the River Shin (Gourlay, 1996).

Lairg appears only sporadically on maps from the late 16th century onwards, although some (e.g. Ortelius's c.1580 *Scotula tabula* and Mercator's c.1595 map of Scotland) show Loch Shin. In late 16th century maps, and the majority of 17th century maps of the area, Invershin (spelled variously as Innershyn or Iners hin) appears more frequently than Lairg. The first appearance of Lairg on a map of the area is c.1636–52, on Robert Gourlay's map of Scotland north of Loch Linnhe and west of the River Deveron, marked by what appears to be a church or other ecclesiastical building, differentiating it from the other nearby settlements. This indicates Lairg's importance, in a time when ecclesiastical and political power were closely linked. Sallochy, on Loch Shin, and Achany, where a great deal of the Lairg Project fieldwork was carried out in the 1980s and 1990s are also shown. Lairg also appears on Robert Greene's 1679 'New map of Scotland with the roads' (marked as 'Larg'), Frederik deWit's 1680 map and Jean Baptiste Nolin's 1690 map of Scotland, as well as Blaue's late 17th/early 18th century map.

Roy's military survey is the only pre-Ordnance Survey topographic map available for Scotland. Lairg is shown, and it is possible to ascertain some details about the surrounding landscape. Between Lairg and Invershin it is possible to make out some arable land extending onto what appears to be higher ground (although there are no contour lines).
Most of the known archaeology in the area is located in or near to settlements (namely the village of Lairg itself) and local transport infrastructure. This is unsurprising, given that archaeological recording often occurs in the context of development. Additionally, sites within the local landscape may have undergone cycles of use and reuse throughout the history of human occupation of the area due to favourable attributes – perhaps well-drained or less exposed sites.
Most of the archaeology around Lairg is on relatively high ground, around or above 100m OD. This bias towards higher ground in the archaeological record is likely (at least partially) to be the result of the differential survival of remains on high and lower ground, with archaeology on lower ground being more likely to be destroyed or rendered less visible because of later farming or settlement activity. This is evidenced by differences between first and second edition six-inch Ordnance Survey maps of the area. On the first edition OS map, surveyed in 1873 and published in 1879, a site marked 'Tumuli and Hut Circles' is shown as visible remains in open ground. By the time the 1908 second edition map of the area was surveyed, in 1903, the site was now part of a system of fields, with the site marked as 'Site Of' tumuli and hut circles, indicating that its remains had been obscured or obliterated.

5.2.1 The Mesolithic to Bronze Ages

Although there are few known Mesolithic sites in the historic county of Sutherland, Neolithic remains, like chambered cairns, are common, often sited in prominent places within the landscape (Gourlay, 1996). Only ten sites included in the desk-based assessment of the area around Lairg were assigned to the Neolithic or Bronze Age, although a further 140 are described as being either prehistoric or possibly prehistoric, including hut circles, burnt mounds and other monuments.
Near Lairg, there are two chambered cairns on the Ord Hill (the Ord North and the Ord South), suggesting the hill was a focal point for activity in prehistory. There are three later round cairns and a burnt mound at the site, as well as a possible henge or defended farmstead c. 26m in diameter (*ibid.*).
In terms of henges, stone circles, and megalithic monuments more generally, there are several in the direct vicinity of the Lairg Project study area. At Drum Bhaile Fuir, Achany, the stone circle has settings for ten stones, although by the mid-1990s, nine of these had fallen and only three were left at the site. At Achinduich, also in Achany Glen, there is a double

stone circle, although few of the stones of either the inner or outer circle remain standing. On the banks of the River Shin near Lairg, there are supposedly two stone circles, known as 'Twinners', although Gourlay (1996:44) describes them as being 'unconvincing', suggesting the southern circle may in fact be a hut circle, and noting that both are heavily overgrown. There are also two standing stones at Invershin Farm.

There is a proliferation of Bronze Age hut circles and settlement remains in Sutherland (Cowley, 1996; Gourlay, 1996), mostly found in groups of two or three, but sometimes in groupings of up to 30, with associated banks and clearance cairns. These are usually found on higher ground, perhaps because, as discussed elsewhere, those built on lower ground have been destroyed by later farming activity. Gourlay (1996) notes substantial clusters of hut circles and associated farming remains in the parishes of Farr, Rogart, Eddrachilles, Durness, the Strath of Kildonan and Dornoch. During the course of desk-based research, 123 sites within the study area were described as being hut circles, platforms or roundhouses, with a further six described as settlement sites, including one enclosed settlement. Over 120 sites in the area were described as having an agricultural function (enclosures, dykes, field systems etc.) although only 102 of these were not assigned to the medieval or post-medieval periods and these types of site are generally difficult to date. The Migdale Hoard, a significant Early Bronze Age hoard, was discovered at Bonar Bridge, c. 10 miles from Lairg (Anderson, 1901).

5.2.2 The Iron Age

Iron Age remains are also visible in the county, in the forms of brochs and duns (including some vitrified duns), and five crannogs also were noted as part of the desk-based assessment. Gourlay (1996) lists several Iron Age monuments in the vicinity of Lairg, including a broch at Sallachy, on Loch Shin, which was heavily rebuilt during the Victorian period. He also includes brochs at West Shinness, Ferry Wood and Dalchork in his gazetteer, and a possible crannog on Loch Shin. It is also likely that at least some of the roundhouse/hut circle/platform sites recorded during the desk-based assessment date to the Iron Age.

5.2.3 The medieval and modern periods in Sutherland and at Lairg

There is little available information on the medieval period in the area around Lairg, due to a lack of documentary sources. The majority of the county was under the control of the Earls and Dukes of Sutherland from the medieval period into the 20th century. This includes Lairg itself, although (at least by the 18th century) the small Gruids estate was located just to the west of the town (Bangor-Jones, 2002). The Sutherland family were extremely wealthy; by 1850, the Duke of Sutherland was the largest landowner in Western Europe, with a Scottish estate covering 1.1 million acres.

The population of this estate peaked in 1861 at 25,246 people (Tindley, 2010), although populations had been growing since around 1740. This growth in population would have put a great deal of pressure on the estate's land, which was not famous for its fertility: in the later 19th century, large sheep farmers often had to send their flocks to Caithness and Ross-shire for winter feeding, as enough grain could not be produced in Sutherland (*ibid.*). Moorland was colonised as shielings became permanent settlements and outfield land was converted to inbye (McCullagh, 1993). The low fertility of the land in Sutherland can probably be at least partly attributed to damp ground conditions (Tindley, 2010).

From c.1700 onwards there was an expansion in the cattle trade, leading to more intensive pasture use, and by the late 18th century, smaller tenants were being removed from their 48 land to create larger cattle grazings (McCullagh, 1993). These small tenants would have also grown oats and barley, with the former being more commonly found in upland areas, although in inland areas people were often reliant on imported grain (*ibid.*).

Some sheep farms had been established around Lairg by the late 18th century (Bangor-Jones, 2002). In the 19th century, sheep became the income source of choice, and then deer for shooting. By the 1860s the bulk of the estate's rental income came from large sheep farms and deer shooting tenants with only a small amount coming from tenants of small farms (Tindley, 2010). The settlements of Achimor and Achinduich, located within the Lairg Project survey transect, were cleared to make way for a large sheep farm, known as the 'Great Sheep Tenement' or 'Lairg Sheep Farm' between 1807 and 1808 (McCullagh, 1993).

From 1869 onwards, land reclamation 'on the largest scale ever attempted in Britain' (Tindley, 2010:35) took place across the Sutherland estate. The area around Lairg was one of the main areas of land reclamation, with 1500 acres (approximately) along the northern banks of Loch Shin being included in the scheme. The scheme ran there from 1870–1878, and involved ploughing, liming and fertilising the land. Despite the massive efforts which went into the land reclamation project, very little of the improved ground was still under cultivation by the 1890s (Tindley, 2010).

Due to falling wool prices, in the latter part of the 19th century the state struggled to find sheep farming tenants, and deer forests became the main source of income, and type of land use, on the estate. In the 1880s, land hunger (due to the increasing amount of land being given over to deer shooting tenants combined with the area's large population) had set in, leading to congestion in the estate's townships and overuse of land still available, impacting its productivity (*ibid.*).

5.2.4 Summary and significance

The above is a brief overview of the phases of land use around Lairg and in Sutherland more generally. The results of the desk-based assessment process indicate a landscape heavily impacted upon human activities over a period of millennia.

Agricultural land use (involving ploughing, trampling and erosion caused by pastured animals) will also have affected both upstanding and underlying archaeology. This is likely to have had the greatest impact on archaeology located below the post-medieval limit of cultivation 49 (generally seen in the line of head dykes), given the evidence for intensive agriculture, high populations and land improvements in the 18th and 19th centuries. This is likely to be a factor in the survival of Bronze Age settlement sites on higher ground.

5.3 The Lairg Project

The Lairg Project was a large-scale programme of survey, archaeological excavation and palaeoenvironmental reconstruction which took place between 1988–1996, as rescue archaeology in the context of the upgrading of the A836 road (see Figure 4), which runs between Ross and Cromarty to Caithness. During this project, a total of 198 sites were surveyed/recorded, and multiple sites were excavated, including the remains of eight prehistoric roundhouses at the Allt na Fearna quarry site (seen in Figure 4), in Achany Glen, close to the present-day Lairg Station. A programme of palaeoenvironmental reconstruction, involving pollen analysis from three different sites in Achany Glen, accompanied these excavations, providing an overview of land use in the area throughout prehistory.

The individual roundhouses were given unique ‘house’ numbers, from one to eight, and this is how the sites are described here. House 1 and House 4 were excavated as one site, as House 4 had been built on top of the remains of House 1. Furthermore, Houses 2, 3 and 6 were also excavated together, as the stratigraphy of the three buildings was connected and overlapped. Houses 5, 7 and 8 were excavated separately. However no suitable material for dating was recovered from House 8 during the course of either the works in the 1990s or this current research.

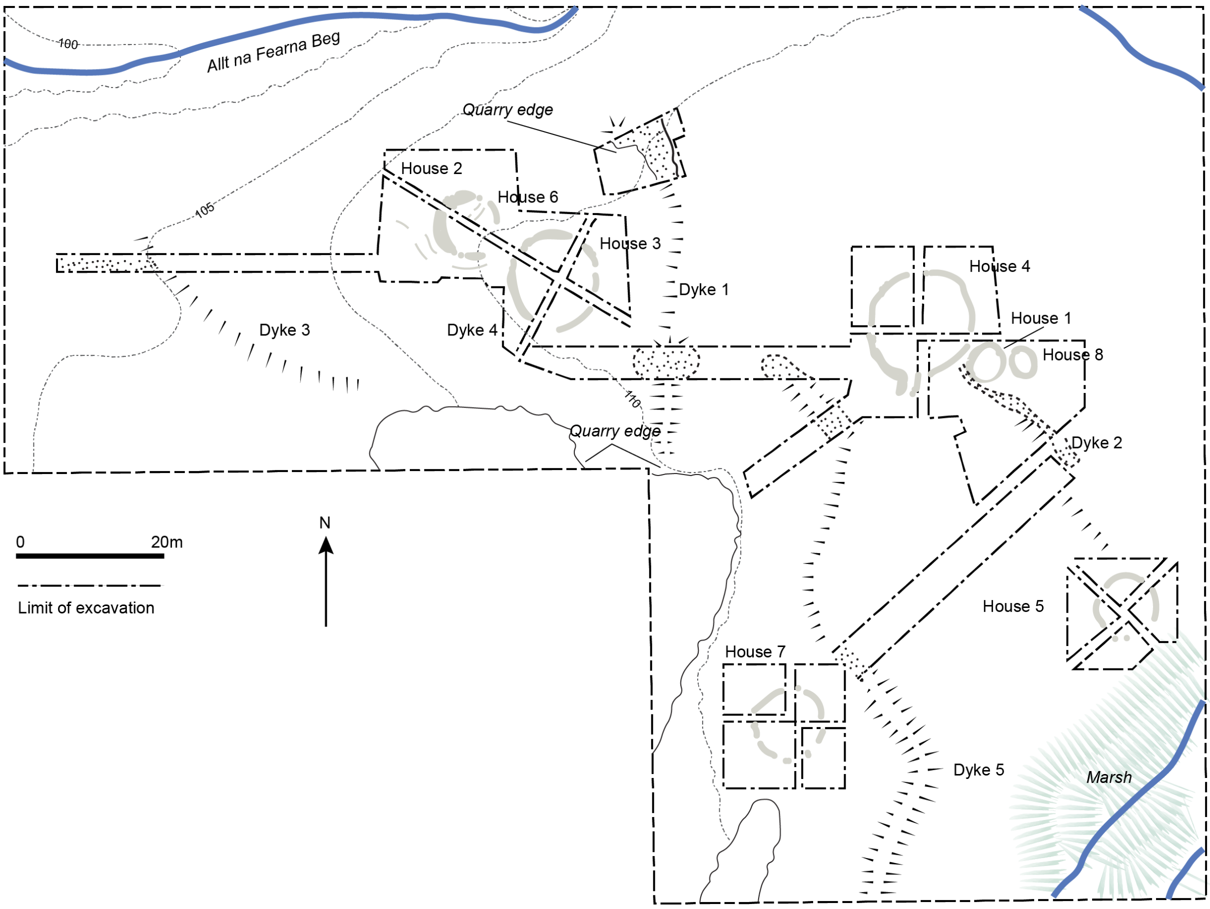

Figure 4: The extent of the excavations at the Allt na Fearna quarry site (adapted from McCullagh & Tipping, 1998: 32).

Lab ID	Context	Material	δ13C (‰)	Radiocarbon Age (BP)
GU-3162	3185	Bulk charcoal		3380±100
GU-3308	3634	Bulk charcoal		3380±60
GU-3310	3665	Bulk charcoal		3390±90
GU-3150	2243	Bulk charcoal		3190±50
GU-3152	2169	Bulk charcoal		3200±100
GU-3298	2477	Bulk charcoal		3250±50
GU-3303	2516	Bulk charcoal		3290±50
GU-3304	2522	Bulk charcoal		3300±50
GU-3141	2238	Bulk charcoal		3420±70
GU-3299	2483	Bulk charcoal		3430±70
GU-3300	2487	Bulk charcoal		3480±70
GU-3301	2501	Bulk charcoal		3520±80
GU-3149	2178	Bulk charcoal		3240±100
GU-3145	2228	Bulk charcoal		3280±70
GU-3144	2139	Bulk charcoal		3310±60
GU-3295	2193	Bulk charcoal		3430±60
GU-3147	2170	Bulk charcoal		6450±70
GU-3153	3321	Bulk charcoal		2930±90
GU-3156	3074	Bulk charcoal		3010±60
GU-3155	3321	Bulk charcoal		3100±110
GU-2853	7077	Bulk charcoal		3110±50
GU-2809	1109	Bulk charcoal		3150±50
GU-3154	3019	Bulk charcoal		3170±80
GU-2799	1105	Bulk charcoal		3180±50
GU-3159	3014	Bulk charcoal		3190±80
GU-2852	7076	Bulk charcoal		3220±60
GU-3160	3016	Bulk charcoal		3220±50
GU-3164	3271	Bulk charcoal		3220±60
GU-2851	7078	Bulk charcoal		3240±60

GU-3151	3003	Bulk charcoal		3240±50
GU-3166	3111	Bulk charcoal		3260±70
AA-10500	3131	Single entity sample		3300±50
GU-3157	3186	Bulk charcoal		3350±50
GU-3168	3131	Bulk charcoal		6410±70
AA-8788	4106	Single entity sample		2960±60
GU-3137	4030	Bulk charcoal		3010±70
GU-3293	2099	Bulk charcoal		2960±60
GU-3302	2515	Bulk charcoal		3010±70
GU-2801	4098	Bulk charcoal		3020±50
GU-3139	2133	Bulk charcoal		3040±50
GU-3146	2211	Bulk charcoal		3060±50
GU-3296	2215	Bulk charcoal		3100±50
GU-3142	2095	Bulk charcoal		3120±50
GU-3143	2136	Bulk charcoal		3170±50
GU-3140	2126	Bulk charcoal		5770±150
GU-3161	1045	Bulk charcoal		2070±90
GU-3169	1024	Bulk charcoal		2140±90
GU-3163	1124	Bulk charcoal		2220±80
GU-3167	1116	Bulk charcoal		2270±60
GU-3165	1134	Bulk charcoal		2290±60
GU-3171	1024	Bulk charcoal		5320±190
GU-3170	1070	Bulk charcoal		11200±550
SUERC-87275	3185	Charcoal (Betula)	-27.5	3196±24
SUERC-87276	3100	Charcoal (Corylus)	-26.2	3020±24
SUERC-87277	3111	Charcoal (Corylus)	-26.4	3096±24
SUERC-87278	3665	Charcoal (Betula)	-26.4	3272±24
SUERC-92824	3692	Charcoal (Alnus)	-27.1	3263±22
SUERC-92825	3458	Charcoal (Betula)	-25.8	3288±24

SUERC-92826	3277	Charcoal (Alnus)	-26.8	3136±22
SUERC-92827	3686	Charcoal (Betula)	-26.2	3228±24
SUERC-92828	3657	Charcoal (Corylus)	-26.5	3125±22
SUERC-92832	3638	Charcoal (Alnus)	-26.2	3233±25
SUERC-92833	3111	Charcoal (Corylus)	-26.5	3189±22
SUERC-92834	3277	Charcoal (Salix)	-27.9	3192±25
SUERC-92835	3293	Charcoal (Salix)	-26.9	3165±22
SUERC-92836	3462	Charcoal (Betula)	-26.0	3260±23
SUERC-92837	2180	Charcoal (Corylus)	-25.4	3324±22
SUERC-92838	2250	Charcoal (Alnus)	-26.9	3497±25
SUERC-92842	2123	Charcoal(Alnus)	-25.0	3253±22
SUERC-92843	2229	Charcoal (Corylus)	-26.3	3048±25
SUERC-92844	2130	Charcoal (Alnus)	-26.0	3003±25
SUERC-92845	2131	Charcoal (Betula)	-27.9	2902±22
SUERC-97907	1097	Charcoal (other)	-27.3	2179±29
SUERC-97911	4030	Charcoal (Corylus)	-29.7	3120±29
SUERC-97912	4098	Charcoal (Corylus)	-28.2	3181±29
SUERC-97913	4102	Charcoal (Alnus)	-25.8	3116±29
SUERC-97914	4042	Charcoal (other)	-25.6	6023±29
SUERC-97915	1024	Charcoal (Betula)	-25.1	2176±29
SUERC-97916	1045	Charcoal (other)	-27.8	2101±29
SUERC-97917	1116	Charcoal (other)	-25.8	2202±29
SUERC-97921	1124	Charcoal (Betula)	-26.5	2501±29
SUERC-97922	1090	Charcoal (other)	-25.2	2154±29
SUERC-97923	1110	Charcoal (other)	-26.7	2142±29
SUERC-97924	1068	Charcoal (Betula)	-27.0	2203±29

Table 1: Legacy (GU-) and new (SUERC-) dates from Lairg.

A total of eight contexts were dated both as part of the legacy dating programme and the new dating programme, namely contexts 3185, 3665, 3100, 3111, 4030, 1024, 1124 and 1116. OxCal's R_Combine function was used as a 'check' on the similarity of the legacy and new dates – the function is usually used to combine two or more dates relating to the same event/sample (see Hamilton & Kenney, 2015).

In this instance, only dates from contexts 3185, 3665, 3100, 1024 and 1116 could be combined, with attempts to combine the legacy and new dates from contexts 3111, 4030 and 1124 failing a χ^2 test (at *T=4.991, T=5.917* and *T=10.614* respectively). For all three of the contexts from which dates from the legacy and new dating programmes could not be successfully combined, the legacy dated programme had produced older dates than those from the new dating programme. It is possible that for those dates that could successfully be combined, this was only possible due to the large error margins on the legacy dates.

This indicates that at least some of the legacy dates from bulk samples at Lairg have an inbuilt 'old wood' effect (see Ashmore, 1999) – that the bulk samples contained wood older than the context being dated (either residual/reworked material or wood from long-lived species). Therefore, three models were constructed for each roundhouse: one containing only legacy dates; one containing only new dates, and a final model incorporating both new and legacy determinations, using a *Charcoal Outlier* model (see Bronk Ramsey, 2009b) with legacy determinations treated as charcoal outliers.

5.4 House 1/House 4

The archaeology of the House 1/House 4 site consisted of two superimposed roundhouse structures, with preceding, intervening and post-abandonment phases of agriculture. This site was located at the highest point of the excavated area of the Allt na Fearna site, adjacent to House 2. House 4 had been built over the remains of House 1, separated from that building by a layer of shallow, tilled soil. According to the site's excavators, House 4 was particularly prominent in the landscape at Allt na Fearna – the House 4 hut circle was around 15m in diameter.

5.4.1 House 1

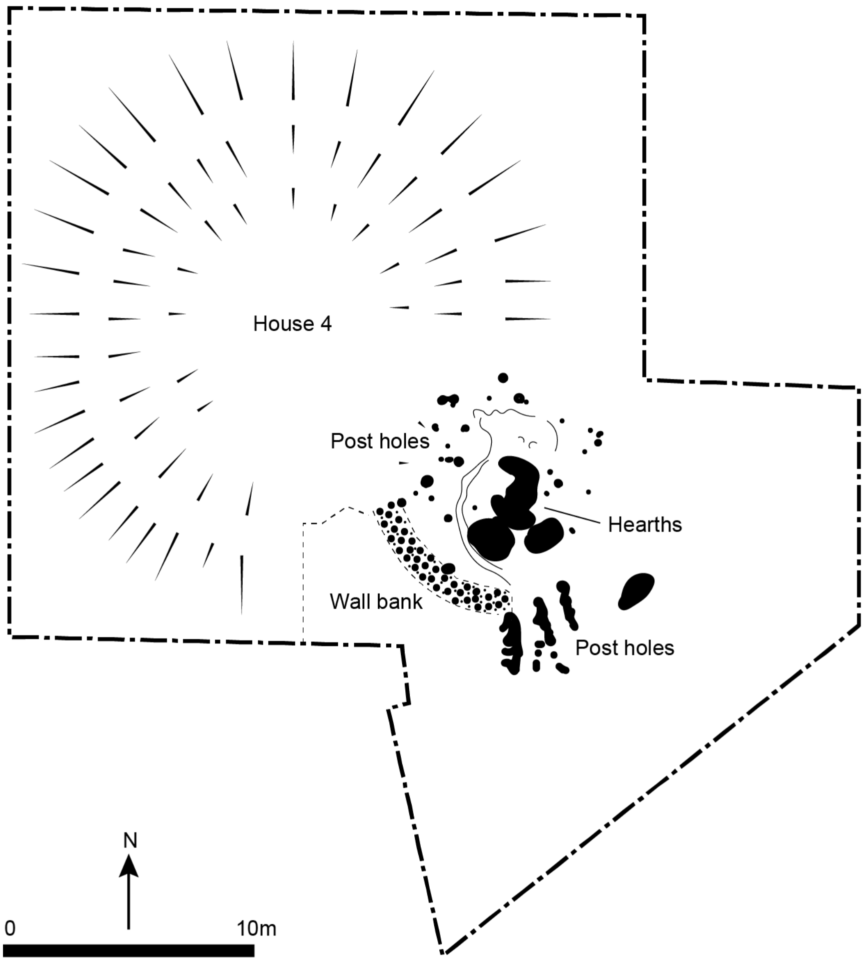

Figure 5: Plan of House 1 (adapted from McCullagh & Tipping, 1998: 39).

House 1 (Figure 5), the predecessor to House 4, had been built on previously tilled soil. This soil layer overlaid truncated pits and possible post-holes (interpreted as the remains of an earlier structure or structures). Based on radiocarbon dates derived from internal contexts, House 1 was given an 'approximate age' (McCullagh, 1998: 38) of the earlier 2nd millennium BC, with use of the building thought to have centred on the centuries around 1800 cal BC. The site was interpreted as having been domestic in function, with multiple hearth features identified.

The use of House 1 is thought to have been contemporary with the construction of Dyke 2, a field boundary built on top of ard-marked soil, leading excavators to conclude that the dyke represented the division of a previously open, cultivated area of land. This pre-dyke, pre-House 1 tilled soil also contained deposits of weathered pottery fragments (McSween, 1998), potentially indicating use of the site prior to the building of the roundhouse or field boundary.

5.4.2 House 4

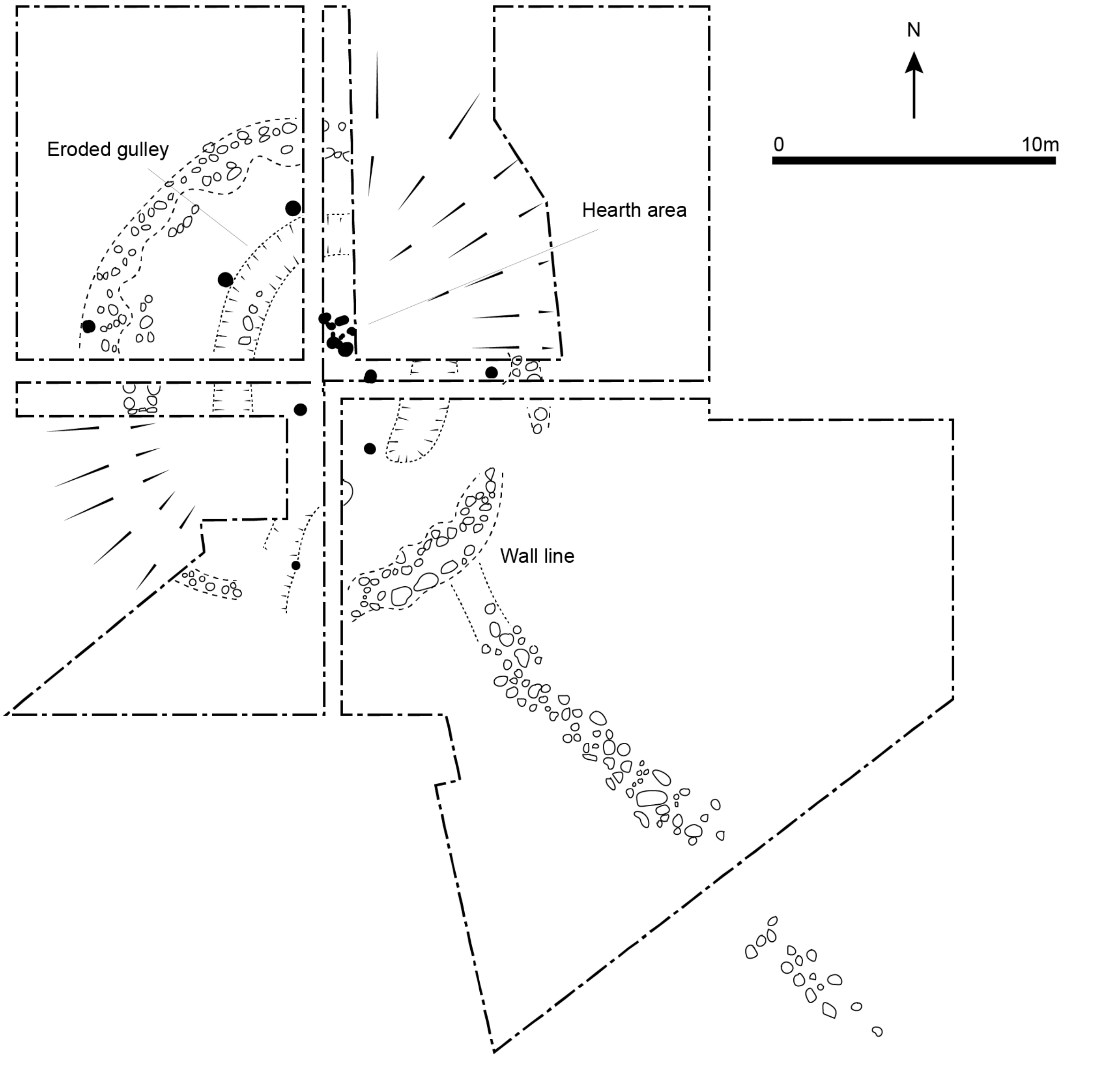

Figure 6: Plan of House 4 (adapted from McCullagh & Tipping, 1998: 47).

House 4 (Figure 6) was built directly on top of the remains of House 1, and was predominantly constructed from earth or turf, with stones embedded in the wall's outer face The southern part of the house wall incorporated courses of dry-stone masonry, possibly to make the entrance appear grander and more elaborate. A gulley, potentially a drain, encircled the building. The building is likely to have been roofed, although among the post-holes present in the building's interior, there was no clear evidence of a post-ring which would have held up a roof. Instead, it was proposed that the roof would have been supported by a ring of posts set on pads or plinths rather than in post-holes.

Eighteen radiocarbon dates were obtained from House 4 – the most from any house at the site. Initially this was thought to be a testament to the long duration and multiple phases of its use. The basic outline of House 4's use follows: construction and initial use; re-design (during which the southern façade of the building was re-faced and an aisle or porch was added to it, which may have been gated); apparently extended use of the now-remodelled site; infill with charcoal-rich material, thought to be the result of a fire destroying the building; and then further re-occupation. This re-occupation involved a further reconstruction of the entranceway and revetment of the building's now-collapsed walls. According to the excavators, stratigraphy for this final phase of occupation was difficult to understand, due to natural soil processes homogenising contextual boundaries and differences, but post-holes and hearth slabs from this phase of use were identified.

Eventually, the building was abandoned and ultimately covered by peat. Although unable to establish a temporal relationship between the later stage of House 4's use and the adjacent small timber building House 8, excavators proposed that this structure was a replacement for House 4.

Most of the radiocarbon dates from House 4 were obtained from the charcoal-rich contexts thought to be the result of the burning of the primary structure at the site, and samples were chosen on the basis that they represented structural timbers, and other wood present in the building at the time of the fire. Occupation or use of the site continued after the burning of the original structure of House 4; excavators suggested that the site was in use until c.1000 BC.

5.4.3 House 1/House 4: The legacy contexts

All samples from House 1 and House 4 were bulk samples, containing charcoal from a mixture of species including alder, hazel, birch and willow, although efforts were made to avoid long-lived species such as oak. Legacy dated contexts from House 1 included 3185 (GU-3162), 3634 (GU-3308) and 3665 (GU-3110). Context 3185 was interpreted as a posthole, likely to be part of the building's structure, and contexts 3664 and 3665 came from earlier and later hearths respectively.

Legacy dated contexts from House 4 were 3051 (GU-3158), 3186 (GU-3157), 3100 (GU3155), 3321 (GU-3153), 3074 (GU-3156), 7077 (GU-2853), 1109 (GU-2809), 3019 (GU3154), 1105 (GU-2799), 3014 (GU-3159), 7076 (GU-2852), 3016 (GU-3160), 3271 (GU3164), 7078 (GU-2851), 3003 (GU-3151), 3111 (GU-3166), 3131 (AA-10500; GU-3168; GU3166). Context 3131 was the fill of House 4's floor gulley, represented by three separate dated samples. Of these, GU-3168 produced a far earlier date than the other two samples, indicating the possibility that this context included reworked older material. Context 3051 was the fill of the roundhouse's outer gulley or drip trench, and like the interior gulley was probably filled prior to the catastrophic burning event at the site. Contexts 3100 and 3321 post-dated the burning event at the site. Both context numbers referred to material within a deposit of fire-cracked stone, filling a negative feature c.1m in diameter; the context card for 3321 mentioned cobbling in reference to the stone inclusions. All other contexts were layers or deposits relating to the burning event.

These relationships were used to inform the choices made in constructing a chronological model based on these legacy dates. Contexts from House 1 were placed into a single phase *(Phase House 1)*, with a sequence representing the known stratigraphic relationship between the earlier and later hearths nested within this phase (*Sequence House 1 Hearths*). The next phase included contexts relating to the construction and primary use of House 4 (*Phase House 4 Construction/Primary Use*). This included contexts relating the burning event at the building, as they were likely to represent structural and/or occupation material. A final phase included dates relating to the post-conflagration use of the site (*Phase House 4 Secondary Use*).
This approach resulted in a model with good agreement (*Amodel=78.7*). According to this model (see Figure 7), activity began at the site in *2020–1550 cal BC* (*95% probability; House 1 Start*), and probably *1805–1630 cal BC* (*68% probability*). Activity at House 1 spanned *0–405 years* (*95% probability*), probably *0–155 years* (*68% probability*), before an interval of *0–160 years* (*95% probability*), probably *0–80 years* (*68% probability; Difference House 1*

House 4 Interval), before activity began related to the House 4 structure. The positive value for the calculated interval indicates that the hiatus between the use of the two buildings was real–their use is not likely to have overlapped.

Dated activity related to the House 4 structure began at some point between *1640–1465 cal BC* (*95% probability*), probably between *1595–1520 cal BC* (*68% probability; Boundary House 4 Construction/Primary Use Start*). Dated use of this structure spanned *0–275 years* (*95% probability*), probably *105–230 years* (*68% probability*), with dated use ending at some point between *1490–1320 cal BC* (*95% probability*), probably in *1430–1360 cal BC* (*68% probability; Boundary House 4 Construction/Primary Use End*). After an intervening period of secondary use (*Phase House 4 Secondary Use*), dated activity at the site ended at some point between *1490–1035 cal BC* (*95% probability*), probably in *1410–1245 cal BC* (*68% probability; Boundary House 1/House 4 End*).

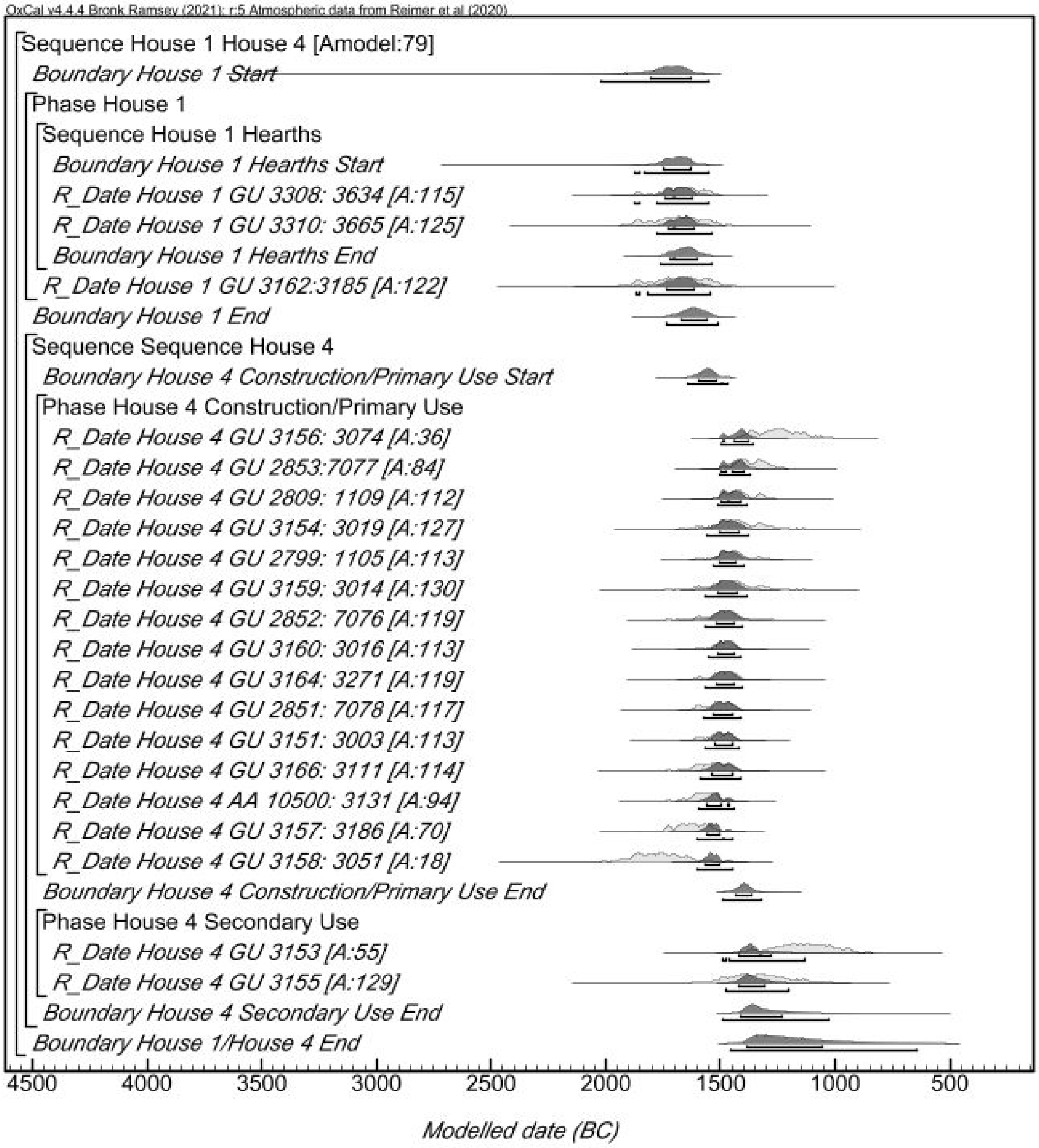

Figure 7: Model constructed using legacy dates from House 1 and House 4.

5.4.4 House 1/House 4: The new dates

A total of 16 contexts were selected for inclusion in the updated dating programme for the House1/House 4 site. Of the samples taken from these contexts, two had insufficient carbon, taken from contexts 3164 (a turf layer) and 3051 (the fill of a gulley feature to the roundhouse's exterior). Both contexts had been sampled as part of the original dating programme.

In order to provide a 'check' on the accuracy of the legacy dates, five of the contexts sampled from the House 1/House 4 site as part of this updated dating programme came from legacy contexts. These were 3185 and 3665 from House 1, and 3051, 3100 and 3111 from House 4. The remaining contexts selected for dating were chosen on a taphonomic basis. Dates from pits, post-holes and hearths were favoured – in order to minimise the opportunity for disturbance and to maximise the probability that the charcoal within the contexts related to material from activity occurring within the buildings during their use-lives. From House 1, these new contexts comprised 3665 (the lower fill of a hearth deposit, one of the later hearths excavated at the site), 3692 (also a hearth fill, one of the later hearths excavated at the site), 3458 (the fill of a structural post-hole), 3686 (also the fill of a post-hole, part of a group of features related to the early entrance of the building), 3638 (the upper fill of a hearth feature, one of the earlier features related to the building's occupation), 3462 (the fill of a structural post-hole) and 3614 (a charcoal spread around a hearth feature, interpreted as one of the early hearths/occupation-related features excavated at the site).

Stratigraphic information regarding contextual relationships was used to produce a chronological model for the site using these new dates. A sequence was constructed (Sequence House 1 House 4, see Figure 8), with dates from House 1 placed into a phase (Phase House 1) preceding those from House 4. From context records, it was possible to establish early and late hearth features, and these were placed into a sequence within Phase House 1. The difference function (Difference Interval Between House 1 House 4) was used to represent the hiatus between the use-lives of the two buildings at the site (seen in the layer of tilled soil between the remains of House 1 and House 4), with dates from contexts related to the structural/internal features of the House 4 roundhouse placed into a phase following this interval (Phase House 4 Structural/Internal Features). Following this phase, a single determination from context 3100, described in context records as a 'post-conflagration soil layer', was the final date in the sequence.

This approach resulted in a model with good agreement (*Amodel=95.1*). According to this model, dated activity began at the site at some point between *1575–1470 cal BC* (*95% probability*), probably in *1540–1505 cal BC* (*68% probability; Boundary Start House 1*). Activity at House 1 spanned *0–105 years* (*95% probability*), probably *1–60 years* (*68% probability; Difference Span House 1*), ending at some point between *1515–1445 cal BC* (*95% probability*), probably in *1510–1475 cal BC* (*68% probability; Boundary End House 1).* There was then an interval of *0–75 years* (*95% probability*), probably *10–60 years* (*68% probability*), before the beginning of dated activity associated with the House 4 building at some point between *1490–1415 cal BC* (*95% probability*), probably in *1460–1425 cal BC* (*68% probability; Boundary Start House 4 Structural/Internal Features*). The primary phase of activity at House 4, preceding the conflagration, spanned *0–125 years* (*95% probability*), probably *10–80 years* (*68% probability; Difference Span House 4*), before ending at some point between *1435–1320 cal BC* (*95% probability*), probably in *1415–1380 cal BC* (*68% probability; Boundary End House 4 Structural/Internal features*). Activity ceased at the site at some point between *1405–1110 cal BC* (*95% probability*), probably in *1385–1260 cal BC* (*68% probability; Boundary End House 4*).

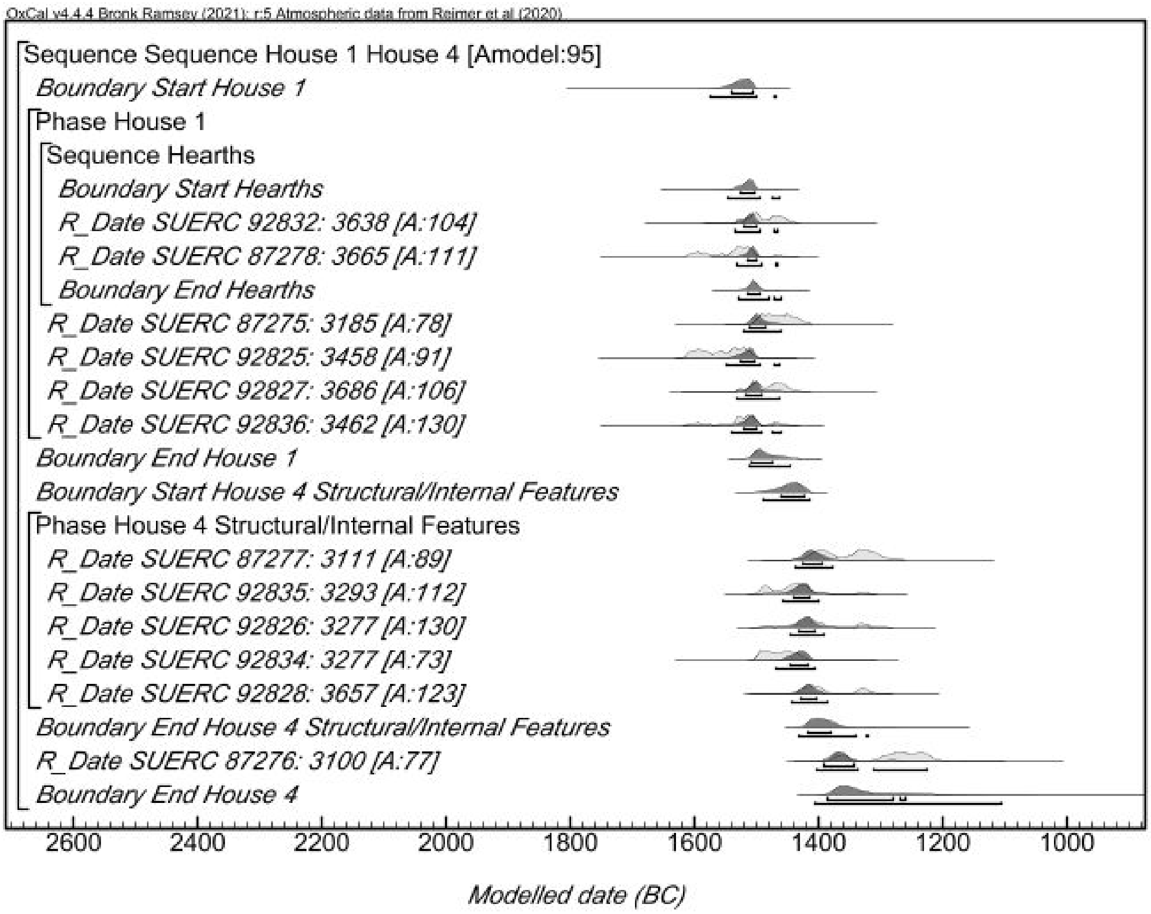

Figure 8: Model constructed using new dates from House 1 and House 4.

5.4.5 Houses 1 and 4: Legacy and new dates combined

As is detailed elsewhere in this chapter, combining dates from contexts dated as part of both the legacy and new dating programme indicated that the legacy dates from Lairg are likely to have an inbuilt old wood effect (older material included in the bulk dating sample, resulting in a date older than the event we are interested in). Therefore, it was decided that a *Charcoal Outlier* model (see Bronk Ramsey, 2009b) would be applied to all legacy dates from bulk samples.

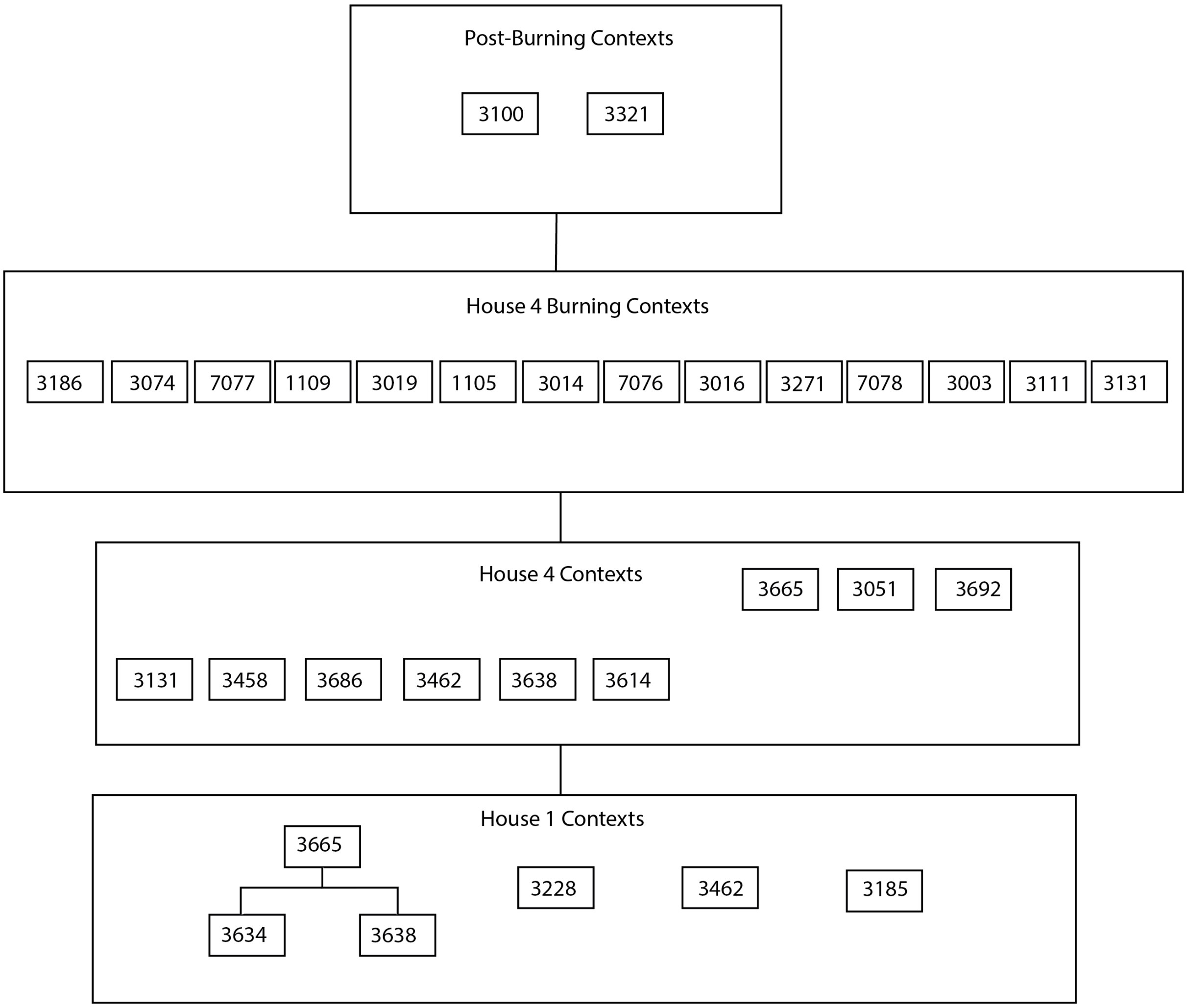

Figure 9: Diagram showing the stratigraphic relationships between dated contexts from House 1 and House 4. Contexts shown higher in the 'House 4 Contexts' box were thought to be later than those positioned lower.

Legacy and new dates from the House 1/House 4 site were included in the same model, following a similar structure to the legacy model described above (see Figure 7, also Figure 9 for phasing).

Based on this model (shown in Figure 10), activity began at House 4 in *1600–1500 cal BC* (*95% probability*), probably at some point between *1545–1510 cal BC* (*68% probability; Boundary House 1 Start*) and lasted between *0–130 years* (*95% probability*), probably *5–65 years* (*68% probability*). Dated use of House 1 ended at some point between *1515–1445 cal BC* (*95% probability*), probably in *1480–1440 cal BC* (*68% probability; Boundary House 1 End*).

There was an interval (visible in the archaeological record as a layer of tilled soil) of *0–65 years* (*95% probability*), probably *2–40 years* (*68% probability; Difference House 1 House 4 Interval*) before dated use of House 4 began in *1495–1425 cal BC* (*95% probability*), probably at some point between *1480–1440 cal BC* (*68% probability; Boundary House 4 Construction/Primary Use Start*).

The main phase of use of House 4 lasted between *1–135 years* (*95% probability*), probably *40–105 years* (*68% probability; Difference House 4 Primary Use Span*). This main phase of use ended at some point between *1430–1350 cal BC* (*95% probability*), probably *1410–1370 cal BC* (*68% probability; Boundary House 4 Construction/Primary Use End*). There was then a period of secondary use of the site, which ended at some point between *1400–1085 cal BC* (*95% probability*), probably in *1385–1255 cal BC* (*68% probability; Boundary House 4 Secondary Use End*). This chronology is very similar to that produced using solely new dates, indicating that the chronology constructed using determinations produced through the new dating programme is robust.

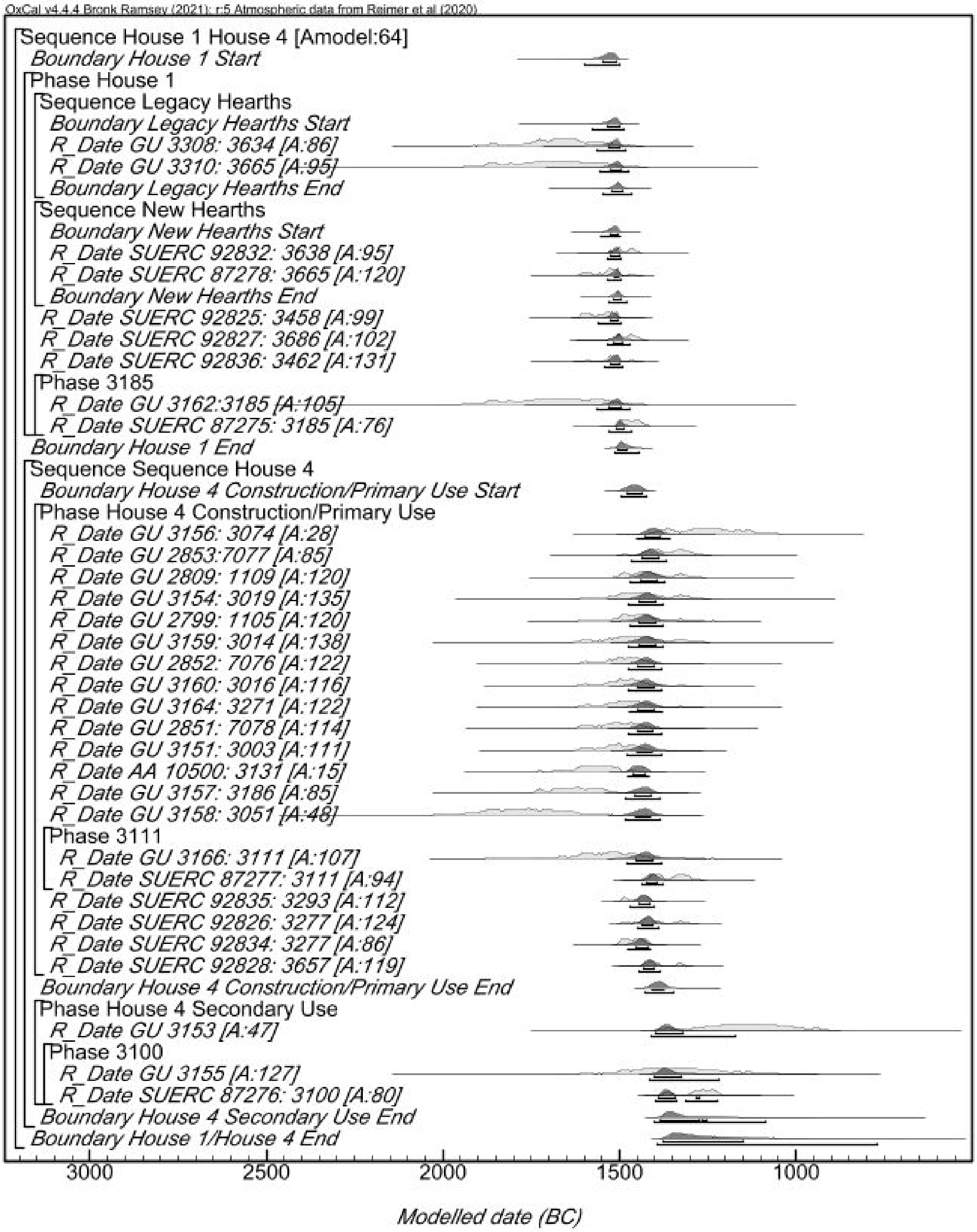

Figure 10: Model constructed using legacy and new dates from House 1 and House 4, with a Charcoal Outlier model applied. Legacy dates from bulk contexts have been treated as charcoal outliers.

5.5 Houses 2,3 and 6

Houses 2, 3 and 6 were, as described above, located close to each other in the north-west of the Allt na Fearna site. The House 2/House 6 site consisted of two superimposed buildings with an intervening layer of agriculture (and potentially additional evidence for settlement). House 6 overlay the remains of House 2. House 3 was immediately adjacent to the House 2/House 6 site. House 2 and House 3 returned dates from the mid-2nd millennium BC, while House 6 was thought to have been constructed and used somewhat later and may not have had an entirely domestic function. House 2 and House 3 had been thought to be broadly contemporary by the site's excavators, and the following models will explore the possibility of whether they were contemporary or not.

Much like the House 1/House 4 site, the area of Houses 2, 3, and 6 was characterised by episodes of construction, intervening periods of agriculture, and reconstruction. This pattern of site re-use at Lairg could relate to shifting settlement (see Halliday, 2015; 2021); the re-use of advantageously positioned places within the landscape (well-drained, sheltered, or prominent), or to a conscious re-use of socially or culturally important places within the landscape.

5. 5.1 House 2

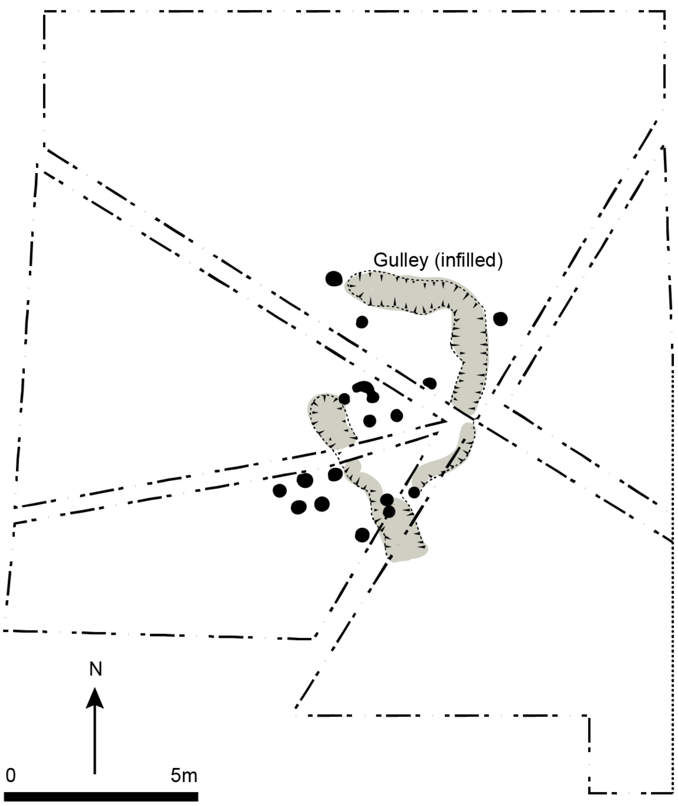

Figure 11: Plan of House 2 (adapted from McCullagh & Tipping, 1998: 42).

House 2 (Figure 11) yielded the earliest dates of this particular grouping of houses and was thought to have dated to the earlier 2^{nd} millennium BC – pre-1500 BC. The site was highly truncated by later agriculture but consisted of the remains of a large (estimated 12– 14m in diameter) hut circle, defined by an interior curvilinear gulley and post-holes. The internal eroded features matched those found in House 3, discussed below.

As at the House 1/House 4 site, there was evidence of earlier use of the House 2 site in the form of truncated pits and possible post-holes outwith the gulley area, three of which contained cremated human bone. It was suggested by excavators that this could indicate an earlier burial structure at the site. The eastern bank of House 2 overlay these fragments of cremated bone, which may have been a deliberate decision. The legacy dates (although there have been issues raised regarding reliability when radiocarbon dating burnt bone [Minami *et al.*, 2019; Olsen *et al.*, 2008; Snoeck *et al.*, 2014]) were interpreted as indicating a short period between the interment of these remains and the construction of House 2.
As with other house sites at Lairg discussed here, the entrance of House 2 was thought to be south facing. The eroded features within the hut circle, including a hearth with associated charcoal deposits, were interpreted as indicating a prolonged period of occupation, and the 67 nature of this pattern of erosion, identical to that seen in House 3, could indicate ordered or prescribed use of space within the building.
At some point, the activity causing this erosion ceased, and sediment accumulated within the building. This was followed by infilling of the eroded features within House 2 with rubble and slabbing (including a saddle quern). This was interpreted as a break in the occupation of the building followed by a change in the nature of that occupation (or use). Finally, House 2 was abandoned, and either levelled prior to or by the intensive tillage of the site.

5.5.2 House 3

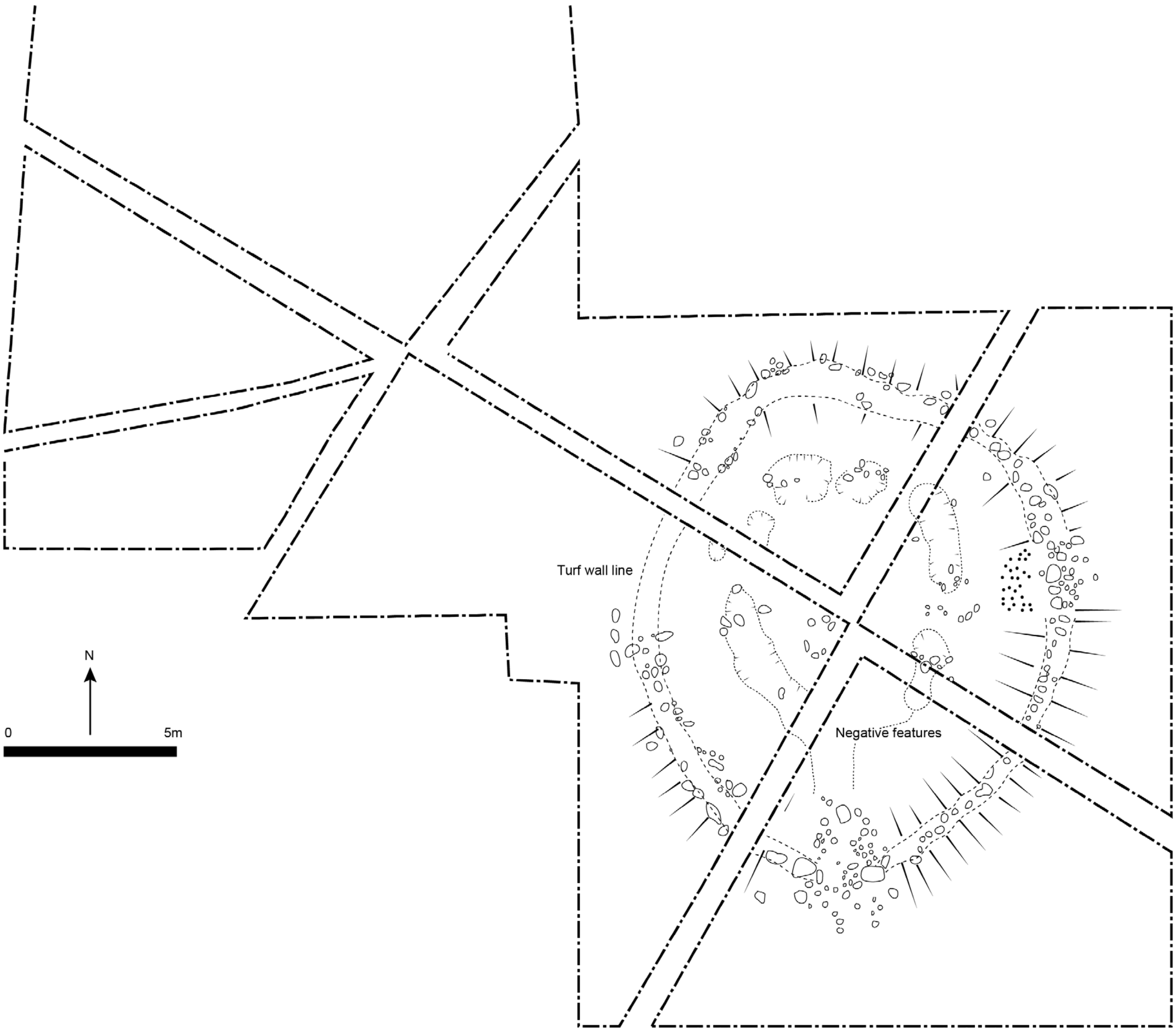

Figure 12: Plan of House 3 (adapted from McCullagh & Tipping, 1998: 44).

House 3 (see Figure 12) was thought, based on the structural similarities between the two, to be broadly contemporary with House 2 and legacy radiocarbon dates from the site were interpreted as indicating the building was in use in the early 2nd millennium BC. This hut circle was larger than House 2, at approximately 15–17m in diameter, with a south facing entrance. The wall of the house's south side was built to a greater height than in other areas, and was faced with upright quartz boulders, reminiscent of the decorative facing of the entrance side of House 4. The building's use had caused erosion of the subsoil, in a similar pattern to that described above for House 2 (although no hearth deposits were excavated) and in a similar pattern to other hut circles at Lairg, negative features were found beneath the bank of House 3. In this case, the features were thought to be erosional, and had been overlain by compacted gravel spreads. This points to an earlier use of the site, thought by the excavators to date to the Neolithic, like similar features seen at the site of House 1.

The site's use was divided into phases by the excavators, with the first of these (post-construction) being the activities resulting in the creation of the eroded, discontinuous penannular gulley seen in the building's floor. This gulley was, at some point in the life of the building, infilled with rubble and soil, again, as at House 2, including a face-down saddle quern. Following this, the entrance to House 3 was blocked, and from this point onwards the remains of the building (thought to be unroofed at this point) were accessed by a break in its western bank. Paving was extended between House 6 (which almost abutted House 3) and House 3, extending into the latter's interior. This was thought to indicate a change of use of the building, from a dwelling to a stockyard associated with the later construction and use of House 6. Later, House 3 may have been used as an enclosed garden, indicated by a deep soil worked into rigs, which were discontinuous with those outside of the area of the building's banks. Peat is thought to have encroached on the site by the early 1st millennium AD.

5.5.3 House 6

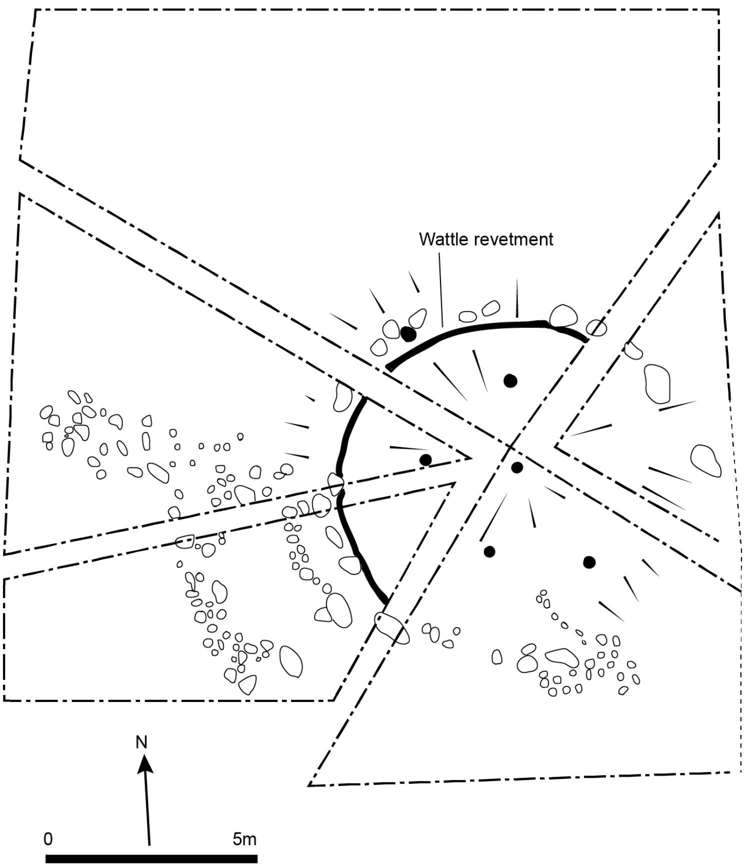

Figure 13: Plan of House 6 (adapted from McCullagh & Tipping, 1998: 54).

House 6 (Figure 13) was the latest of the buildings discussed here, and overlay the truncated remains of House 2, adjacent to (to the point of almost abutting) House 3. Unlike those two buildings, its entrance was east facing. It was smaller, at only 8.5m in diameter. The soil overlying the remains of House 2, upon which House 6 was constructed, was deep (around 0.2m) and showed signs of having been cultivated. Potential evidence for an additional structure built on the site between House 2 and 6 also underlay House 6, in the form of the remains of a cobbled surface and some unstratified post-holes.

House 6 itself was thought to have been a small building, primarily made from turf and wattle and dating to the second half of the 2nd millennium BC. A roof at some point in its history was evidenced by an arc of post-holes in the building's interior. The interior area of House 6 was not heavily eroded, and there was no evidence of a hearth area, indicating both that its use-life was short and that it may not have been domestic in function. House 6 was interpreted by excavators as somehow being connected to both the redesign and change of use of House 3, and to the construction of Dyke 4, and may have been used to house livestock.

5.5.4 House 2, 3 and 6: The legacy dates

As part of the original Lairg Project dating programme, a total of ten contexts from House 2, six contexts from House 3 and nine contexts from House 6 were sampled for dating. From House 2, these comprised 2487 (GU-3300), the fill of an early pit in the building's interior; 2501 (GU-3301), the fill of a tillage-truncated pit in the vicinity but outwith the structure of House 2; 2483 (GU-3299), the fill of a pit outwith the House 2 structure; 2238 (GU-3141), described as a 'thin layer' or spread relating to later occupation at House 2; 2522 (GU-3304), the fill of an interior trench; 2516 (GU-3303), a later occupation deposit; 2169 (GU-3152), a post-abandonment soil layer of brown silt; 2243 (GU-3150), a post-abandonment charcoal-rich soil; 2477 (GU-3298), the fill of a post-abandonment pit, one of a group of similar features; and 2515 (GU-3302), a post-abandonment deposit described as a 'soil layer' in context records.

Contexts from House 6 were 2136 (GU-3143), 2215 (GU-3296) and 2211 (GU-3146), all soil layers relating to the tillage activity between the remains of House 2 and House 6; 4098 (GU-2801) and 2095 (GU-3142), both part of the turf fabric of the building's bank; 2126 (GU-3140), a layer of disturbed possible cobbling representing a potential intermediary layer of activity between the agriculture post-dating House 2 and the building and use of House 6; 2515 (GU-3302), the fill of a structural post-hole; 2099 (GU-3293), a layer/spread interpreted as occupation-related material; and 2133 (GU-3139), a soil layer related to the occupation of House 6. From House 3, sampled contexts were 2170 (GU3147), the fill of a tillage-truncated pit interpreted as pre-dating the construction of House 3; 2178 (GU-3149), cobbling or a gravel spread pre-dating the construction of House 3; 2193 (GU-3295), charcoal inclusions within the turf material of the House 3 wall; 2139 (GU-3144) the fill of an internal gulley, described in context records as a late internal sediment; and 2228 (GU-3145), the stony fill of the internal gulley described previously.

Separate models were constructed for the House 2/House 6 site and House 3, despite their being excavated as a single site, to allow an understanding of any temporal relationship between House 2 and House 3. For the House 2/House 6 site, dates were placed into a sequence (*Sequence House 2/House 6*, see Figure 14), with dates relating to the use of House 2 placed in a phase (*Phase House 2*) preceding those from the phase of post-abandonment use of the site and those from House 6.

The difference function was used to ascertain the duration of individual phases of use and that of any intervals in use. A phase containing contexts assigned to the post-abandonment use of House 2 was placed next in the sequence (*Phase House 2 Post-Abandonment*), before another interval (*Interval House 2 Post-Abandonment/Tillage*). Contexts interpreted as relating to this period of tillage were placed in a phase following this interval (*Phase Tillage Contexts*), followed by another interval (*Interval Tillage/House 6 Occupation*) representing any interval between this period of tillage and the construction and use of House 6. The final phase in this sequence (*Phase House 6 Occupation Contexts*) included contexts relating to the use of the House 6 building. The two dates derived from contexts within the House 6 wall, 4098 (GU-2801) and 2095 (GU-3142), were excluded from the model as it was not possible to ascertain the relationship of this charcoal to that included in the other contexts.

This approach resulted in a model with good agreement (*Amodel=84*). According to this model, dated activity began at the House 2 site at some point between *1850–1540 cal BC* (*95% probability*), probably in *1725–1565 cal BC* (*68% probability; Boundary Start House 2*). Activity relating to the primary use of House 2 spanned between *0–250 years* (*95% probability*), probably *0–112 years* (*68% probability; Difference Span House 2*), ending between *1675–1495 cal BC* (*95% probability*), probably in *1620–1530 cal BC* (*68% probability; Boundary House 2 Abandonment*).

There was then an interval of between *0–160 years* (*95% probability*), probably *590 years* (*68% probability*) between this primary phase of use of the House 2 site and the post-abandonment use of the site, which began at some point between *1595–1440 cal BC* (*95% probability*), probably between *1540–1470 cal BC* (*68% probability; Boundary Start House 2 Post-Abandonment*). Post-abandonment use of the site spanned between *0–150 years* (*95% probability*), probably between *0–75 years* (*68% probability; Difference Span House 2 Post-Abandonment*), ending between *1525–1390 cal BC* (*95% probability*), probably between *1490–1425 cal BC* (*68% probability; Boundary End House 2 Post-Abandonment*). Tillage began at the site at some point between *1475–1320 cal BC* (*95% probability*), probably in *1455-1385 cal BC* (*68% probability; Boundary Start Tillage Contexts*), spanning between *0–150 years* (*95% probability*), probably between *0–70 years* (*68% probability; Difference Span Tillage*), ending at some point between *1425–1265 cal BC* (*95% probability*), probably in *1410–1300 cal BC* (*68% probability; Boundary End Tillage Contexts*).

There was then an interval of between *-185–5 years* (*95% probability*), probably between *-70–5 years* (*68% probability*) before the start of dated occupation evidence at House 6 at some point between *1400–1205 cal BC* (*95% probability*), probably in *1380–1240 cal BC* (*68% probability; Boundary Start House 6 Occupation Contexts*). In practice, the negative value indicates that the date ranges associated with the cessation of tillage activity and the beginning of use of House 6 overlap–the interval between the two phases may have been very short. The occupation of the House 6 building spanned *0–185 years* (*95% probability*), probably between *0–70 years* (*68% probability; Difference Span House 6*), before dated activity at the site ended at some point between *1380–1100 cal BC* (*95% probability*), probably between *1365–1185 cal BC* (*68% probability; Boundary End House 6 Occupation Contexts*).

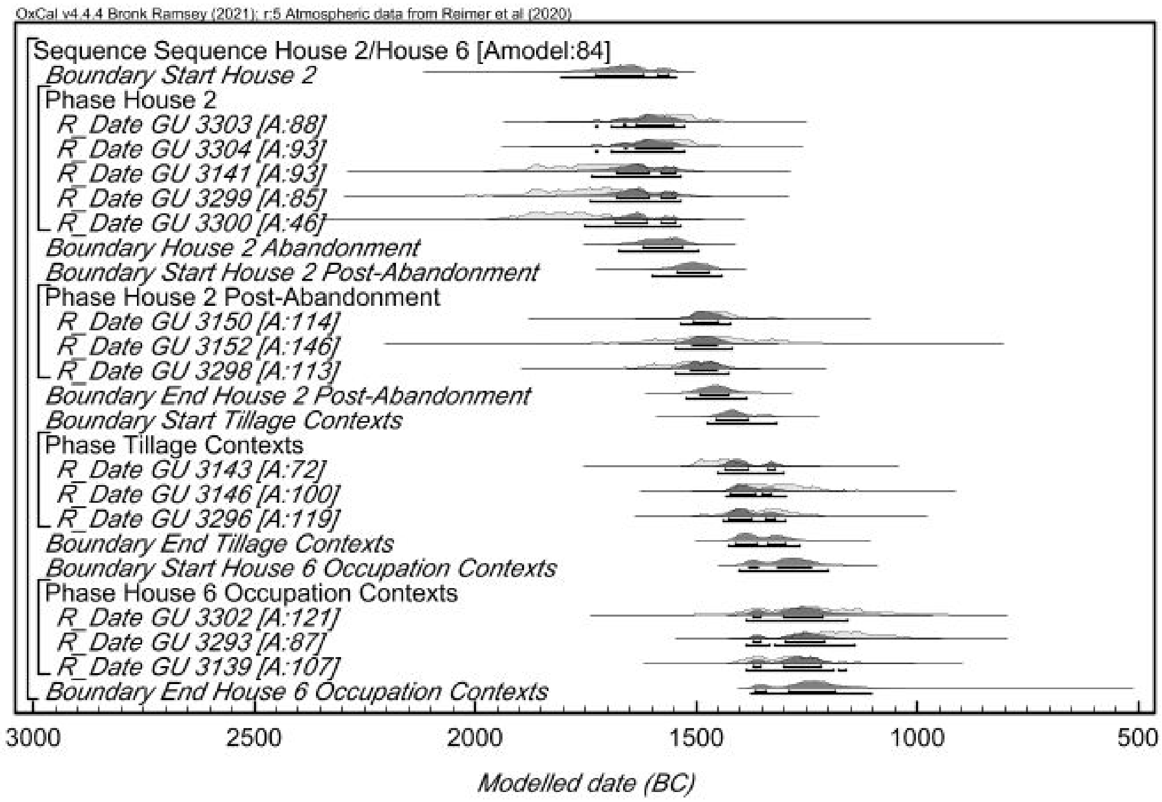

Figure 14: Model constructed using legacy dates from House 2 and House 6.

For House 3, the legacy dates were placed into a sequence designed to reflect the stratigraphy of the site. A phase containing dates from contexts relating to activity pre-dating the construction of House 3 (*Phase House 3 Pre-Construction Sediments*, see Figure 15) was placed before a phase containing dates from contexts relating to the use of the House 3 building (*Phase House 3 Gulley Infill*). This approach resulted in a model with good agreement (*Amodel=69.7*). According to this model, dated activity began at the site at some point between *8795–5230 cal BC* (*95% probability*), probably between *6345–5335 cal BC* (*68% probability; Boundary Start House 3 Pre-Construction Sediments*), with pre-construction activity coming to a close at the site at some point between *1850–1520 cal BC* (*95% probability*), probably in *1730–1565 cal BC* (*68% probability; Boundary End House 3 Pre-Construction Sediments*).

However, the very early date for GU-3147 has pulled the chronology for the House 3 site backwards in time – either pre-construction activity at the House 7 site was ongoing (probably not continuously) over millennia, residual material was contained within the bulk sample, or laboratory error occurred. The charcoal dated by GU-3147 may also have been non-anthropogenic in origin. Dated activity related to the infilling of the interior gulley of House 3–the only chronological evidence available for use of the site–began between *1730–1465 cal BC* (*95% probability*), probably between *1640–1520 cal BC* (*68% probability;*

Boundary Start House 3 Gulley Infill), ending between *1670–1040 cal BC* (*95% probability*), probably between *1585–1410 cal BC* (*68% probability; Boundary End House 3 Gulley Infill*).

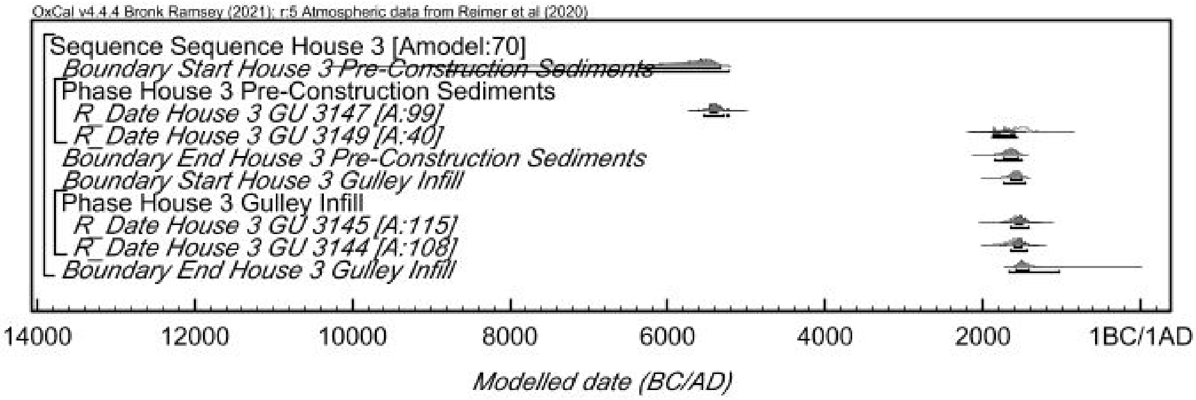

Figure 15: Model constructed using legacy dates from House 3.

5.5.5 Houses 2, 3 and 6: The new dates

As outlined in the descriptions of the sampled contexts above, the majority of legacy dates from the House 2/House 3/House 6 site were derived from contexts described as 'spreads', 'layers' or 'soil layers' as well as from charcoal inclusions within the turf matrices of building walls. There are taphonomic issues around using material from contexts such as this for dating – from where did the charcoal originate? What activities produced that charcoal, and what is the risk that this material has been disturbed, or is in some way residual or intrusive?

The reliance on these types of context for dating is likely to have been an artefact of a lack of more secure types of context (post-holes, hearths etc.) containing sufficient charcoal for radiometric dating. When re-visiting the site archive to identify suitable contexts for the updated dating programme, it was clear that material for dating these structures was available from only a small number of suitable, secure contexts. Therefore, only three contexts from House 2 and three contexts from House 3 were included in the re-dating programme for Lairg. Suitable material for dating could not be identified from House 6.
From House 2, the contexts included in the re-dating programme were 2250, the charcoal-rich fill of the pit containing the Beaker cremation burial (MacSween, 1998: 141); 2130, a burnt deposit associated with the primary hearth of House 2, and 2131, a burnt deposit directly overlying 2130, also associated with the primary hearth of House 2.
From House 3, the selected contexts were 2180, the fill of a post-hole relating to the main phase of occupation/use of the House 3 structure; 2229, the fill of the interior floor trough/gulley of House 3; and 2133, the fill of the dripline/gulley to the exterior of the House

3 bank. All contexts were selected on the basis that the charcoal within them was likely to derive from activity related to the use of the buildings, and where possible, to represent as many as possible of the phases of use of the buildings.
To build a chronology for the House 2 site, the dates from the contexts described above were placed into a sequence (*Sequence House 2*, see Figure 16), with the date from 2250 (SUERC-92838), the Beaker grave underlying the main House 2 structure, preceding those from the primary hearth deposits. This determination was excluded as an outlier, as the context did not directly relate to the use of the House 2 building. This approach resulted in a model with good agreement (*Amodel=93*), representing the beginning and primary use of the site. According to this model, activity relating to the primary use of House 2 at began at some point between *1995–1130 cal BC* (*95% probability*), probably in *1515–1140 cal BC* (*68% probability; Boundary Start House 2 Primary Hearths Use*).

Primary use of House 2, based on dates from the two superimposed hearth contexts, spanned *1–1440 years* (*95% probability*), probably *20–715 years* (*68% probability*), with dated evidence for primary use of the site ending at some point between *1195–340 cal BC* (*95% probability*), probably in *1185–345 cal BC* (*68% probability; Boundary End House 2 Primary Hearths Use*). For House 3, as direct stratigraphic relationships between the selected contexts could not be ascertained, the three dates were placed in a single unsorted phase (*Phase House 3*) within a sequence (*Sequence House 3*, see Figure 17). This approach resulted in a model with good agreement (*Amodel=99.7*), with a start date for dated activity at the site at some point between *2720–1520 cal BC* (*95% probability*), probably in *1760–1545 cal BC* (*68% probability; Boundary Start House 3*). Dated activity at the site spanned between *145–1500 years* (*95% probability*), probably *200–680 years* (*95% probability; Difference Span House*), ending at some point between *1410–205 cal BC* (*95% probability*), probably in *1385–1150 cal BC* (*68% probability*; *Boundary End House 3*).

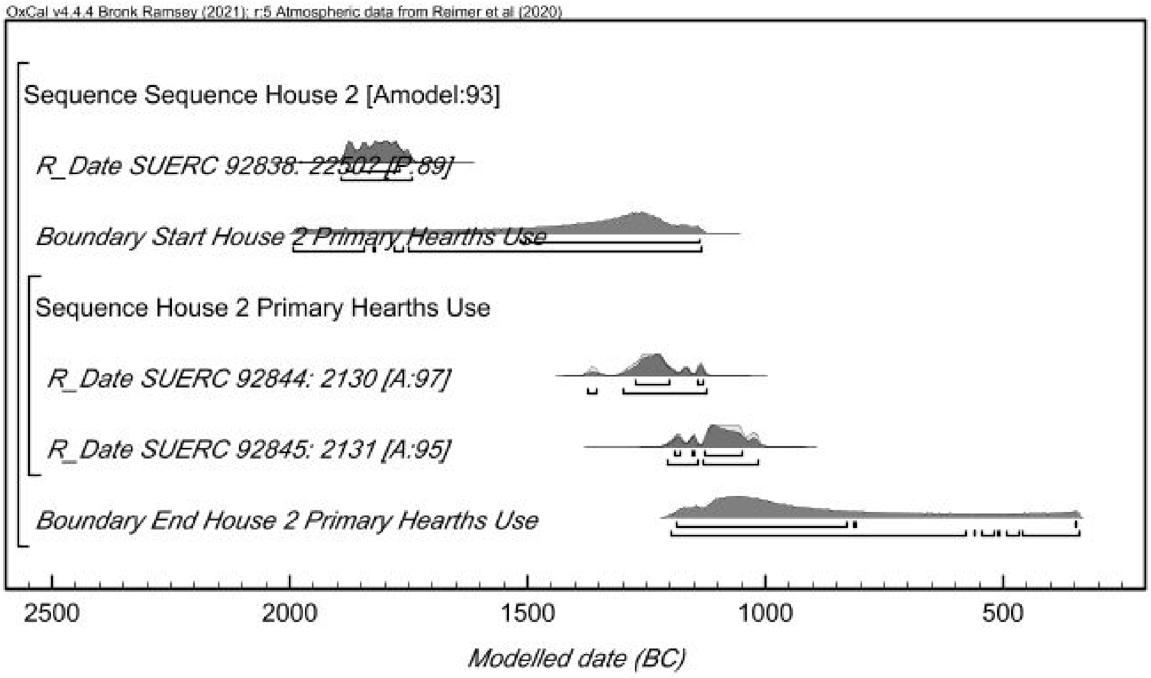

Figure 16: Model constructed using new dates from House 2.

5.5.6 Houses 2, 3 and 6: Legacy and new dates combined

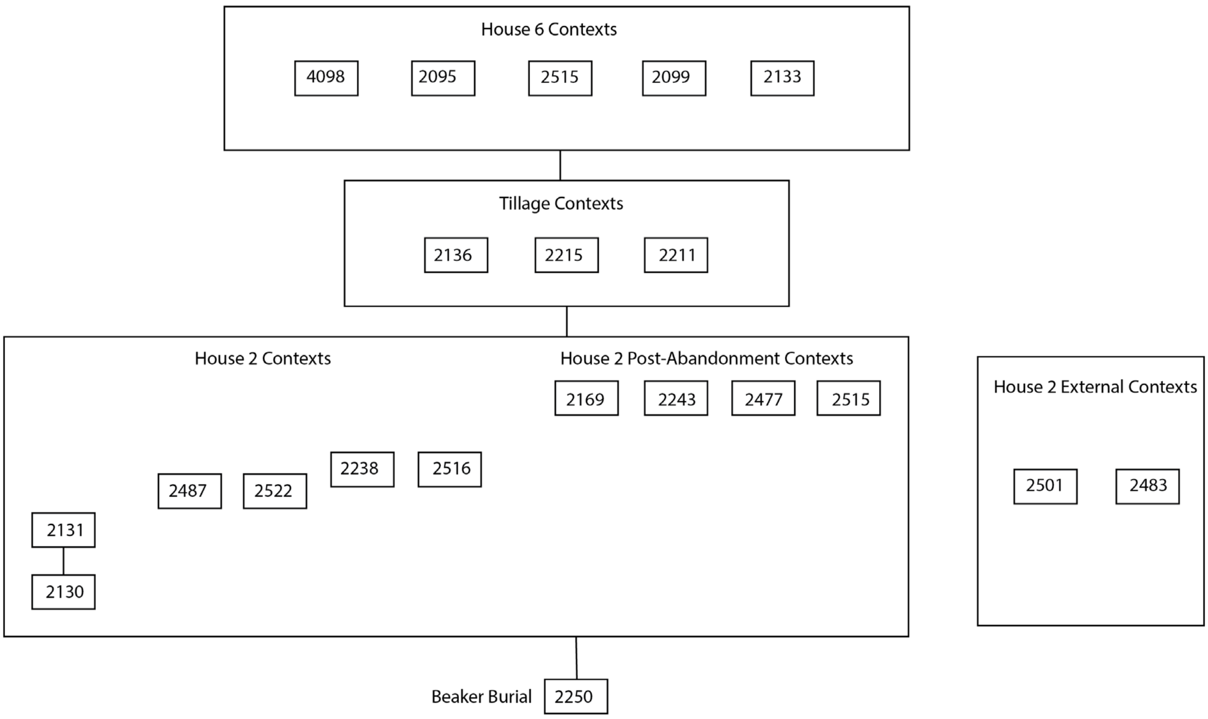

Figure 17: Diagram showing the stratigraphic relationships between dated contexts from House 2 and House 6.

As for the House 1/House 4 site, both legacy and new dates from House 2/House 6 and House 3 were included in two additional models, with legacy dates from bulk samples flagged as Charcoal Outliers, likely to contain older material. The structure of this model was similar to that for the legacy dates from House 2/House 6 (see Figure 17 for stratigraphic relationships, and Figure 18 for model), with the date from context 2250, SUERC-92838 excluded as an outlier.

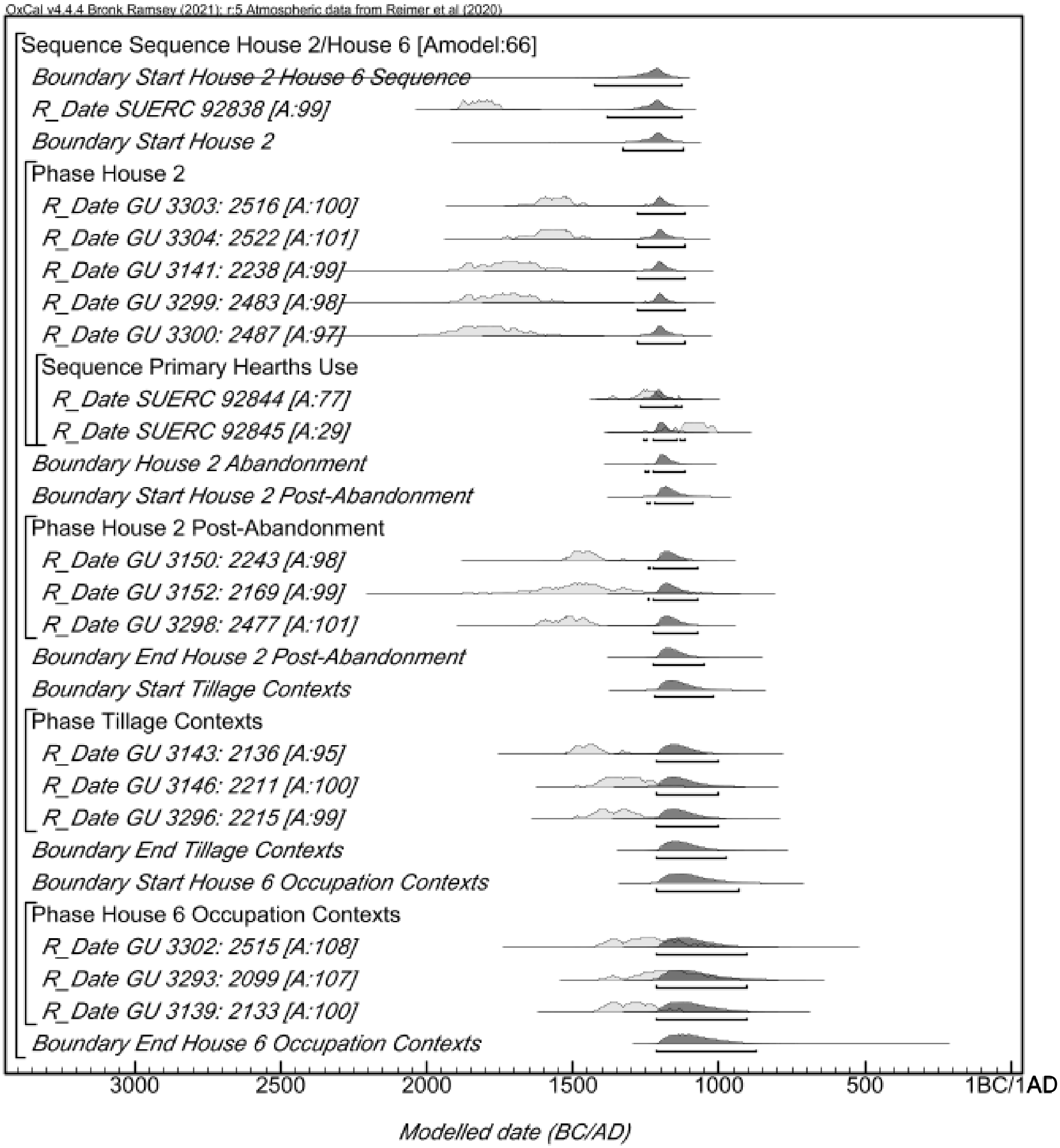

Figure 18: Model constructed using legacy and new dates from House 2 and House 6, with a Charcoal Outlier model applied. Legacy dates from bulk contexts have been treated as charcoal outliers.

According to this model, dated activity associated with House 2 began in *1330–1125 cal BC* (*95% probability*), probably at some point between *1245–1170 cal BC* (*68% probability*; *Boundary Start House 2*). Activity associated with the primary use of House 2 lasted between *0–155 years* (*95% probability*), probably between *0–40 years* (*68% probability*; Difference Span House 2).
Tillage at the site began at some point between *1220–1020 cal BC* (*95% probability*), probably in *1200–1110 cal BC* (*68% probability*; *Boundary Start Tillage Contexts*). Tillage activity probably spanned *0–75 years* (*95% probability*), probably *0–20 years* (*95% probability*; *Difference Span Tillage*).
Dated activity associated with the occupation of House 6 began at some point between *1215–930 cal BC* (*95% probability*), probably in *1190–1060 cal BC* (*68% probability*; *Boundary Start House 6 Occupation Contexts*) and spanned *0–95 years* (*95% probability*, probably *0–25 years* (*68% probability*). This activity ended at some point between *1215–870 cal BC* (*95% probability*), probably in *1190–1030 cal BC* (*68% probability*; *Boundary End House 6 Occupation Contexts*).

This approach resulted in a model with very different results to those produced using the legacy data alone. House 2 and House 6 look to have been inhabited within a short window of time in the later 2nd millennium cal BC, with both buildings likely to have been in use for only a generation or so, and separated by a short period, when the site was subject to tillage.

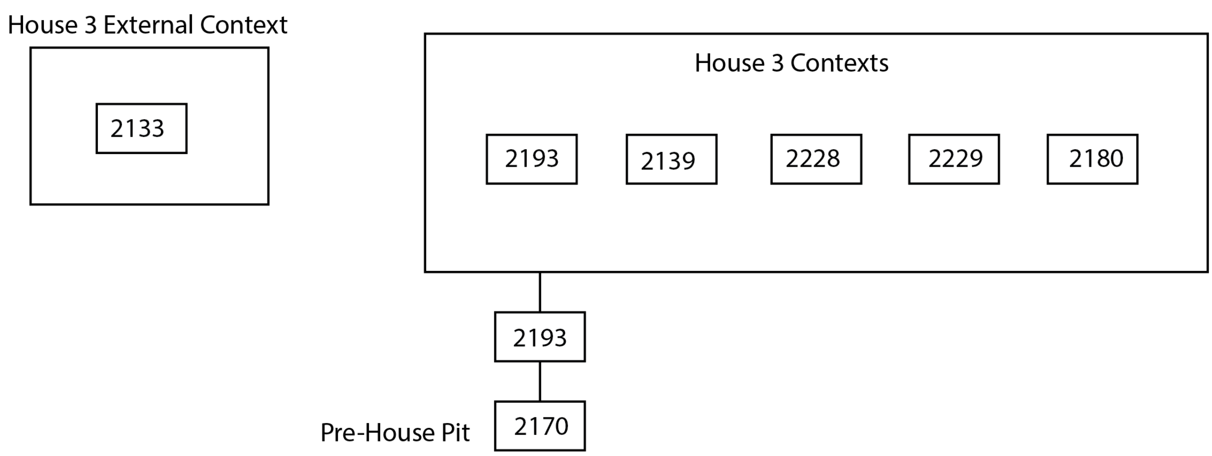

Figure 19: Diagram showing the stratigraphic relationships between dated contexts from House 3.

The same process was undertaken for the House 3 site, constructing a model including both the legacy and new dates for the site (see Figure 19 for stratigraphic relationships), applying a Charcoal Outlier to all legacy determinations. The structure of this model was similar to that constructed using the legacy dates from House 3, with contexts relating to the infilling of the House 3 gulley and the building's use placed together in a phase (*Phase House 3 Use/Gulley Infill*, see Figure 20). Use related to the building began at some point between *1720–1530 cal BC* (*95% probability*), probably between *1640–1555 cal BC* (*68% probability*; *Boundary Start House 3 Use/Gulley Infill*), ending at some point between *1410–1050 cal BC* (*95% probability*), probably in *1385–1245 cal BC* (*68% probability*; *Boundary End House 3 Use/Gulley Infill*).

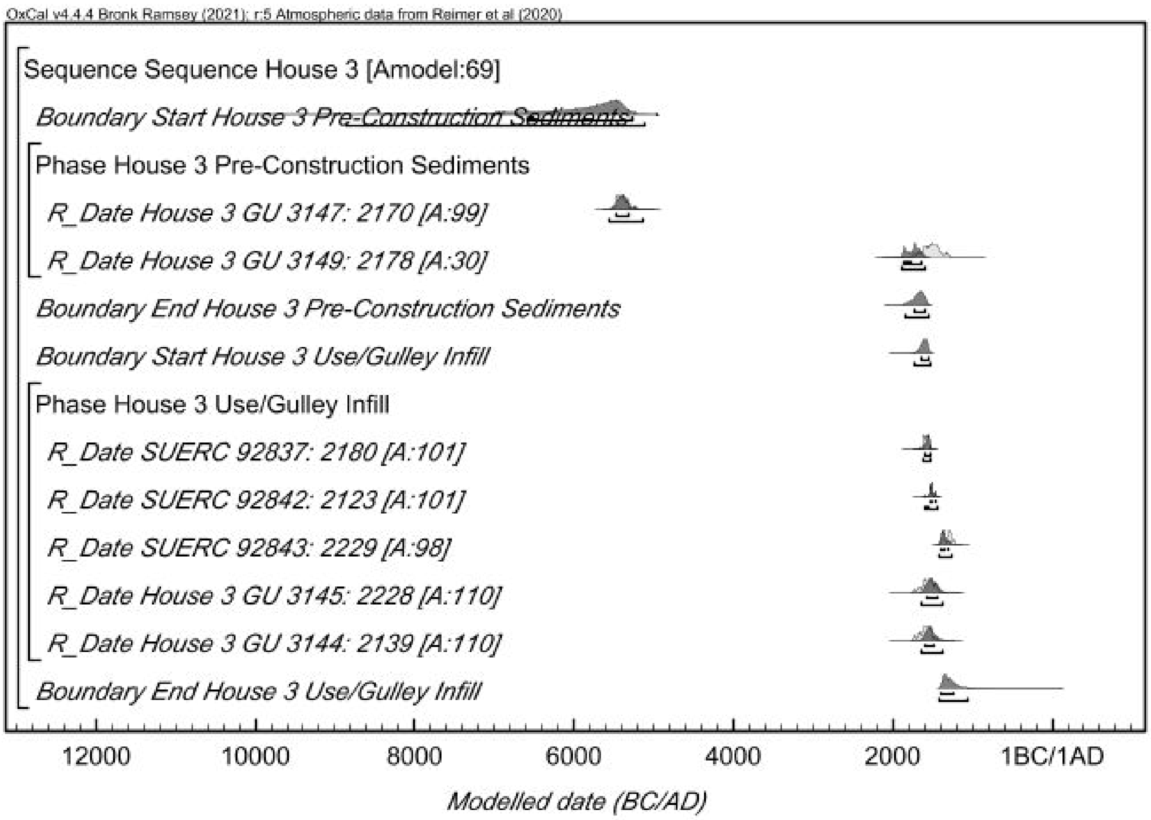

Figure 20: Model constructed using legacy and new dates from House 3, with a Charcoal Outlier model applied. Legacy dates from bulk contexts have been treated as charcoal outliers.

5.6. House 5

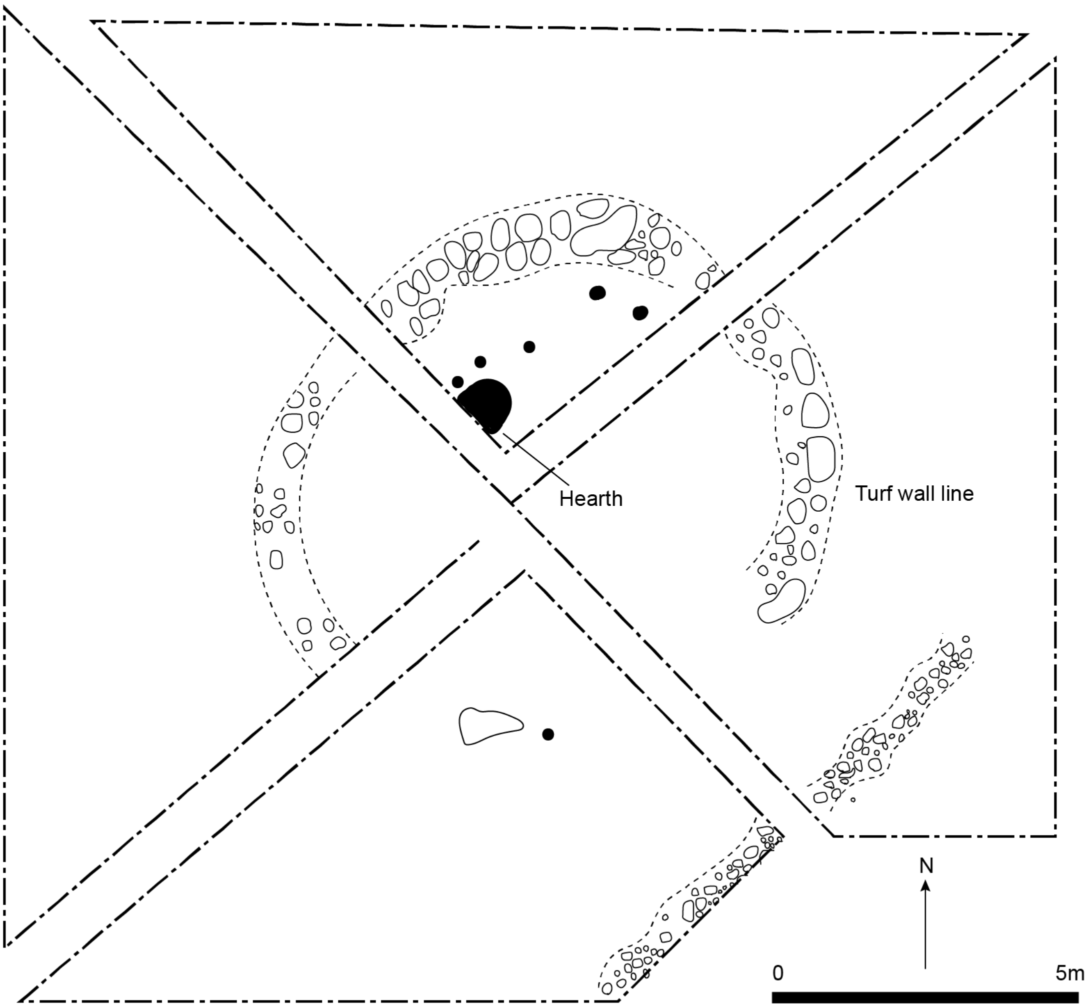

Figure 21: Plan of House 5 (adapted from McCullagh & Tipping, 1998: 51).

The excavation of House 5 (Figure 21) was curtailed by on-site flooding (the site being the lowest-lying of the roundhouses excavated at Lairg), meaning few contexts were available for dating.

House 5 was sited approximately 40m south of the House 4 site, downslope, and on the edge of the well-drained area on which the excavated hut circles were clustered. Due to its proximity to wetter ground, the site flooded during the excavation, and was therefore not fully excavated. At c.10m in external diameter, House 5 was closest in size to House 6, the final building at the House 2/3/6 site. Like the other houses excavated at Lairg, the external wall was at least partially stone-built, with stone concentrated (potentially as facing) on the inner and outer sides of the wall.

House 5’s life can be roughly split into several phases. The first of these was its construction. There was no evidence that it, like the other house sites at Lairg, had been built over earlier remains, although this may be due to the incomplete nature of its archaeological investigation. The second phase was its primary use, represented by a probable hearth feature (reddened, hardened sub-soil) and a sediment layer containing charcoal, carbonised grain, weed seeds and pottery.

Following this, ard cultivation and rig formation took place at the site, removing much of the earlier archaeological evidence. The sediment layer highlighted in the preceding paragraph had been removed in places by clear ard marks. Probably as part of this cultivation activity, rubble was deposited over the revetment separating the structure from the adjacent wetter ground.

A secondary phase of use of the building took place, although it is unclear as to its nature– stake holes and pits were dug (potentially indicating the erection of a structure). It is difficult to disentangle the chronological relationship between this and the formation of the rigs described above – whether the pits and stake holes are contemporary with or earlier than this cultivation evidence. Later, peat encroached upon the site.

5.6.1 House 5: The legacy dates

Only two contexts were sampled from House 5 as part of the original dating programme at Lairg, 4030 (GU-3137), a sediment thought to be related to the use of the building and 4106 (AA-8788), the fill of a post-hole related to later use of the site. As a model based on only two dates would not be particularly informative, the dates were simply calibrated (see Figure 22). Based on these dates, we can see that activity took place at the House 5 site at some point in the mid-2nd millennium BC, and that later activity occurred in the mid-1st millennium AD.

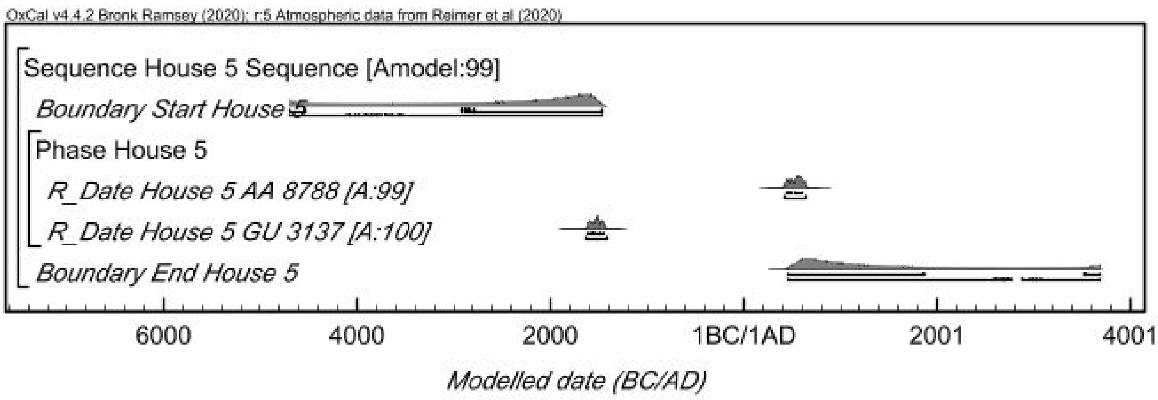

Figure 22: Model constructed using legacy dates from House 5.

5.6.2 House 5: The new dates

As part of the updated dating programme for Lairg, a total of four contexts were selected from the House 5 site for dating. These were 4042, the fill of a cut feature to the hut circle's exterior, stratigraphically related to other early features at the site; 4102, the fill of a posthole pre-dating the hut circle; 4098, the fill of a hearth feature pre-dating the hut circle; and 4030, the lower level of the cultivated soil/floor surface in the hut circle's interior, underlying the stone wall of the hut circle. These dates were derived from contexts stratigraphically earlier than the House 5 hut circle, and therefore the model constructed provides a TPQ for this hut circle, while also providing a chronology for earlier activity at the site.

A sequence was constructed (*Sequence House 5*, see Figure 23), with the three dates from contexts described as 'early features', 4102, 4098 and 4042, placed in a phase (*Phase House 5 Early Features*) preceding that from 4030, the cultivated soil/floor surface stratigraphically later than these features. Initial modelling indicated that SUERC-97914 (sampled from context 4042) was likely to be an outlier, and the fact that the context was external to the building could indicate that it in fact represented earlier, unrelated activity. Therefore, this determination was excluded as an outlier.
This approach resulted in a model with good agreement (*Amodel=86.5*), with dated activity at the site, according to this model, beginning at some point between *1910–1400 cal BC* (*95% probability*), probably in *1545–1415 cal BC* (*68% probability*; *Boundary Start House 5 Early Features*). This phase of earlier use ended at some point between *1480–1315 cal BC* (*95% probability*), probably between *1435–1365 cal BC* (*68% probability*; *Boundary End House 5 Early Features*).

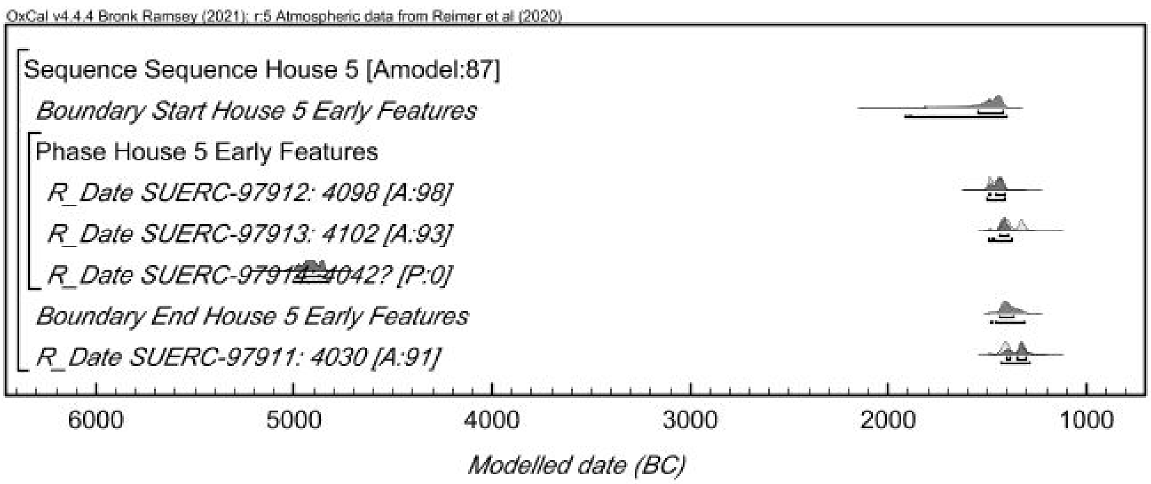

Figure 23: Model constructed using new dates from House 5.

5.6.3 House 5: Legacy and new dates combined

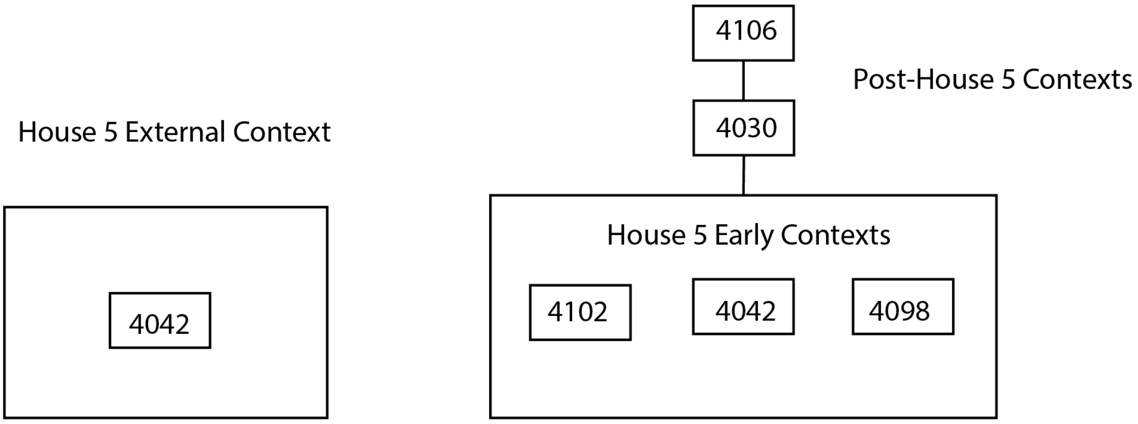

Figure 24: Diagram showing the stratigraphic relationships between dated contexts from House 5.

As for the House 1/House 4 and the House 2/3/6 sites, a model was constructed including dates from both legacy and new dating programmes, with legacy dates from bulk samples labelled as Charcoal Outliers. This model had a similar structure to that constructed using the legacy dates from House 5 (see Figure 24 for stratigraphic relationships, Figure 25 for model). According to this model, activity related to the use of House 5 began at some point between *1575–1400 cal BC* (*95% probability*), probably in *1470–1415 cal BC* (*68% probability*; *Boundary Start House 5 Early Features*). Use of the site ended at some point between *1445–1215 cal BC* (*95% probability*), probably in *1435–1360 cal BC* (*68% probability*; *Boundary End House 5 Use*).

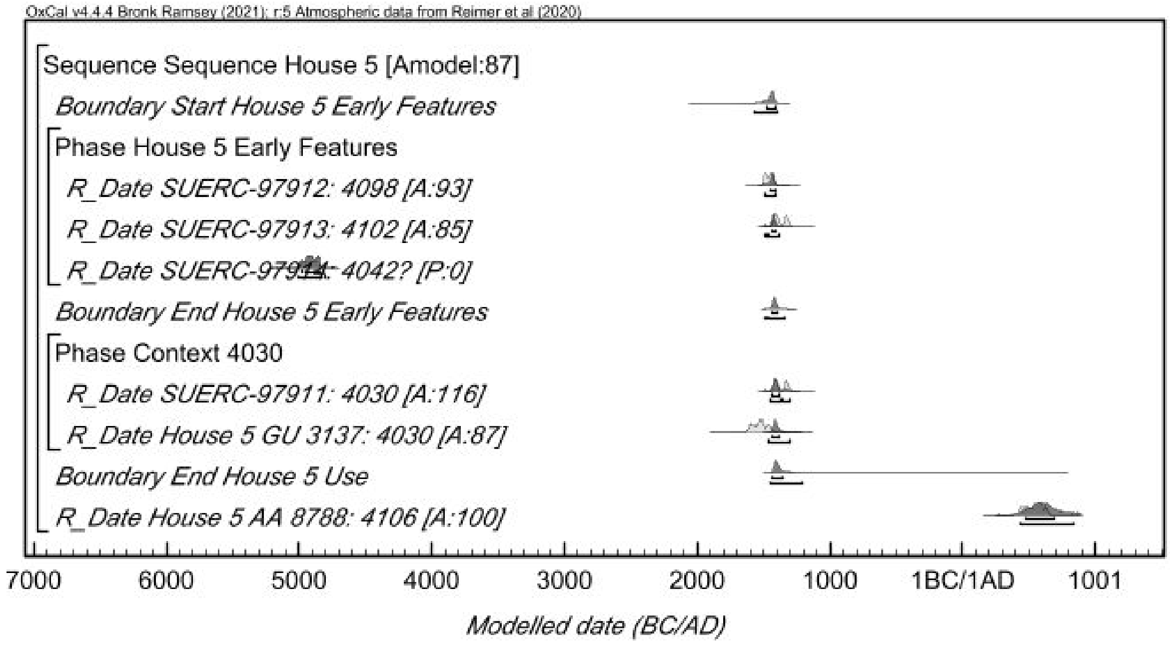

Figure 25: Model constructed using legacy and new dates from House 5, with a Charcoal Outlier model applied. Legacy dates from bulk contexts have been treated as charcoal outliers.

5.7 House 7

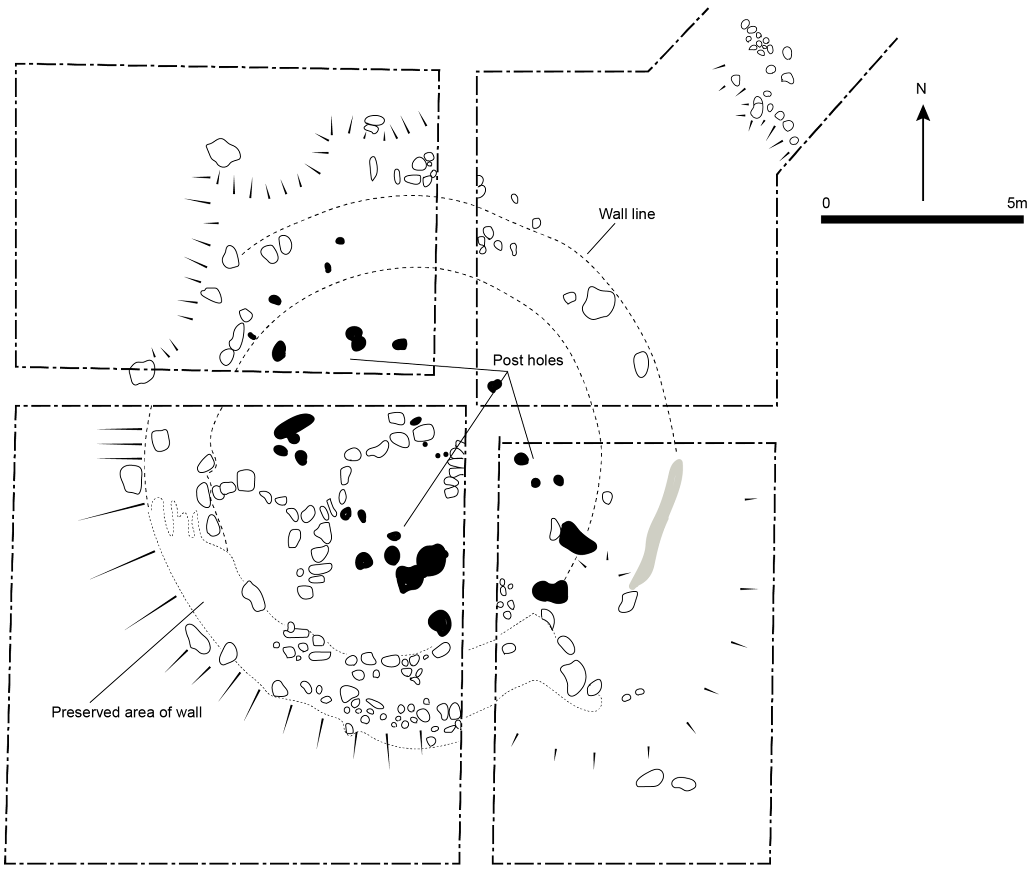

Figure 26: Plan of House 7 (adapted from McCullagh & Tipping, 1998: 59).

House 7 (Figure 26) was the latest of the excavated roundhouses at Lairg, with contexts producing 1st millennium BC dates. The stratigraphy of the site in the north-east and northwest had been heavily damaged by later tillage, resulting in shallow features.
House 7 was positioned lower than any of the other houses excavated at Lairg, and much of the surrounding ground to the west of the site has been subject to quarrying. It was noted that the site is separated from the other excavated hut circles by Dyke 5, and it did not appear to be linked to them.

House 7 was not originally securely recorded as a hut circle or roundhouse but was thought to have possibly been a cairn: this is apparent in the excavation record, where the site is referred to as 'the monument' on context records and the line of what is now clearly a wall was recorded without suggesting this as a possible interpretation. It measured approximately 15m in diameter, and was primarily constructed using stone, apparently to a greater extent than the other excavated hut circles at Lairg. Like some of the other house sites, particularly House 3 and House 5, the stratigraphic evidence had been disturbed and partially removed by later ploughing.
Like other excavated houses at Lairg, House 7 had been built over evidence of earlier use, in this case, a series of ard marks running parallel to each other, but sparser and more fragmentary than the ard marks seen at House 5 and House 6. This activity was followed by the building and then use of the House 7 structure, approximately 11–12m in diameter with a c.1.5m wide wall. House 7 differed from the houses upslope in several ways: there was no depression caused by erosion around its entrance, and the interior contained no evidence of erosional features. This phase included evidence for over 40 interior pits, potentially post settings, most less than 20cm deep.
According to the excavation report, thin, charcoal-rich spreads in the hut interior post-date this primary occupation/use phase, although in context records in the excavation archive they are referred to as potentially related to a hearth feature. Another phase of use followed this, with fire-fractured stone slabs representing hearths, overlying the charcoal-rich spreads mentioned above. Post-final abandonment, cultivation took place at the site.

House 7 is thought to have had an internal post-ring, a feature not seen at the other excavated houses at Lairg. It is thought to have had a domestic function, at least in its secondary phase of use, based on the hearth evidence and wheat and oat macro plant remains, but based on the post-ring and the lack of evidence for erosion in the building's entrance and interior, it would appear that the character of that settlement was different from the houses upslope.

5.7.1 House 7: The legacy dates

A total of five contexts from House 7 were dated as part of the original Lairg Project dating programme. These comprised 1024 (GU-3171 and GU-3169), a stone spread underlying the primary building features; 1116 (GU-3167) the fill of a structural post-hole; 1134 (GU-3165), the fill of a non-structural feature, potentially a rabbit hole; 1124 (GU-3163), the fill of a shallow, non-structural negative feature cutting pre-House 7 ard-marks; and 1045 (GU3161), a charcoal-rich sediment in the building's interior, deposited after the building's collapse.

To create a chronological model based on the House 7 legacy dates, dates from these contexts were placed into a sequence (Sequence House 7, see Figure 27), with a date from 1024 (GU-3171), thought to pre-date the use of the House 7 structure, placed preceding those from contexts related to the use of the building, which were placed into a phase (Phase House 7 Use). The date from context 1045 (GU-3161) was placed last in the sequence. GU-3165, from context 1134, was excluded from the model as the feature it was derived from was thought to be the result of rabbit activity and cannot be securely linked to the use of the building.
This approach resulted in a model with good agreement (*Amodel=109.5*). Dated activity was ongoing at the site by *10845–3865 cal BC* (*95% probability*), most likely by *7255–4020 cal BC* (*68% probability*; *Boundary Start Pre House 7 Use*). Dated use related to the House 7 structure began at some point between *2725 –170 cal BC* (*95% probability*), probably in *625–220 cal BC* (*68% probability*; *Boundary start House 7 Use*). Dated use of the House 7 structure ended between *380 cal BC–cal AD 5* (*95% probability*), probably between *300–105 cal BC* (*68% probability*; *Boundary End House 7 Use*).

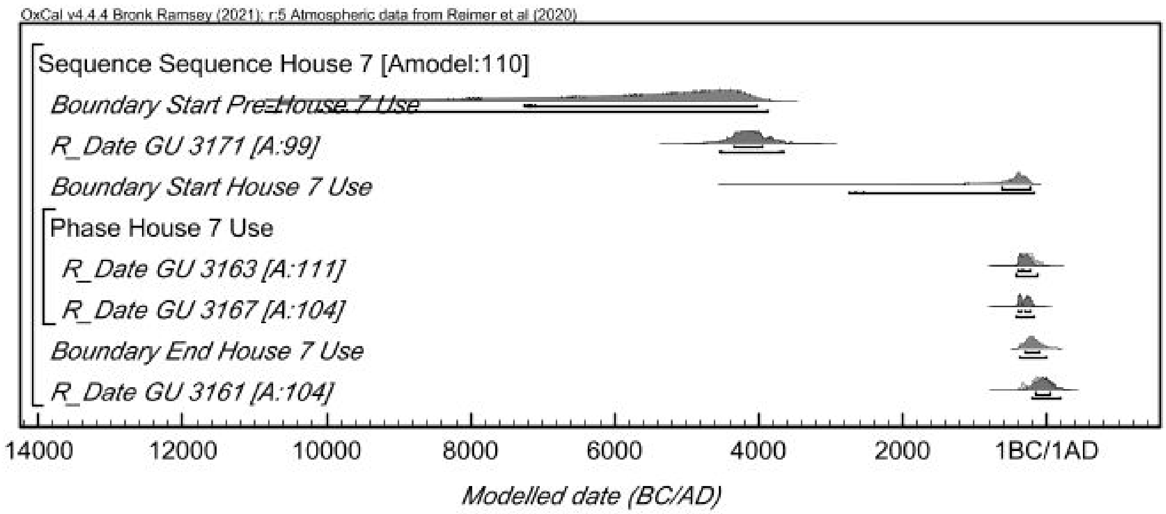

Figure 27: Model constructed using legacy dates from House 7.

5.7.2 House 7: The new dates

Eight contexts from House 7 were included in the re-dating programme, designed to represent as wide a range of the phases of the building's use as possible, prioritising secure contexts (pits, post-holes, hearths etc.) with a high likelihood that the charcoal within them was deposited during the use-life of the building. These contexts comprised 1024, the stone spread underlying the House 7 structure; 1124, the cut feature overlying the pre-House 7 ard-marks; 1097, the fill of a post-hole related to the House 7 structure; 1116; the fill of a post-hole related to the House 7 structure; 1090, the fill of a post-hole related to the House 7 structure; 1110, the fill of a post-hole related to the House 7 structure; 1068, the fill of a posthole related to the House 7 structure; and 1045, a spread of charcoal-rich material around a hearth feature thought to post-date the primary use of the House 7 building.

To create an updated chronology for the House 7 site, these dates were placed into a sequence reflecting the stratigraphy of the site (*Sequence House 7*, see Figure 28). The date from 1024 (SUERC-97915), the pre-House 7 stone spread, was placed first in the sequence, prior to those relating to those relating to the primary use of the building, which were placed in a single phase (*Phase House 7 Primary Use*). A final date relating to post-House 7 use of the site from context 1045 was placed last in the sequence.

This approach resulted in a model with good agreement (*Amodel=95*), with dated activity beginning at the site at some point between *555 –170 cal BC* (*95% probability*), probably in *375–180 cal BC* (*68% probability*; *Boundary Start Pre-House 7 Use*). Activity related to the primary use of House 7 spanned *0–180 years* (*95% probability*), probably *0–65 years* (*68% probability*; *Difference Span House 7 Primary Use*), ending between *345–90 cal BC* (*95% probability*), probably between *185–45 cal BC* (*68% probability*). Activity at the site ended between *345 cal BC–cal AD 230* (*95% probability*), probably between *190–45 cal BC* (*68% probability*; *Boundary End House 7 Use*).

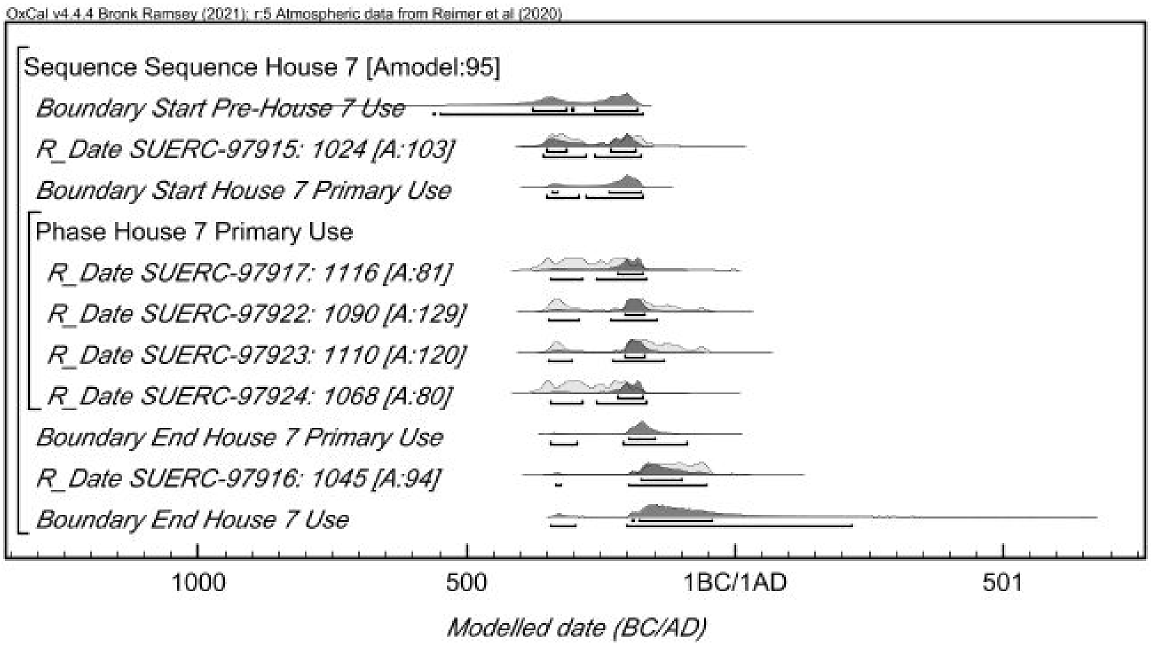

Figure 28: Model constructed new dates from House 7.

5.7.3 House 7: Legacy and new dates combined

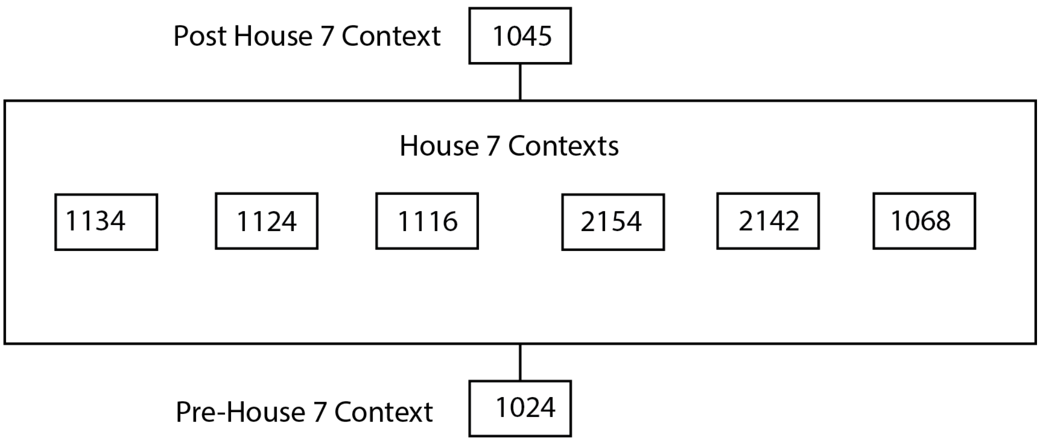

Figure 29: Diagram showing stratigraphic relationships between dated contexts from House 7.

As for the other house sites, legacy and new dates from House 7 were included in the same model, with a similar structure to that constructed using the new dates from the site. A Charcoal Outlier model was used, with legacy dates from bulked samples identified as Charcoal Outliers. A date from context 1024 (GU-3171) was excluded as an outlier – it was thought to represent activity pre-dating the use of House 7. According to this model (see Figure 29 for stratigraphic relationships, Figure 30 for model), dated activity associated with the primary use of House 7 began at some point between *465–180 cal BC* (*95% probability*), probably between *400–200 cal BC* (*68% probability*; *Boundary Start House 7 Primary Use*). This main phase of use of House 7 spanned *2–365 years* (*95% probability*), probably *1–190 years* (*68% probability*; *Difference Span House 7 Primary Use*). Use of House 7 ended at some point between *190 cal BC–cal AD 1285* (*95% probability*), probably in *165 cal BC–cal AD 475* (*68% probability*; *Boundary End House 7 Use*).

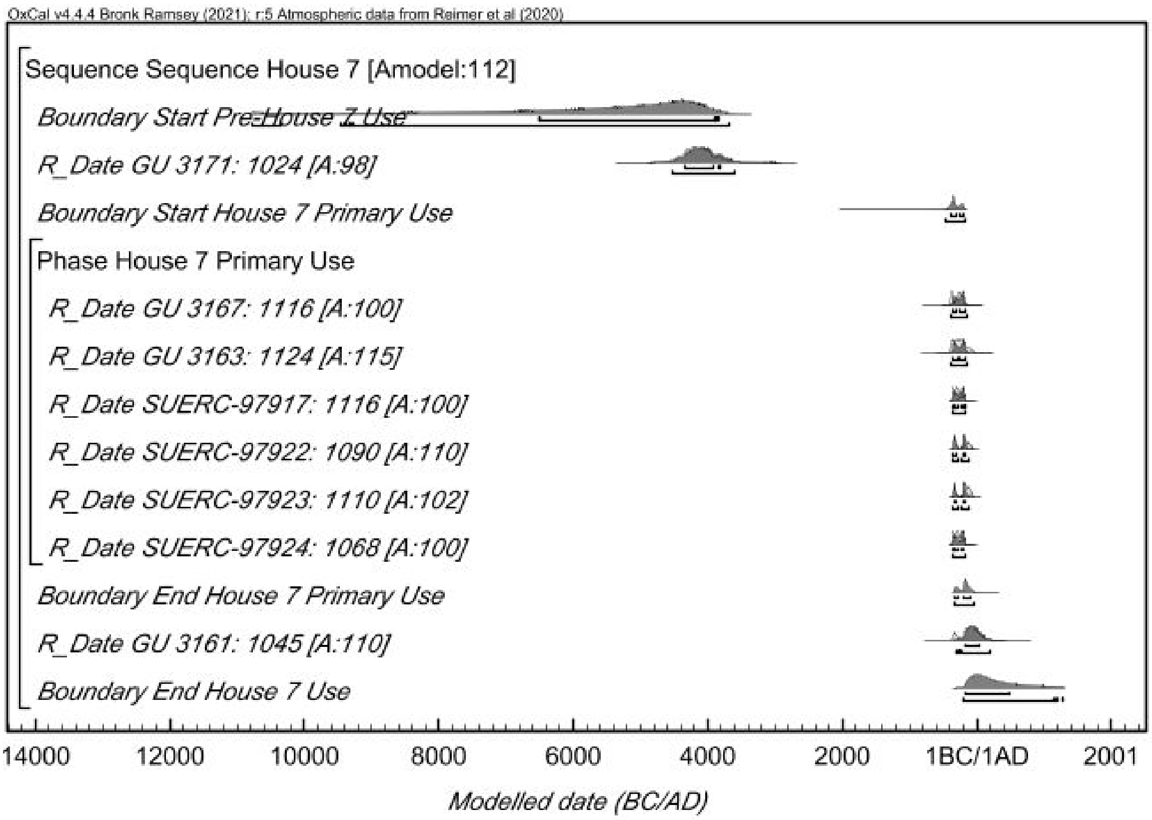

Figure 30: Model constructed using legacy and new dates from House 7, with a Charcoal Outlier model applied. Legacy dates from bulk contexts have been treated as charcoal outliers.

5.8 Discussion

It is clear from the evidence discussed above that the landscape around Lairg is rich in evidence of human activity through the prehistoric and historic periods. At the Allt na Fearna quarry, sites within the landscape were subject to periods of use and re-use, for domestic and agricultural purposes. This use and re-use of favourable locations within the landscape has been noted at other sites in Scotland and elsewhere (Barber, 1997; Barrett, 1999; Cavers *et al.*, 2016; McCullagh & Tipping, 1998), in both prehistoric and later contexts (Davies, 2007), and may have functioned as an adaptive mechanism to mitigate against the negative impacts associated with living in and farming upland landscapes in a northerly climate (see Davies, 2007; McDonald *et al.*, 2021).

Activity at the Allt na Fearna site centred broadly on the mid-2nd millennium BC, with most dated settlement activity taking place in the centuries around c.1500 cal BC. Evidence for settlement is only really seen in the record at the site from c.1700 cal BC onwards, in line with Caswell's (2020) research into Bronze Age settlement across mainland Britain, which identified a settlement horizon at both upland and lowland locations at c.1700 cal BC. This broadly coincides with north-west Europe-wide shift away from large-scale burial monuments and ostentatious funerary practices (Parker Pearson *et al.*, 2005; Caswell & Roberts, 2018) could indicate a real shift in the way in which societies were structured around this time.

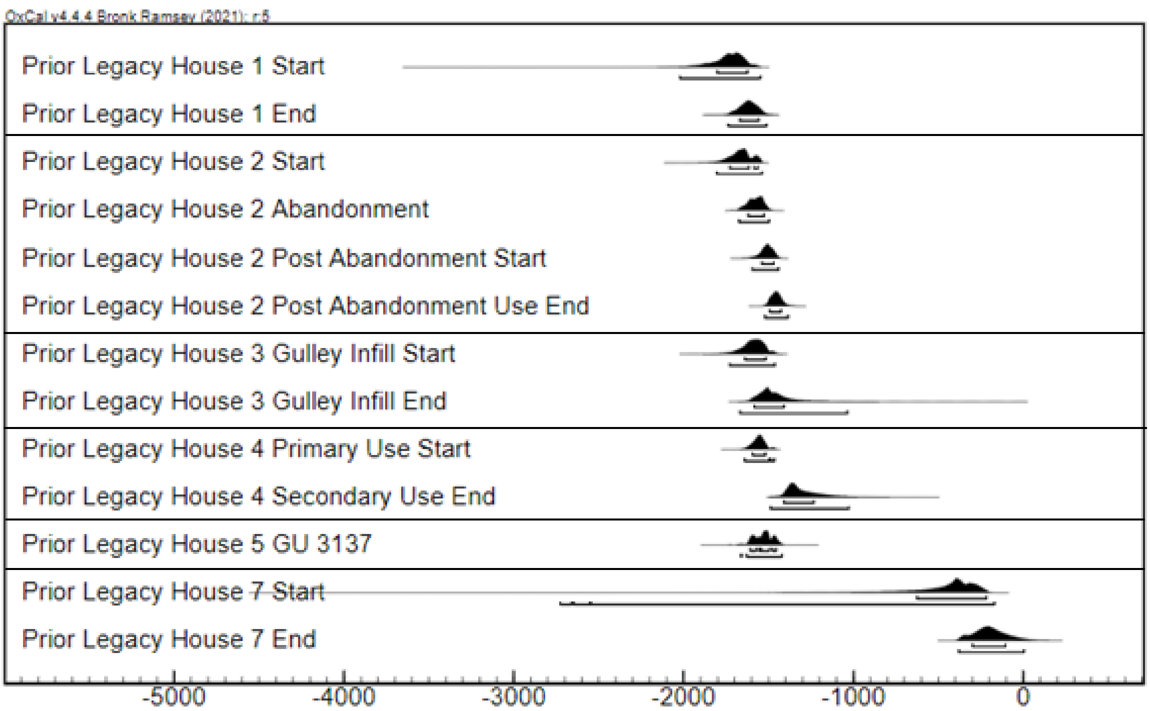

Figure 31: Start and end points for the main phases of use of the prehistoric buildings at the Allt na Fearna site (based on the models constructed using legacy dates). X-axis in cal AD/BC.

Both the updated chronologies for the settlement sites at the Allt na Fearna quarry generally indicate activity post-dating this c.1700 cal BC horizon, as do those constructed using the legacy data (see Figure 31 and Figure 32). While the site's excavators had suggested, for example that House 1, 2 and 3 sites were likely to have been in use from c.1800 BC onwards, both the chronological models produced using the legacy and the new data indicate that House 1 dates to or post-dates the mid-2nd millennium BC, while the legacy models for House 2 and 3 also suggest this.

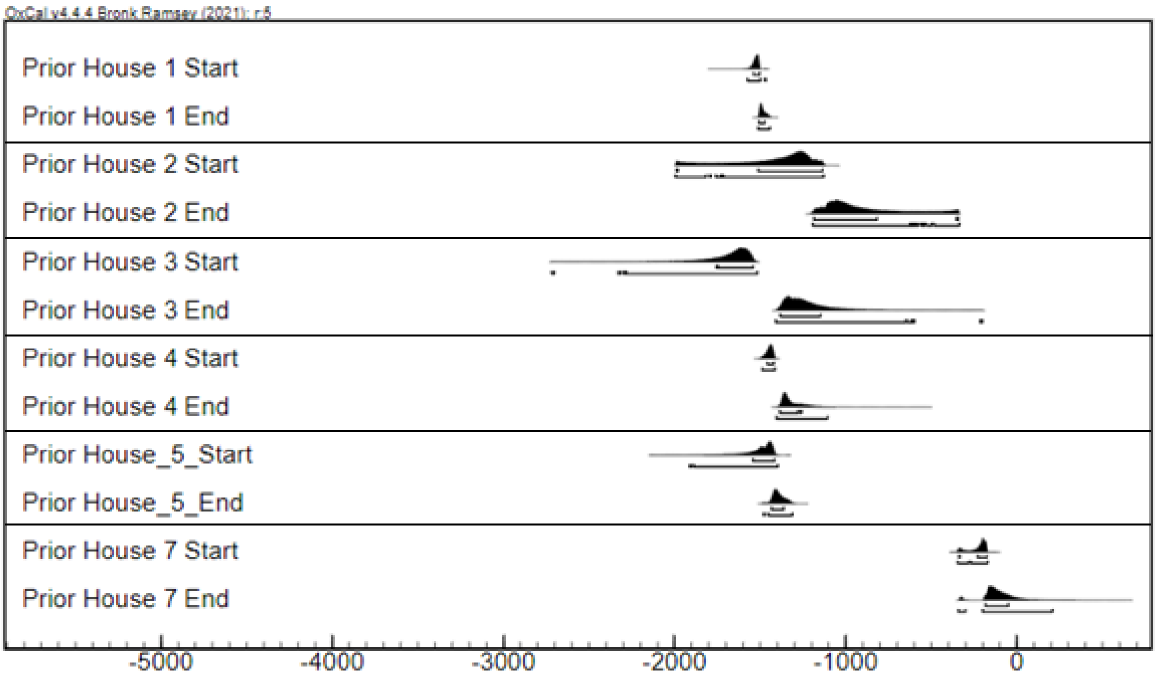

Figure 32: Start and end points for the main phases of use of the prehistoric buildings at the Allt na Fearna site (based on the models constructed using new dates). X-axis in cal AD/BC.

The broad distributions for the start and end points of activity at the House 2 and House 3 sites produced through modelling the new dates are likely to be at least partially due to the small number of determinations used to construct these models: more data allow for more precise modelling. This demonstrates the value of Bayesian modelling of radiocarbon dates. Legacy dates which are imprecise by modern standards can be used to construct far more precise chronologies than those produced through visual analysis of radiocarbon dates. Additionally, Bayesian modelling of the new dates has produced more precise start and end points for activity at Houses 1, 4, 5 and 7.

As discussed above, it is likely that at least some of the legacy dates from Lairg contain an inbuilt old wood effect (see Ashmore, 1999). This could have implications for other sites with chronologies produced before the advent of routine AMS dating, and for narratives based on these chronologies.

As has been stated elsewhere in this thesis, chronologies based on only a small number of dates lack precision. For some of the House sites at Lairg (notably Houses 2 and 3) it was not possible to recover enough suitable samples to construct a precise chronology for the site. However, including new dates in a model with legacy dates, with the legacy determinations treated as charcoal outliers allows us to produce a more precise chronology than that constructed using only the new dates, and a more accurate chronology than that produced through using only legacy dates, not treated as charcoal outliers. Chronological precision is also generally improved compared to models constructed using legacy dates alone (see Figure 30). Balancing accuracy and precision, it is therefore recommended that the most suitable models on which to base the chronology for Bronze Age settlement at the Allt na Fearna site are the chronologies combining legacy and new dates (see Figures 10, 18, 20, 25 and 30), with the Charcoal Outlier function used to mitigate against any old wood effect inherent in the legacy dates.

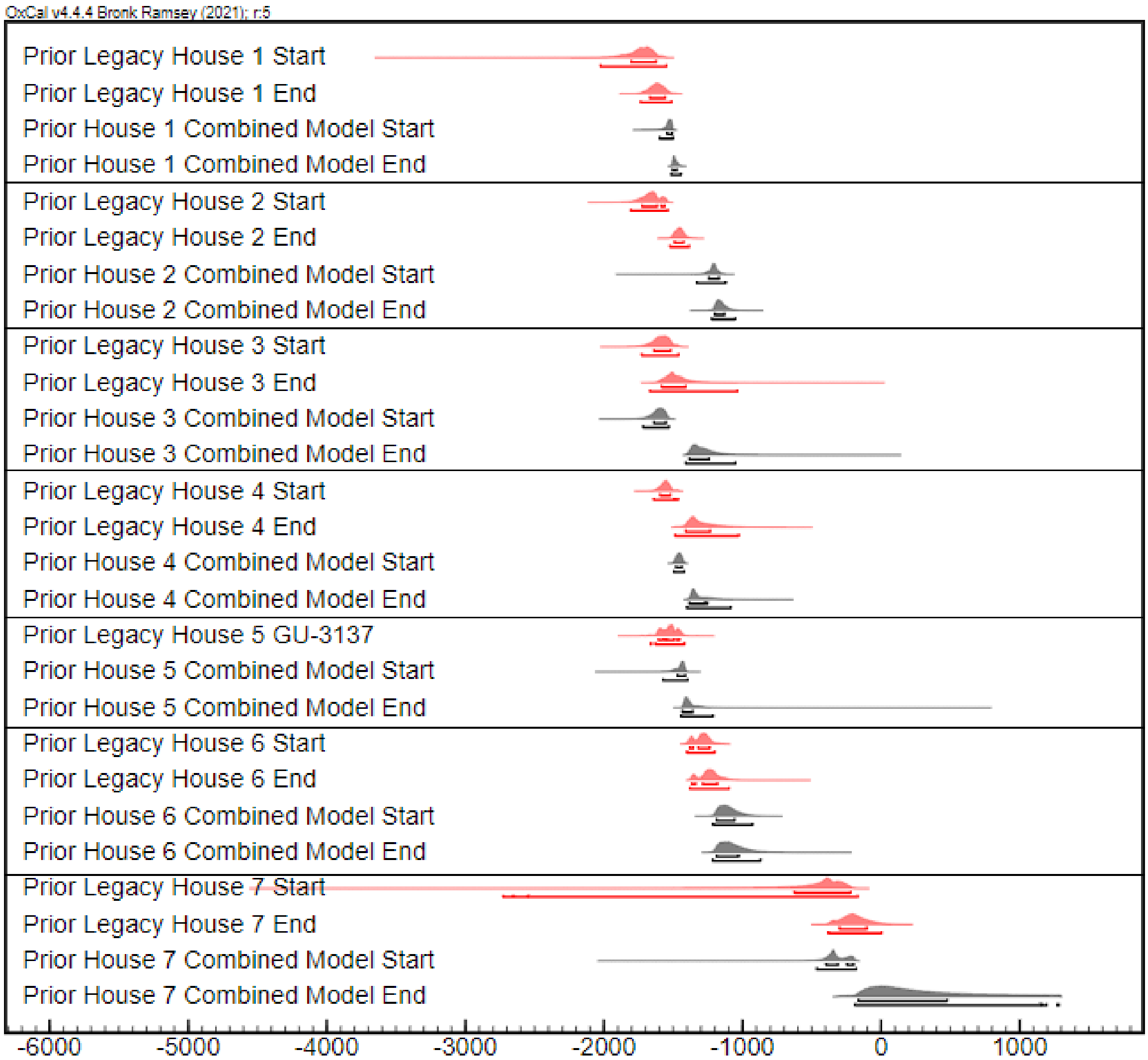

Figure 33: Start and end points for the main phases of use of the prehistoric buildings at the Allt na Fearna site, comparing those from models constructed using only legacy dates with those from models including both legacy (shown in red) and new dates. X-axis in cal AD/BC.

Although issues regarding the obtaining of suitable samples from desirable contexts meant that a finegrained chronology representing most phases of use could not be produced for all the roundhouse sites at Lairg, it would appear that at least some of the Bronze Age buildings at the site were in use for a generation or so, with intervening periods of agricultural use also lasting <100 years on average. This can be seen in the updated models for House 1/House 4 and the model constructed using legacy dates for the House 2/House 6 site. Again, this finding is supported by other research looking into the use-lives of prehistoric buildings (Barber & Crone, 2001; Crone *et al.*, 2018) and could be linked to ideas relating the house as a building to the concept of individual households (Brück, 1999; 2000). From the models created using both only the new dates, and those including both legacy and new dates, it

appears that the majority of the Bronze Age roundhouses at Lairg were not in use at the same time (see Figure 33), with little overlap in the distributions of the modelled start and end points for use of the buildings, apart from for House 1 and House 5.
In conjunction with evidence for intervening periods of agricultural activity at sites where the remains of buildings overlapped, this pattern of shifts between agricultural and domestic use of the 'house' sites could indicate shifting settlement, moving around a landscape (Halliday, 2015; 2021; Tipping, 2015).

Bronze Age settlement activity at the Allt na Fearna site appears to have declined before the beginning of the 1st millennium BC (although it should be noted that there are numerous unexcavated roundhouse sites in the area and those described here are only represent a sample). Only one house, House 7, post-dated this point and dated to the latter part of the 1st millennium BC, indicating a significant hiatus in identifiable settlement activity. This is congruent with broader narratives of Bronze Age upland settlement, proposing a decline and retreat from upland areas, associated with climatic downturn, in the Late Bronze Age (Amesbury *et al.*, 2008; Burgess, 1985; Burgess, 1989; Burgess; 1990, Burgess; 1995; Fleming, 1988; Parker Pearson, 1993). Whether or not the decline in settlement activity seen at Lairg in the Late Bronze Age was associated with climate change or not is uncertain, but clearly there was a very real hiatus in domestic activity at the site for much of the 1st millennium BC.

Chapter 6: Updated Palaeoenvironmental Reconstructions from Lairg

6.1 Introduction

As outlined in the literature review section of this thesis, understanding the past ecological dynamics of Bronze Age upland settlement sites is key to understanding a) the drivers behind past upland land-use and b) how these sites were used – was agriculture accompanying settlement activity primarily pastoral, or did arable activity take place? High-resolution palaeoenvironmental chronologies are not widely available for later prehistory in Britain and Scotland. Updated, precise chronologies for environmental archives would allow us to better explore the relationship between the environment, land-use and settlement at sites such as Lairg.

There is a longstanding and still-pervasive idea in the archaeological literature that due to their marginality for agriculture and settlement, upland sites are well-placed as case studies through which to examine the relationship between human activity and environmental change (e.g. Parry,1978). As part of the 1990s programme of research at Lairg, a total of three pollen cores were taken and analysed – one from the valley floor (AG2), one from the shore of a lochan atop a plateau above the excavated settlement site (AG1), and one from a peat deposit directly below the excavated settlement site (AG3) (McCullagh & Tipping, 1998). The results of these analyses have been influential in interpretations of Scottish upland use and are widely cited in discussions of upland land use in Scotland during the Bronze Age.

While the chronologies produced for the palaeoenvironmental record from the three sample sites are of a high standard for the period when they were produced, it is now possible to produce chronologies of a far higher resolution (outlined in Chapter 3). As part of the research for this thesis, the opportunity was taken to re-sample one of the locations included in the earlier palaeoenvironmental work at Lairg, providing an updated pollen record with a high-resolution chronology. This updated, precise chronology was intended to shed light on the relationship between settlement, land-use and the environment at Lairg through time, and for an assessment of the reliability of legacy environmental data, on which a number of modern studies are based.

It was decided to re-sample the AG3 site, as due to its proximity to the excavated settlement site, data from AG3 (a small peat basin, likely to have a local pollen catchment) would be more likely to directly reflect events there (cf. Bunting *et al.*, 2005; Calcote, 1995; Davies & Tipping, 2004; Sugita, 1994). This site was located just south and directly downslope from the excavated settlement site, on the south side of the Allt na Fearna burn (Figure 34). For detailed methodology outlining the radiocarbon dating and pollen analysis carried out, see Chapter 4.

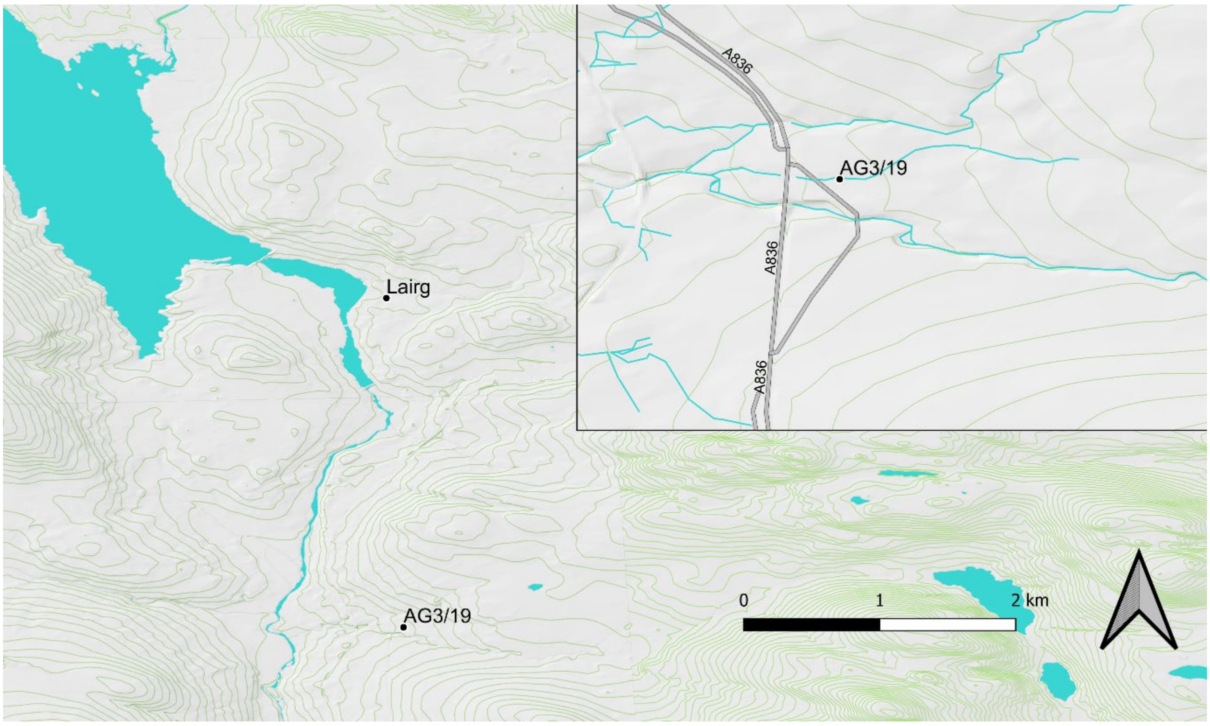

Figure 34: Map showing the AG3/19 sample site, from which the AG3/19A and AG3/19B cores were taken (map data from Google, 2020)

6.2 Results

The results, and elements of the interpretation and discussion sections of this research, have been published elsewhere (McDonald *et al.*, 2021). Efforts have been made to adapt aspects of the interpretation of the pollen data from the AG3/19 site for use in this thesis, although there are naturally some similarities of argumentation and phrasing.

6.2.1 Lithostratigraphy and Chronology

Depth (m)	Troels-Smith Description	Sediment Description
0.00–0.09	nig 2; strf 0; elas 2; sicc 3; lim 1; hum 1; Tb 1; Tl 0; Th 4.	Brown, poorly humified herbaceous peat, with vertical rootlets.
0.09–0.38	nig 2; strf 1; elas 1; sicc 3; lim 3; hum 3; Tb 2; Tl 0; Th +; Gmin +.	Brown, humified, *Molinia* peat with visible bands of silt.
0.38–1.04	nig 3; strf 0; elas 3; sicc 3; lim 1; hum 3; Tb +; Tl 2; Th 0.	Dark brown, well humified peat with occasional wood fragments.
1.04–1.56	nig 3; strf 1; elas 2; sicc 3; lim 2; hum 3; Tb +; Tl 0; Th 2.	Very dark brown, humified fibrous peat.
1.56–2.0	nig 3; strf 1; elas 2; sicc 2; lim 0; hum 3; Tb 1; Tl 2; Th 1.	Very dark brown, humified, *Molinia* peat with wood fragments

Table 2: Lithostratigraphy of the AG3/19A core, after Troels-Smith (1955)

The results of the core lithology are presented in Table 2. When building the chronology for the AG3/19A core, both the humic acid and humin fractions were dated, as agreement between the two can provide confidence in the accuracy of the results (Dunbar *et al.*, 2016). However, agreement between the two fractions was poor, and it was not possible to combine the two sets of dates to create a single chronology. Dates from humic acid samples from AG3/19A were generally younger, although there was no systematic offset between the two sets of dates. Dates from the humic acid and humin fractions of peat can differ significantly, with humic acids usually producing younger dates than those from the humin fraction (Brock *et al.*, 2011; Kilian *et al.*, 2000; Shore *et al.*, 1995).This effect could be seen in the dates from the AG3/19A core, which could be due to the downward transport of younger humic acids within the peat column (Brock *et al.*, 2011; Piotrowska *et al.*, 2011; Shore *et al.*, 1995).

The sample site was located close to the Allt na Fearna burn, which could have increased the possibility for inwashed or intrusive material in the humin fraction (as discussed in Piotrowska, 2011). The humic acid dates were then used to create a 'youngest possible' chronological framework for palaeoenvironmental reconstruction at Lairg (Figure 35).

The base of the AG3/19A core, at 200cm, was modelled to 8535–8290 cal BC and a sample from 15cm depth produced a post-1950 date. All calibrated and modelled dates are quoted at >95% probability. The core was determined to span 10,440—13,145 years, with an average accumulation rate of 1–2 cm per 100 years, equivalent to a deposition time of 55–57 years per cm. The *P_Sequence* age-depth model (Figure 35) had good agreement (*Amodel:86*) between the dates and the sequence.

Lab ID	Material	δ13C (‰)	Radiocarbon age (BP)	Calibrated date (95.4% probability)	Depth (cm)
SUERC-92846	Humic acid	-30.8	post-1950	/	5
SUERC-92864	Humin	-29.7	post-1950	/	5
SUERC-92847	Humic acid	-29.6	post-1950	/	15
SUERC-92865	Humin	-29.5	36 ±24	cal AD 1695–1915	15
SUERC-88387	Humic acid	-29.8	566 ±30	cal AD 1310–1425	25
SUERC-89093	Humin	-29.7	690 ±25	cal AD 1275–1385	25
T=10.054(df=1; 5% 3.8)					
SUERC-92848	Humic acid	-29.3	1240 ±24	cal AD 14–205	30
SUERC-92866	Humin	-30.0	2172 ±22	355–125 cal BC	30
T=50.633(df=1; 5% 3.8)					
SUERC-92852	Humic acid	-29.7	3274 ±24	1615–1500 cal BC	35
SUERC-92867	Humin	-30.5	3338 ±22	1685–1535 cal BC	35
T=3.861(df=1; 5% 3.8)					

SUERC-92853	Humic acid	-30.0	3720 ±22	2200–2035 cal BC	40
SUERC-92868	Humin	-30.7	3631 ±24	2130–1900 cal BC	40
T=123.322(df=1; 5% 3.8)					
SUERC-92854	Humic acid	-29.6	3852 ±22	2455–2205 cal BC	45
SUERC-92872	Humin	-29.9	3977 ±25	2575–2460 cal BC	45
T=14.116(df=1; 5% 3.8)					
SUERC-88388	Humic acid	-29.7	4168 ±30	2880–2630 cal BC	50
SUERC-89094	Humin	-29.7	4269 ±25	2920–2875 cal BC	50
T=6.674(df=1; 5% 3.8)					
SUERC-92855	Humic acid	-29.5	4672 ±23	3520–3370 cal BC	62
SUERC-92873	Humin	-30.0	4729 ±22	3630–3380 cal BC	62
SUERC-88389	Humic acid	-29.4	4851 ±30	3705–3530 cal BC	75
SUERC-89095	Humin	-29.1	5003 ±25	3940–3660 cal BC	75
T=15.096(df=1; 5% 3.8)					
SUERC-92856	Humic acid	-29.4	5276 ±24	4230–3995 cal BC	87

SUERC-92874	Humin	-29.8	5106 ±23	3970–3805 cal BC	87
T=26.173(df=1; 5% 3.8)					
SUERC-88390	Humic acid	-29.5	5266 ±30	4230–3990 cal BC	100
SUERC-89096	Humin	-29.4	5468 ±25	4355–4255 cal BC	100
T=26.629(df=1; 5% 3.8)					
SUERC-92857	Humic acid	-29.6	5713 ±24	4670–4460 cal BC	112
SUERC-92875	Humin	-29.3	5854 ±24	4795–4620 cal BC	112
T=17.256(df=1; 5% 3.8)					
SUERC-88391	Humic acid	-29.1	5550 ±30	4450–4345 cal BC	125
SUERC-89097	Humin	-28.4	5849 ±25	4795–4615 cal BC	125
T=58.199(df=1; 5% 3.8)					
SUERC-92858	Humic acid	-29.6	5247 ±22	4225–3980 cal BC	137
SUERC-92876	Humin	-29.0	5672 ±22	4550–4450 cal BC	137
T=186.379(df=1; 5% 3.8)					
SUERC-88392	Humic acid	-28.8	6626 ±30	5625–5485 cal BC	150

SUERC-89098	Humin	-28.5	6691 ±26	5665–5555 cal BC	150
SUERC-92862	Humic acid	-28.7	8765 ±24	7950–7660 cal BC	162
SUERC-92877	Humin	-29.1	8898 ±25	8225–7960 cal BC	162
T=14.737(df=1; 5% 3.8)					
SUERC-88393	Humic acid	-28.5	7872 ±30	6980–6605 cal BC	175
SUERC-89102	Humin	-28.7	8074 ±25	7140–6840 cql BC	175
T=26.629(df=1; 5% 3.8)					
SUERC-92863	Humic acid	-28.8	8931 ±25	8245–7965 cal BC	187
SUERC-92878	Humin	-28.3	8894 ±25	8220–7960 cal BC	187
SUERC-88397	Humic acid	-28.5	9154 ±30	8530–8290 cal BC	200
SUERC-89103	Humin	-28.3	9350 ±25	8710–8490 cal BC	200
		T=25.074(df=1; 5% 3.8)			

Table 3: Radiocarbon dates from the AG3/19A core including T values for combined dates from selected depths

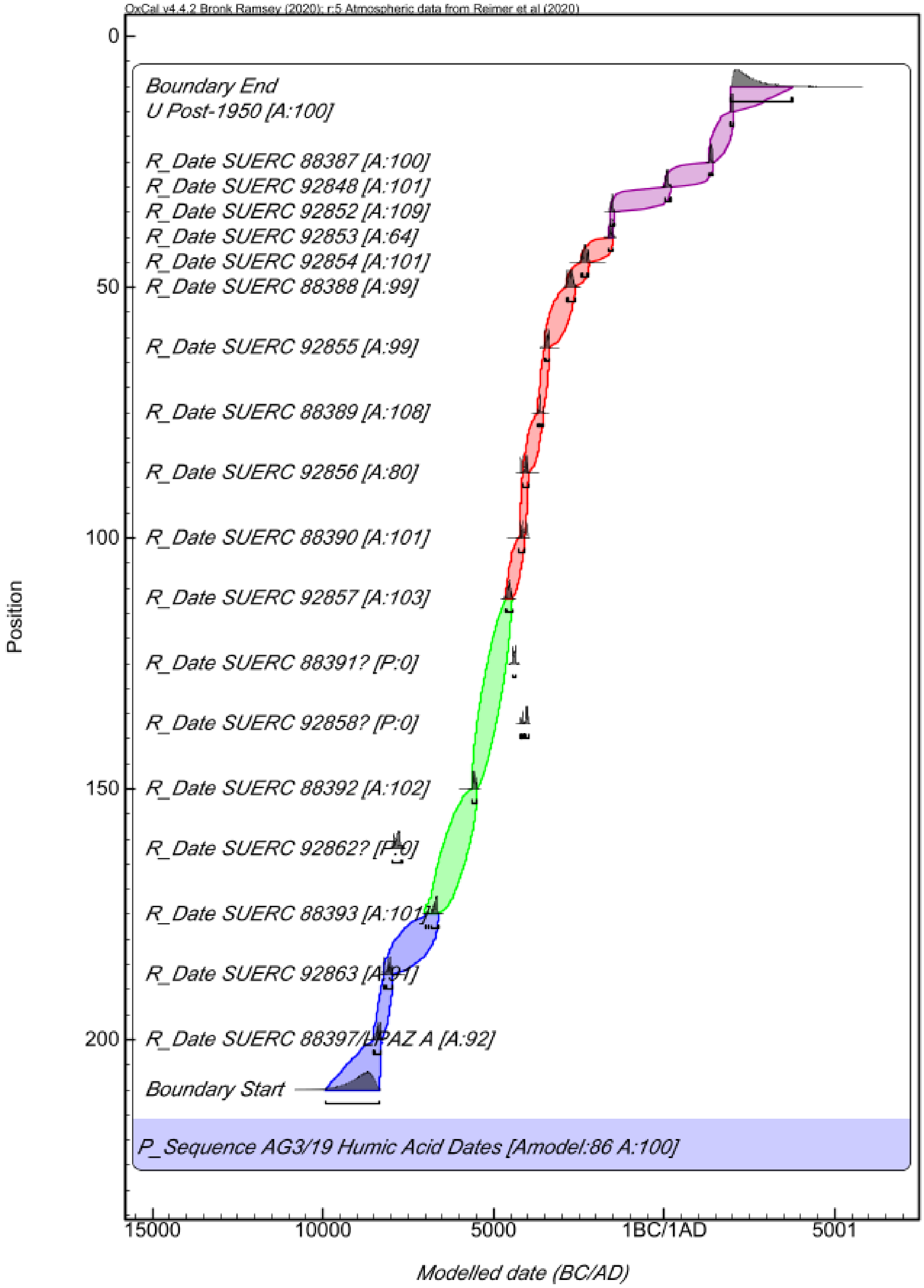

Figure 35: Age-depth model for AG3/19A, constructed in OxCal 4.4.2 (Bronk Ramsey, 2020) using the IntCal20 calibration curve (Reimer et al, 2020) and the P-Sequence function (Bronk Ramsey, 2008). SUERC-88391, SUERC-92858 and SUERC-92862 were excluded as previous versions of the model indicated there was a high likelihood that they were outliers.

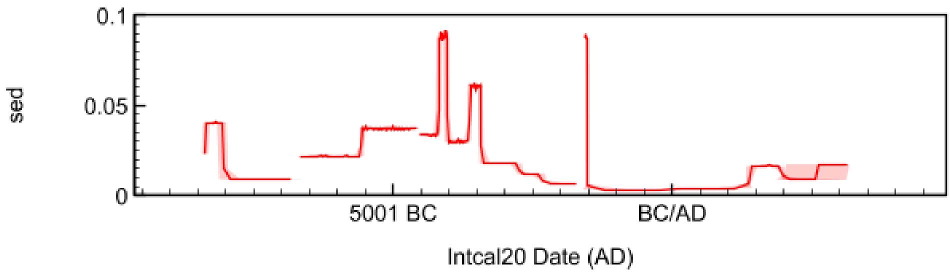

Figure 36: The sedimentation rate (cm/year) of AG3/19A (based on the P_Sequence shown in Figure 35). A hiatus in sediment accumulation can be seen at c.1500 cal BC.

6.2.2 Palynological analysis and Loss on Ignition (LOI)

Pollen analysis was undertaken was undertaken by the author and Dr Kevin Kearney (University College Cork) and interpretation was carried out primarily by the author, with advice from Dr Kevin Kearney and Dr Ben Gearey (also University College Cork). Pollen data is presented in the percentage pollen diagram (Figure 37). All values stated are as a percentage of the TLP (total land pollen). The pollen diagrams have been divided into 9 local pollen assemblage zones (LPAZ) on the basis of visual inspection, with dates for LPAZ boundaries given as posterior distributions derived from the age-depth model shown in Figure 32. The results of loss on ignition are presented in Figure 6. Zonation for LOI data follows the LPAZ used in the pollen diagram.

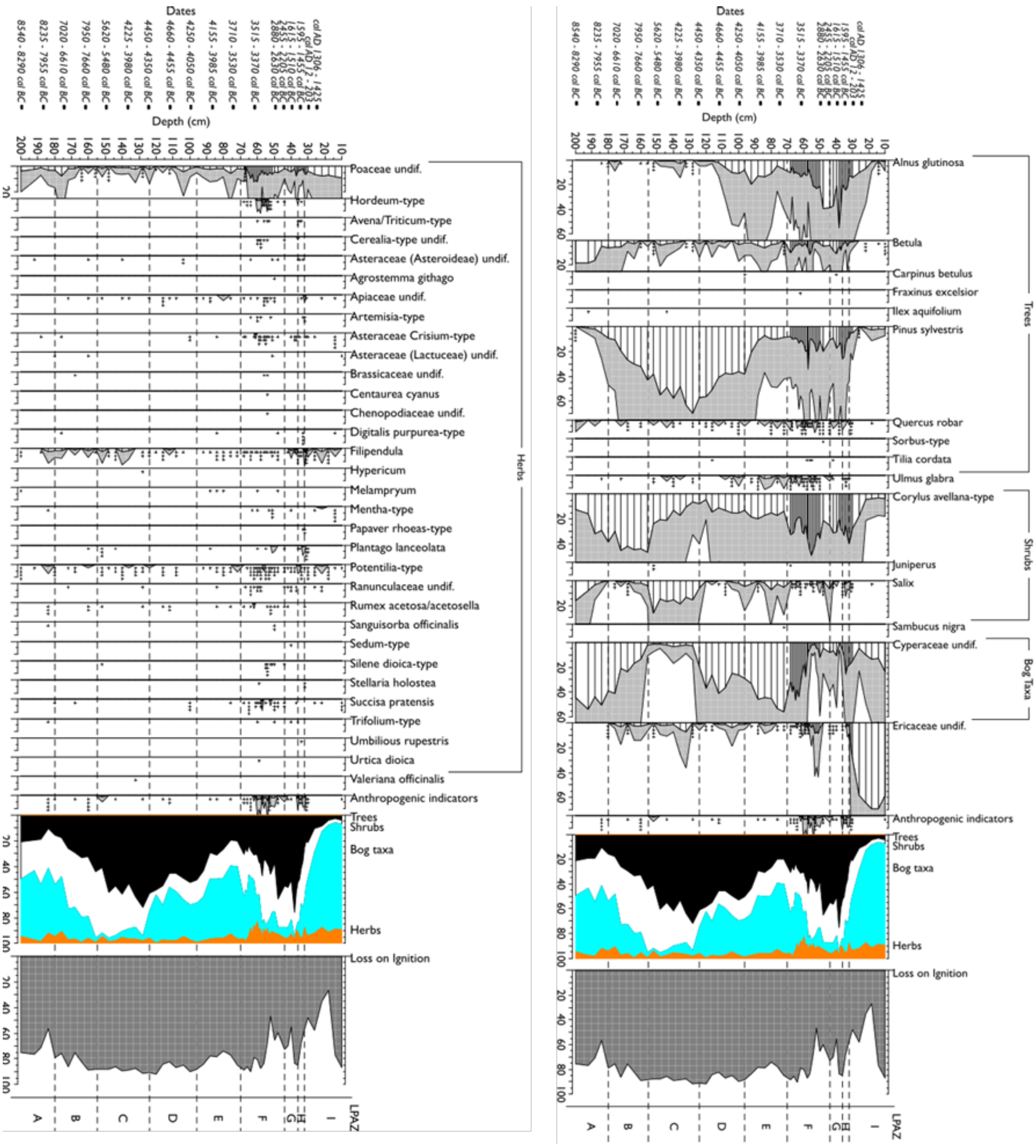

Figure 37: Pollen data and loss on ignition results from AG3/19A. Dates for the LPAZ boundaries were calculated using the Date function in OxCal 4.4.2 (Bronk Ramsey, 2020). Grey shading is for exaggeration purposes.

6.3 Interpretation

LPAZ A: 2.00–1.80m (*8540–8290 cal BC* to *7870–6730 cal BC*)

The AG3/19 pollen diagram (Figure 37), spans much of the Holocene from *8540–8290 cal BC to cal AD 120–post 1950*, from the Mesolithic to present. Local vegetation in LPAZ A is typical of early Holocene records from elsewhere in Scotland (Huntley *et al.*, 1997; Kelly *et al.*, 2017), with the woodland component consisting primarily of *Betula* (birch) and *Corylus* (hazel), averaging c.20% and c.30% respectively, while the presence of open environments are indicated by sustained values of *Poaceae* (grasses), averaging c.3%, and *Cyperaceae* (sedges) c.45%. *Pinus sylvestris* (Scots pine) begins to increase to c.10% by the top of the LPAZ, indicating the tree species had become established within the local landscape, although the relatively low values across the LPAZ may also suggest long distance transport from beyond the immediate vicinity of the site (cf. Lageard *et al.*. 1999) (Lisitsyna *et al.*, 2011).

LPAZ B: 1.80–1.55m (*7870–6730 cal BC* to *6150–5540 cal BC*)

LPAZ B is characterised by the expansion of woodland taxa, primarily hazel (to c.45%) and Scots pine (to c.40%), while sedges decreased from c.40% to c.2%, indicating drier conditions and the development of woodland in the area.

LPAZ C: 1.55–1.24m (*6150–5540 cal BC* to *5155–4610 cal BC*)

At the beginning of LPAZ C, tree pollen continued to increase in prevalence. Values for pine increased to c.70% by the end of the zone, while hazel values are reduced to c.10%, indicating the establishment of a closed, pine-dominated woodland canopy. *Salix* (willow) increased from 4% to a high of 27% in Zone C, and instances of *Quercus* (oak) and *Ulmus* (elm) pollen were also recorded, although at low percentages. The site's northern latitude is likely to be a factor in the low levels of oak and elm pollen seen in this period (and throughout the record at Lairg), as both species are sensitive to the cold conditions experienced at higher latitudes (Birks, 1970). Values for arboreal pollen were consistently above 80% in this zone, reaching highs of c.90%. Combined with persistently low values for sedges (less than 10%), this is indicative of relatively dry conditions at the site.

LPAZ D 1.24–0.96m (*5155–4610 cal BC* to *4225–4040 cal BC*)

Scots pine began to decline gradually in LPAZ D, from c.70% to c.40% from the beginning to the end of the zone. Values for *Alnus* (alder), birch and hazel remained steady or increased slightly, with alder increasing from 1% to c.9% by the end of the LPAZ. Sedges increased, with values generally between 40% and 50% throughout LPAZ D. This is likely to reflect a shift to wetter surface conditions at the site.

LPAZ E: 0.96–0.70m (*4225–4040 cal BC* to *3660–3435 cal BC*)

In Zone E, Scots pine underwent a second, more rapid phase of decline, falling to values consistently below 20% (and at some depths in this zone, below 10%). This is likely to have been associated with a shift to wetter conditions, seen in the continued increase in sedges (to a high of nearly 70% by the end of Zone E). Values for tree species more tolerant of wetter conditions, such as alder, birch, and hazel generally remained steady or increased in this zone.

LPAZ F: 0.70–0.44m (*3660–3435 cal BC* to *2455–1720 cal BC*)

It is not until LPAZ F, broadly dated to the Middle to Late Neolithic (although there are issues with the dates from approximately the end of LPAZ F onwards) that significant increases in anthropogenic indicators such as *Rumex acetosa* (sorrel) and *Potentilla*-type (cinquefoil) are observed. *Hordeum* (barley), *Avena/Triticum* (oat/wheat) and undifferentiated cereal-type pollen are also recorded with greater frequency. Anthropogenic indicators consistently comprised over 1% of the record in this zone, reaching a high of c.5%. Cereal pollen was observed in the record from 68cm (*3630—3410 cal BC)* onwards, beginning with single grains and reaching a high of 2.4% for barley pollen at 58cm.

Additionally, some indicators of more open ground, such as *Ranunculaceae* (buttercups) and *Asteraceae* (daisies) became more prevalent in this zone, although values for tree pollen remained relatively high (consistently over 40%). Values for grasses also increased, from c. 2% at the beginning of LPAZ F to a high of c.13% at 60cm. This could indicate a landscape characterised by grassy or cultivated clearings within woodland.

Bog taxa (sedges and heath species) decreased in prevalence across this LPAZ (from values of over 40% to less than 10%) and pollen from trees increased (from c. 30% to over

50%). LOI data showed a general decline in organic content with notably low values at 0.54m (c.68%), 0.52m (c.46%), 0.50m (c.65%) and 0.48m (c.59%). This downturn followed a prolonged period where organic material had consistently made up 80–90% of samples. The modelled date range at 50cm was 2880–2630 cal BC. Increasing anthropogenic indicators and cereal pollen, in combination with the LOI values at this point, suggests the deposition of eroded sediments, as a result of tillage and/or grazing upslope from the sample site.

LPAZ G: 0.44–0.36m (*2455–1720 cal BC* to *1600–1460 cal BC*) and LPAZ H: 0.36– 0.32m (*1600–1460 cal BC* to *1510 cal BC–cal AD 120*)

In LPAZ G there was a decline in incidence of anthropogenic indicators, from 1% at the beginning of the zone to 0% by its end. Scots pine increased to over 25% by the end of this zone, after a period of consistent values below 20%. Anthropogenic indicators returned to the record in LPAZ H.
It is at this point that the dates for AG3/19A indicate potential disturbance of the core, mobility of material within the peat, or lab error. A hiatus in sedimentation can be observed just before *1500 cal BC* (Figure 5). While we see a return to the presence of anthropogenic indicators in LPAZ H (constituting over 2% of the record for the majority of this zone), dates for this section of the AG3/19A core are not necessarily reliable in term of their relationship to the pollen stratigraphy. The pollen record itself could also have been affected by any disturbance or movement of the peat at AG3.

LPAZ I: 0.32–0.05 m (*cal AD 120 –post-1950*)

Dates for LPAZ I, the topmost portion of the diagram are likely to be unreliable, for reasons outlined in section 4.2. The most significant feature of LPAZ I is consistently low organic values (below 60% for the majority of the zone), potentially a result of inwash or other disturbance. Vegetation was dominated by bog taxa within this zone.

6.4 Discussion

6.4.1 AG3/19: An overview

The pollen sequence from AG3/19A begins with a typical early Holocene landscape for northern Scotland, with grassy, open ground and developing birch/hazel woodland (Birks, 1989; Kelly *et al.*, 2017). Over the course of the Mesolithic, a woodland dominated by Scots pine continued to expand, until the decline of pine in the area, beginning at c. *5155 –4610 cal BC*. This initial decline was gradual, and it is only after *4225 –4040 cal BC* that pine began to decline dramatically. It has been suggested that a widespread 'pine decline' occurred across Scotland at c.4000 BC, linked to increasingly wet climatic conditions (Birks, 1975; Gear and Huntley, 1991; Blackford *et al.*, 1992), although anthropogenic factors may also have played a part (Tipping *et al.*, 2008a).
At Lairg, a decline in the Scots pine population occurred somewhat earlier than this, although the timing of the pine decline was by no means uniform across Scotland – some areas saw no Neolithic reduction in pine at all (see Anderson *et al.*, 1998; Froyd and Bennett, 2006; Tipping *et al.* 2006; Tipping *et al.*, 2008a). A shift to wetter conditions (seen in the increasing prevalence of sedges in LPAZs D and E) is more likely to have been a causal factor in this decline than anthropogenic activity, for which there was little evidence in this period. A two-stage pine decline, albeit somewhat later than that observed at Lairg, also took place at Loch Farlary, Sutherland, where an initial reduction (attributed to shifts in mire surface wetness) at c.4250—3550 cal BC was followed by a more gradual decline, thought to be the result of grazing pressures, from c.2250–1350 cal BC (Tipping *et al.*, 2008b).

Significant evidence for a human presence in the landscape at Lairg was not seen until the Neolithic, with increasing anthropogenic indicators in LPAZ F and the first recording of cereal pollen at *3630 –3410 cal BC*. This is consistent with the introduction of agriculture to Scotland in the earlier centuries of the 4th millennium BC (Whittle *et al.*, 2011). Although oat/wheat pollen is referred to in the above results, oat remains are rarely found at Neolithic sites (Bishop *et al.*, 2009).
Mixed agriculture (including cereal cultivation) probably took place in the vicinity of the sample site throughout the Neolithic, based on the pollen data and LOI evidence for inwashing of material, probably caused by cultivation-associated soil disturbance upslope. Archaeobotanical analyses undertaken as part of the Lairg Project also recorded evidence of naked barley and emmer wheat being stored on-site, dated to the later Neolithic (3290–2910 cal BC, GU-2862) (Holden, 1998).Tree species continued as a significant feature of the pollen record in this period, particularly alder (presumably on the wet soils) and hazel on

better drained areas, although landcover simulation experiments indicate that open land taxa are generally under-represented in the pollen record in comparison to arboreal species (Bunting *et al.*, 2005; Caseldine and Fyfe, 2006; Sugita, 1999).

Comparisons with the results of the Lairg Project research show some similarities between the two records. While according to that research, peat formation commenced at the site at c.5800 cal BC, later than the date of *8535 –8290 cal BC* for the lowest part of the AG3/19A core, the area was also thought to have been wooded from this point. Pine became the dominant tree species by c.5000 BC, facing competition from alder from the 4th millennium BC onwards. A decline in pine at AG3 was thought to have begun in the 4th millennium BC, slightly later than that seen in the more recent reconstruction and attributed by investigators to human activity. This was accompanied by an increase in open ground indicators and grasses. Barley-type pollen grains were recorded at c.3250 BC.

In the results from the modern AG3/19A core, after a decline in anthropogenic indicators in LPAZ G, evidence for human activity increased again in LPAZ H. However, based on the age depth model for AG3/19A, it is likely that this section of the core was subject to disturbance. From the results shown in Figure 4, there is an obvious issue with the dates for the top 45 cm or so of the AG3/19A core. Between 45 cm and 40 cm there is a shift from *2455 –2205 cal BC* to *1615 –1510 cal BC* that would equate to only 5 cm of peat formation over three-quarters of a millennium.

This sort of change in accumulation rate is not seen in the lower part of the AG3/19A core. This could be the result of a disturbance to the peat in this part of the core – perhaps a removal of material in antiquity (anthropogenic or otherwise), a significant inwash event, or a combination of the two. LOI data (Figure 36) indicates a drop in the percentage of organic material to below 50% at around 45 cm depth in AG3/19B. Being located at the edge of the Allt na Fearna stream, this decrease in the organic content of the core likely indicates an erosive event, such as a flood. A hiatus in accumulation at approximately this point can be seen in Figure 5. Following this section, there is also a significant difference between the dates for samples at 35 cm and 30 cm sediment depth, and a similar jump is seen through the top 25 cm of AG3/19A, again associated with a decrease in the organic content of the peat to less than 50%.

Peat has been used for fuel and to enrich soils in Scotland since as early as the Neolithic (Mills *et al.*, 2004), and historic settlement was also recorded in the immediate vicinity of the sample site (McCullagh and Tipping, 1998). It may be the case that peat from the AG3 site was removed for use as fuel, building materials or to enrich soil, disturbing the upper part of the profile, although no evidence for burnt peat was found in samples of prehistoric soils from the site (Carter, 1996). Unfortunately, the hiatus corresponds with the period to which hut circle activity at Lairg was dated, meaning that there is a lack of palaeoenvironmental evidence for that period. Similar issues were not observed during analysis of the core taken at AG3 in the 1990s.

6.4.2 The Neolithic in Achany Glen

From the above results, we can see that human activity had an important impact on the landscape at Achany Glen during the Neolithic, with clear evidence for cereal cultivation. This is in line with legacy pollen data from the AG3 site, which indicated that there was barley cultivation ongoing in the area c.3700–2900 BC. There was also evidence from the AG2 site, on the valley floor, that wheat was cultivated there during the Neolithic, although the chronological resolution for this pollen core was poor, meaning that start and end points for this activity were difficult to determine (McCullagh & Tipping, 1998). Investigators speculated as to whether this indicated agricultural specialisation, with hardier barley grown in less favourable areas within the landscape (*ibid.*). This would indicate a connection or cooperation between the communities active in the uplands and those active on the valley floor (*ibid.*). Evidence for cereal storage and processing was also evident in plant macrofossil evidence from Lairg, with emmer and barley chaff, and the evidence for grain storage described above (Holden, 1998: 169-170).

Results from the 1990s core from AG3 also indicated that woodland regeneration occurred in the 3rd millennium cal BC, with woodland again dominant by c. 2800–2700 cal BC. Increasing arboreal pollen can also be observed at this point in results from the modern core. At c.1800 BC, a further episode of woodland clearance and a rise in anthropogenic 107 indicators was observed in the 1990s results. Oak and elm abundance remained high, and it was speculated that they may have been intentionally preserved or cultivated as a timber resource. This cleared landscape was thought to have persisted through the 2nd millennium BC, with the presence of grazing indicators and frequent charcoal in the record (although cereal pollen was not recorded in this period) taken as evidence of managed grazing in the area. Woodland regeneration was thought to have occurred again in the early 1st millennium BC.

Archaeological evidence supports the palaeoecological record from Lairg, with tilled soils pre-dating the excavated hut circles described in Chapter 5 of this thesis. Based on the evidence for cereals, and also grazing indicators, farming at Lairg during the Neolithic was probably mixed, with both pastoral and arable activity taking place. This may have involved the use of small-scale plots, ranging across or moving around the landscape, as suggested by McCullagh & Tipping (1998). Neolithic agriculture is generally thought to have taken place in small, garden-like plots where intensive cultivation was practised (Barclay, 2003a; Guttman, 2005; Guttman *et al.*, 2006; Jones, 2005).

There is evidence in the archaeological record for relatively substantial buildings dating to the earlier 4th millennium BC (Bradley, 2019; Sheridan, 2013), including timber 'halls' such as those excavated at Crathes (Murray *et al.*, 2009), Claish (Barclay *et al.*, 2002) and Balbridie (Fairweather & Ralston, 1993). Potential functions of these structures are discussed by Brophy (2007). However, Middle and Later Neolithic settlement is often characterised as ephemeral or semi-mobile (discussed in Chapter 2; e.g. Barrett, 1999; Bradley, 2019; Brophy, 2006; Pollard, 1999; Thomas,1999; 2013; Thomas & Renfrew, 1991). This model is heavily based on evidence from the south of England and may not be appropriate for Scotland (see discussion in Chapter 2; Barclay, 1996, 2003b, 2004; Brophy, 2006, 2016).

This ephemerality or transience has been linked to a proposed agricultural recession, triggered by climatic deterioration and accompanied by a decreasing population from c.3700 BC onwards. Both archaeologists (Bradley, 2008; see Thomas, 2013 for summary) and those studying the palaeoenvironmental record (e.g. Bevan *et al.*, 2017; Colledge *et al.*, 2019; Shennan *et al.*, 2013; Stevens and Fuller, 2012, 2015; Woodbridge *et al.*, 2014; Woodbridge *et al.*, 2020) have explored this theory, with a focus on woodland clearance in legacy datasets as a proxy for the presence/absence of human activity (Farrell *et al.*, 2020), using summed probability distributions of radiocarbon dates (SPDs) as a proxy for population (issues with this method are outlined in Chapter 2). These findings have been challenged, particularly with regard to the evidence for cereal cultivation in Scotland during this period of proposed agricultural recession (Bishop, 2015a; 2015b; discussed in McDonald *et al.*, 2021 and rebuttal in Stevens & Fuller, 2015).

Pollen records indicate woodland loss across Scotland c.4050–3450 cal BC (Edwards *et al.*, 2019; Woodbridge *et al.*, 2014), potentially linked to increases in population size. Woodland regeneration, accompanied by a downturn in population (based on SPD data), is thought to have taken place from c.3600 cal BC until a recovery in both population size and woodland clearance in the mid-3rd millennium BC (Woodbridge *et al.*, 2014). SPDs based on dates from charred cereal grains have also been used to argue for a cessation of agriculture across Britain from c.3600–2450 BC, linking this to climatic deterioration in this period (Stevens & Fuller, 2012; 2015), and other archaeobotanical and palaeoenvironmental studies have also made this link (Bevan *et al.*, 2017; Colledge *et al.*, 2019; Woodbridge *et al.*, 2014; Woodbridge *et al.*, 2020), as have researchers working with environmental evidence from Ireland (e.g. McClatchie *et al.*, 2014; Whitehouse *et al.*, 2014).

At many Scottish sites, there is only significant pollen evidence for cereal cultivation from the Bronze Age onwards (although many chronologies for palaeoenvironmental sequences are based on a small number of dates, limiting their precision and increasing opportunities for error associated with interpolation). However, the pollen evidence that does exist for Neolithic cereal cultivation in Scotland does not necessarily support a widespread recession of cereal agriculture in the Middle to Late Neolithic. Along with evidence from both the historic and recent reconstructions from Lairg for cereal cultivation in this period, the pollen records from sites such as Loch Farlary (Tipping *et al.*, 2007), also an upland site in Sutherland; North Mains, Strathallan (Hulme & Shirriffs, 1985) and Eilean Domhnuill, North Uist (Mills *et al.*, 2004) all showed evidence for cereal cultivation in the 4th and early 3rd millennium cal BC.

6.4.3 The Bronze Age at Achany Glen

Unfortunately, due to the hiatus in the AG3/19A pollen core described above, there are no modern palaeoenvironmental results encompassing Bronze Age activity at the Achany Glen site. According to the legacy data, there was minimal human impact at the AG3 site c.2900–2200 BC. Hekla 4 tephra was identified in the original core from AG3, at c.2200BC, broadly contemporary with a decline in evidence for pine in the pollen record from that core and AG2, and with humification data suggesting a shift to wetter conditions at the site (Smith, 1998). However, volcanically-driven climatic deterioration of a severity affecting human activity at the site was dismissed by the investigators (Tipping & McCullagh, 1998). Hekla 3 tephra was not identified in environmental records from Lairg, and was similarly dismissed as a driver of Late Bronze Age settlement decline there (*ibid.*).

During the Bronze Age, indicator species associated with open ground and pasture began to appear in the pollen record from AG3, interpreted as evidence for reoccupation. Intensification of pastoralism has been observed in the pollen records from sites across upland Britain in the 1500–200 BC period (Tipping, 2002), and expansion of upland pastoral activity has been linked to the newly open ground resulting from climatic deterioration and an associated decline in pine populations (Davies, 2007). No cereal pollen was recorded, although oat/wheat pollen was recorded infrequently in the record from AG2, on the valley floor, from c.1700 to 200 BC, accompanied by pollen from grazing indicator species. There was archaeobotanical evidence from the excavated settlement sites at Lairg that grain was being consumed – the remains of naked barley were present in buildings dated to the Bronze Age, and a cache of stored grain was recovered from House 4. A lack of chaff was taken as evidence that while grain was being consumed and stored on-site during the Bronze Age, it may not have been produced in the immediate vicinity of the settlement. The remains of fat hen, sorrel and corn spurrey were interpreted as the remains of potential cultivars, and it is thought that root crops were likely also grown around the settlement site in garden-like fields (Tipping, 2002).

6.4.4 Climate change and upland agriculture in later prehistory

Upland, 'marginal' sites have long been characterised as vulnerable to climate change in the literature (Tipping *et al.*, 2008) – studies such as Parry's (1978; 1981) work on upland land-use during the Little Ice Age cemented and promoted ideas of a 'retreat from the margins' during periods of climatic downturn. As discussed in Chapter 2, the climatic downturn observed at the end of the Bronze Age has been linked to a decline in the use of upland areas for settlement and agriculture across Scotland and Britain (Amesbury *et al.*, 2008; Barber, 1997; Barber and Brown, 1984; Burgess, 1985; 1989; Cowley, 1998; Turney *et al.*, 2016), and also a potential decline in population (see Armit *et al.*, 2014; Bevan *et al.*, 2017; Tipping *et al.*, 2008 for discussion). However, while the impact of environmental change on human societies is widely accepted (Berglund, 2003), there is evidence to suggest that there is not necessarily a strong link between climate change at the end of the Bronze Age and population decline (Armit *et al.*, 2014). Palaeoenvironmental records suggest that farming continued at upland sites across Britain (Gates, 1993; Tipping, 2002; Young & Simmonds, 1995; Young, 2000; Dark, 2006) and specifically in Scotland (Tipping, 2002; Tipping *et al.*, 2008; Davies, 2007; Davies *et al.*, 2004).

For both the Late Neolithic and the Late Bronze Age, then, there is a narrative of ephemeral or declining land use and reduced population levels (specifically linked to upland areas in the Bronze Age), caused by cooler/wetter conditions (Amesbury *et al.*, 2008; discussed in Armit *et al.*, 2014; Barber, 1997; Barber and Brown, 1984; Bevan *et al.*, 2017; Burgess, 1985;

1989; Cowley, 1998; Turney *et al.*, 2016). While the legacy pollen data from Lairg do not disprove this hypothesis for the Late Bronze Age, the updated pollen record from Lairg for the Late Neolithic, combined with archaeological evidence for cultivation preceding the construction of the Bronze Age roundhouses at the site, casts doubt on the idea of a linear relationship between climatic shifts and human behaviour.
Narratives foregrounding environmental change in past societal change or collapse have been criticised for being overly deterministic, minimising the role of human agency (see Middleton, 2017). The concept of resilience (as outlined by Redman, 2005; Redman & Kinzig, 2003) foregrounds the importance of social memory and behavioural adaptations in mitigating (or failing to mitigate) any adverse effects of environmental change. Essentially, social, economic and political traditions or habits can help societies or systems to avoid collapse in times of stress. Over the long term, aspects of these traditions or habits can become ingrained due to their adaptive advantages. The concept of resilience avoids environmental determinism. Evidence for the continuation, and in some cases, expansion of agriculture in upland areas during periods of climatic downturn in later prehistory can be viewed through this frame.

At Lairg, archaeological evidence for prehistoric agriculture was concentrated on raised, well-drained sites within the landscape, a pattern of land-use found at other sites in northern Scotland (Davies *et al.*, 2004; Davies, 2007). Additionally, from the updated pollen record for the Late Neolithic at Lairg, we can see that barley, hardier and more tolerant of cool/wet conditions than wheat, was the primary cereal being cultivated. This has been observed at other sites in Britain and studies of northern Europe more generally, with the suggestion that an existing reliance on barley rather than wheat was an adaptive mechanism allowing for resilience to the adverse effects of climatic deterioration during this period (Bevan *et al.*, 2017; Bishop *et al.*, 2009; Bishop, 2015; Colledge *et al.*, 2019; Stevens & Fuller, 2015).

Syntheses of pollen (and other palaeoenvironmental) data are often based on analysis of multiple legacy datasets. While this approach has value in affording a broad overview of patterns in data (Gearey *et al.*, 2020), there are potential issues regarding the chronologies of legacy datasets. For example, although the 1990s core from AG3 was well-dated for its time, no hiatus was identified, while a hiatus was identified in the Bayesian chronology constructed for the AG3/19A core. Chronologies for legacy pollen data are often based on linear-interpolated age-depth models, constructed using a limited number of radiocarbon determinations (see McDonald *et al.*, 2021). There are also issues of differing chronological resolution across palaeoenvironmental, climate and archaeological records, meaning inferring causality from temporal correlation between changes in climate and events observed in the archaeological or pollen records should be undertaken cautiously (discussed in Gearey *et al.*, 2020).

Often, evidence for woodland clearance in pollen records (declining arboreal pollen) is used as a proxy for prehistoric agriculture (Farrell *et al.*, 2020). However, intensive cultivation in small, garden-like plots (Barclay, 2003a; Guttman, 2005; Guttman *et al.*, 2006; Jones, 2005) would not necessarily have led to widespread disturbance of forested areas. This type of agricultural activity may not register in studies looking for evidence of large-scale woodland clearance (Jones, 2005; Bishop, 2015) or records from sample sites with regional-level pollen catchments such as lakes or larger bogs (Davies & Tipping, 2004). Cereal and herb pollen are also generally under-represented in pollen records (Caseldine and Fyfe, 2006; Overland & Hjelle, 2013). Records from individual sites with high-resolution chronologies, such as the new pollen data for Lairg described above, can provide valuable evidence regarding the nuanced responses of past communities to climate change that may be 'missed' in large-scale syntheses (see McDonald *et al.*, 2021; c.f. Gearey *et al.*, 2020).

6.5. Conclusion

It is unfortunate that a detailed pollen record contemporary with the occupation of the roundhouses at Lairg could not be obtained in the course of this research. However, through the production of a new, high-resolution Bayesian chronology for the site it was possible to identify a hiatus in or disturbance of peat formation at the AG3/19 site from the later 3rd millennium cal BC onwards, potentially caused by human activity. The discrepancy between this new chronology for the environmental record at the site and the legacy data from AG3 (which did not indicate a hiatus in peat formation) highlights the importance of revisiting legacy data, on which received narratives of past change are often based.

From the results described above, it is possible to show that it is likely that human populations were active in the vicinity of the Allt na Fearna quarry from at least *3660–3435 cal BC* onwards. Although the top portion of the AG3/19A core appears to have been disturbed, there was a clear increase in anthropogenic indicators and barley-type pollen in the section of AG3/19A dated to the Middle to Late Neolithic. The data also provide clear evidence of the use of upland areas of Scotland for mixed farming in the Neolithic period. While a shift to a cooler/wetter climate in the Middle and Late Neolithic is thought to have led to a decline in both agricultural activity and population in Britain (Bevan *et al.*, 2017; Colledge *et al.*, 2019; Stevens & Fuller, 2012; 2015; Woodbridge *et al.*, 2014; Woodbridge *et al.*, 2020), in areas where environmental conditions already necessitated a reliance on barley rather than wheat, cultivation could have persisted. Cultivation may have taken place in small, well-drained areas within the landscape, activity unlikely to register in pollen sequences from larger bogs or lakes, or in studies primarily using woodland clearance as a proxy for agriculture.

Parallels can possibly be drawn between the evidence for the persistence of Neolithic agriculture in upland areas and narratives of a retreat from upland areas due to climatic deterioration at the end of the Bronze Age. While the new pollen evidence from Lairg cannot shed light directly on this issue, there is evidence that agriculture and other human activity persisted at other upland sites in northern Scotland during the likely climatic downturn in the Late Bronze Age. It is possible that, as for the Late Neolithic, a reliance on large scale analyses/syntheses and narratives built on legacy data with poor chronological control has obscured evidence for nuanced responses and resilience in the face of climatic downturn in upland areas.

Chapter 7: Supplementary Sites

7.1 Introduction

Lairg, Sutherland, is the key case study for this research. However, it is neither desirable nor appropriate to make wider interpretations about how people were using upland landscapes in the 2nd millennium BC without context or comparisons. Initially, it was intended that an additional three or four supporting case study sites would be selected, with upland and lowland locations represented over a wide geographical spread. A similar process of context identification, sampling, dating/re-dating and modelling would have taken place, with the results compared with those from Lairg.

The majority of this work was planned to take place in 2020, and due to the cycles of lockdowns, restricted travel and limitations on access to archives, along with communication issues associated with staff furloughs at museum and archive services, this was not possible. Another approach was required in order to provide a comparison dataset for the results from Lairg, and to illustrate potentially wider patterns in land-use and settlement.
A selection of published, radiocarbon dated hut circle sites were instead chosen as supplementary case studies, (the original selection of case study sites included both published and unpublished sites). As a 'check' on the accuracy of the radiocarbon dates, only sites excavated and published since the year 2000 were included, as after this point, single-entity samples and AMS dating were routine in Scotland (although while these practices were being implemented before this point, uptake was not universal).

To allow for comparison between upland and lowland settlement practices, three lowland (<100m OD) and five upland (>100m OD) sites were selected, following the definition by Pope (2015). All were excavated by commercial units as part of construction/infrastructure projects, meaning that detailed site reports were available online, and one site, Kintore, Aberdeenshire, also had a monograph published detailing the excavations there. All sites were located north of the River Forth/River Clyde line.

Details of the archaeology of the sites, radiocarbon dates, and sample and context details were all derived from site reports, generally freely available online. It was not possible to consult site archives during the period this research was undertaken.

7.2 The lowland sites

7.2.1 Meadowend Farm

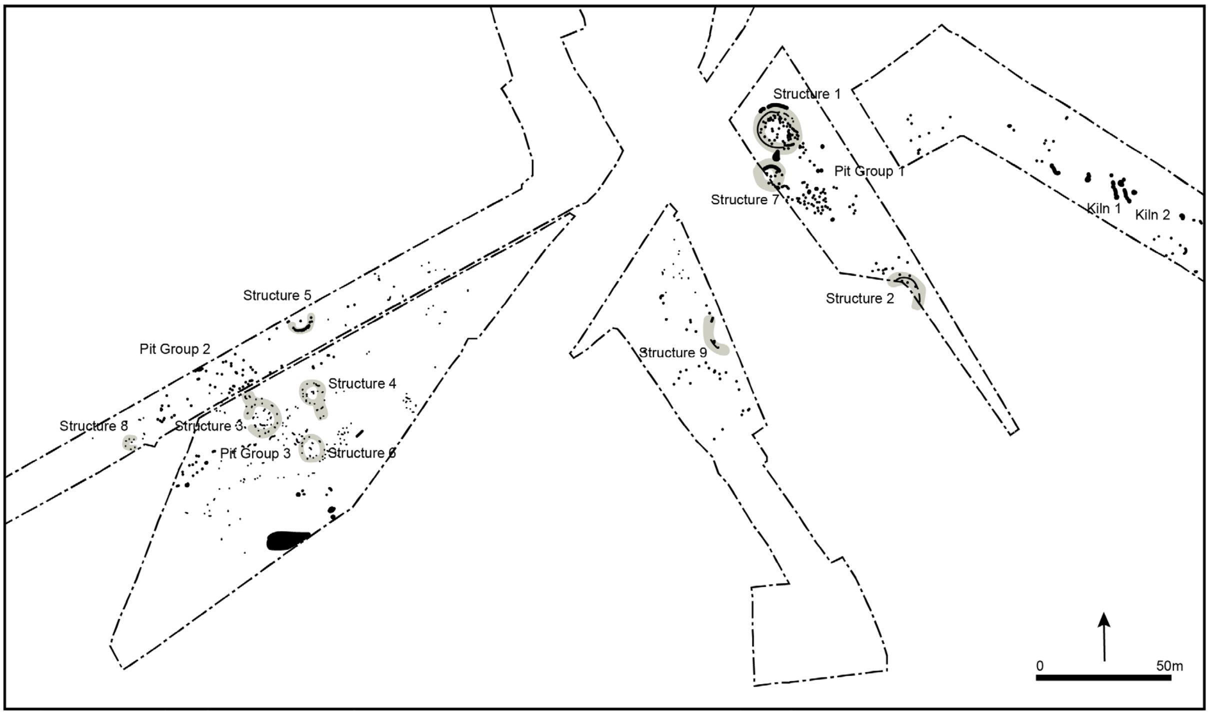

Figure 38: Site plan of Meadowend Farm (adapted from Jones *et al.*, 2013: 6).

The following information has been adapted from Jones *et al.* (2013). The site of Meadowend Farm, Clackmannanshire (Figure 38), is located on the northern side of the River Forth, between the settlements of Kincardine and Clackmannan. At c.35m OD, it is a lowland site, although somewhat higher and better-drained than the surrounding carse. During the excavation of the site in 2006, activity spanning the early Neolithic to the Late Bronze age was revealed, including six roundhouses. Forty-three radiocarbon dates were obtained from on-site contexts.

Neolithic activity was well-represented at Meadowend Farm, with the assemblage primarily consisting of pits, post-holes and pottery, including the largest known assemblage (206 individual vessels) of Middle Neolithic Impressed Ware in Scotland. Two features, a single pit and a post-hole (within a later pit group) produced Early Neolithic radiocarbon dates, and material from a post-hole (part of an arcing, semi-circular feature interpreted as a possible shelter) was dated to the Middle Neolithic. Further pit groups and isolated pit features were assigned to the Neolithic on morphological grounds, as well as on the basis of radiocarbon

dates and finds within them. At least three ‘pit groups’ were identified by the site’s excavators, with pits containing pottery (including the previously mentioned Impressed Ware), charcoal, cereal grains and flint. Excavators suggested that it was likely that Neolithic structures at the site were fairly insubstantial.
After a hiatus following the Middle Neolithic activity at Meadowend Farm, Early Bronze Age dates were obtained from material sampled from a post-pipe feature associated with a Middle Neolithic pit group, and from the ring-groove structure Structure 5 and an associated pit. Structure 5 was the only feature at the site dated to the Early Bronze Age, and like other, similar structures such as those at Kintore, there was evidence (in the form of charcoal in the ring-groove) that the building was likely to have burned down. Other pit features at the site contained pottery typologically assigned to the Early Bronze Age.

The majority of structures excavated at Meadowend Farm were dated to the Middle Bronze Age, including Structure 2, a ring-groove structure with a possible post-ring, as well as a range of associated features. In total, four roundhouses of Early to Middle Bronze Age date were excavated at the site. The final phase of prehistoric settlement at Meadowend Farm consisted of two double-ring roundhouses, dated to the Middle to Late Bronze Age (Structures 3 and 4), a smaller, oval building and a series of other smaller structures, thought to be potentially ancillary to the roundhouses.

All roundhouses excavated at the site had been truncated due to repeated agricultural activity over time. It was hypothesised that the site was subject to repeated phases of re-occupation, based on current understandings of the likely short use-lives of these types of buildings (Barber and Crone, 2001; Brück, 1999; Reynolds, 1993). However, unlike at Lairg, there was little vertical stratigraphy at the site, a lack of evidence that the same sites had been subjected to the phases of use and re-use observed there. However, evidence from Structure 1 in particular indicated repair to the building. It was also suggested that Structure 1 and Structure 7 were ‘paired’ – in use at the same time – potentially also seen in the suggested contemporaneity of the House 2 and House 3 structures at Lairg. A pattern of shifting settlement loci through the 2nd millennium BC was suggested for Meadowend Farm, with later dates from Structures 3, 4, 6 (and other, smaller structures) as evidence for this.

A total of 42 contexts from Meadowend Farm were sampled for dating. Several of these contexts were part of the numerous pit features – solitary and in groups – excavated at the site. Many of these were likely part of the well-documented Neolithic practice of deposition of material within pits. Whether this type of activity was related to settlement or had some other, more esoteric function has been discussed elsewhere, but it is clear that material deposited in these features was related to some sort of human activity at the site. Context 3418 was the upper fill of an isolated pit, containing naked barley grains and sherds of Early Neolithic Carinated Bowl pottery, as well as charcoal and burnt bone. Context 3924 was also the upper fill of a pit feature, on the edge of a pit group. This pit also contained pottery, charred grain and possibly burnt daub, interpreted as being related to occupation of the site. Context 2309 was the single fill of a pit, part of Pit Group 1, no pottery but some charred plant remains. Context 2319 was also the single fill of a pit in Pit Group 1, containing Impressed ware. The sample from this feature produced a medieval date, indicating intrusive material, probably introduced through ploughing at the site: Pit Group 1 was bisected by a large furrow. Other fills of pit features from Pit Group 1 were 2369, 2950 and 2623, all of which contained cereal grains and other detritus.

Contexts from another cluster of around 40 pit and post-hole features, described as ‘Pit Group 2’, were also dated. These included context 3948, the single fill of a pit containing Impressed Ware, hazelnut shells, and charcoal. It was part of an arc of five similar features, intercutting each other and containing a homogenous fill. This feature was subject to plough disturbance. Context 3944 was the fill of another pit, part of the same arc of pits as that containing 3948 and containing a similar fill. Context 3907 was the fill of a post-pipe within a post-hole within Pit Group 2, not part of any coherent feature.

Other dated post-hole features, unrelated to named structures at the site, included context 3974, the fill of a post-hole on the edge of a pit group, part of an arc of four similar features and containing Carinated Bowl sherds and charred hazelnut shells. Context 2166 was also the fill of a post-hole, part of a group of eight small post-holes, possibly the remains of a post-built structure. This fill contained emmer wheat grains, charcoal and sherds of Carinated Bowl pottery. Truncation was noted as an issue for both of these contexts. Context 2542 was the single fill of a post-hole within a pit, part of a central cluster of pits at the site. As with other features at the site, this context contained pottery fragments and cereal grains.
Dated contexts related to Structure 1 at Meadowend Farm included 2074, the fill of a pit within, but thought to pre-date, Structure 1. The pit containing this fill was part of a group of four similar features containing charcoal-rich fills, all thought to pre-date Structure 1. Context 3043 was the single fill of a post-hole in the interior of Structure 1–charcoal within this context was thought to relate to the use of the building. Context 2034 was the fill of Structure 1’s ring-groove. This context was described as varying in composition and was truncated by plough furrows, indicating the possibility of disturbance. Context 2991 was the lower fill of

Structure 1's southern hearth, thought to be earlier than the building's other, more northerly hearth. This feature was thought to be part of a rebuilding phase at Structure 1. Context 2792 was the middle fill of the second, more northerly hearth of Structure 1, also thought to be associated with the rebuilding of the structure–the date for this context came from charred barley from a deposit representing the final firing of this hearth. Context 2437 was the single fill of a feature described as a working hollow in the interior of Structure 1–material within this feature may have been related to the use of the building.

The sole dated context from Structure 2 was context 2674, the fill of the Structure 2 ring-groove. This feature was discontinuous, with stake-holes in its base. This fill contained both charcoal and cinders, potentially waste associated with burning activity inside the roundhouse. From Structure 3, dated contexts included 3357, the single fill of a post-hole, part of the structure's inner ring of post-holes. Context 3682 was the fill of a post-pipe within a post-hole comprising part of the Structure 3 porch. Context 3449 was also the fill of a post-hole making up the Structure 3 porch – in this instance, a smaller, outer post-hole, potentially acting as buttressing for the primary posts or related to a gate. Context 3468 was the single fill of a post-hole, part of the outer post-ring of Structure 3. The feature filled by 3468 was likely to have been plough-truncated. Post-holes in the south-west part of the structure's post-ring had been lost completely to plough damage, and elsewhere were shallow. This feature was located in the north-western part of the outer post-ring. Finally, context 3739 was the single fill of a post-hole, part of Structure 3's inner post-ring. This post-hole was thought to have been a secondary, replacement post-hole. Material within these post-holes could have been associated with activity in the house, potentially swept into these features as part of cleaning the building.

From Structure 4, dated contexts included 5701, the fill of a post-pipe within a post-hole, part of the Structure 4 post-ring. Context 5685 was the single fill of a post-hole, also part of this post-ring, as was context 5687. Truncation was noted as an issue for this structure: the site was heavily truncated in this area, and only a post-ring and a single post-hole related to the porch remained of the roundhouse.
Dated contexts from Structure 5 included 3294, the fill of the structure's ring-groove. Charcoal within this context was thought to relate to the burning of the building, the northern half of which had been lost to plough-truncation. Context 3635 was the upper fill of a pit located north of Structure 6, containing a layer of heat-cracked stones and charcoal, including pieces of large timbers. Excavators hypothesised that this material was related to activity at Structure 5.

From Structure 6, dated contexts included 3700, the fill of a post-hole, part of the structure's post-ring. This feature contained what was described as a small amount of pottery, indicating that domestic material had potentially become incorporated into the context during the use of the building. The fill of a post-pipe, context 3682, within a post-hole making up part of Structure 6's 'annexe' was also sampled for dating, and also contained some pottery remains. Structure 6 was the least well-defined of the excavated structures at the site, and it was suggested that it could have comprised the remains of several superimposed roundhouses.
From Structure 7, dated contexts included 2571, the single fill of an internal post-hole, and context 2300, also the fill of an internal post-hole, part of the structure's later inner post-ring – in some cases, post-holes making up this post-ring directly cut earlier features. Context 2672 was the single fill of Structure 7's ring-ditch, only remaining in the northern part of the structure. This feature, along with the rest of the structure, had been truncated. Context 2648 was the fill of a pit cutting the Structure 7 ring-ditch. This fill was described as containing residual material associated with earlier pit-digging activity at the site.

From Structure 8, dated contexts included 3247, the upper fill of a post-hole, part of the structure's post-ring. It was suggested that the post had been burnt, and it was unclear whether charcoal within this context originated from the burnt post, or activity associated with the building's occupation.
Contexts dated from Structure 9 included 2378, the single fill of a post-hole. The sample from this context produced an Iron Age date, and it was suggested that the dated material was potentially intrusive, as there was no other evidence for Iron Age activity at the site. The structure had been partially ploughed out. Context 2763, the single fill of Structure 9's ring-groove, was also dated, with the sample from this context producing a medieval date. It was suggested that this material was also potentially intrusive. Dates from contexts 2752 and 2319 were also thought to have originated from intrusive material.

The dates from Meadowend Farm (excluding the three medieval dates, SUERC-16877, SUERC-16878 and SUERC-16839) were, as part of this research, initially modelled as a single phase (see Figure 39), resulting in a model with good agreement (*Amodel=98.1%*). According to this model, activity at the site began between *4055–3675 cal BC* (*95% probability*), probably between *3910– 3735 cal BC* (*68% probability; Boundary Meadowend Farm Start*). Settlement at the site spanned *3280–3590 years* (*95% probability*), probably *3330–3525 years* (*68% probability*), before ending between *395–85 cal BC* (*95% probability*), probably between *385–240 cal BC* (*68% probability; Boundary Meadowend Farm End*).

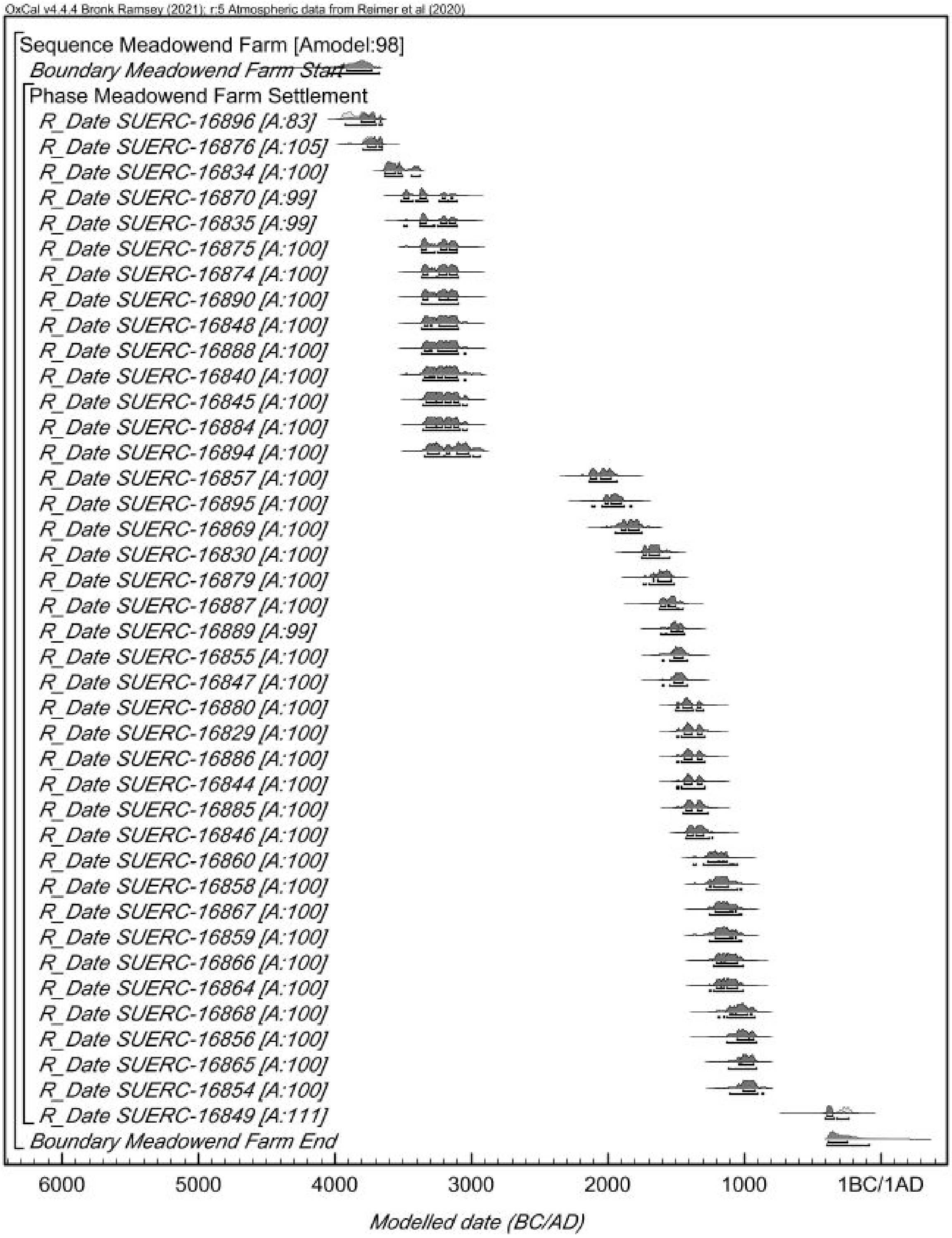

Figure 39: Dates from Meadowend Farm modelled as a single phase.

Next, the dates from Meadowend Farm were used to construct a model organised by feature type (see Figure 40). Pits are generally associated with the Neolithic, and the majority of pit features from the site returned Neolithic dates. Therefore, dates from pit features were placed in a phase together (*Phase Pit Activity*) within a sequence (*Sequence Meadowend Farm*), followed by a phase containing dates from structure features (*Phase Structure Activity*). A date from Structure 9 (SUERC-16849) was placed last in the sequence, as this house was dated to the Iron Age. SUERC-16830 and SUERC-16895 were excluded as outliers. SUERC-16830 was from a pit feature thought to predate Structure 1, and while the date from this feature was earlier than the other dates from Structure 1, it was considerably later than the other pit features at the site, likely representing a different phase of activity. SUERC-16895 derived from the fill of Structure 5's ring-groove – not necessarily a secure context. Structure 5 had been heavily plough-truncated and it is possible that this date represents reworked/residual material.

This approach resulted in a model with good agreement (*Amodel=98.3*). Activity associated with the Bronze Age structures at the site began at some point between *1735–1525 cal BC* (*95% probability*), probably in *1650–1550 cal BC* (*68% probability*; *Boundary Pit Activity End/Structure Activity Start*). This activity spanned *520–835 years* (*95% probability*), probably *575–723 years* (*68% probability*; *Difference Span Bronze Age Structures*). Clearly activity was happening at different times in different structures–Structures 1, 2, 7 and 8 appear to date to the mid 2nd millennium BC, while Structures 3, 4 and 6 dated to the latter part of the 2nd millennium BC. Activity associated with the Bronze Age structures at Meadowend Farm ended at some point between *1045-845 cal BC* (*95% probability*), probably in *1005–910 cal BC* (*68% probability; Boundary Bronze Age Structure Activity End*).

These results demonstrate that, as seen at Lairg (see Chapter 5), settlement activity at Meadowend Farm focused on the middle to late 2nd millennium BC, declining in intensity by the early 1st millennium BC. As at Lairg, occupation or use of individual structures was probably not contemporaneous.

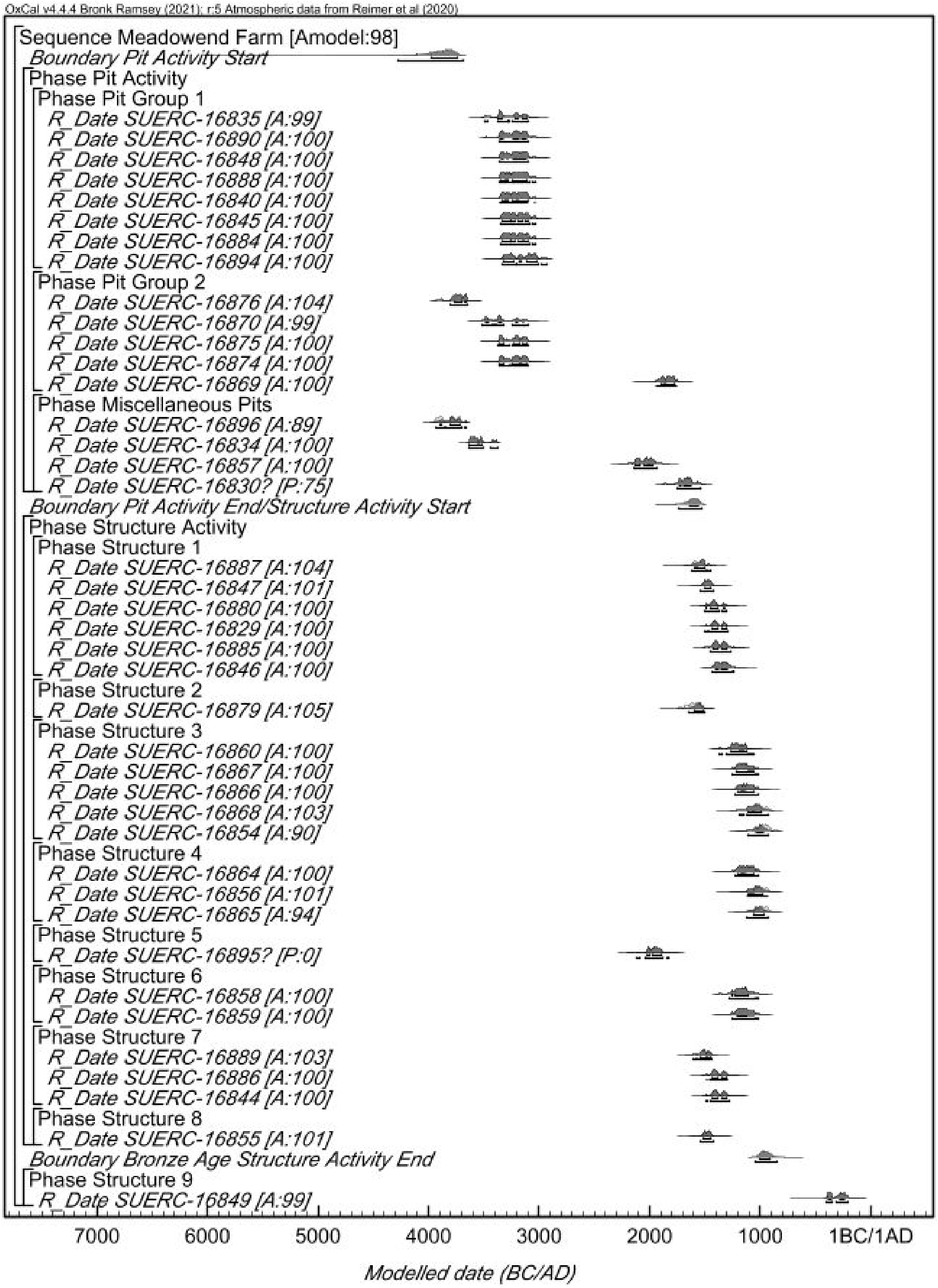

Figure 40: Dates from Meadowend Farm modelled incorporating phasing.

Laboratory Code	Context Number	Material	Context Description	Radiocarbon age (BP)	δ13C (‰)
SUERC-16896	3418	Charcoal *(Alnus)*	Upper fill of isolated pit near Structure 5.	5025 ±35	-25.5
SUERC-16876	3974	Charred nut shell *(Corylus avellana)*	Fill of post-hole within Pit Group 2.	4695±35	-25.0
SUERC-16834	2166	Charcoal (*Alnus)*	Fill of post-hole/isolated pit.	4750±35	-24.7
SUERC-16870	3294	Charcoal *(Corylus avellana)*	Upper fill of pit in Pit Group 2.	4590±40	-25.3
SUERC-16835	2140	Cereal grain *(Hordeum vulgare var nudum)*	Upper fill of pit in Pit Group 1.	4560±35	-24.4
SUERC-16875	3948	Charred nut shell *(Corylus avellana)*	Fill of pit in Pit Group 2.	4540±35	-24.6
SUERC-16874	3944	Carbonised nut shell *(Corylus avellana)*	Fill of pit in Pit Group 2.	4525±35	-24.6
SUERC-16890	2309	Carbonised nut shell *(Corylus avellana*)	Fill of pit in Pit Group 1.	4520±40	-26.1
SUERC-16848	2542	Cereal grain *(Hordeum vulgare var nudum)*	Fill of post-hole in Pit Group 1.	4510±35	-24.4
SUERC-16888	2648	Cereal grain *(Hordeum vulgare var nudum)*	Fill of pit, interpreted as residual Neolithic	4505±40	-23.1

			material from Pit Group 1.		
SUERC-16840	2319	Cereal grain *(Hordeum vulgare var nudum)*	Fill of pit in Pit Group 1.	4500±35	-24.5
SUERC-16845	2369	Cereal grain *(Hordeum vulgare var nudum)*	Fill of pit in Pit Group 1.	4485±35	-24.3
SUERC-16884	2950	Cereal grain *(Hordeum vulgare var nudum)*	Fill of pit in Pit Group 1.	4485±35	-24.0
SUERC-16894	2623	Cereal grain *(Hordeum vulgare var nudum)*	Fill of pit in Pit Group 1.	4450 ±40	-24.4
SUERC-16857	3635	Charcoal *(Corylus avellana)*	Fill of pit, north of Structure 6– interpreted as related to activity at Structure 5.	3660±35	-25.9
SUERC-16895	3294	Charcoal *(Alnus)*	Fill of Structure 5 ring-groove.	3600±35	-26.4
SUERC-16869	3907	Charred nut shell *(Corylus avellana)*	Fill of post-pipe within post-hole, ambiguous feature within Pit Group 2.	3520±35	-24.4
SUERC-16830	2074	Charcoal *(Corylus avellana)*	Single fill of pit, within but	3880±35	-26.0

			thought to pre-date Structure 1.		
SUERC-16879	2674	Charcoal *(Corylus avellana)*	Fill of Structure 2 ring-groove.	3335±	-26.2
SUERC-16887	3043	Charcoal *(Corylus avellana)*	Fill of structure 1 interior post-hole.	3275±35	-26.0
SUERC-16889	2571	Charcoal *(Alnus)*	Fill of Structure 7 interior post-hole.	3245±35	-26.2
SUERC-16855	3247	Charcoal *(Alnus)*	Upper fill of post-hole in Structure 8 post-ring.	3225±35	-27.3
SUERC-16847	2034	Charcoal *(Corylus avellana)*	Fill of Structure 1 ring-groove.	3220±35	-25.2
SUERC-16880	2792	Cereal grain *(Hordeum vulgare var nudum)*	Middle fill of Structure 1 hearth.	3140±35	-25.9
SUERC-16829	2126	Charcoal *(Populus)*	Fill of Structure 1 interior post-hole.	3125±35	-24.8
SUERC-16886	2672	Charcoal *(Alnus)*	Fill of Structure 7 ring-ditch.	3125±35	-26.2
SUERC-16844	2300	Cereal grain *(Hordeum vulgare var nudum)*	Fill of Structure 7 later interior	3120 ±35	-24.9

			post-hole in post-ring.		
SUERC-16885	2991	Charcoal *(Alnus)*	Lower fill of Structure 1 hearth.	3110±35	-27.5
SUERC-16846	2437	Charcoal *(Alnus)*	Fill of working hollow in Structure 1 interior.	3085±35	-25.8
SUERC-16860	3357	Charcoal *(Corylus avellana)*	Fill of Structure 3 post-hole (inner ring).	2980±35	-24.5
SUERC-16858	3700	Charcoal *(Alnus)*	Fill of post-hole in Structure 6 post-ring.	2955±35	-25.6
SUERC-16867	3456	Charcoal *(Corylus avellana)*	Fill of post-pipe in post-hole, part of Structure 3 porch.	2940±35	-27.3
SUERC-16859	3682	Charcoal *(Alnus)*	Fill of post-pipe in post-hole, part of Structure 6 annexe.	2940±35	-24.8
SUERC-16866	3449	Charcoal *(Alnus)*	Fill of post-hole, part of Structure 3 porch.	2925±35	-24.8
SUERC-16864	5685	Charcoal *(Alnus)*	Fill of post-hole, part of Structure 4 post-ring.	2925±35	-26.5

SUERC-16868	3468	Charcoal *(Alnus)*	Fill of post-hole, part of Structure 3 outer ring.	2860±35	-27.0
SUERC-16856	5701	Charcoal *(Corylus avellana)*	Post-pipe in post-hole, part of Structure 4 post-ring.	2850±35	-25.8
SUERC-16865	5687	Cereal grain *(Hordeum vulgare var nudum)*	Fill of post-hole, part of Structure 4 post-ring.	2835±35	-24.1
SUERC-16854	3739	Charcoal *(Alnus)*	Fill of post-hole, part of Structure 3 inner ring.	2820±35	-26.0
SUERC-16849	2378	Charcoal *(Alnus)*	Fill of Structure 9 post-hole.	2265±35	-27.4
SUERC-16877	2763	Cereal grain *(Triticum aestivo-compactum)*	Fill of Structure 9 ring-groove.	705±35	-23.3
SUERC-16878	2752	Cereal grain *(Avena)*	Intrusive medieval material (Pit Group 1).	575±35	-25.7
SUERC-16839	2319	Cereal grain *(Avena)*	Intrusive medieval material (Pit Group 1).	540±35	-25.7

Table 4: Dates from Meadowend Farm.

7.2.2 Kintore

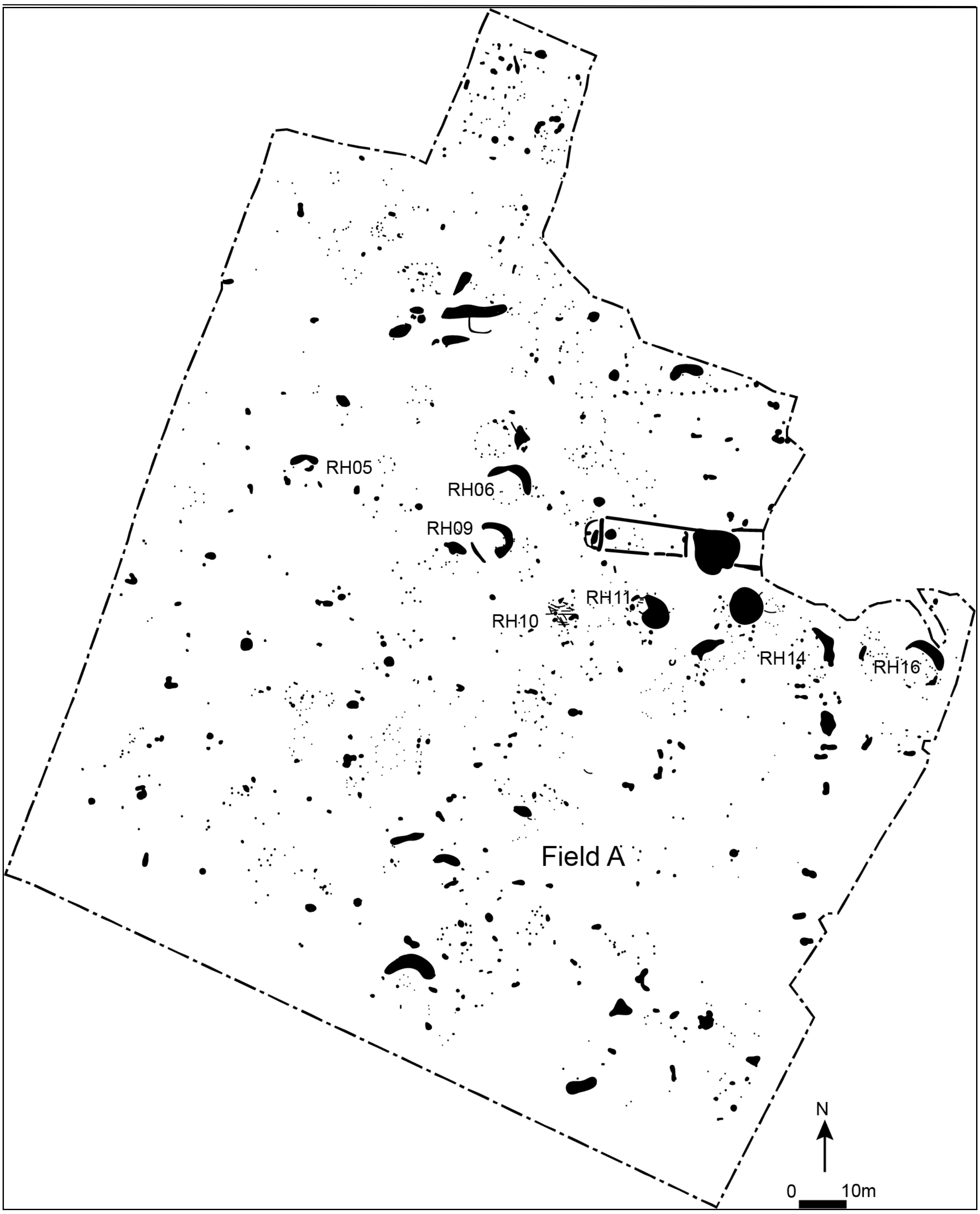

Figure 41: Site plan of Field A, Kintore, showing selected structures (adapted from Cook & Dunbar, 2008: 22).

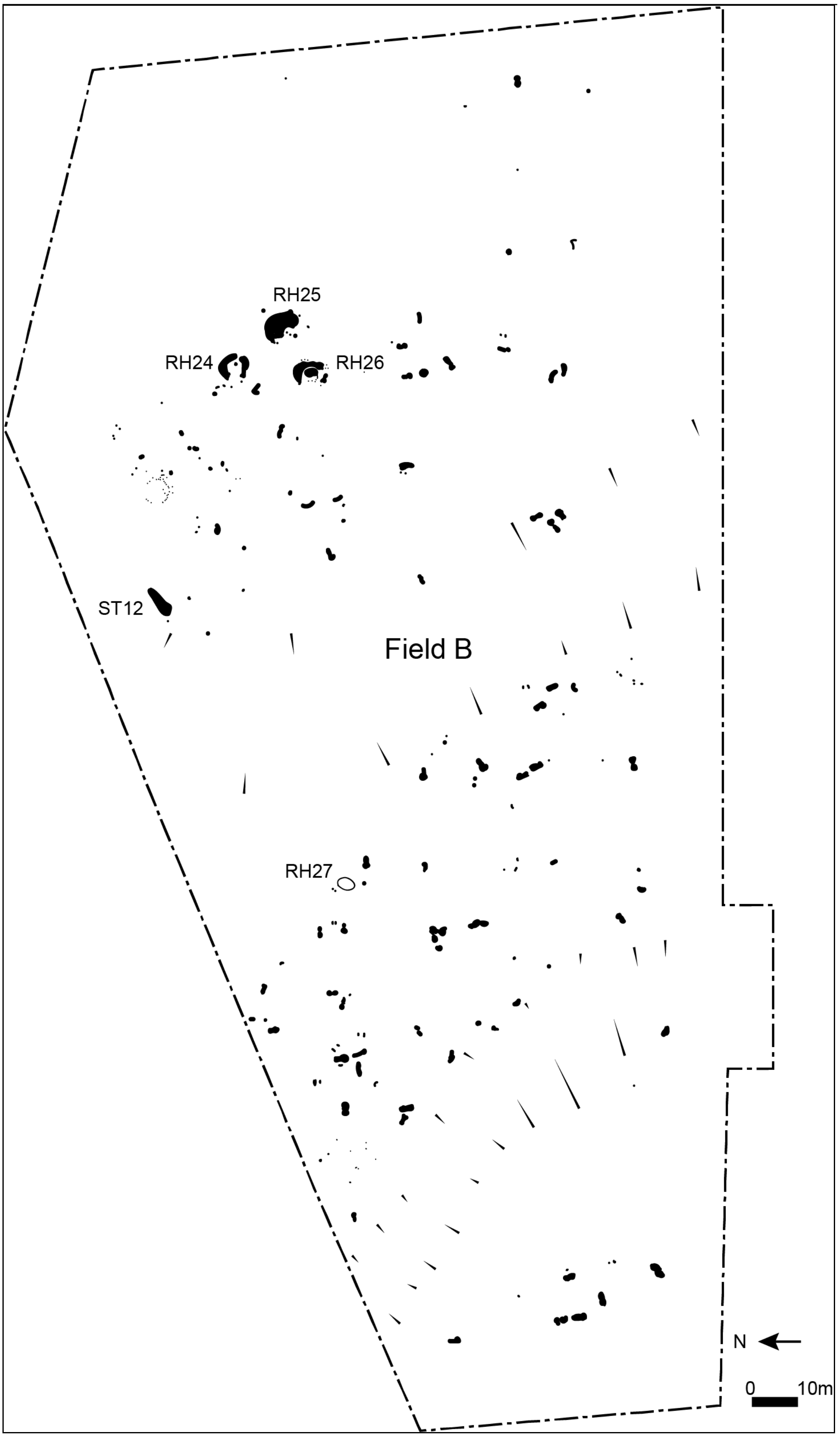

Figure 42: Site plan of Field B, Kintore, showing selected structures (adapted from Cook & Dunbar, 2008: 4).

The following is adapted from Cook & Dunbar (2008). Excavations at Kintore, Aberdeenshire took place between 2000 and 2006. The main focus of the archaeological work at Kintore focused on the site of a Roman marching camp at Forest Road, on the town's south-west outskirts. Forest Road is a low-lying site, at 50–65m OD, and the area primarily constitutes land for arable farming. The early 2000s excavations indicated a rich archaeological record, with the Neolithic to the Roman period represented. The earliest excavated remains were a group of pits dated to the Early Neolithic, interpreted as the remains of large rectilinear structure similar to the 'timber halls' excavated at Balbridie and Crathes (both in Aberdeenshire), and Claish, Stirling.

A further group of Early Neolithic pits, containing pottery sherds, were also excavated and dated. Here, there are parallels with Lairg, where (although there was no evidence for an Early Neolithic timber hall) pits, generally a feature associated with Neolithic activity, underlay two of the Bronze Age roundhouses.

Evidence for Early Bronze Age activity was also revealed during excavations at Forest Road, in the form of a pit containing a sherd of Food Vessel-style pottery. Following this, the archaeological record throughout later prehistory was dominated by roundhouses, potentially from as early as the Late Neolithic onwards, as discussed below. While no definitive structures dated to the Late Iron Age were excavated at the site, Late Iron Age roundhouses have been recorded in the vicinity, at Tavelty and Thainstone.

7.2.2.1 Roundhouses at Kintore

A total of 27 roundhouses were excavated at Kintore, producing radiocarbon dates spanning the Late Neolithic to Early Historic periods.

7.2.2.2 Late Neolithic

Two roundhouses excavated at Kintore, RH13 and RH27, were potentially thought to date to the Late Neolithic. The remains of these were relatively ephemeral and heavily truncated, consisting in both instances of curved bedding slots for stake-holes.

The remains of RH27 included 11 stake-holes within a curved bedding-slot (forming a somewhat oval, rather than perfectly circular shape), with another five stake-holes extending beyond the slot. These stake-holes averaged 8cm in diameter, spaced c.40cm apart. A larger stake-hole (20cm in diameter, containing evidence of burning) and a double post-hole lay just outside the line of the bedding-slot, and may have formed an entrance. RH27 was

dated based on two sherds of Grooved Ware recovered from the bedding slot, and a radiocarbon date from willow charcoal from the bedding-slot (AA-53176).
RH13 primarily consisted of a curved, bedding-slot, like that described for RH27. This slot appeared to have been re-cut at some point. Six small post/stake-holes (diameters c.20cm) lay along the line of this bedding slot, and it was suggested these may have contained structural timbers. A further two post-holes and a small pit lay beyond the line of the bedding-slot. RH13 was stratigraphically earlier than the Late Bronze Age roundhouse which partially overlay it, RH12, but no contexts from the structure itself were radiocarbon dated.

Both RH27 and RH13 were of a much lighter construction than the Bronze and Iron Age roundhouses excavated at Kintore, but were similar in form to Neolithic remains from Chapelfield, Cowie, Stirling and Beckton farm, Dumfries and Galloway. The walls of these round/oval buildings are likely to have consisted of wattle and daub, and it is possible, given the lack of internal features, that they had a non-domestic function. However, this lack of internal features may also simply be the result of plough-truncation.

7.2.2.3 Middle Bronze Age

No features at Kintore produced Early Bronze Age radiocarbon dates, although Beaker pottery was recovered from two pits and an inhumation at the site, indicating that some form of activity continued during the Chalcolithic or early Bronze Age. From the Middle Bronze Age onwards, roundhouses proliferated at the site. Three roundhouses at Kintore were radiocarbon dated to the Middle Bronze Age (defined by the excavators as c.1800–1300 BC), RH24, RH25 and RH26. The structures were tightly spaced and lay in the north-western part of the excavated area in Field B.

RH24 was a ring-ditch roundhouse with an internal diameter of c.7m. Two possible post-holes (one external, one internal) were excavated, along with two pits–two radiocarbon dates (SUERC-1386 and SUERC-1385) were derived from samples from the deeper of the two. On the basis of a thin layer of burnt material (including charcoal and bone) on the base of the ring-ditch, it was concluded that this had been deposited on the roundhouse floor. Worked stones, including four querns, were recovered from the base of the ring-ditch.

RH25, like RH24, was a ring-ditch roundhouse cut into a south-western facing slope. It would have had an internal diameter of c.8m. Dates were retrieved from a charcoal deposit representing in situ burning (AA-53190 and AA-53192). This charcoal-rich layer was overlain by the dumped remains of a wood fire, deposited directly on the surface below – the building had no hearth, although a small stone setting was associated with burning. This deposit was thought to represent the final stage of activity in the building. Again, worked stones – two querns and a rubber – were recovered from the ring-ditch.

RH26 was similar in form and position to the other two MBA roundhouses, although better-preserved than both. It is unlikely that it was directly contemporary with at least RH25, as RH26 would have blocked that building's entrance when standing. 13 of the post-holes comprising the post-ring had survived, and material (a post burnt *in situ*) recovered from one of these was dated to the later 2nd millennium BC (SUERC-2641). A hearth was also preserved in the building's interior. Dates were obtained from a burnt deposit, thought to represent the final use of this hearth (AA-52403, AA-52404 and AA-52405). A final date came from the charcoal-rich basal fill of the roundhouse's ring-ditch (AA-52402). As with RH24 and RH25, saddle querns and rubbers were recovered from the ring-ditch of RH26. RH26 may have been deliberately burnt down, with an artefact- and charcoal-rich fill of the structure representing a closing deposit.

7.2.2.4 Late Bronze Age

Five roundhouses were radiocarbon dated to the Late Bronze Age (here defined as c.1300–800 BC), with further examples although thought to date from this period. Three of these, RH10, RH11 and RH14, were arranged in an east-west oriented row (two further, undated roundhouses also formed part of this row). RH10, the furthest west of these structures, was c.8m in diameter with a ring of 10 post-holes. No hearth was excavated, although several pits were and pottery and other domestic material was recovered from the building's interior. A date was obtained from a post burnt in situ (AA-52415), with a further date (AA-52414) obtained from the post-hole of the four-poster structure, RH10a, thought to represent the roundhouse's porch/entrance. As with earlier roundhouses at Kintore, RH10 is thought to have burned down, although whether this is accidental or deliberate was unclear.
RH11, the next roundhouse east from RH10, was slightly larger at 10m diameter. A radiocarbon date (GU-10539) was obtained from charcoal sampled from the fill of the building's interior – RH11 was thought to have been burnt, resulting in the building's collapse. Therefore, this sample probably represented structural timber, burnt in situ. As with the earlier roundhouses at Kintore, querns had been deposited within RH11, in this instance in pits in the building's interior, along with fragments of pottery.

RH14 lay 30m east of RH11, and was 11m in diameter, with a four-poster entrance (similar to the RH10a structure). Dates were obtained from charcoal with one of the four-poster structure's post-holes (GU-11324) and from charcoal sampled from the building's ring-ditch (GU-10542). Deposits of charcoal, ash, pottery and quern remains were recovered from the building's interior, both within and outwith pit features. As with the other two LBA roundhouses discussed here, RH14 was thought to have burnt down in situ, potentially deliberately but probably accidentally (based on the open pits excavated in the building's interior). The difference in the dates obtained from the ring-ditch sample and the material from the four-poster entrance structure was attributed to potential maintenance/replacement of elements of this feature during the building's use-life.

Two of the radiocarbon dated LBA roundhouses were located outside of the putative row of houses described above. RH04 and RH06 lay 24m north of RH10, and both buildings may have had entrance structures. RH04 was thought to have been used for a single phase of occupation before being burnt down, probably accidentally again, based on open pit features in the building's interior). RH04 was dated based on a sample from a post burnt in situ in a post-hole in the building's post-ring (SUERC-1362). RH06, 11m in diameter, was located c.10m from RH04. Dates were obtained from charcoal sampled from the base of the building's ring-ditch (SUERC-1345 and SUERC-1346).

7.2.2.5 Early Iron Age

A further three roundhouses were radiocarbon dated to the Early Iron Age, along with a single four-poster structure. All of these were roughly in the vicinity (no more than 50m away) from the LBA roundhouses discussed above. RH05 and RH09 formed part of a small group of these, along with another undated, possible EIA roundhouse (RH03) and the four-poster structure FP08 (dated by sample AA-52416). RH05, at only 4m in diameter, was comprised of seven post-holes and few internal features had survived/existed, with no evidence of a hearth or an entrance. It was dated on the basis of two samples from the fill of one of these post-holes (SUERC-1365 and SUERC-1364). The remains of RH09 had been severely impacted by a gas pipeline, with half of the building rendered unsuitable for excavation and the remaining half truncated. The ring-ditch structure contained an inner post-ring of six post-holes, and probably had an internal diameter of 10m. Again, no hearth feature had survived. The house was dated on the basis of a sample from the base of the ring-ditch's fill (GU-10537), which contained primarily burnt birch, oak and hazel roundwood along with burnt bone, perhaps deposited as a result of the burning of a thatched roof or hurdle screen. A possible entrance feature to RH09 had survived, and the feature contained a face-down stationary quern – the only artefact recovered, which supports the interpretation that the building was deliberately cleared before being destroyed by burning.

RH16 lay in an isolated position in relation to the other LIA roundhouses, 100m south-east in the eastern corner of Field A. The area had been in use during the LBA, at the end of the row of LBA roundhouses described above. The building had an internal diameter of c.13m, with a ring-ditch and internal post-ring. Further clusters of post-holes lay outwith the post-ring. Three radiocarbon dates (AA-53179, AA-53181 and AA-53182) were obtained from charcoal rich soil at the base of RH16's ring-ditch. Again, few artefacts were recovered from the structure, with a fragment of a slug-quern and two pottery sherds recovered from the fill of the ring-ditch. Less extensive interior erosion than that observed at other structures was interpreted as evidence for a potentially short, single-phase use-life for the building.

7.2.2.6 Modelling settlement at Kintore

The chronology as understood by Kintore's original investigators has been outlined in the preceding sections and was based both on the results of the radiocarbon dating programme and typological chronologies. Broadly, following an Early Neolithic characterised by ephemeral structures, the earliest dated structures at the site were thought to have been in use during the Late Neolithic. A hiatus was identified between Early Neolithic and the beginning of Late Neolithic activity at the site, with domestic settlement evidence, including two possible roundhouses dated to the Late Neolithic. A second hiatus was identified in the Early Bronze Age. Activity resumed and continued through the Middle Bronze Age and Late Bronze Age. The majority of roundhouses excavated at the site were dated to or thought to date to the Middle Bronze Age onwards, with construction and use continuing into the Iron Age, although for the purposes of this research, a 'cut-off' has been introduced in the Early Iron Age.

Modelling prehistoric activity at Kintore as a single phase (Figure 43) broadly supported this chronology, with dated activity at the site beginning in the Neolithic, at *4050–3680 cal BC* (*95% probability*), and probably between *3875–3720 cal BC* (*68% probability; Boundary Kintore Start*). From the beginning of Neolithic use at the site to the end of Early Iron Age use spanned *3115–3475 years* (*95% probability*), and probably between *3230–3355 years* (*68% probability*). Early Iron Age use of the site ended between *585–150 cal BC* (*95% probability*), probably between *490–315 cal BC* (*68% probability; Boundary Kintore End*). However, this approach does not allow us to make any further interpretations as to any hiatuses in use, the duration of unique phases of use, or to begin to think not only about when but how the site was being used at any given point in the past. The excavators' phasing of the site was not solely based on the results of the radiocarbon dating programme, but incorporated typological information (based on, for example, pottery and lithic finds).

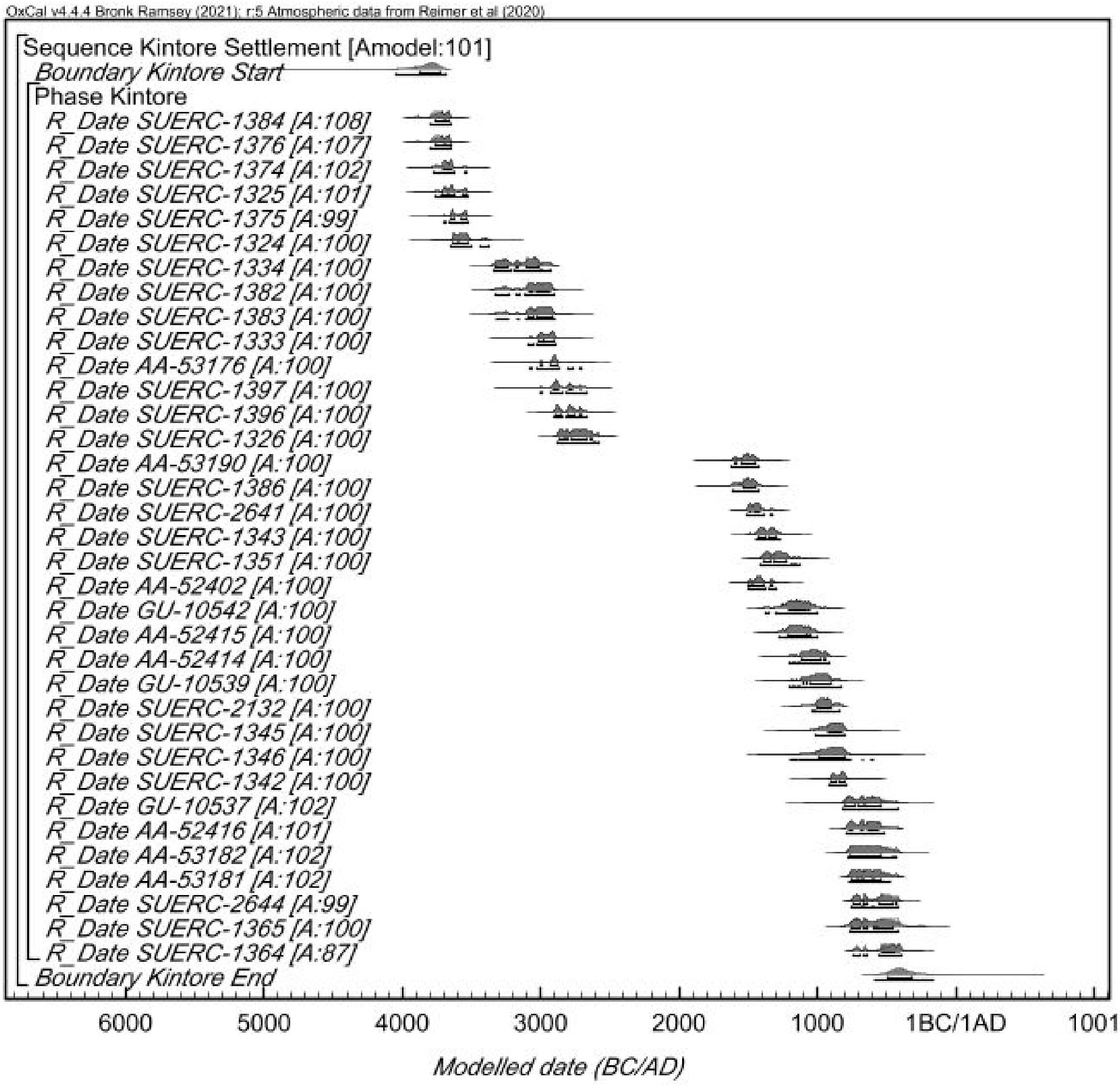

Figure 43: Dates from Kintore modelled as a single phase.

Dates from charcoal from securely identified short-lived species were used to construct this model; dates from unidentified wood species and other material were excluded.
All dates derived from charcoal from short-lived species (to control for any old-wood effect) were then modelled as a sequence (see Figure 44). Phasing was based on feature type, incorporating the original excavators' phasing: dates from Neolithic features (pits and structures) were placed in a phase at the start of this sequence *(Phase Neolithic Activity).* This was followed by a phase containing dates from features assigned to the Bronze Age (roundhouse and ovens) (*Phase Bronze Age Activity*), then a final phase containing dates from features assigned to the Early Iron Age (roundhouses, ovens and a four-poster structure) (*Phase Early Iron Age Activity*).

This approach resulted in a model with good agreement (*Amodel=99.3*). According to this model, activity associated with the Bronze Age roundhouses at the site began in *1740–1455 cal BC* (*95% probability*), probably in *1610–1485 cal BC* (*68% probability*; *Boundary Start Bronze Age Activity*). This activity spanned *640–1020 years* (*95% probability*), probably between *705–870 years* (*68% probability*; *Difference Span Bronze Age Activity*), ending at some point between *870–655 cal BC* (*95% probability*), probably in *815–725 cal BC* (*68% probability*; *Boundary End Bronze Age Activity/Start Early Iron Age Activity*). From this model we can see that it is unlikely that the dated roundhouses at Kintore were in use at the same time.

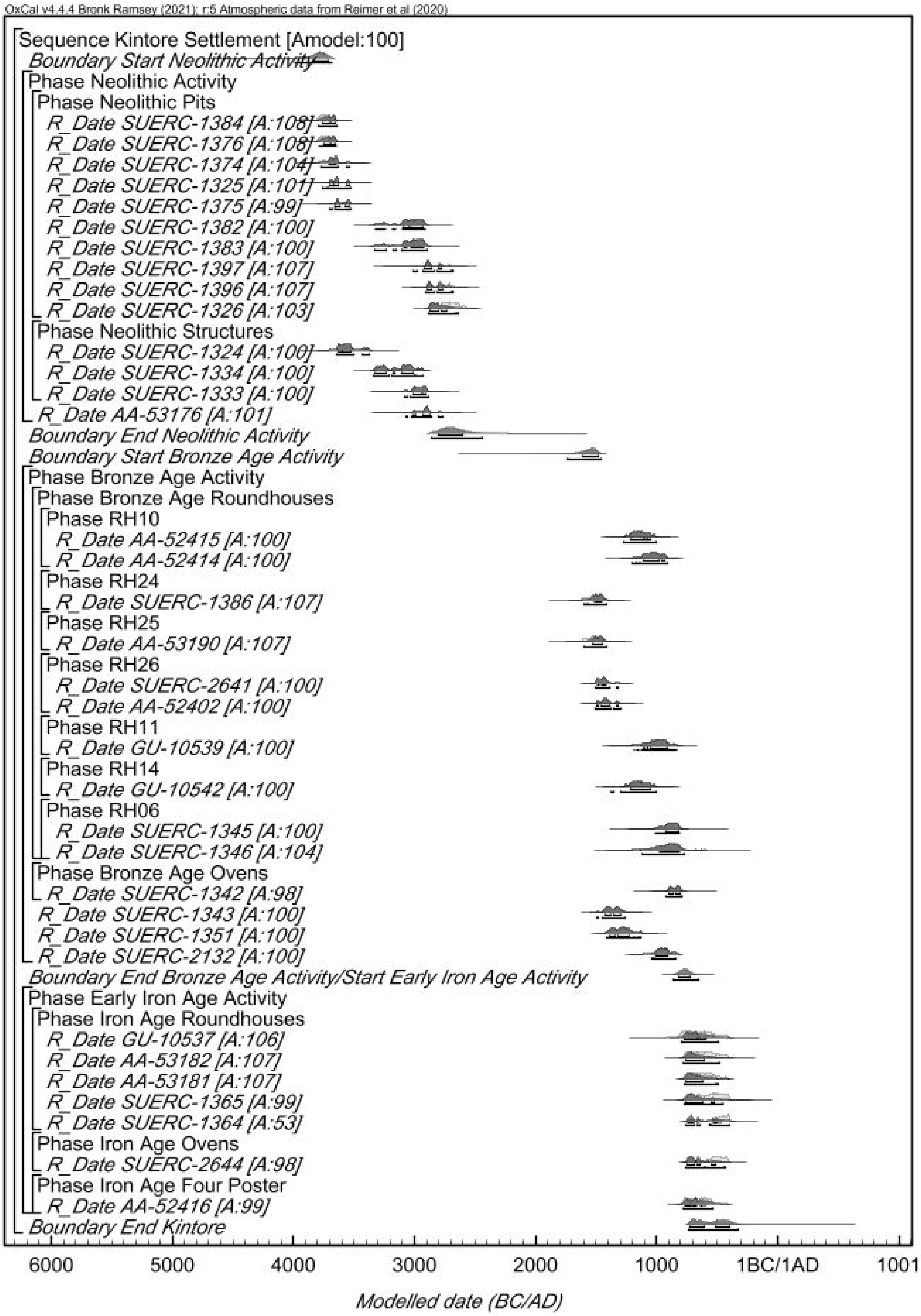

Figure 44: Dates from Kintore modelled incorporating excavators' phasing.

Clearly, this model is not definitive, and there are potential issues introduced by using the phases designated by the site's excavators. For the purposes of this research, the hiatus between Late Neolithic and Middle Bronze Age use may be significant, as it parallels the pattern observed at Lairg, where following evidence for Late Neolithic agriculture, the majority of the roundhouses at the site were dated to the mid/later 2nd millennium BC.

Laboratory Code	**Context Number**	**Material**	**Context Description**	**Radiocarbon age (BP)**	**δ13C (‰)**
SUERC-1367	11006	Charcoal (*Corylus avellana*)	ST06	5250±60	-26.4
SUERC-1371	11009	Charcoal (*Corylus avellana*)	ST06	5075±45	-26.7
AA-52420	11008	Charcoal (*Salix*)	ST06	5040±50	-26.7
SUERC-1384	11415	Charcoal (*Betula*)	P50 pit fill	4970±40	-26.2
SUERC-1376	11315	Charcoal (*Alnus*)	P35 pit fill	4965±40	-27.3
SUERC-1374	11131	Charcoal (*Betula*)	P25 pit fill	4895±45	-25.2
SUERC-1325	5504	Charcoal (*Corylus avellana*)	P12 pit fill	4865±50	-24.9
SUERC-1375	11132	Charcoal (*Alnus*)	P21 pit fill	4835±40	-25.1
SUERC-1334	7788	Charcoal (*Corylus avellana*)	ST12	4440±40	-26.4
SUERC-1382	11354	Charcoal (*Alnus*)	P52 pit fill	4400±45	-25.6
SUERC-1383	11401	Charcoal (Alnus)	P47 pit fill	4385±50	-28.4
SUERC-1333	7788	Charcoal (*Alnus*)	ST12	4340±40	-25.6

AA-53176	7462	Charcoal (*Salix*)	RH27	4290±45	-25.6
SUERC-1397	11563	Charcoal (*Corylus avellana*)	P46 pit fill	4250±45	-26.4
SUERC-1396	11563	Charcoal (*Betula*)	P46 pit fill	4215±40	-27.1
SUERC-1326	7013	Charcoal (*Corylus avellana*)	P53 pit fill	4145±40	-28.5
AA-53190	11262	Charcoal (*Corylus avellana*)	RH25	3245±50	-25.2
SUERC-1386	11423	Charcoal (*Alnus*)	RH24	3240±45	-25.0
SUERC-2641	7362	Charcoal (*Betula*)	RH26	3170±35	-24.7
AA-52402	7283	Charcoal (*Corylus avellana*)	RH26	3145±40	-27.0
SUERC-1343	8639	Charcoal (*Corylus avellana*	P18 pit fill	3105±40	-26.1
SUERC-1351	8749	Charcoal (*Corylus avellana*)	P15 pit fill	3035±45	-26.4
GU-10542	9360	Charcoal (*Betula*)	RH14	2940±50	-27.7
AA-52415	8777	Charcoal (*Corylus avellana*)	RH10	2935±45	-26.5
AA-52414	8605	Charcoal (*Corylus avellana)*	RH10a	2860±45	-25.1
GU-10539	8701	Charcoal (*Salix*)	RH11	2830±60	-26.1
SUERC-2132	8749	Charcoal (*Betula*)	P15 pit fill	2825±40	-24.5
SUERC-1345	8716	Charcoal (*Alnus*)	RH06	2730±60	-25.1

SUERC-1346	8716	Charcoal (*Corylus avellana*)	RH06	2730±50	-26.7
SUERC-1342	8446	Charcoal (*Corylus avellana*)	O014	2860±45	-25.2
GU-10537	8541	Charcoal (*Corylus avellana*)	RH09	2540±80	-26.8
AA-52416	9343	Charcoal (*Salix*)	FP08	2510±40	-26.0
AA-53182	9201	Charcoal (*Betula*)	RH16	2480±55	-26.1
AA-53181	9131	Charcoal (*Corylus sp*)	O031	2440±35	-27.1
SUERC-1365	9927	Charcoal *(Betula)*	RH05	2435±65	-25.4
SUERC-1364	9927	Charcoal (*Alnus*)	RH05	2375±40	-25.8

Table 5: Dates from Kintore.

7.2.3 Oldmeldrum

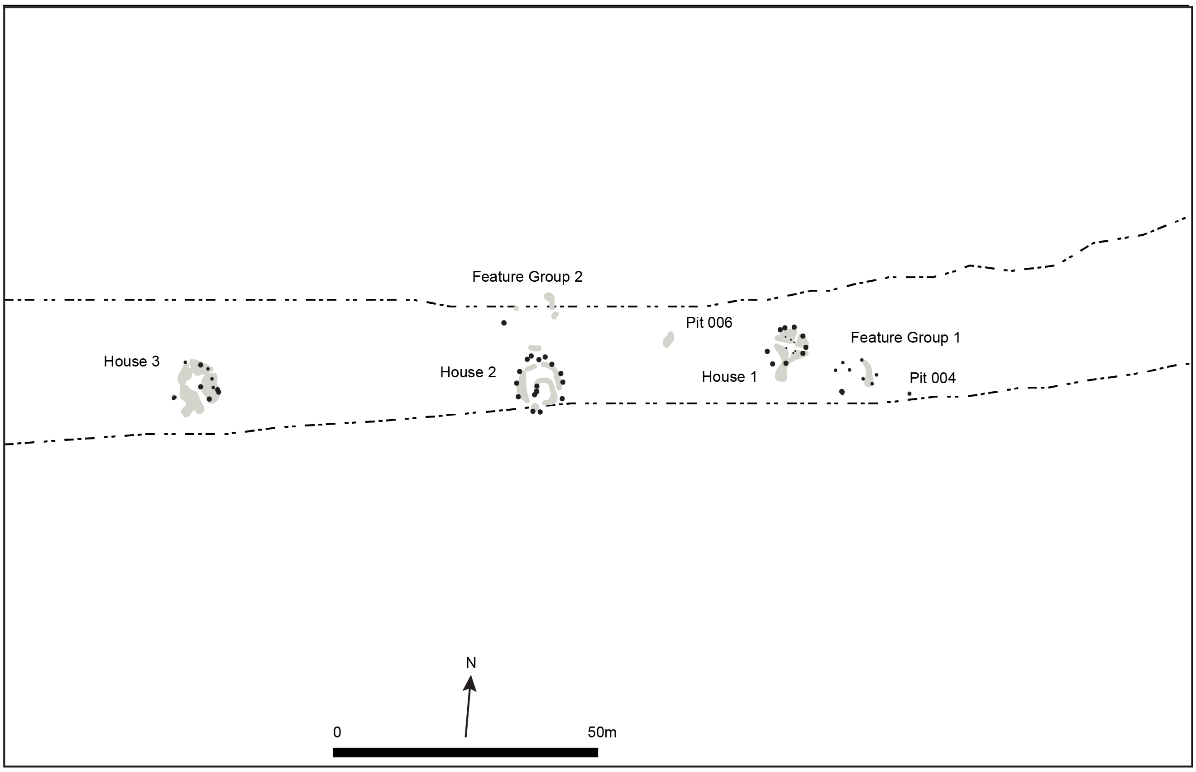

Figure 45: Site plan of Oldmeldrum (adapted from White *et al.*, 2010: 2)

The following is adapted from White *et al.* (2010). The site of Oldmeldrum, Aberdeenshire (Figure 45), was excavated in 2005. Three plough-truncated roundhouses were excavated as part of this project, along with two pits and two other possible roundhouses (although these were very heavily truncated and it was not possible to definitively describe them as such). All three confirmed roundhouses had a ring-ditch construction with evidence for interior post-rings. House 1 was thought to have had an additional porch structure, and there was some evidence that Houses 2 and 3 may also have had porches or entrance features. Cobbled surfaces were also present in building interiors, and all three buildings contained hearth features.

Radiocarbon dates were derived primarily from hearth and post-hole features, and one internal pit. Pottery, charcoal and coarse and worked stone tools indicated a domestic function for the buildings, while archaeobotanical evidence of naked and possibly also hulled barley (unusual for this period) along with chaff and the remains of weeds of cultivation like chickweed and fat hen indicates that crop cultivation and processing took place in the vicinity of these buildings.

Only House 2 showed any evidence of a secondary phase of use–some post-holes appeared to have been re-cut. A ditch cutting earlier features comprising this structure could also indicate a secondary phase of use at the site. House 1 and House 3 lacked evidence for any preceding or succeeding structures, although residual early prehistoric lithic artefacts were found across the Oldmeldrum site.

Seven contexts from the Oldmeldrum site were sampled for dating. Contexts 1103 and 11049 were the fills of post-holes, part of the post-ring and porch of House 1 respectively. Both contexts contained pottery sherds as well as charcoal, and material in these contexts may have been swept in as a result of cleaning or other activity in the building during its use. Contexts 1004, 10075 and 10077 were all the fills of post-holes making up the House 2 post-ring, and again, material may have been incorporated during the building's use. Contexts 17016 and 17005 were, respectively, the upper fill of the House 3 hearth pit and the fill of a large pit in the centre of the House 3 structure. It is assumed that the two dating samples from the hearth fill, which were both cereal grains, related to the use of the building although it is less clear how the dated material from the interior pit relates to the building's use.

As there were no direct stratigraphic relationships between the roundhouses at Oldmeldrum, it was decided to model their use as a single phase (see Figure 46), providing a general start and end point for the use of the roundhouses. Agreement for this model was good (*Amodel=92.5*). Use of the roundhouses began at *1595–1340 cal BC* (*95% probability*), and probably at some point between *1510–1405 cal BC* (*68% probability*; *Boundary Oldmeldrum Use Start).* Use of the buildings spanned *330–755 years* (*95% probability*), and probably *425–615 years* (*68% probability*; *Difference Span Oldmeldrum).* Use of the roundhouses at Oldmeldrum is likely to have ended between *1080–785 cal BC* (*95% probability*), and probably between *1005–885 cal BC* (*68% probability*; *Boundary Oldmeldrum Use End).*

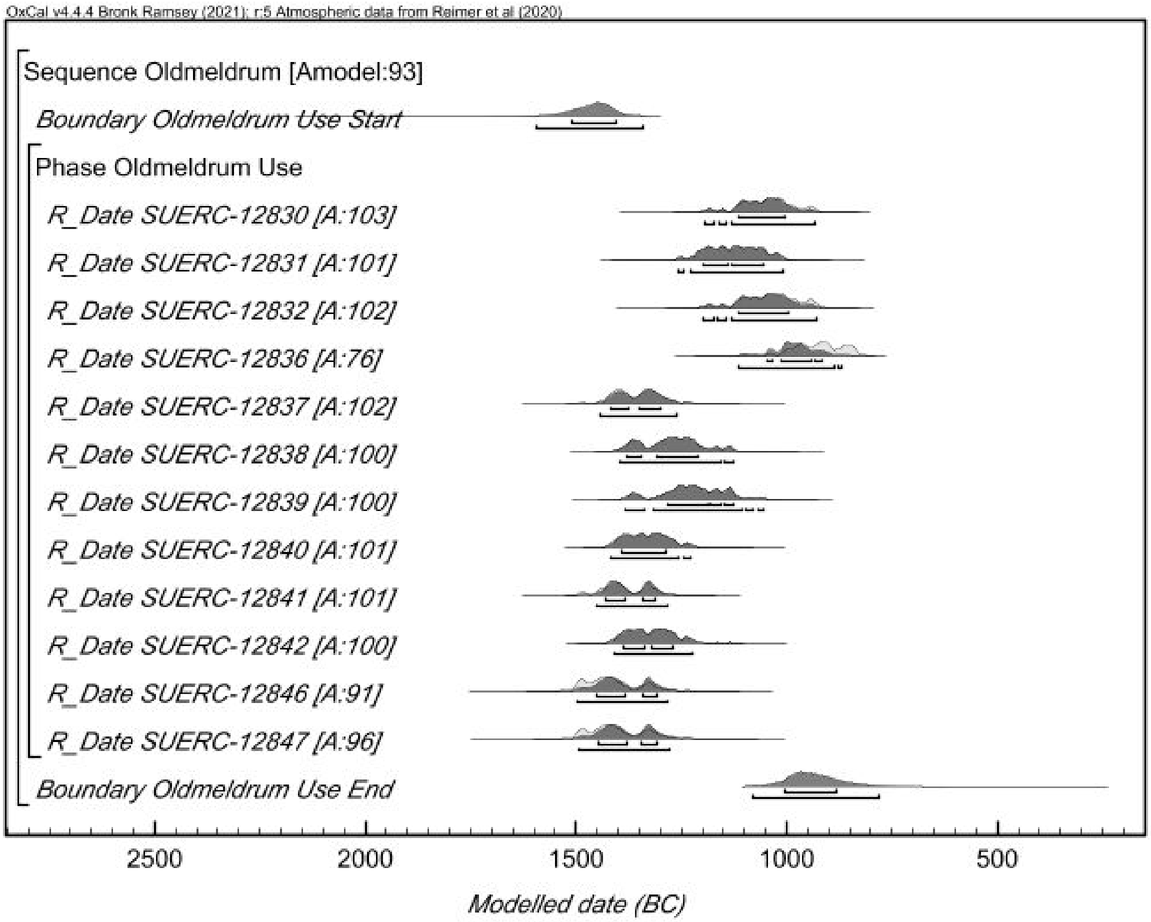

Figure 46: Dates from Oldmeldrum modelled as a single phase.

Laboratory Code	Context Number	Material	Context Description	Date (uncal BP)	*δ*13C
SUERC-12830	11033	Grain *(Hordeum)*	Fill of House 1 post-hole (cut through ring-ditch edge).	2870±35	-22.4
SUERC-12831	11033	Grain *(Hordeum)*	Fill of House 1 post-hole (cut through ring-ditch edge).	2925±40	-23.5
SUERC-12832	11049	Nut shell *(Corylus avellana)*	Fill of House 1 post-hole, part of porch.	2865±40	-27.1
SUERC-12836	11049	Charcoal (*Corylus avellana*, roundwood)	Fill of House 1 post-hole, part of porch.	2775±40	-27.0
SUERC-12837	10004	Nut shell (*Corylus avellana*)	Fill of House 2 post-hole, part of post-ring.	3100±40	-26.0
SUERC-12838	10004	Nut shell *(Corylus avellana)*	Fill of House 2 post-hole, part of post-ring.	3020±40	-26.3
SUERC-12839	10075	Grain *(Hordeum)*	Fill of House 2 post-hole, part of post-ring.	2990±40	-24.5
SUERC-12840	10077	Nut shell *(Corylus avellana)*	Fill of House 2 post-hole, part of post-ring.	3070±35	-26.2
SUERC-12841	10077	Nut shell *(Corylus avellana)*	Fill of House 2 post-hole, part of post-ring.	3125±35	-26.0
SUERC-12842	17016	Nut shell *(Corylus avellana)*	Fill of House 3 interior pit.	3060±35	-24.5

SUERC-12846	17005	Grain *(Hordeum)*	Upper fill of House 3 hearth.	3155±50	-22.9
SUERC-12847	17005	Grain *(Hordeum)*	Upper fill of House 3 hearth.	3145±40	-24.9

Table 6: Dates from Oldmeldrum.

7.3. The upland sites

7.3.1 Navidale

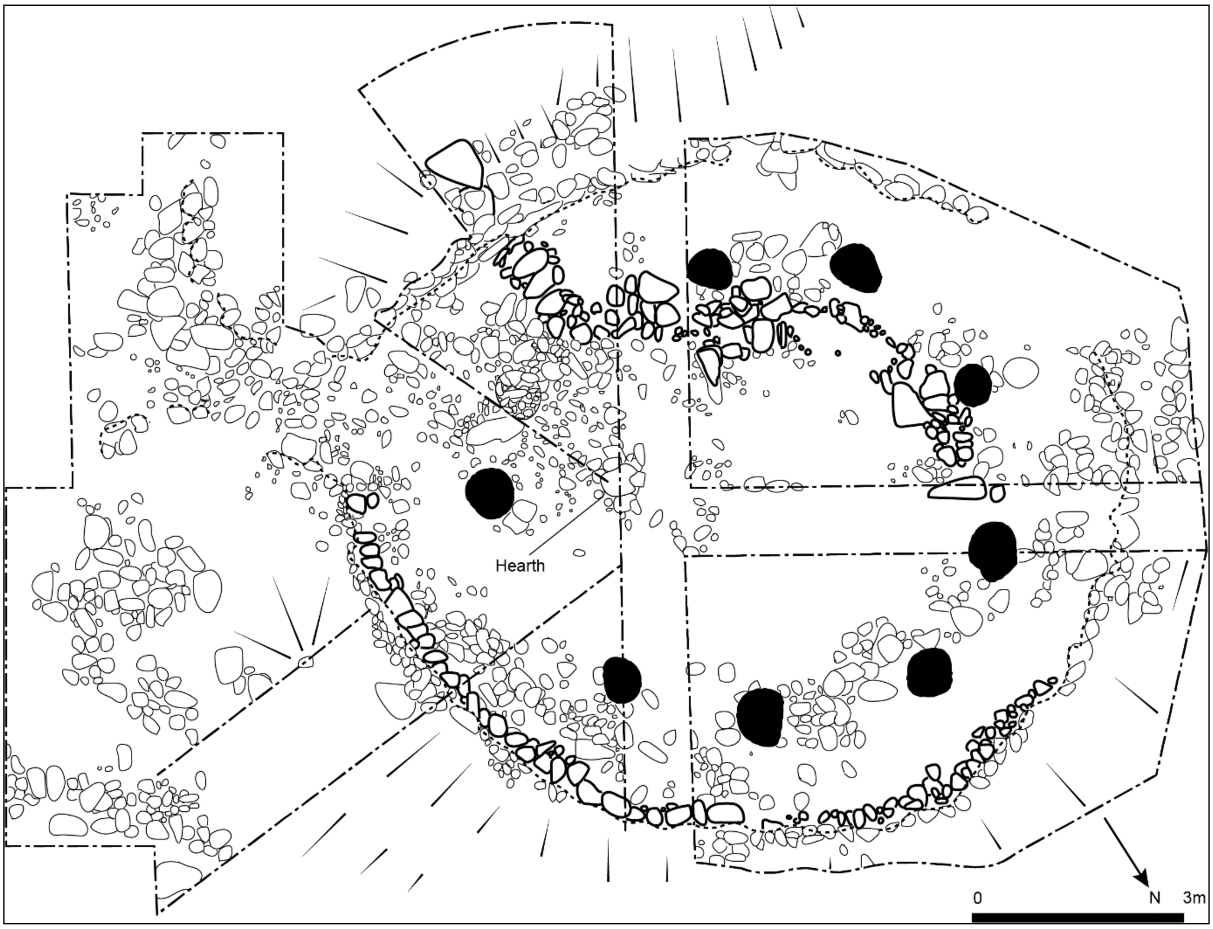

Figure 47: Plan of Navidale, drain shown in bold. (adapted from Dunbar *et al.,* 2008: 140).

The following information is adapted from Dunbar *et al.* (2008). The site of Navidale, near Helmsdale, Sutherland (Figure 47), was excavated in 2002 as part of a process of upgrading the A9 trunk road, uncovering a well-preserved roundhouse in an upland location c.140m above sea level. The roundhouse was part of a landscape containing at least five further roundhouses/hut circles within the surrounding c.500m. The site comprised (unusually) the remains of a bank and stone wall, two drains and an internal post-ring and hearth, in contrast to more heavily truncated examples such as those seen at Kintore and Meadowend Farm. The remains of a cobbled stone floor and a hearth feature were excavated–worked stone, including a cup-and-ring marked stone and a quern, had been repurposed as part of the hearth and flooring.
The roundhouse was thought to have been constructed and used in a single phase. Dating samples reflected this, with samples taken from both internal and perimeter drains, as well as two post-holes. Another dating sample was taken from a post-abandonment deposit, proving a *terminus ante quem* (TAQ) for activity at the site. An external perimeter drain (dated by SUERC-4392), lay upslope from the roundhouse and had not been covered by post-abandonment deposition. It was overlain by rubble tumble, and excavators suggested that intrusive material could, therefore, have found its way into the deposit.

Dating samples were explicitly selected on the basis that the dated material would have originated from activities taking place within the roundhouse. Context 152 was the fill of an internal post-hole, part of a sub-circular ring of internal post-holes (potentially a post-ring). Excavators observed no evidence of bioturbation. Context 122 was also the fill of a post-hole, in this case a replacement post-hole–evidence for repair and maintenance of the structure. Some bioturbation was evident in the upper part of this context. Context 124 was the fill of the roundhouse's internal drain, up to 0.35m deep with a stone cap, while context 135 was the fill of the external, perimeter drain, also stone-capped. There is the potential that these drain features may have continued to accumulate material after the roundhouse itself had gone out of use, perhaps originating from activity in the structure's vicinity. Finally, context 152 was described as a 'floor layer', containing ash and charcoal flecks deposited after the abandonment of the roundhouse. This material was interpreted as relating to a single event, although there is the potential that it was deposited by water action, according to site records.

The contexts relating to the use of the roundhouse at Navidale were modelled as a single phase (see Figure 48), with the determination from the abandonment/post-abandonment deposit closing the sequence. Initial agreement for this model was poor (*Amodel*= *37.1%).* This is likely due to the inclusion of SUERC-4395–initial outlier analysis indicated that this determination was highly likely to be an outlier, indicating the possibility for the inclusion of later material in the context. This sample was retrieved from the same perimeter drain as SUERC-4392. Re-running the model, both of these determinations were excluded as outliers.

Following the exclusion of these determinations, the model had good agreement *(Amodel=111.1).* Based on this model, activity at the site is likely to have begun between *1600–1225 cal BC* (*95% probability*), and probably at some point between *1410–1275 cal BC* (*68% probability*; *Boundary Start Navidale Use).* The roundhouse's use spanned between *0–102 years* (*95% probability*), and probably *0–35 years* (*68% probability*; *Difference Span Navidale Use),* before coming to an end between *1390–1025 cal BC* (*95% probability*), and probably at some point between *1370–1210 cal BC* (*68% probability; Boundary End Navidale Use/Abandonment).*

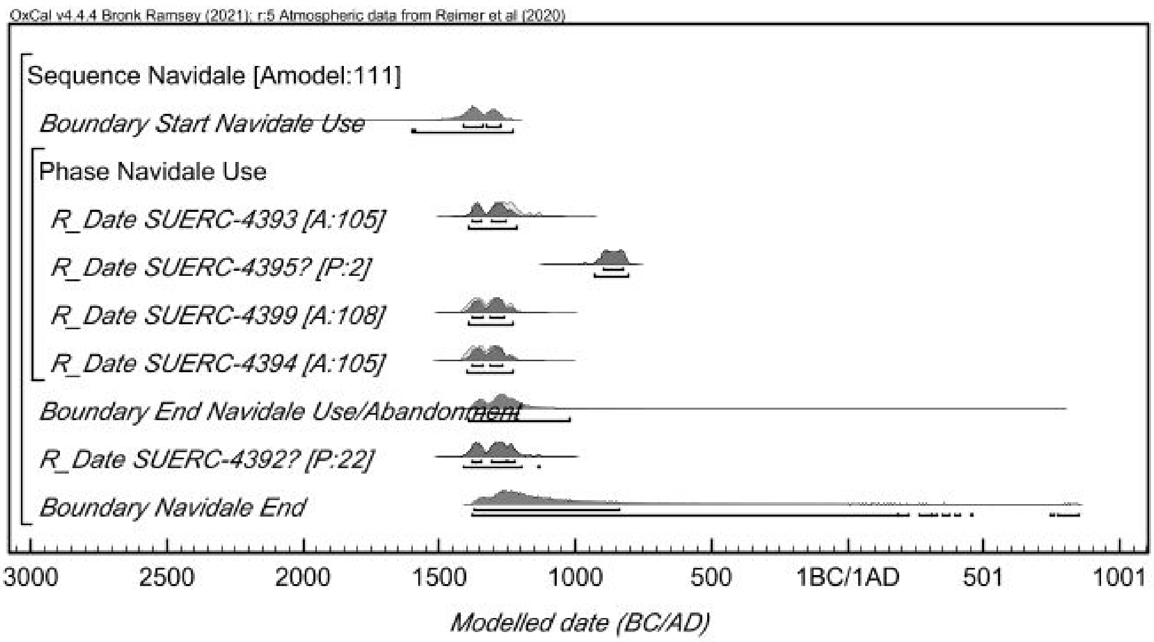

Figure 48: Model constructed using dates from Navidale.

Laboratory Code	Context Number	Material	Context Description	Date (uncal BP)	δ13C
SUERC-4393	122	Charcoal *(Alnus)*	Fill of replacement post-hole.	3020±35	/
SUERC-4392	113	Charcoal *(Corylus avellana)*	Abandonment/post-abandonment deposit (perimeter drain).	3035±35	/
SUERC-4395	135	Charcoal *(Alnus)*	Fill of perimeter drain.	2720±35	/
SUERC-4399	152	Charcoal *(Alnus)*	Fill of post-hole.	3050±35	/
SUERC-4394	124	Charcoal *(Alnus)*	Fill of internal drain.	3030±35	/

Table 7: Dates from Navidale.

7.3.2 Craigellachie

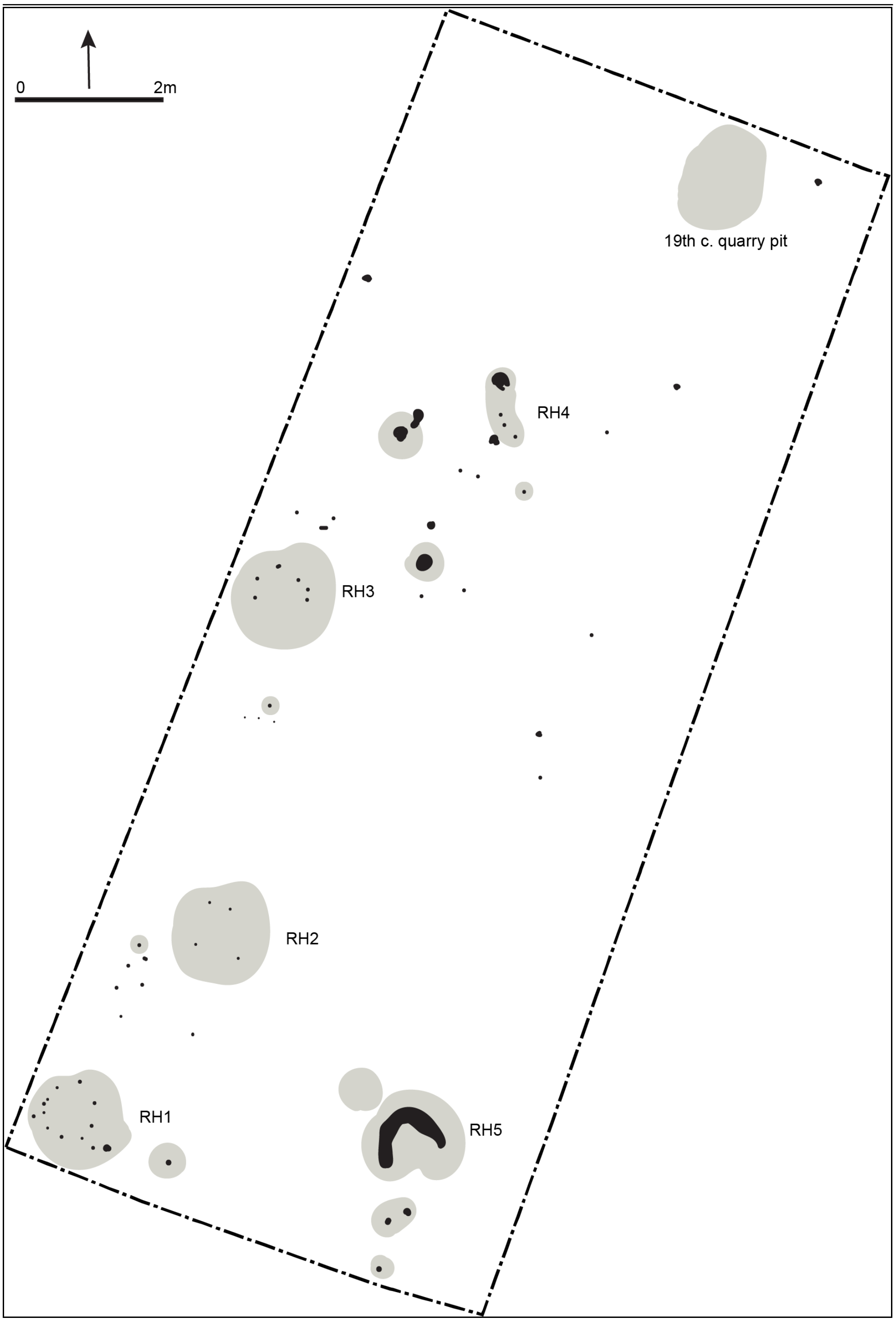

Figure 49: Site plan of Craigellachie (adapted from Dunbar *et al*., 2017: 4).

The following is adapted from Dunbar *et al.* (2017). The site of Macallan Distillery, Craigellachie, Moray (Figure 49), was excavated in 2014. The site is located on a gravel terrace above the River Spey, situated on a slope at c.130m OD. Excavations identified up to four discrete phases of use: pit-digging activity, dated to the Middle Bronze Age; a series of up to four roundhouses, assigned to the Late Bronze Age; a single Middle Iron Age roundhouse; and finally, deposits representing early medieval (9^{th}–12^{th} century AD) activity. A single pit, one of several present at the site, was dated to the Middle Bronze Age. It was suggested that any associated settlement evidence may have been located beyond the excavation area, perhaps on higher ground. The next phase of use was represented by roundhouses, numbered one to four. Only RH1 and RH4 were radiocarbon dated to the Bronze Age, with deposits from RH2 and RH3 producing early medieval dates, although given the proximity and similarities in morphology of the structures' remains, excavators hypothesised that these dates derived from intrusive materials, travelling from later features slightly upslope.

RH1 consisted of a post-ring – internal features appeared to have been severely plough-truncated. There was some evidence that post-holes may have been re-cut/superimposed, providing possible evidence of repair or restoration of the building. The remains of barley grains were recovered from the structure, indicating the storage or processing of grain. Dating samples were taken from structural post-holes and a pit related to the structure. RH4 was more heavily truncated than RH1, and it was unclear whether the remains represented a single, coherent roundhouse. Dating samples were taken from a single post-hole, although discrepancies indicate possible residuality of earlier material or contamination by later. As outlined above, RH3 and RH4 produced material dated to the early medieval period, although a single Bronze Age date was derived from a post-hole. While excavators interpreted the buildings as ultimately Bronze Age, with contexts contaminated by later material, the taphonomy of samples from these structures appears to be insecure. The ring-ditch roundhouse, RH5, dated to the Middle Iron Age, was positioned at a slight distance from the other roundhouse structures at the site, which were arranged close together. A four-poster structure was also dated to the Late Bronze Age and may have been associated with one or more of the roundhouses.

Contexts dated from RH1 comprised 4001, the fill of a post-hole, part of the structure's post-ring. The feature was shallow, at 0.2m deep, and was likely to have been impacted by ploughing in the area. Context 4021 was also the fill of a post-hole, again part of the RH1 post-ring and subject to plough truncation. Finally, context 4062 was the fill of a pit containing pottery remains and burnt bone, in the vicinity of RH1 and interpreted as being related to domestic activity at that structure. Pottery from within the fill had evidence for a sooty residue and the pit may have contained waste material from RH1. From the available records, there does not appear to be a direct stratigraphic link between this pit feature and RH1.

From RH2, dated contexts included 4092, the fill of a post-hole in the RH2 post-ring. The context contained material interpreted as both food and fuel debris, thought to relate to the use of the building. However, two different samples from the context – a piece of hazel charcoal and a cereal grain – produced Late Bronze Age and early Medieval dates respectively, indicating either intrusive or residual material. This was most likely to be intrusive material introduced through ploughing, given the issues of plough-truncation at the site. Context 4090, the fill of another post-hole in the RH2 post-ring was also dated, with a barley grain recovered from this context also producing a medieval date, indicating similar processes at work.

A total of two contexts from RH3 were dated. Context 4078 was the fill of a post-hole related to the building's porch, described as being heavily truncated, containing burnt bone and plant remains, potentially related to the sweeping out of household waste during the building's occupation. Context 4082 was also the fill of an RH3 post-hole, in this instance part of the main structure of the building – again, this feature had been truncated.

Two contexts from RH4 were dated. These comprised 4118, the fill of a post-hole, part of an arc of four such features, thought to potentially comprise a post-ring. However, the site was very heavily truncated and may, in fact, have not represented the remains of a roundhouse at all. The second dated context from RH4 was 4108, also the fill of one of the four post-holes making up the putative RH4 post-ring. Again, this feature was heavily truncated.

One context from RH5, 1308C, was dated (two samples were dated). This context comprised the fill of the structure's ring-ditch–context descriptions outline a band of thick charcoal close to the base of this fill, but it is unclear whether this was where the dating sample originated. No theory as to the origin of this charcoal was offered in site records.

The four-poster structure on site was dated by a sample from context 4049, the fill of one of its post-holes – no notable disturbance or truncation was noted by excavators.

A series of pits, some solitary, others in groups, from across the site were also sampled for dating. Context 4039 was the fill of an oval pit, >1m in diameter and 0.3m deep, part of a group of three. It is unclear what activity the charcoal contained within this fill originated from. Context 4066 was the fill of a shallow (0.11m deep), isolated pit, containing >100 cereal grains. It was hypothesised that this feature had been used for storage–therefore the grain would relate to occupation/use of the site. Context 4031 was also the fill of a large pit, containing >400 cereal grains and the remains of hazelnuts, thought to have been a deliberate deposition of waste material, potentially relating to settlement or other activity at the site. Context 4100 was the fill of a similar pit to that containing 4031, again containing cereal grains along with charcoal, and also thought to represent deliberate rubbish deposition. The pit containing context 4068, located next to RH3, contained burnt bone and charcoal, potentially also rubbish, perhaps related to the use of that structure.

Modelling the dates from Craigellachie as a single phase (see Figure 50) resulted in a model with good agreement (*Amodel=104.9*). Use of the site began between *2035–1470 cal BC* (*95% probability*), likely between *1740–1535 cal BC* (*68% probability; Boundary Craigellachie Start*), ending between *cal AD 1080-1595* (*95% probability*) and probably between *cal AD 1125–1325* (*68% probability; Boundary Craigellachie End*). However, this model is not particularly informative.

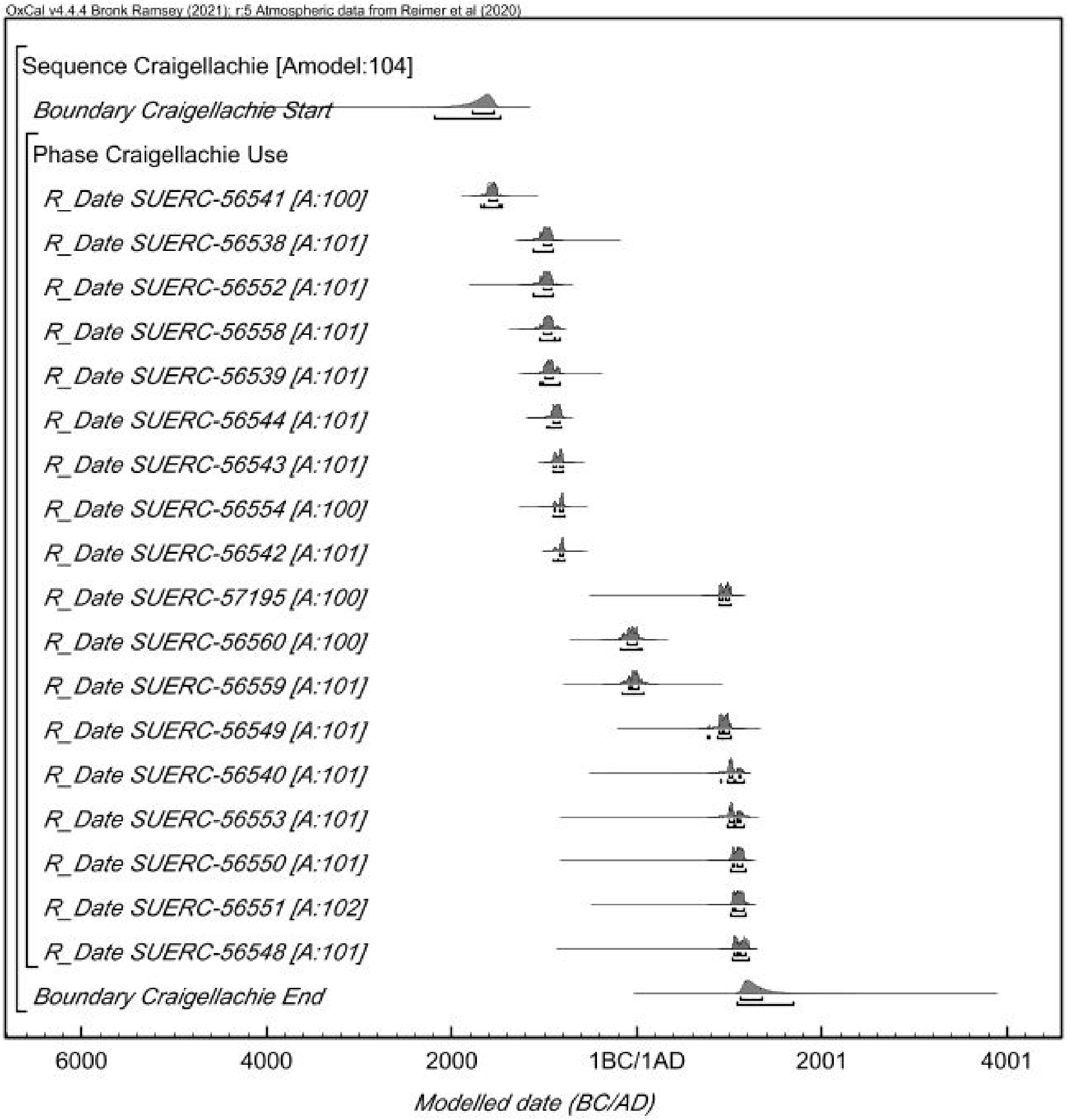

Figure 50: Dates from Craigellachie modelled as a single phase.

An additional model was constructed using the dates from Craigellachie, incorporating the excavators' phasing (see Figure 51). Some samples from contexts within the apparently prehistoric structures produced medieval dates, believed by the excavators to be the result of later contamination (later material travelling downslope to the prehistoric remains. Dates from the Late Bronze Age roundhouses were modelled as a single, simple phase as there was no stratigraphic information available regarding their temporal relationships. SUERC 57195 was excluded from the model as an outlier after initial outlier analysis.

Archaeologically visible activity at the site at some point between 2*400–1470 cal BC* (*95% probability*), and probably between *1830–1530 cal BC* (*68% probability*), with Late Bronze Age activity starting between *1140–915 cal BC* (*95% probability*), probably between *1040–945 cal BC (68% probability; Boundary LBA Start*). This phase spanned *45–405 years* (*95% probability*), likely *125–280 years* (*68% probability; Difference Span LBA),* ending at *890–695 cal BC* (*95% probability*), probably between *835–750 cal BC* (*68% probability*; *Boundary LBA End*). Activity assigned to the Middle Iron Age began between *680 cal BC –cal AD 10* (*95% probability*), probably between *290–5* cal BC (*68% probability*; *Boundary MIA Start*). This phase spanned between *0–1130 years* (*95% probability*), probably *0–515 years* (*68% probability*; *Difference Span MIA*), ending at *105 cal BC–cal AD 755* (*95% probability*), probably between *80 cal BC–cal AD 225* (*68% probability*; *Boundary MIA End),* before a final phase of medieval activity at the site.

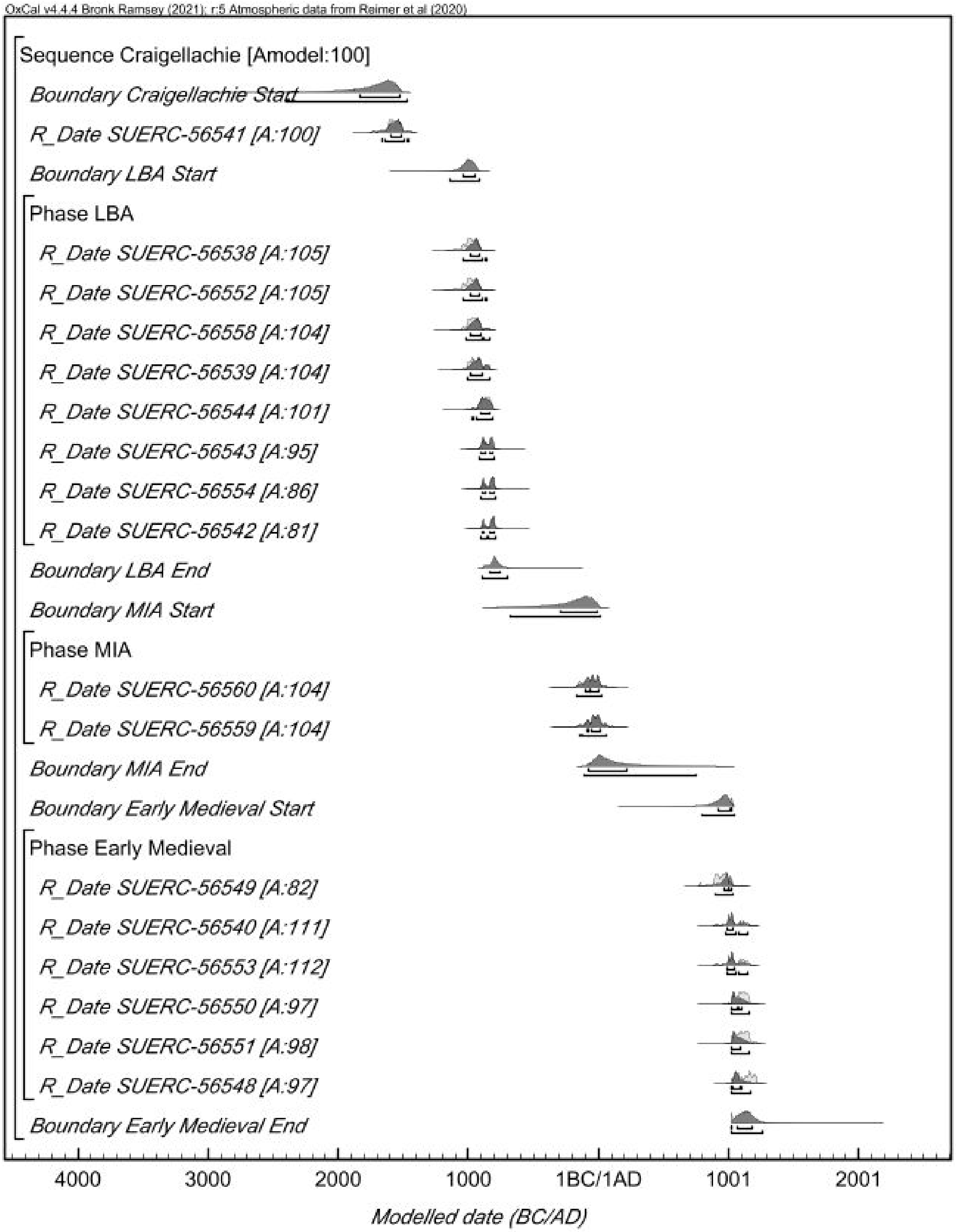

Figure 51: Dates from Craigellachie modelled incorporating excavators' phasing.

Laboratory Code	Context Number	Material	Context Description	Date (uncal BP)	δ13C
SUERC-56541	4039	Charcoal *(Alnus)*	Fill of pit (part of group).	3306±35	-26.4
SUERC-56538	4001	Charcoal *(Corylus avellana)*	Fill of Roundhouse 1 post-hole.	2827±35	-26.8
SUERC-56552	4092	Charcoal *(Corylus avellana)*	Fill of Roundhouse 2 post-hole.	2827±35	-26.5
SUERC-56558	4118	Cereal grain *(Triticum)*	Fill of Roundhouse 4 post-hole.	2807±35	-24.4
SUERC-56539	4021	Charcoal *(Corylus avellana)*	Fill of Roundhouse 1 post-hole.	2789±35	-26.2
SUERC-56544	4066	Cereal grain *(Hordeum)*	Fill of pit in Roundhouse 1 area.	2731±35	-23.9
SUERC-56543	4062	Charcoal *(Corylus avellana)*	Fill of Roundhouse 1 pit.	2688±35	28.3
SUERC-56554	4108	Charcoal *(Alnus)*	Fill of Roundhouse 4 post-hole.	2662±35	-26.7
SUERC-56542	4049	Charcoal *(Betula)*	Fill of four-poster post-hole.	2652±35	-27.2
SUERC-56560	1308C	Charcoal *(Corylus avellana)*	Fill of Roundhouse 5 ring-ditch.	2055±35	-29.3
SUERC-56559	1308A	Charcoal *(Corylus avellana)*	Fill of Roundhouse 5 ring-ditch.	2035±35	-25.7
SUERC-56549	4078	Charcoal *(Corylus avellana)*	Fill of Roundhouse	1103±35	-27.6

			3 porch post-hole.		
SUERC-57195	4092	Cereal grain *(Hordeum)*	Fill of Roundhouse 2 post-hole (possibly intrusive).	1084±30	-24.0
SUERC-56540	4031	Cereal grain *(Hordeum)*	Fill of pit.	1015±35	24.4
SUERC-56553	4100	Cereal grain *(Hordeum)*	Fill of pit.	1004±35	-24.5
SUERC-56550	4082	Charcoal *(Alnus)*	Fill of Roundhouse 3 post-hole.	957±35	-27.9
SUERC-56551	4090	Cereal grain *(Hordeum)*	Fill of Roundhouse 2 post-hole (possibly intrusive).	943±35	-24.4
SUERC-56548	4068	Charcoal *(Alnus)*	Fill of Roundhouse 3 pit.	907±35	-26.3

Table 8: Dates from Craigellachie.

7.3.3 Drumyocher and Hospital Shields

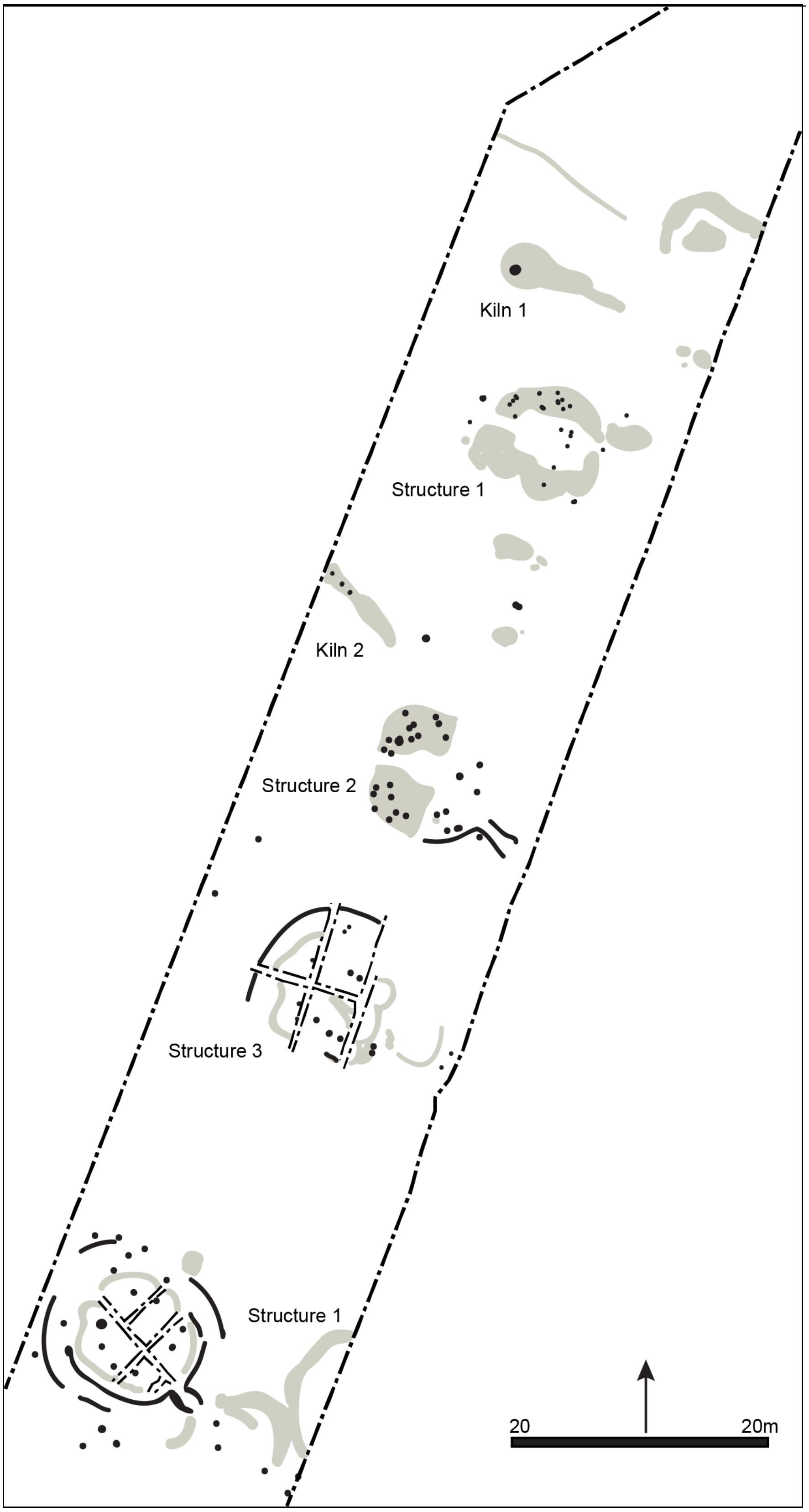

Figure 52: Site plan of Drumyocher (adapted from Johnson *et al.,* 2017: 3).

The following is adapted from Johnson *et al.* (2017). The sites of Drumyocher, near Arbuthnott, and Hospital Shields, near St Cyrus, Aberdeenshire, were excavated as part of pipeline construction in the area in 2004. Prehistoric roundhouses, radiocarbon dated to the Bronze Age, were excavated at both sites.

At Drumyocher, a total of four roundhouses (Structures 1 to 4) were excavated, located on a south-east facing slope c.125m OD. Although only Structure 1 contained evidence for a hearth, finds of pottery, charcoal and lithic artefacts indicated a domestic function for the site generally. Little archaeobotanical evidence was recovered from the site, although the presence of naked barley indicates storage or processing in the general vicinity. A fifth roundhouse and accompanying souterrain, dated to the Iron Age, lay slightly to the north of the four Bronze Age roundhouses, which were located in an unenclosed cluster over an area of c.125x25m.

A total of 14 contexts from Drumyocher were sampled for dating. Context 653 was the shallow fill of a post-hole, part of a group of features potentially related to the occupation of Structure 1 or perhaps an earlier, truncated ring-ditch structure. Context 661 was also the fill of a negative feature in the area of Structure 1 – in this instance a shallow pit, part of a group in the area of Structure 1's entrance. This feature may have been related to the use of Structure 1, or to earlier activity at the site. The features containing both 653 and 661 were both heavily truncated.

Three contexts related to Structure 2 were sampled for dating. Context 128 was the fill of a pit at the eastern side of this structure's interior, described in the data structure report for the site as a post-hole. It was suggested that this feature could relate to multi-phase construction at Structure 2. Context 188 was the fill of the Structure 2 'scoop', a 10x10.5m feature within the structure containing a number of pits. Context 188 was the middle of three distinct fill layers within this 'scoop', at the inner edge of the feature to the north-west area of the structure. It is not clear what the source of the charcoal within context 188 was – whether it was related to the primary use of the building or deposited post-abandonment. The fill of a further pit, 339, was also dated. Again, this feature was described as a post-hole fill in the site's data structure report. It underlay the fill of the 'scoop', and the charcoal within this fill may have been deposited during the primary use of this structure.

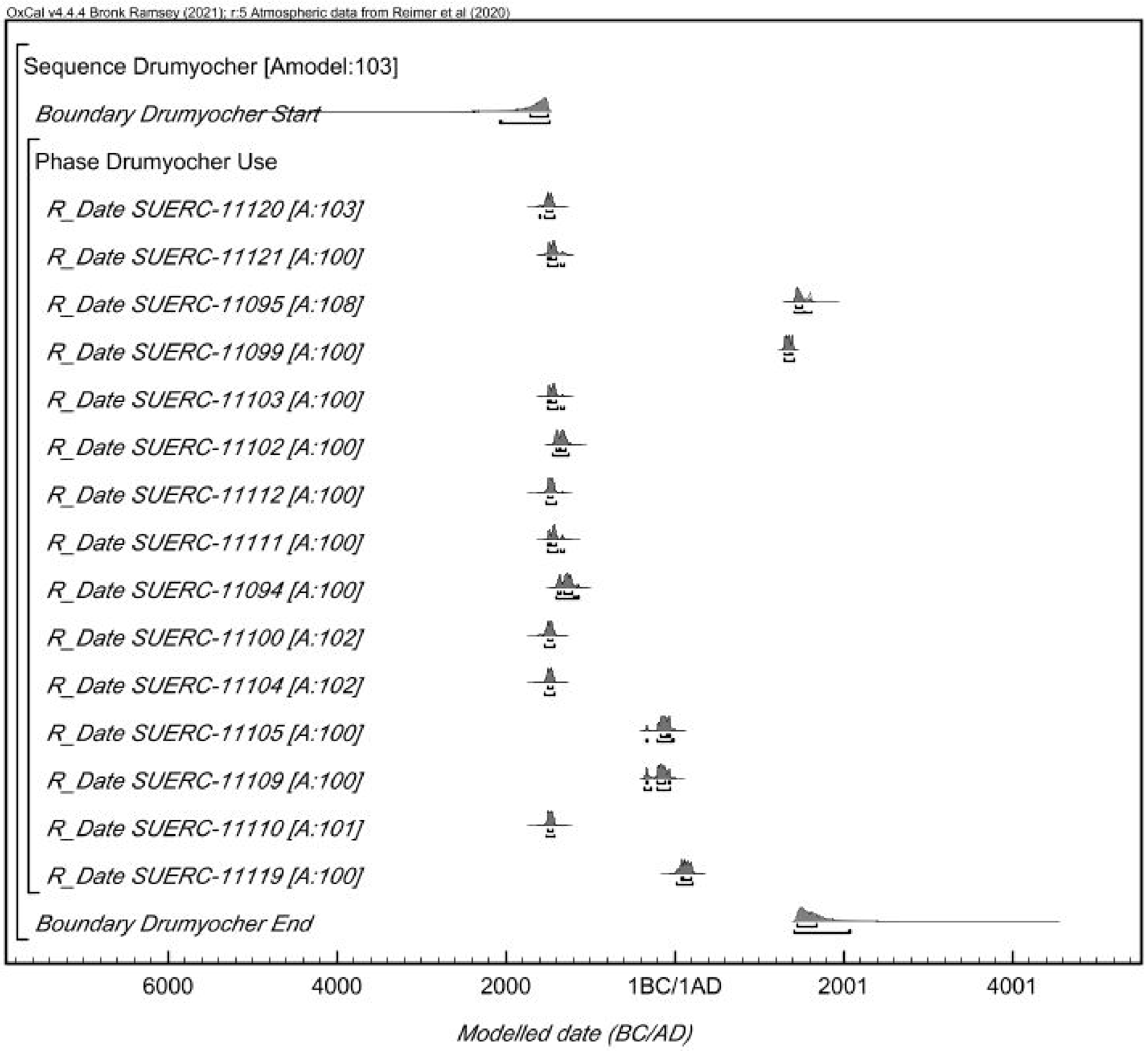

Figure 53: Dates from Drumyocher modelled as a single phase.

Initially, all dates from Drumyocher were modelled as a single phase (see Figure 53). This resulted in a model with good agreement (*Amodel=103.4)*. According to this model, activity began at the site between *2075–1475 cal BC* (*95% probability*) and probably between *1710–1495 cal BC* (*68% probability*; *Boundary Drumyocher Start*). Dated activity spanned between *2915–3135 years* (*95% probability*), and probably between *2925–3025 years* (*68% probability*), before ending between *cal AD1425–2085* (*95% probability*), likely at *cal AD 1450–1690* (*68% probability*; *Boundary Drumyocher End*). While this model tells us that use of the site began in the 2nd millennium BC, it is not possible to discern any further information about the Bronze Age use of the site sue to the inclusion of samples relating to later activity and potentially intrusive material in this model.

Next, a model incorporating the excavators' phasing was constructed (see Figure 54), taking into account the potential taphonomy of the dated samples. The dates from the suggested Bronze Age roundhouses at Drumyocher were modelled as a single phase, as it was not possible to discern any temporal relationships between the buildings on the basis of stratigraphy. Dates from samples thought to be intrusive (SUERC-11095 and SUERC-11099) were excluded from the model. *Avena* (oat) is not thought to have been widely cultivated until the Iron Age in Scotland. Two determinations from contexts thought to post-date the Bronze Age roundhouses at the site (SUERC-11109 and SUERC-11105) and a date from a roundhouse with a souterrain (SUERC-11119) (generally thought to be a feature of Iron Age buildings) were placed later in the sequence.

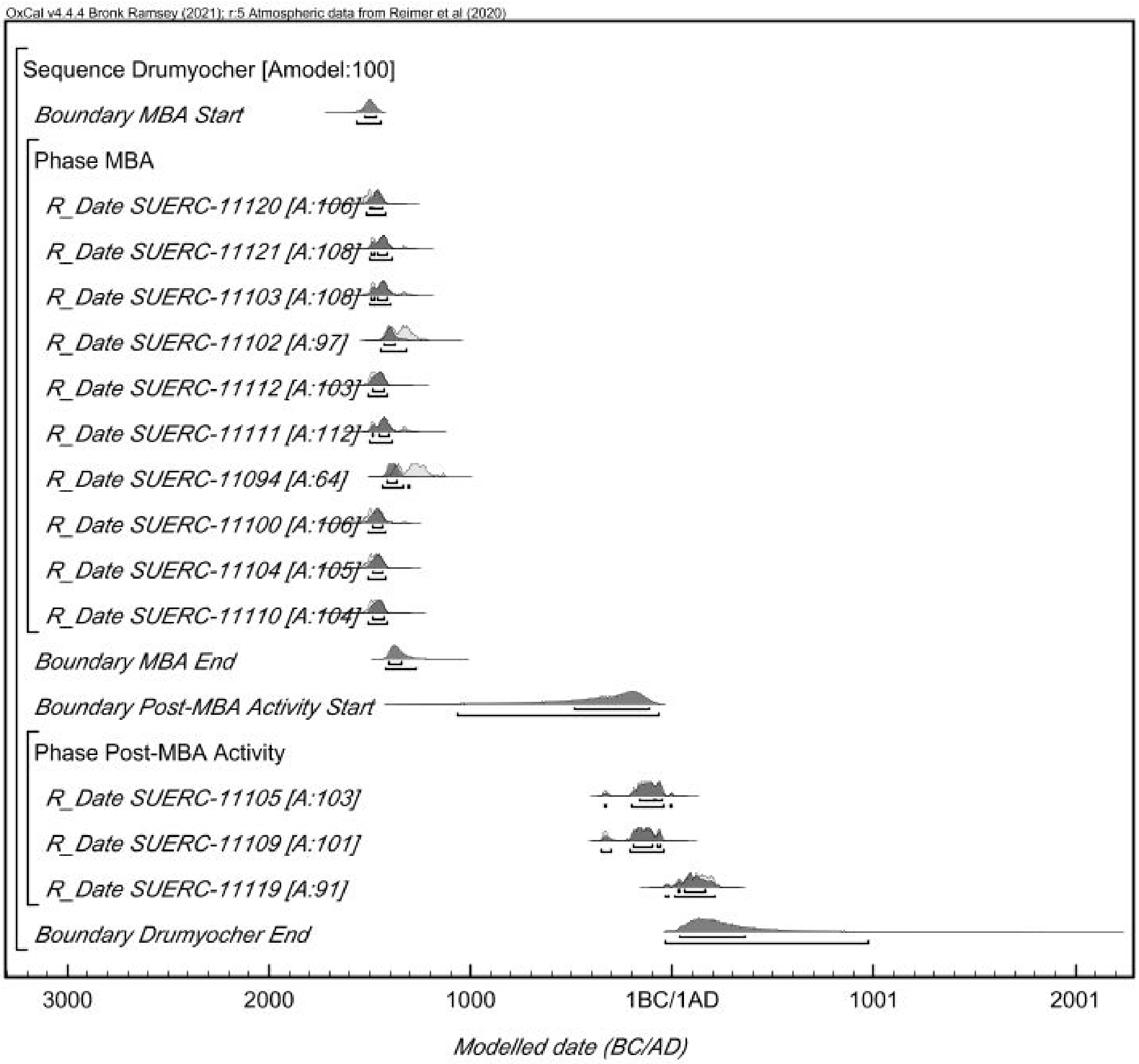

Figure 54: Dates from Drumyocher modelled incorporating excavators' phasing, with potentially intrusive samples excluded.

This approach resulted in a model with good agreement *(Amodel=104.7),* with a start point for dated activity between *1565–1445 cal BC* (*95% probability*), probably between *1525–1470 cal BC* (*68% probability*; *Boundary MBA Start*). Activity assigned by the excavators to the Middle Bronze Age spanned between -*35–275 years* (*95% probability*), likely between *40–365 years* (*68% probability*; *Difference Span MBA Drumyocher*), before ending between *1425–1270 cal BC*, likely between *1405–1345 cal BC* (*68% probability*; *Boundary MBA End*).

Laboratory Code	**Context Number**	**Material**	**Context Description**	**Date (uncal BP)**	**δ13C**
SUERC-11120	653	Cereal grain *(Hordeum)*	Fill of pit, possibly associated with Structure 1 occupation.	3230±35	-23.7
SUERC-11121	661	Cereal grain *(Hordeum)*	Fill of pit, possibly associated with Structure 1 occupation.	3165±35	-23.4
SUERC-11095	128	Cereal grain *(Avena)*	Fill of Structure two post-hole (thought to be intrusive).	410±50	-25.0
SUERC-11099	128	Cereal grain *(Avena)*	Fill of Structure two post-hole (thought to be intrusive).	605±35	-24.6
SUERC-11103	188	Cereal grain *(Hordeum)*	Fill of Structure 2 ‘scoop’.	3165±35	-24.0

SUERC-11102	188	Cereal grain *(Hordeum)*	Fill of Structure 2 'scoop'.	3090±35	23.3
SUERC-11112	339	Nut shell *(Corylus avellana)*	Fill of Structure 2 post-hole.	3195±35	-26.1
SUERC-11111	339	Cereal grain *(Hordeum)*	Fill of Structure 2 post-hole.	3155±35	-23.5
SUERC-11094	101	Cereal grain *(Hordeum)*	Fill of pit associated with Structure 4 entrance passage.	3030±35	-21.1
SUERC-11100	182	Cereal grain *(Hordeum)*	Fill of post-hole, part of Structure 4 post-ring.	3220±35	-21.0
SUERC-11104	204	Cereal grain *(Hordeum)*	Fill of post-hole, part of Structure 4 post-ring.	3215±35	-25.4
SUERC-11105	254	Cereal grain *(Hordeum)*	Fill of shallow pit, thought to post-date Structure 4.	2110±35	-22.9
SUERC-11109	254	Cereal grain *(Hordeum)*	Fill of shallow pit, thought to post-date Structure 4.	2135±35	-22.9
SUERC-11110	276	Cereal grain *(Hordeum)*	Fill of post-hole, part of Structure 4 post-ring.	3205±35	-24.1

Table 9: Dates from Drumyocher.

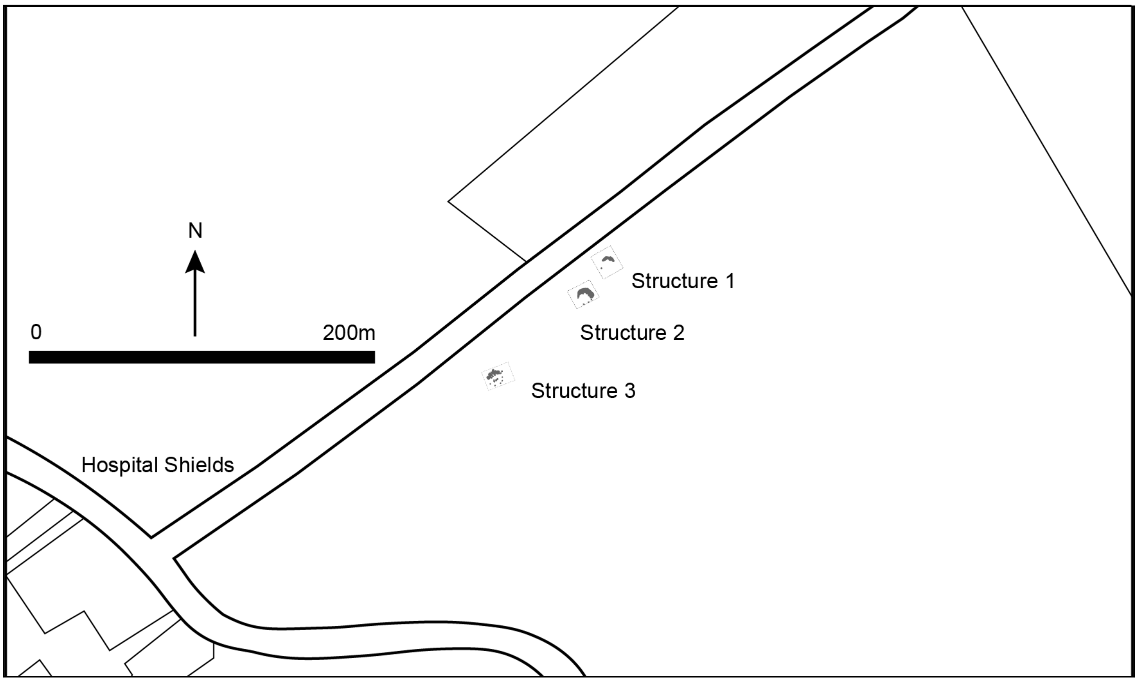

Figure 55: Site plan of Hospital Shields (adapted from Johnson *et al.*, 2017: 46-47, 49-50).

The Hospital Shields site (Figure 55), located on a south-facing slope at c.170m OD, comprised three ring-ditch roundhouses (Structures 1-3). The structures were more severely truncated than those at Drumyocher, and it is thought that the surviving features represented deeper pits and post-holes.

A total of three contexts from the Hospital Shields site were sampled for dating, all from the area of Structure 3. Context 015 was the fill of a pit, part of a ring of such features thought to have supported the structure's roof. Contexts 028 and 046 were the fills of large pits on the north-west side of structure 3. Context 028 filled two distinct pit features, while 046 was the lower fill of a pit feature. All three contexts were heavily truncated, and it is unclear where the material dated from contexts 028 and 046 originated, although the dated barley grain from 015 could have been deposited during the use of Structure 3.

Only one of the roundhouses, Structure 3, produced suitable material for dating (five radiocarbon dates were obtained from contexts comprising this structure). This means it is not possible to determine whether any or all of these roundhouses were in use at the same time. Modelling the dates from Structure 3 as a single phase (see Figure 46) produced a model with good agreement (*Amodel=97.2*). Use of Structure 3 was underway by *1035–840 cal BC* (*95% probability*) and probably by *945–855 cal BC* (*68% probability*) (*Boundary Hospital Shields Use Start*). Dated use of the building spanned between *0–250 years* (*95% probability*) and probably only *0–105 years* (*68% probability*) (*Difference Span Hospital Shields Use*), ending at *915–750 cal BC* (*95% probability*) and probably at *890–810 cal BC* (*68% probability*) (*Boundary Hospital Shields Use End*).

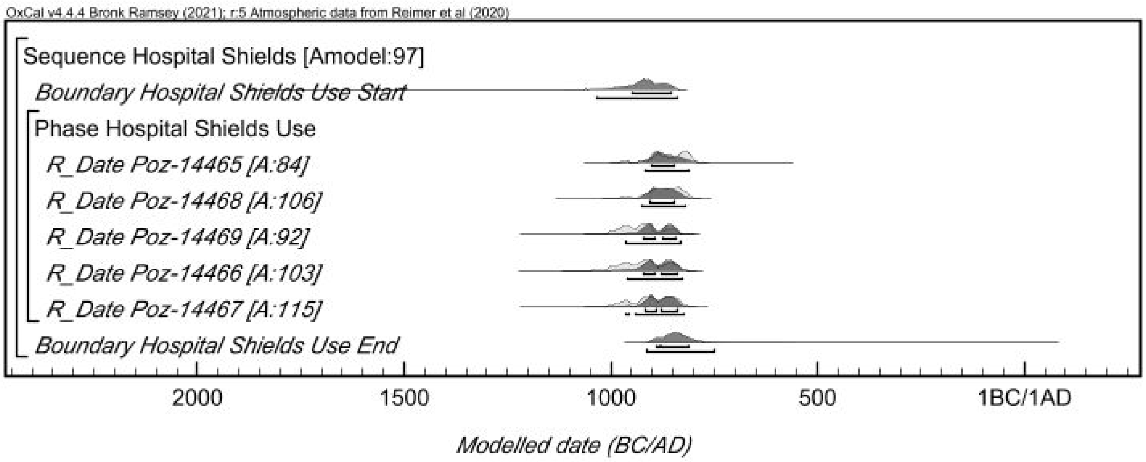

Figure 56: Dates from Hospital Shields modelled as a single phase.

Laboratory Code	Context Number	Material	Context Description	Date (uncal BP)	δ13C
Poz-14465	015	Cereal grain *(Hordeum)*	Fill of Structure 3 pit, part of post-ring.	2690±35	-17.4
Poz-14468	028	Cereal grain *(Hordeum)*	Structure 3 pit.	2725±35	-16.0
Poz-14469	028	Cereal grain *(Hordeum)*	Structure 3 pit.	2780±30	-20.3
Poz-14466	046	Cereal grain *(Hordeum)*	Structure 3 pit.	2775±35	-22.0
Poz-14467	046	Cereal grain *(Hordeum)*	Structure 3 pit.	2760±35	-13.6

Table 10: Dates from Hospital Shields.

7.4 Discussion

The models described above for the selected sites are not necessarily definitive, as they are based on a partial insight into the available data regarding site stratigraphy and sample taphonomy. However, they offer an insight into the chronology of Bronze Age roundhouse sites supported by other studies: short use-lives of individual buildings; evidence for Neolithic activity (and a potential Late Neolithic/Early Bronze Age hiatus at some sites), and horizons for start and end points at c.1700 cal BC and c.800 cal BC respectively.

7.4.1 Settlement use-lives

In the later 20th century, the dominant paradigm regarding roundhouse usage was that these buildings had relatively long use-lives, based in part on analogies with timber-framed medieval buildings and in part on flawed interpretations of long calibrated ranges for radiocarbon determinations (e.g. Reynolds, 1977; see Halliday, 2021 for discussion; Pope, 2003 for summary). However, from the early 2000s onwards this model came into question, and it is now believed that roundhouses were probably in use for short periods, probably no more than 40 years (Barber & Crone, 2001; Crone *et al.*, 2018). For the case studies described above, estimated use-lives of the sites ranged from centuries to decades. The variety of excavation strategies employed in the case studies above allows us to compare the use of single buildings with chronologies for multi-structure, multi-period sites. At Navidale, where a single roundhouse was excavated (although several were recorded in its immediate vicinity), the site may have been in use for less than 35 years. The use of Structure 3 at Hospital Shields was also probably generational, potentially with a use-life of less than 60 years.

If we are to understand that the use-lives of individual roundhouses were generally short, on the level of individual generations (Barber and Crone, 2001; Brück, 2000; Crone *et al.*, 2018; Halliday, 2007), then it seems is fair to suggest that for the sites with longer modelled use-lives, use of the various individual buildings sampled as part of the respective dating programmes was probably not contemporaneous. At Kintore, Meadowend Farm, Oldmeldrum and Craigellachie, the use of each given site spanned centuries, indicating that the individual roundhouses excavated were not likely to have been in use at the same time. It is not possible to say on the basis of the models described above whether this was part of a pattern of rotating settlement, with households moving around a landscape over the course of several generations (as proposed by e.g. Rideout, 1995; Haselgrove *et al.*, 2001), or of a more straightforward pattern of re-use of favourable sites within a landscape.

7.4.2 Evidence for Neolithic settlement

In terms of the lowland sites included in this sample, both Meadowend Farm and Kintore revealed evidence for Neolithic use of the sites, although no Neolithic phase was identified at Oldmeldrum. At both Kintore and Meadowend Farm, we can observe a hiatus in dated/excavated use in the Late Neolithic, with use of Meadowend Farm resuming earlier than at Kintore, in the Early Bronze Age, while at Kintore archaeologically visible use of the site did not resume until the middle of the 2nd millennium BC, broadly at the same time as use began at the Oldmeldrum site. At Meadowend Farm, dated activity ceased before c.800 cal BC, and at Oldmeldrum activity also stopped in the earlier part of the 1st millennium BC. At Kintore, activity continued into the Iron Age (and beyond, although this information was not included in the models for the site).

At the upland sites described above, no evidence for Neolithic land-use was observed. Activity at Navidale is likely to have begun and ended in the later part of the 2nd millennium BC, with a similar pattern seen at Drumyocher, although use there started slightly earlier, in the mid-2nd millennium BC. Both of these sites were potentially in use for only a generation or so, as discussed above. Use continued for longer at Craigellachie, where the onset of use at the site was modelled to the early-mid-2nd millennium BC, ending in the first centuries of the 1st millennium BC. At Hospital Shields, a different pattern was observed, with use of the site beginning and ending in the early 1st millennium AD, although again, the site was probably in use for only a short period of time.

The lack of Neolithic evidence at the upland sites included in this sample is not congruent with evidence from Lairg, where ard-marked soils underlay hut circles dated to the Bronze Age, and the pollen record indicates that cereal cultivation continued throughout the Neolithic. In recent years a number of studies, primarily based on summed probability distributions (SPDS) of radiocarbon dates and comparison with other proxies for activity such as pollen data, have suggested that after an Early Neolithic characterised by population increases and widespread arable agriculture, from c.3700 BC onwards agricultural recession and population decreases occurred. This has been linked to a shift to a cooler, wetter climate (Bradley, 2008; see Thomas, 2013 for summary; Bevan *et al.*, 2017; Colledge *et al.*, 2019; Shennan *et al.*, 2013; Stevens and Fuller, 2012, 2015; Woodbridge *et al.*, 2014; Woodbridge *et al.*, 2020).

The use of SPDs of radiocarbon dates as a proxy for human populations is based on the concept introduced by Rick (1987) that levels of human activity (evidenced by radiocarbon dates) in a given place at a given time correlate to population levels: more activity = more dates = more people. Issues of dating strategies at individual sites, taphonomic and research biases and the effects of the calibration curve have all been raised as critiques of this approach (see Williams, 2012; Surovell *et al.*, 2009; Bishop, 2015; Culleton, 2008; Chapter 2 of this thesis). It has also been proposed that even assuming a direct relationship between population size and numbers of radiocarbon dates, to be able to distinguish any real changes from statistical 'noise' would require far larger datasets than are generally available to archaeologists (Contreras & Meadows, 2014).

Studies incorporating historic pollen data to support findings from SPDs tend to rely on evidence for woodland clearance as a proxy for human activity (Farrell *et al.*, 2021), and often include data sets with low chronological resolution (discussed in McDonald *et al.*, 2021). While there is evidence for climatic deterioration in the Late Neolithic, it is not clear that this led to widespread changes in levels of human population or activity (*ibid.*; also see Chapter 6 for further discussion).

7.4.3 Late Bronze Age settlement decline

From the models described above (see Figure 57), there appears to a cessation of activity, or a pause prior to the beginning of further activity, at both upland and lowland sites in the first centuries of the 1st millennium BC. There is a longstanding narrative in British archaeology that climatic deterioration at the end of the Bronze Age led to a ‘retreat from the margins’ – an abandonment of previously settled upland areas which had become unviable for cultivation (e.g. Burgess,1984; 1985). There is evidence for a shift to a wetter climate at c.800 BC, not only in Britain but across Europe (van Geel, 1996; Yeloff *et al.*, 2007; Barber *et al.*, 2003; Charman *et al.*, 2006), sometimes described as the 2.7 Ka event (Brown, 2008). While some studies indicate a potential link between this shift and the timing of abandonment of some upland areas (e.g. Amesbury *et al.*, 2008), this is by no means universally borne out (Dark, 2006; Tipping *et al.*, 2008).

However, whether linked to climatic shifts or not, based on the evidence outlined above there do appear to be two key settlement horizons at both upland and lowland sites. Across all sites described above, both upland and lowland, activity related to Bronze Age roundhouses is likely to have begun after c.1700 cal BC, ending in the centuries around 800 cal BC (see Figure 57). This pattern or aspects of this pattern have been observed by other authors (e.g. Pope, 2015), notably in Caswell’s (2020) survey of dated Bronze Age settlement sites across Britain.

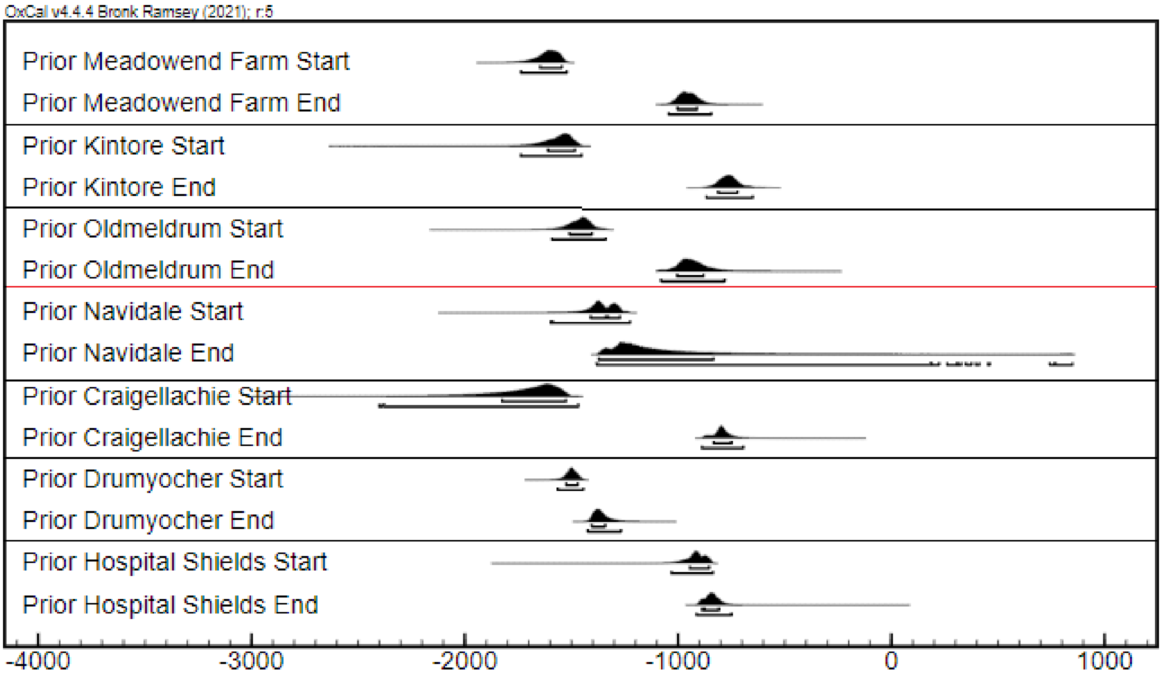

Figure 57: Modelled start and end points for Bronze Age settlement evidence at the sites described above (the red line separates upland and lowland sites).

Changing patterns of settlement from the Neolithic to the Late Bronze Age are discussed elsewhere in this thesis (Chapters 2 and 5), but it is clear that the settlement chronologies seen at these supplementary case study sites mirror patterns observed more widely in British and Scottish archaeology. Following less extensive evidence for Neolithic settlement (discussed in Chapters 2 of this thesis) roundhouse settlements appear to have proliferated in the 2nd millennium BC, before a decline in archaeologically visible settlement at the end of that millennium. It is likely that these sites were inhabited relatively briefly, with individual buildings in use for a generation or so. It appears that early 1st millennium BC settlement reorganisation or decline took place at both upland and lowland sites, potentially refuting ideas of a ‘retreat from the margins’ linked to climatic deterioration.

Chapter 8: Discussion

8.1 Introduction

Through exploring the chronologies for Bronze Age activity across Lairg and the additional sites analysed, this thesis has attempted to shed light on when, where and why settlement expansion occurred during the 2nd millennium BC in Scotland, north of the Forth/Clyde line. In this chapter, the findings of Chapters 5, 6 and 7 will be discussed in the context of the literature outlined in Chapters 2 and 3.

A clear chronological narrative has been developed during the course of this research: increasing evidence for settlement activity at sites in both upland and lowland areas from the early to mid-2nd millennium BC onwards; relatively short use-lives of individual buildings and short intervening periods of cultivation; with a decline in evidence for settlement again across most sites in the latter part of the 2nd millennium BC/first centuries of the 1st millennium BC. Here, this chronology is put in context, conclusions are outlined and suggestions for further research are made.

8.2 Lairg

8.2.1 A new narrative for Lairg

Through the dating and modelling process outlined in Chapters 4 and 5, it has been possible to create nuanced, precise chronologies for roundhouses excavated at the Allt na Fearna quarry as part of the Lairg Project.
The first of these to be explored was the House 1/House 4 site, which consisted of the superimposed remains of two roundhouses (see Figures 6 and 7). Archaeological evidence for tilled soils underlay the remains of House 1, stratigraphically the earliest of the buildings at the site. The existence of a tilled soil layer is potentially congruent with the pollen evidence discussed in Chapter 6, which provided evidence for arable agriculture at the Allt na Fearna site during the Late Neolithic.

The dated use of the House 1 building is likely to have begun at some point between *1600–1500 cal BC* (*68% probability*; *Boundary House 1 Start*). This contrasts with the chronology established by the site's original investigators, who proposed that House 1 could have been in use as early as 1800 cal BC, based on visual inspection of the legacy radiocarbon dates from the site. House 1 is likely to have been in use for only a short period of time, probably between *5–65 years* (*68% probability*; *Difference Span House 1*), with a brief intervening period of agricultural activity – probably less than *40 years* (*68% probability*; *Difference House 1 House 4 Interval*) – between the abandonment of the House 1 building and the construction and use of House 4.

House 4 dated to the mid-2nd millennium BC, and was probably in use by some point between *1480–1440 cal BC* (*68% probability*; *Boundary House 4 Construction/Primary Use Start).* These modelled results are similar to the chronology proposed by the Lairg Project investigators, who suggested that House 4 broadly dated to the mid-2nd millennium BC, representing a 'high point' of settlement at the site. The main phase of use of the House 4 building lasted between *40 and 100 years* (*68% probability*; *Difference House 4 Primary Use Span*), probably ending at some point between *1410–1370 cal BC* (*68% probability*; *Boundary House 4 Construction/Primary Use End*)*.* The house was destroyed in a conflagration event, and after a period of re-use of the site after this episode of destruction and abandonment, overall use of the site had ceased entirely *by the mid-1200s cal BC*.

Evidence for earlier activity also underlay the House 2 structure, excavated as a group along with House 3 and House 6. Pits and post-hole features, some containing burnt bone, underlay House 2. A context dating to this phase of use, containing material including cremated bone and Beaker pottery, was dated as part of the new programme and was found to date to 1890–1745 cal BC (SUERC-92838). These features were interpreted as the potential remains of a burial monument. In contrast to the original narrative for the site, which positioned the building and use of House 2 in the early 2nd millennium BC, the results of the new dating and modelling programme suggest that House 2 was in fact in use in the late 2nd millennium BC, probably coming into use at some point between *1245–1170 cal BC* (*68% probability*; *Boundary Start House 2*).

This building was also only in use for a short period – probably *less than 40 years* (*68% probability*; *Difference Span House 2*) – with an intervening period of tillage lasting probably *no more than 20 years* (*68% probability*; *Difference Span Tillage*) before the beginning of activity associated with House 6. Modelling suggests House 6 dated to the very end of the 2nd millennium BC, with activity associated with the structure starting between *1190–1060 cal BC* (*68% probability*; *Boundary Start House 6*). Use of this building is also likely to have been relatively brief, potentially *less than 25 years* (*68% probability*; *Difference Span House 6*). Activity at the House 6 site probably ended at some point between *1190–1030 cal BC* (*68% probability*; *Boundary End House 6*).

The chronology for House 3 was less precise than those produced for Houses 1, 2, 4 and 6, with fewer dates available (both from the legacy and new datasets). Activity associated with the building broadly centred on the mid-2nd millennium BC. There is the possibility that intrusive, later material could have found its way into the external gulley feature from which two dates were derived, resulting in an extended chronology for the site. It is unlikely that, as suggested by the Lairg Project investigators, Houses 2 and 3 were contemporary. This interpretation was based at least in part on morphological similarities between the two buildings, which may have implications for how we understand roundhouse typologies (e.g. Pope, 2015).

House 5 was originally dated by just two samples, one of which is likely to have derived from later activity at the site. The updated chronology for this building again indicates that it was in use in the mid-2nd millennium BC, with dated activity probably beginning between *1470–1415 cal BC* (*68% probability*; *Boundary Start House 5 Early Features*) and ending in *1435–1360 cal BC* (*68% probability*; *Boundary End House 5 Use*). Most of the dated contexts from this building related to a phase of activity preceding the primary floor deposit, and it is not possible to accurately ascertain the full duration of the building's use. However, given the evidence for short use-lives of the other Bronze Age buildings at the Allt na Fearna site, and for roundhouses more generally, it was probably in use for less than a century.
There was then a significant gap in the settlement record at the Allt na Fearna quarry. The final excavated building at the site, House 7, dated to the 1st millennium BC, with activity associated with this roundhouse probably beginning at some point between *400–200 cal BC* (*68% probability*; *Boundary start House 7 Primary Use*). This building was probably in use for between *1–190 years* (*68% probability*; *Difference Span House 7 Primary Use*), with dated use ending at some point between *165 cal BC–cal AD 475* (*68% probability*; *Boundary End House 7 Use*).

There is a clear pattern in the use of the excavated roundhouses at the Allt na Fearna quarry site (see Figure 31). These buildings came into use in the mid-2nd millennium BC, with settlement sharply declining before the 1st millennium BC. The roundhouses were generally in use for a short period of time, and it is unlikely that many of the buildings were in use at the same time (although there is the possibility for some overlap between the chronologies of House 1 and House 5).

8.2.2 The new narrative in context

This new chronology for the use of the excavated roundhouses at Lairg has implications for narratives regarding Bronze Age settlement in Scotland and Britain. Most importantly, the new programme of dating and chronological modelling has brought the chronology for the settlement at Lairg forward in time. The original proposition that Bronze Age settlement activity began in the first few centuries of the 2nd millennium BC, reached a zenith in the mid-2nd millennium BC, and then declined (see McCullagh & Tipping, 1998), is replaced by a narrative that begins with roundhouses being built and occupied from roughly the mid-2nd millennium BC onwards, declining around or at the end of the 2nd millennium BC (see Figure 58).

According to the results of the new dating and modelling programme, Bronze Age activity at Lairg took place over a much shorter period of time than was previously thought.

Sites such as Tormore, Arran (Ashmore, 1996; Barber, 1997); Kilearnan Hill, Sutherland (McIntyre *et al.*, 1999); and Lintshie Gutter, Peebleshire (often cited as Scotland's earliest dated upland roundhouse, see Ashmore [1996] and Pope [2015]; Terry, 1995; Terry *et al.*, 1996) are also thought to have dated to the early 2nd millennium BC. The excavation of these sites took place at a point prior to the routine use of AMS dating, and it is possible that a re-examination of their chronologies could also shift the narratives for these sites forward in time.

As has been stated elsewhere in this thesis, the new chronology for the use of the Bronze Age roundhouses at Lairg is congruent with Caswell's (2020) recently produced chronology for Bronze Age settlement across Britain, which identified a proliferation of settlement evidence after c.1700 BC. Other authors have identified a shift in settlement patterns in the Middle Bronze Age, around the mid-2nd millennium BC, with more visible settlement and agricultural remains (Ashmore, 1996; Brück, 2000; Champion, 2009) (as discussed in Chapter 2). This is generally linked with the idea that Neolithic settlement was largely ephemeral (Barrett, 1999; Pollard, 1999; Thomas, 1999; 2013) (also discussed in Chapters 2 and 6) and potentially mobile or semi-mobile (Brophy, 2006; Whittle, 1997).

It has been suggested that an expanding population in the Bronze Age, potentially following a Late Neolithic population collapse linked to climatic deterioration, was a factor in this (Stevens & Fuller, 2012; see Bishop, 2015 for counter-argument). Population expansion has also been explicitly linked to an increasing visibility of settlement in upland areas during the Bronze Age (Barclay, 2005a; Cowie & Shepherd, 1997; Halliday, 2015). The pollen record for the Allt na Fearna site, detailed in Chapter 6 (also see McDonald *et al.*, 2021), indicates that arable agriculture was ongoing there during the proposed period of population and agricultural decline in the Late Neolithic. There is also archaeological evidence at the sites of House 1 and House 2 for activity pre-dating the Bronze Age roundhouses. In the case of House 2, as outlined above, this activity was dated to the early 2nd millennium BC. Therefore, the available evidence does not suggest that the settlement activity that took place at Lairg from the mid-2nd millennium BC onwards involved movement into previously unused areas. Instead, it could represent an infilling of settlement in a landscape (c.f. Cowie & Shepherd, 1997) that was already very much in use.

Narratives for Middle Bronze Age settlement have foregrounded the idea that this was a period of increased sedentism (Ashmore, 1996; Brück, 2000; Champion, 2009; Darvill, 2013; Evans *et al.*, 2006; Hingley, 1992; Parker Pearson, 2009). The proposed decline in visible monumentality seen from c.1800 BC onwards (e.g.Bradley, 2019; Caswell & Roberts, 2018; Parker Pearson *et al.*, 2005; Roberts, 2013; although see Bradley and Sheridan, 2005 for evidence of Late Bronze Age use of monuments) and the increasing prominence of settlement in the landscape have been interpreted as representing a shift in belief systems and societal organisation (Bradley, 1997; Brück, 2000; Cavers, 2006; Parker Pearson, 2009). It has been suggested that large-scale, widespread social networks became less important as the household or household group became the key organising unit in society (Johnston, 2005). The evidence from Lairg broadly supports the proposed chronology for a tipping of the balance of the archaeological record from monumentality to settlement, but it is not clear that this was part of a move to a form of sedentism we would recognise today.

Based on the chronological models outlined above and detailed in Chapter 5, the Bronze Age roundhouses at the Allt na Fearna site were occupied for a generation or so before falling out of use. This is in line with current understandings of the use-lives of roundhouses (Barber & Crone, 2001; Crone *et al.*, 2018), but is at odds with any idea that settlement became more permanent in the Middle Bronze Age. The evidence from Lairg better supports a model such as that suggested by Cavers *et al.* (2016), Cowley (1998) and Halliday (2007; 2015) of settlement activity shifting around a landscape – the tilled soils between superimposed houses at Lairg suggest areas of constantly changing use through time. As noted by Halliday (2021), this would maximise opportunities for agricultural production across a landscape. The roughly generational use-lives of the roundhouses at Lairg could indicate a conceptual link between the house as a building and the household residing in it (e.g. Brück, 1999; 2000).

The roundhouses at Lairg were probably not occupied at the same time. While there is the possibility of overlap in the chronologies of House 1 and House 5 (see Figure 33), busy, village-like settlements were unlikely to have been a feature of the landscape at the Allt na Fearna quarry in the 2nd millennium BC.

Figure 58: Modelled start and end points for all sites – individual houses at Lairg above the thick black line, with lowland and upland sites separated by the red line. X-axis values are in cal BC/AD.

8.3 The wider context of Bronze Age settlement

8.3.1 Upland sites

Chronologies were constructed for a total of four upland sites during the course of this research. The first of these was Navidale, in Sutherland, a site consisting of a single roundhouse. This building was in use in the second half of the second millennium BC, with use of the site probably beginning between *1410–1275 cal BC (68% probability; Boundary Start Navidale Use)*. The site, similarly to Houses 1, 4, 2 and 6 at Lairg, was probably in use for only a generation *(68% probability; Difference Span Navidale Use)* before falling into disuse at some point between *1390–1200 cal BC (68% probability; Boundary End Navidale Use/Abandonment)*.

At Craigellachie, Moray, where four Middle Bronze Age roundhouses were excavated and dated, evidence for activity associated with these buildings is likely to have begun later, at a point between *1040–945 cal BC (68%; Boundary LBA Start)*, lasting somewhere between *125–280 years (68%; Difference Span LBA)* before ending in *835–750 cal BC (68%; Boundary LBA End)*. There was also evidence for Middle Bronze Age use of the site in the form of pit features, and after a hiatus in activity in the early to mid-1st millennium BC, settlement returned to the site in Middle Iron Age.

Evidence for Iron Age (later 1st millennium BC) settlement was also excavated at Drumyocher, where there were also four Bronze Age roundhouses. Activity at these roundhouses started somewhat earlier than at Craigellachie, likely at a point between *1525–1470 cal BC (68%; Boundary MBA Start)*, probably spanning somewhere between *1–105 years (68%; Difference Span MBA Drumyocher)* before ending in *1405–1345 cal BC (68%; Boundary MBA End)* – a chronology closer to that of House 4 at Lairg. At nearby Hospital Shields, three roundhouses were excavated, only one of which could be dated. Use of this building probably began in the early 1st millennium BC, between *945–855 cal BC (68% probability; Boundary Hospital Shields Use Start)*, probably lasting no more than *105 years (68%; Difference Span Hospital Shields Use)* and falling out of use between *890–810 cal BC (Boundary Hospital Shields Use End)*.

Chronologies for these sites spanned a range of dates, although all probably dated to the later 2nd millennium BC, similar to the chronologies of the buildings at Lairg. Where it was possible to construct chronologies for individual buildings, at Navidale and Hospital Shields, it is likely these buildings were in use for no more than two generations or so, again in line with chronologies from individual buildings at Lairg, and with current understandings of roundhouse use-lives (Barber & Crone, 2001; Crone *et al.*, 2018).

8.3.2 Lowland sites

Three lowland sites were included as supplementary sites in this research, two of which had been excavated as part of intensive programmes of investigation, resulting in a detailed understanding of prehistoric activity at each site. The first of these, Meadowend Farm, had strong evidence for Neolithic activity, in the form of multiple pits and Impressed Ware finds. There was also some evidence for activity at the site in the Early Bronze Age (potentially also seen in the contexts underlying House 2 at Lairg) in the form of a possible ring-groove feature and pottery finds. Activity associated with the multiple Bronze Age roundhouses at the site probably began at some point in the mid-2nd millennium BC, between *1650–1550 cal BC (68%; Boundary Pit Activity End/Structure Activity Start)*, likely spanning between *575–725 years (68%; Difference Span Bronze Age Structures)*, with activity probably ending at the site in the *first century or so of the 1st millennium BC (68% probability; Boundary Bronze Age Structure Activity End)*.

Like Meadowend Farm, Kintore was subject to a large-scale programme of excavation. There was evidence for Late Neolithic activity at the site, but no strong evidence for activity in the Early Bronze Age beyond some Beaker-type pottery. Activity associated with the Bronze Age roundhouses at Kintore probably began in the mid-2nd millennium BC, as at Meadowend Farm, between *1610–1485 cal BC (68% probability; Boundary Start Bronze Age Activity)*, lasting for somewhere between *705–870 years (68% probability; Difference Span Bronze Age Activity)*, before ending in the early 1st millennium BC, at some point between *815–725 cal BC (68%; Boundary End Bronze Age Activity/Start Early Iron Age Activity)*. At Kintore, and at Meadowend Farm, it is unlikely that most of the individual roundhouses were in use at the same time as there is little overlap between the distributions from individual buildings (see Figures 51 and 52).

Oldmeldrum was the final lowland site included in this research, with activity associated with the three roundhouses at this site probably beginning at some point between *1510–1405 cal BC (68% probability; Boundary Oldmeldrum Use Start),* spanning *425–615 years (68% probability; Difference Span Oldmeldrum)* before likely ending at a point between *1005–885 cal BC (68% probability; Boundary Oldmeldrum Use End).* Again, it is unlikely that these three buildings were in use at the same time, given the extended span of activity at the site and the evidence for short use-lives of later prehistoric roundhouses.

8.3.3 Bronze Age settlement in Scotland: key patterns and trends

There are several key patterns common to the supplementary sites included in this research and to the roundhouses at Lairg. Activity associated with the Bronze Age roundhouses at Lairg and all supplementary sites included probably began in mid to late 2nd millennium BC, after the c.1700 cal BC horizon identified by Caswell (2020). At Kintore and Meadowend Farm, there was evidence for Neolithic/Early Bronze Age activity at the sites, seen also in the palaeoenvironmental and archaeological evidence at Lairg. Where it was possible to construct robust chronologies for individual roundhouses, it appears that use-lives were probably short, a generation or two, at Lairg, Navidale and Hospital Shields. At Meadowend Farm and Kintore, where multiple dates from individual buildings meant that it was possible to structure models according to feature type, it is possible to observe that it was unlikely that all or most of the excavated roundhouses were in use concurrently (see Figures 57 and 58). Again, this supports the model of shifting settlement (Cavers *et al.*, 2016; Halliday, 2007; 2015; 2021) discussed above and in Chapter 2, with settlement activity moving periodically around defined areas; relatively short use-lives for individual buildings, and relative continuity of land use observed in pollen records (Halliday, 2015; Tipping, 2015). Activity across all sites, in upland and lowland locations, appears to have ceased by the first few centuries of the 1st millennium BC.

8.3.3.1 Settlement and society in the mid-2nd millennium BC

An increase in evidence for settlement appears to have occurred fairly uniformly across upland and lowland locations in the Middle Bronze Age, rather than an expansion of settlement into upland areas. This period seems to have seen a change in the form and intensity of settlement across all altitudes. The impression that this was a phenomenon of upland areas is likely to be due to biases in the preservation of the archaeological record (c.f. Halliday, 2021; Thoms & Halliday, 2014). Findings from modern developer-led archaeology have the potential to change this narrative: all lowland sites included in this research were excavated relatively recently, in the context of development.

It is unlikely that settlement expansion in this period can be tied to any wider environmental factors. The mid-2nd millennium BC immediately followed a period when records potentially suggest a shift to cooler/wetter conditions (Anderson *et al.*, 1998; Coles & Mills, 1998; Davies, 2007; Tipping, 2015). Arguments relating to population expansion or agricultural intensification pushing settlement activity into higher altitudes (see Barclay, 2005a; Burgess, 1985; Cowie & Shepherd, 1997; discussed in Halliday, 2015) also do not make sense given that increased evidence for settlement activity is seen at both lowland and upland sites.

There is always the possibility that the increased evidence for settlement in the Middle Bronze Age described above is an artefact of taphonomic processes – that evidence for earlier settlement has been obscured by mid-2nd millennium BC buildings (as discussed in Bradley, 2019). Halliday (2021) explains how the accumulating plaggen soils and machair of the Northern and Western Isles respectively have better preserved Neolithic and Early Bronze Age settlement (c.f. Parker Pearson, 2019), while on the hillsides of mainland Scotland, natural processes of sediment shedding as well as human activity could have obscured earlier settlement remains. Available building materials will have also influenced the visibility of different periods in the settlement record. As noted in Chapter 2 of this thesis, stone-built Neolithic and Chalcolithic/Early Bronze Age structures can be found across the Northern and Western Isles (e.g. Card *et al.*, 2018; Card *et al.*, 2020; Clarke, 1976; Parker Pearson, 2012; Richards & Jones, 2016; Richards *et al.*, 2016; c.f. Parker Pearson, 2019).

However, it is also possible that change in the settlement record were real, and linked to wider social and economic changes. As discussed in Chapter 2, it has been argued that from c.1600–1500 BC onwards there were shifts in patterns of trade and exchange linked to metal production (Radivojević *et al.*, 2019). Access to metal ores and metallurgical skills with uneven spatial distributions was a defining aspect of the Bronze Age, and necessitated the formation of long-distance exchange and communication networks (Kristiansen & Suchowska-Ducke, 2015). Vandkilde (2016) has proposed that in the first half of the 2nd millennium BC, Europe (along with parts of Africa and Asia) was undergoing a process of ‘bronzisation’, analogous to the modern process of globalisation. According to this model, social change and the growth of long-distance networks accompanied the uptake of bronze technology, especially between the mid-2nd millennium BC (c.1600-1500) and c.1200 BC.

The earliest metal production in Britain and Ireland is likely to have centred on Ross Island, County Kerry, Ireland (O’Brien, 2004; Rohl & Needham, 1998; Timberlake & Marshall, 2014). Metal production in the earlier 2nd millennium BC is thought to have been distributed across north-west England and Wales (Timberlake, 2001; Timberlake & Marshall, 2014), with metal

production contracting primarily to Great Orme in the mid-2nd millennium BC (Timberlake, 2001; 2017; Timberlake & Marshall, 2014; Williams & Le Carlier de Veslud, 2019).
The decline in the number of known metal extraction sites in Britain and Ireland by the mid-2nd millennium BC was accompanied by an increase in metal objects in circulation across Europe (Roberts, 2013). Production is thought to have peaked at Great Orme c.1600-1400 BC (Timberlake & Marshall, 2014; Williams & Le Carlier de Veslud, 2019), with increasing evidence for metal from Alpine sources reaching Britain from c.1400 BC onwards (Ling *et al.*, 2019; Melheim *et al.*, 2018; Timberlake & Marshall, 2014).
Exchange of metal goods was clearly taking place beyond modern political borders in the late 3rd and early 2nd millennium BC (e.g. Needham, 2009). From c.1600–1500 BC, lead isotope analysis of artefacts from across Europe indicates that copper production at certain key centres, including Great Orme, could have scaled up dramatically, expanding long-distance connections (Radivojević *et al.*, 2019; Vandkilde, 2016; Williams & Le Carlier de Veslud, 2019). A complex network of European trade networks is thought to have developed in the Middle and Late Bronze Age (Cunliffe, 2015).

Caswell (2020; 2022) has suggested that increasing evidence for settlement in the mid-2nd millennium BC (also identified in this research) was potentially linked to the ‘boom’ in production at Great Orme, thought to be broadly contemporary. It is suggested that an observed distribution of Bronze Age settlement evidence along navigable rivers is linked to a trading or ‘workshop’ function (Caswell, 2022). However, this narrative does not satisfactorily account for proposed settlement intensification observed hundreds of miles from Great Orme.
Establishing chronological control regarding the provenance of metal objects is complex and difficult. There is the possibility of a significant lag between an object being produced and arriving at its final destination, and metal can be recycled multiple times (Pollard *et al.*, 2014). There appears to be a broad correlation between the timing of changes observed in the settlement record across Britain and north-west Europe in the mid-2nd millennium BC and the expansion of bronze-based trade networks. However, the chronological resolution of the artefact record and settlement record differ (see Fokkens & Harding, 2013: 5; Roberts *et al.*, 2013), and it is difficult to identify any direct causal mechanism linking the two phenomena. What can be stated is that the increasing evidence for settlement in Scotland observed around the mid-2nd millennium BC in this research and by Caswell (2020) appears to be broadly coincidental with evidence for shifting networks of exchange and communication across and beyond Europe, with potential social, economic and political consequences.

8.3.3.2 Uplands and lowlands: differences in settlement dynamics?

Some discernible differences between upland and lowland sites were established. Although pollen evidence from Lairg, an upland site, was indicative of arable agriculture being practised there in the Late Neolithic, there appears to be stronger archaeological evidence of Neolithic and Chalcolithic activity at the lowland sites of Kintore and Meadowend Farm.

Although uplands were clearly in use at points in the Neolithic – henges, chambered cairns and long barrows are all found at relatively high altitudes (Bradley, 2019; Loveday, 2016) – it is possible that lowland areas were favoured for settlement prior to the Middle Bronze Age (although the Beaker material beneath House 2 at Lairg indicates earlier activity at at least this upland site). Additionally, while use of the Bronze Age roundhouses at all sites included in this research had declined by the early 1st millennium BC, it is only at Kintore, a lowland site in Scotland's fertile north-east, that there was any evidence for activity in the Early Iron Age. As outlined in Chapter 2 of this thesis, a key feature of the literature is that late Bronze Age settlement decline in upland areas was the result of climatic deterioration (Amesbury *et al.*, 2008; Barclay, 2005a; Barber, 1997; Barber and Brown, 1984; Burgess, 1985; 1989; Champion, 2009; Cowley, 1998; Turney *et al.*, 2016), and potentially related population decline (Armit *et al.*, 2014; Bevan *et al.*, 2017; Tipping *et al.*, 2008).

8.3.3.3 Environmental, societal and settlement shifts during the Late Bronze Age/Early Iron Age transition

The Early Iron Age in Britain is often discussed in terms of absence or unknowns – the period from c.800 BC to the mid-1st millennium BC is often described as being defined by a lack of settlement or burial evidence (Haselgrove & Pope, 2007; Pope, 2003), although this may be in part due to geographic biases in excavation and misattribution of some Early Iron Age settlement sites to earlier or later periods (Haselgrove, 2015; Haselgrove & Pope, 2007; Ralston & Ashmore, 2007). There are also issues in dating any material from or to the Early Iron Age, due to the presence of the Hallstatt plateau in the radiocarbon calibration curve – calibration of radiocarbon determinations of around 2450 bp will result in a range of approximately 800-400 cal BC. Although increasing precision of radiocarbon determinations and the application of Bayesian methodologies can aid in the production of more precise chronologies for this period (e.g. Hamilton *et al.*, 2015; Hamilton & Haselgrove, 2019; Jacobsson *et al.*, 2018; Waddington *et al.*, 2019), accepted chronologies for Early Iron Age phenomena are largely based on legacy dates with long calibrated ranges.

There is good evidence for a shift to cooler/wetter conditions at c.800 BC (Blaauw *et al.*, 2004; van Geel *et al.*, 1996; van Geel *et al.*, 1998a; van Geel *et al.*, 1998b; van Geel & Renssen, 1998; Martin-Puertas *et al.*, 2017; Mauquoy *et al.*, 2008; Mayewski *et al.*, 2004). Although pollen evidence from Scottish sites does not support wholesale abandonment of upland areas in the early 1st millennium BC (Dark, 2006; Davies, 2007; Tipping, 2002; Tipping *et al.*, 2008a; Tipping *et al.*, 2008b), there was a clear decline in settlement evidence by the early 1st millennium BC at all sites, across altitudes, included in this research.

Summed probability distributions (SPDs) of radiocarbon dates have been interpreted as indicating reduced anthropic activity in Britain and Ireland after c.1000 BC (Bevan *et al.*, 2017), although the results of SPD studies should not be accepted uncritically (as discussed in Chapter 2; critique of this specific study in Cowley, 2021). Bevan *et al.* (2017) link reduced populations in the early 1st millennium BC to food shortages caused by the climatic downturn outlined above (and in Chapters 2 and 6 of this thesis). However, evidence from Ireland suggests that a Late Bronze Age decline in pollen evidence for agriculture and an associated decline in population, again based on summed probability distributions of radiocarbon dates, was likely to pre- date any evidence for climatic deterioration. According to this research, evidence of human activity was thought to have begun declining c.200 years prior to evidence for rapid climatic deterioration in the 8th century BC (Armit *et al.*, 2014). Armit *et al.* (2014) proposed instead that the decline of bronze-based economies is likely to have disrupted existing economic and power structures, resulting in societal upheaval and demographic change

It has been suggested that from c.800 BC, there was a fundamental shift in societal structures, in Scotland (Ralston & Ashmore, 2007) and across Britain. Changes included a decline in the use and social value of bronze (Burgess, 1979; Cunliffe, 2015; Needham, 2007); shifts in subsistence strategies, and a possible increase in the importance of pastoral over arable agriculture (Haselgrove, 2015; Haselgrove & Pope, 2007). New architectural forms including substantial Atlantic roundhouses developed (Armit, 2015; Cunliffe, 1995; Ralston & Ashmore, 2007; Romanciewicz, 2009). The earliest hillforts emerge in the Late Bronze Age/Early Iron Age (Halsted, 2005; Lock & Ralston, 2022), and the majority of dated hillforts in Britain were constructed and had their primary phases of use in the period between c.800–400 BC (Lock & Ralston, 2022). The Early Iron Age also saw a proliferation of crannog construction in Scotland (Cavers, 2006; Crone, 2012; Ralston & Ashmore, 2007; Stratigos & Noble, 2014; 2017).

Following a peak in deposition of bronze metalwork in hoards c.900–800 BC, a reduction in the quantity of metal objects in circulation appears to have occurred (Haselgrove & Pope, 2007; Needham, 2007). This was concomitant with increased use of iron, and could have been due to a reduced need for (discussed in Cunliffe, 2015) or redundancy of bronze (e.g. Burgess, 1979). It is also possible that overproduction of bronze and a 'spiralling' of bronze-based exchange and value systems led to a reduction in the perceived value of bronze objects (Cunliffe, 2015; Needham, 2007). From the mid-2nd millennium BC to the early 1st millennium BC, a complex network of European exchange routes had developed, based on the exchange of (primarily metal) commodities (Cunliffe, 2015, see Chapter 2). From c.800-500 BC it is thought that these networks became fragmented (Bradley, 1984; Cunliffe, 2015); as bronze became less important, social systems based on controlling bronze-based trade networks declined and collapsed (Needham, 2007).

Material culture finds (brooches, pottery and daggers, for example) indicate that parts of southern England maintained continental links in the Early Iron Age (Cunliffe, 2015). However, it is possible that, based on declining evidence for long-distance trade and increased evidence for food storage and preservation (grain storage pits and salt production), in much of Britain, control over trade networks became less important than maximising agricultural production and safeguarding domestic resources (Cunliffe, 2015; Henderson, 2007; Needham, 2007). In Scotland, increasingly monumental domestic architecture (in some areas) and a decline in emphasis on artefacts and object deposition may have reflected the growing importance of investment in place over access to portable goods (Ralston & Ashmore, 2007).

Haselgrove (2015) and Halliday (2007; 2015; 2021), both suggest that an increasing focus of settlement activity in prime agricultural locations in the Late Bronze Age/Early Iron Age is behind a decline in upland settlement during this period. In the course of this research, reduced evidence for settlement was observed across altitudes, but re-occupation occurred earlier at Kintore, a lowland site, than at the upland sites of Lairg or Craigellachie. It is possible that an apparent lack of Early Iron Age settlement evidence could be due to a retreat to lower-lying areas where it has been obscured or destroyed by more recent activity (Haselgrove & Pope, 2007), although the palaeoenvironmental record provides a contrasting narrative.

While no new pollen evidence dating to the Bronze Age was recovered from Lairg during the course of this research, evidence from the 1990s palaeoenvironmental investigations at the site (McCullagh & Tipping, 1998; Tipping, 1998) indicated that even as settlement activity at the Allt na Fearna site declined at the end of the Bronze Age, the surrounding landscape remained open. This is paralleled at sites across Scotland and Britain (Dark, 2006; Tipping, 2002). Rather than totally abandoning tracts of land, it is suggested that communities reorganised their land use, concentrating on pastoral activity in the uplands and arable agriculture in lower-lying areas (Tipping *et al.*, 2008). This adaptive strategy highlights the resilience (c.f Butzer, 2012; Kleijne *et al.*, 2020) of later prehistoric communities in marginal landscapes.

The decline in evidence for settlement observed around the Late Bronze Age/Early Iron Age transition is likely to have been driven by a complex balance of economic, socio-political and climatic factors. Climatic decline may have acted as a ‘force multiplier’, exacerbating existing socio-economic trends and undermining societal resilience (Molloy, 2022). Differing scales of chronological resolution between the chronologies for settlement evidence, artefact typologies and the palaeoenvironmental record, complicated further by the Hallstatt plateau in the radiocarbon calibration curve, hinder any definitive attribution of causality. However, in the context of cooler, wetter conditions, settlement may have continued in some form, or been more easily re-established, at sites in naturally more productive areas such as Kintore.

8.4 Other considerations

8.4.1 Implications for accepted chronologies

This research has demonstrated the precise chronologies that can be achieved through both Bayesian statistical modelling of radiocarbon dates and the careful selection of samples for dating (c.f. Whittle & Bayliss, 2007). For Houses 1, 4, 2 and 6, it has been possible to achieve generational level chronologies that allow us to ‘historicise’ the past (c.f. Whittle *et al.*, 2008; Whittle *et al.*, 2011; Whittle & Bayliss, 2007; Bronk Ramsey, 2008; Overhöltzer, 2015) – moving from vague, stretched out chronologies (see Bayliss, 2009) to models for site use centring the actions of individuals and groups. A key outcome of this research has been the identification of an old-wood effect in legacy dates derived from bulk samples from Lairg (see Chapter 5), pushing the chronologies for House 1 and House 2, in particular, back significantly in time.

This has broader implications for the narratives based on type sites such as Lairg, excavated and dated prior to the routine practice of AMS dating single-entity samples. Currently, narratives for Bronze Age upland settlement are heavily based on a small number of sites, many of which were excavated in the later 20th century. This research has demonstrated that the widely understood chronologies for the use of sites such as Lintshie Gutter, Kilearnan Hill and Tormore may not be entirely accurate. It is likely that the use-lives of individual buildings were much shorter, and that these buildings were constructed and used later than has been proposed in the past.

There may also be issues associated with legacy palaeoenvironmental chronologies. The new palaeoenvironmental reconstruction work at Lairg identified a hiatus in the peat core at *c.1500 cal BC*, potentially the result of activity upslope or the removal of peat for fuel. It was possible to identify this hiatus due to the high-resolution chronology constructed using the *P_Sequence* function (see Figures 32 and 33). The accumulation rate of the AG3/19A core was also calculated in OxCal. Many of the legacy palaeoenvironmental records available for Scotland (and more widely) are based on a relatively small number of dates, with age-depth models constructed through a process of interpolation. This approach is unlikely to identify any hiatuses or changes in the rate of sediment accumulation, causing chronological inaccuracies. No hiatus was identified at the AG3 site in the course of the Lairg Project palaeoenvironmental reconstructions. However, if a hiatus in accumulation was also present in that core, the chronology of the upper 0.5m or so could be called into question. Influential large-scale syntheses of environmental change in Scotland (e.g. Brown, 2008; Edwards & Ralston, 1997; Edwards *et al.*, 2019) are generally based at least in part on these legacy datasets.

8.4.2 Other research outcomes

Fortunately, it was possible to complete the majority of sample selection and retrieval processes prior to the institution of Covid-19 related restrictions in Scotland. However, the process of archival research revealed several challenges. The separation of the physical and paper archives of the Lairg Project, with the physical archive kept in Inverness Museum by High Life Highland and the paper archive kept by Historic Environment Scotland, was one of these. The size of the paper archive (>100 standard archive boxes of material) meant that it was not practical to search through to find documentation regarding any retained material suitable for dating. Instead, it was necessary to make several trips between the two archives, assessing the availability of material in the physical archive while using the paper archive to inform sample selection. Another key concern was version control in the paper archive. Documents were filed according to year, and without prior knowledge (beyond that available in the project monograph) of the year the excavation of a given site had been fully completed, it was sometimes difficult to understand whether data structure reports and phased context lists were interim or final versions.

There were also some issues regarding missing or poorly filed material. It was not possible to identify the location of some section drawings (which would have aided in the interpretation of site stratigraphy and sample taphonomy) and it was not possible to identify any final Harris matrices for the site within the paper archive. It is suggested that this experience could be used to inform future archiving processes.

8.5 Conclusion

Despite difficulties and interruptions to this research as a result of the Covid-19 pandemic (2020–2022), it has been possible to make several meaningful findings. Firstly, in terms of when Bronze Age upland settlement took place, the accepted chronology for Lairg, a key type-site in understandings of Scottish Bronze Age upland settlement has been radically updated. Rather than having roots in the first centuries of the 2nd millennium BC, roundhouse settlement at the site proliferated from roughly the midpoint of that millennium onwards, declining as the millennium drew to a close. Comparison with other Scottish sites revealed that rather than settlement activity expanding into upland areas during the course of the Bronze Age, there is likely to have been a shift in the mid-2nd millennium BC in settlement form and intensity, potentially associated with economic, social or political changes linked to expanding networks of exchange and communication (discussed in section 8.3.3). While in the past research has focused on upland areas, settlement, in the form of roundhouses, is more archaeologically visible from this point onwards across all altitudes.

A decline in evidence of settlement in roundhouses was observed, again at both lowland and upland sites, by the early 1st millennium BC. This may have been linked to social and economic change rather than solely driven by climatic deterioration (see above), although a shift to a cooler/wetter climate at c.800 cal BC may have deterred the re-establishment of settlement at higher altitudes or in more exposed areas in the Early Iron Age. Unfortunately, this research has not been able to more precisely correlate events in the settlement and environmental records, partly due to the fact that the Bronze Age was ‘missing’ from the AG3/19 cores sampled at Lairg in 2019.

Narratives for Bronze Age settlement have stressed the increasing visibility and permanence of settlement from the Middle Bronze Age onwards, linking this to changes in socio-economic systems (as discussed above and in Chapter 2). The previously vague chronologies available for settlement activity has meant that modern concepts of domesticity could be projected onto the Bronze Age evidence. More nuanced, precise chronologies tell a less familiar story – one of relatively impermanent occupation of individual roundhouses and potentially a high degree of mobility within landscapes, with a lack of strong evidence for contemporary use of multiple buildings at a given site.

Perhaps most importantly, it has been possible to identify evidence for an old wood effect in legacy dates from bulk samples. This has real implications for the accepted chronologies not only for Bronze Age settlement, but any number of prehistoric phenomena. Going forward, it is suggested that legacy chronologies based on dates from bulk samples should be treated with caution. Further re-dating programmes could establish how widespread this issue may be. Similarly, legacy palaeoenvironmental chronologies based on a limited number of dates and constructed through a process of interpolation should also be treated cautiously. Creating new age-depth models based on legacy dates could help to identify any possible hiatuses or changes in the accumulation rate of sediments.

Chapter 9: Conclusion

9.1 Conclusions of this research

This thesis aimed to explore the when, why and how of upland settlement in the 2nd millennium BC – pinning down a precise chronology for settlement in northern Scotland's upland landscapes and using that chronology to better understand Bronze Age settlement dynamics. In Chapter 1, four key considerations were outlined:

- When any intensification in upland settlement took place. Are there differences in the chronologies of upland and lowland sites? Has preservation bias in the archaeological record led to a skewed focus on upland areas?
- Why did any expansion/intensification of upland settlement occur? Can chronologies produced through Bayesian modelling of new and legacy radiocarbon dates allow us to correlate settlement activity with environmental or social phenomena?
- How were Bronze Age settlement sites used? How were individual buildings used, and what patterns of settlement and land-use did they constitute?
- How accurate are the legacy chronologies on which current narratives for Bronze Age settlement are based? Is there an old-wood effect inherent to dates from bulk charcoal samples? If so, what are the implications for prehistoric chronologies more widely?

The 'when' of upland settlement was successfully addressed. As outlined in Chapter 5, this research has managed to significantly alter the accepted chronology for Lairg, a key type-site in discussion of Bronze Age upland settlement in Scotland. Use of the site began later than previously thought, and the duration of settlement activity was shorter. Through comparison with supplementary chronologies from sites across mainland Scotland (north of the Forth/Clyde line) it was possible to identify a change in settlement patterns across upland and lowland areas in the mid-2nd millennium BC – rather than discussing upland expansion in this period, we should be discussing shifts in settlement form and intensification of settlement activity in all areas.

The chronologies produced in the course of this research have allowed us to rule out some proposed drivers of upland settlement in the 2nd millennium BC. As evidence for settlement increased across all altitudes in the mid-2nd millennium BC, narratives of settlement expansion into upland areas from an already established lowland core do not make sense.

The broadly synchronous nature of the change seen could indicate a more widespread social/economic shift in the Middle Bronze Age, perhaps associated with socio-economic changes and expanding exchange networks, although it is not possible to identify any causal mechanism for this. Additionally, it is possible that the widespread decline in evidence for settlement activity observed in the late 2nd/early 1st millennium BC refutes simple, linear arguments for climatic deterioration and upland abandonment. Abandonment did not only occur at upland sites in the Late Bronze Age. While cooler/wetter conditions probably deterred resettlement of upland areas, initial settlement decline may have had more complex causes, linked to social and economic changes.

The precise settlement chronologies described in Chapters 5 and 7 of this thesis have allowed us to explore how these sites were used. The short use-lives identified for the roundhouses at Lairg were congruent with current understandings of roundhouse use (c.f. Barber & Crone, 2001; Crone *et al.*, 2018). There was also a lack of strong evidence for the use of multiple buildings at multi-structure sites at the same time. The extended chronologies of legacy dating programmes have allowed the development of narratives that project modern preconceptions regarding settlement and domesticity onto the Bronze Age. No shift towards long-term sedentism was observed at Lairg or any of the supplementary site. Instead, the narrative presented here is one of relative impermanence and short-lived use of individual homesteads, potentially as part of a pattern of long-term use of a defined territory.

Through the programme of re-dating and Bayesian modelling discussed in this thesis, an old wood effect (see Ashmore, 1999) was identified in legacy dates from bulk samples. This has implications not only for the chronology of Bronze Age settlement at Lairg, but for the accepted chronologies for a range of archaeological phenomena across time periods. By revisiting a previously studied peat bog, potential issues with legacy palaeoenvironmental sequences were also addressed – there is the possibility that hiatuses and changes in the sediment accumulation rate in legacy sequences constructed through interpolation based on a small number of radiocarbon dates could have been missed. This, again, has wider implications for how we understand past environments, in Scotland and further afield.

It was possible to identify these issues and to create nuanced, precise chronologies due to the use of Bayesian statistical modelling and careful sample selection. Sample selection, as far as was possible, reflected the research questions (for example, it was key to understanding the start and end points of phases of domestic activity) and was designed to ensure, again as far as possible, that the selected samples were related to the events of interest. If the Covid-19 pandemic had not occurred during the course of this research, it was intended to apply a similar methodology to that undertaken with the Lairg Project archive to selected supplementary sites. Dating of a selection of new contexts, designed to answer the specific questions of this research, would have allowed for further exploration of the chronologies of individual buildings and groups of buildings at sites across Scotland.

There are still outstanding questions regarding aspects of Bronze Age settlement in mainland northern Scotland. At Lairg specifically, further dating of the pre-roundhouse evidence (earlier pits and the cremation burial described in Chapter 5) would provide a better understanding of use of the site over time and could shed light on settlement patterns on the Scottish mainland in the Late Neolithic–Early Bronze Age. Additionally, due to the missing section of the pollen record relating directly to the Bronze Age, it was not possible to create a richer narrative for the relationship between settlement and land use at Lairg in this period.

Although possible drivers for wider changes in the settlement record have been discussed (see Chapter 8), issues of differing chronological resolution between existing narratives based on legacy dates and artefact typo-chronologies; the palaeoenvironmental record, and high-resolution chronologies such as those produced in the course of this research make it difficult to attribute causal significance to any single factor. Further research incorporating high-resolution palaeoenvironmental chronologies and a focus on nuanced rather than broad-brush interpretations (e.g. Hazell *et al.*, 2022; Gearey *et al.*, 2020; Kearney & Gearey, 2020) is to be welcomed for this period.

9.2 Directions for further research

The most urgent concern raised by the results of this research is the evidence for an old-wood effect in legacy chronologies based on bulk samples. Going forward, further programmes of re-dating, similar to that undertaken for Lairg, will shed light on how widespread this issue is. This does not only apply to settlement sites, or indeed Bronze Age sites; it is likely that chronologies for a variety of different types of sites, across periods, are affected. This would also present an opportunity to develop updated and refined chronologies for a variety of archaeological phenomena. Given the evidence for an old-wood effect, chronologies and syntheses based on legacy dates from bulk samples should be treated with caution, as should legacy palaeoenvironmental sequences constructed through processes of simple interpolation.

Additionally, given the issues raised in Chapter 7 regarding the challenges of working with archival material, it is suggested that a toolkit for dating/analysing archival material should be produced. This would outline best practice in working with archival samples: the optimal order in which to carry out tasks (e.g. cataloguing the physical archive prior to the paper archive); outlining which documents are essential to understanding site stratigraphy/phasing and sample taphonomy, as well as a guide to physically handling samples. This would allow researchers working with archival material to optimise their time, plan their research and prioritise tasks.

The results of this research call into question a number of issues particular to later prehistoric settlement archaeology. The new chronology for Lairg, and the potential issues identified with legacy chronologies more generally, could have ramifications for understandings of, for example, roundhouse typologies (e.g. Pope, 2015). As accepted chronologies for individual sites change, so will broader models for settlement. There is also room for further examination of the relationship between socio-political shifts and settlement. Although this research identified changes in the settlement broadly coincident with changes in economic/value systems and trade networks, causal mechanisms could not be singled out.

Key actions:

- Further research into the extent of the old wood effect in legacy radiocarbon chronologies is recommended. Studies could revisit datasets and key questions across a range of time periods and geographical locations in order to ascertain whether any impact is even across these variables.
- The development of a ‘toolkit’ for working with archival material describing best procedures is recommended.
- Re-examination of legacy palaeoenvironmental chronologies relating to key sites/periods where climatic shifts have been implicated in societal change (e.g. the Mesolithic/Neolithic transition, the period of Roman occupation in southern Scotland; a proposed ‘Dark Age’ climatic deterioration). Ideally, this would take the form of production of high-resolution chronologies for the palaeoenvironmental record, with projects designed to thoroughly explore links between climate, palaeoenvironmental and archaeological records.

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Supplementary Information: OxCal Code for final models (combined legacy and new dates) and AG3/19A *P_Sequence*

House 1/House 4

```
Plot()
 {
  Outlier_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");
  Sequence("House 1 House 4")
  {
   Boundary("House 1 Start");
   Phase("House 1 ")
   {
    Sequence("Legacy Hearths")
    {
     Boundary("Legacy Hearths Start");
     R_Date("GU 3308: 3634", 3380, 60)
     {
      Outlier("Charcoal", 1);
     };
     R_Date("GU 3310: 3665", 3390, 90)
     {
      Outlier("Charcoal", 1);
     };
     Boundary("Legacy Hearths End");
    };
    Sequence("New Hearths")
```

```
 {
  Boundary("New Hearths Start");
  R_Date("SUERC 92832: 3638", 3233, 25);
  R_Date("SUERC 87278: 3665", 3272, 24);
  Boundary("New Hearths End");
 };
 R_Date("SUERC 92825: 3458", 3288, 24);
 R_Date("SUERC 92827: 3686", 3228, 24);
 R_Date("SUERC 92836: 3462", 3260, 23);
 Phase("3185")
 {
  R_Date("GU 3162:3185", 3380, 100)
  {
   Outlier("Charcoal", 1);
  };
  R_Date("SUERC 87275: 3185", 3196, 24);
 };
};
Boundary("House 1 End");
Sequence("Sequence House 4")
{
 Boundary("House 4 Construction/Primary Use Start");
 Phase("House 4 Construction/Primary Use")
 {
  R_Date("GU 3156: 3074", 3010, 60)
  {
```

```
 Outlier("Charcoal", 1);
};
R_Date("GU 2853:7077", 3110, 50)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 2809: 1109", 3150, 50)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 3154: 3019", 3170, 80)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 2799: 1105", 3180, 50)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 3159: 3014", 3190, 80)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 2852: 7076", 3220, 60)
{
 Outlier("Charcoal", 1);
};
```

```
R_Date("GU 3160: 3016", 3220, 50)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 3164: 3271", 3220, 60)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 2851: 7078", 3240, 60)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 3151: 3003", 3240, 50)
{
 Outlier("Charcoal", 1);
};
R_Date("AA 10500: 3131", 3300, 50);
R_Date("GU 3157: 3186", 3350, 50)
{
 Outlier("Charcoal", 1);
};
R_Date("GU 3158: 3051", 3460, 80)
{
 Outlier("Charcoal", 1);
};
Phase("3111")
```

```
 {
  R_Date("GU 3166: 3111", 3260, 70)
  {
   Outlier("Charcoal", 1);
  };
  R_Date("SUERC 87277: 3111", 3096, 24);
 };
 R_Date("SUERC 92835: 3293", 3165, 22);
 R_Date("SUERC 92826: 3277", 3136, 22);
 R_Date("SUERC 92834: 3277", 3192, 25);
 R_Date("SUERC 92828: 3657", 3125, 22);
};
Boundary("House 4 Construction/Primary Use End");
Phase("House 4 Secondary Use")
{
 R_Date("GU 3153", 2930, 90)
 {
  Outlier("Charcoal", 1);
 };
 Phase("3100")
 {
  R_Date("GU 3155", 3100, 110)
  {
   Outlier("Charcoal", 1);
  };
  R_Date("SUERC 87276: 3100", 3020, 24);
```

```
    };
   };
   Boundary("House 4 Secondary Use End");
  };
  Boundary("House 1/House 4 End");
 };
 Difference("House 1 House 4 Interval", "House 4 Construction/Primary Use Start", "House 1 End");
 Difference("House 1 Span", "House 1 End", "House 1 Start");
 Difference("House 4 Primary Use Span", "House 4 Construction/Primary Use End", "House 4 Construction/Primary Use Start");
};
```

House 2/House 6

```
Plot()
{
 Outlier_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");
 Sequence("Sequence House 2/House 6")
 {
  Boundary("Start House 2 House 6 Sequence");
  R_Date("SUERC 92838", 3497, 25)
  {
   Outlier(1);
  };
  Boundary("Start House 2");
  Phase("House 2")
```

```
{
 R_Date("GU 3303: 2516", 3290, 50)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3304: 2522", 3300, 50)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3141: 2238", 3420, 70)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3299: 2483", 3430, 70)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3300: 2487", 3480, 70)
 {
  Outlier("Charcoal", 1);
 };
 Sequence("Primary Hearths Use")
 {
  R_Date("SUERC 92844", 3003, 25);
  R_Date("SUERC 92845", 2902, 22);
 };
```

```
};
Boundary("House 2 Abandonment");
Boundary("Start House 2 Post-Abandonment");
Phase("House 2 Post-Abandonment")
{
 R_Date("GU 3150: 2243", 3190, 50)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3152: 2169", 3200, 100)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3298: 2477", 3250, 50)
 {
  Outlier("Charcoal", 1);
 };
};
Boundary("End House 2 Post-Abandonment");
Boundary("Start Tillage Contexts");
Phase("Tillage Contexts")
{
 R_Date("GU 3143: 2136", 3170, 50)
 {
  Outlier("Charcoal", 1);
 };
```

```
 R_Date("GU 3146: 2211", 3060, 50)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3296: 2215", 3100, 50)
 {
  Outlier("Charcoal", 1);
 };
};
Boundary("End Tillage Contexts");
Boundary("Start House 6 Occupation Contexts");
Phase("House 6 Occupation Contexts")
{
 R_Date("GU 3302: 2515", 3010, 70)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3293: 2099", 2960, 60)
 {
  Outlier("Charcoal", 1);
 };
 R_Date("GU 3139: 2133", 3040, 50)
 {
  Outlier("Charcoal", 1);
 };
};
```

```
  Boundary("End House 6 Occupation Contexts");
 };
 Difference("Interval House 2 Abandonment/Post-Abandonment", "Start House 2 Post-Abandonment", "House 2 Abandonment");
 Difference("Interval House 2 Post-Abandonment/Tillage", "Start Tillage Contexts", "End House 2 Post-Abandonment");
 Difference("Interval Tillage/House 6 Occupation", "Start House 6 Occupation Contexts", "End House 6 Occupation Contexts");
 Difference("Span House 2", "House 2 Abandonment", "Start House 2");
 Difference("Span House 2 Post-Abandonment", "End House 2 Post-Abandonment", "Start House 2 Post-Abandonment");
 Difference("Span Tillage", "End Tillage Contexts", "Start Tillage Contexts");
 Difference("Span House 6", "End House 6 Occupation Contexts", "Start House 6 Occupation Contexts");
};
```

House 3

```
Plot()
{
 Outlier_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");
 Sequence("Sequence House 3")
 {
  Boundary("Start House 3 Pre-Construction Sediments");
  Phase("House 3 Pre-Construction Sediments")
  {
   R_Date("House 3 GU 3147: 2170", 6450, 70)
   {
```

```
    Outlier("Charcoal ", 1);
   };
   R_Date("House 3 GU 3149: 2178", 3240, 100)
   {
    Outlier("Charcoal ", 1);
   };
  };
  Boundary("End House 3 Pre-Construction Sediments");
  Boundary("Start House 3 Use/Gulley Infill");
  Phase("House 3 Use/Gulley Infill")
  {
   R_Date("SUERC 92837: 2180", 3324, 22);
   R_Date("SUERC 92842: 2123", 3253, 22);
   R_Date("SUERC 92843: 2229", 3048, 25);
   R_Date("House 3 GU 3145: 2228", 3280, 70)
   {
    Outlier("Charcoal ", 1);
   };
   R_Date("House 3 GU 3144: 2139", 3310, 60)
   {
    Outlier("Charcoal ", 1);
   };
  };
  Boundary("End House 3 Use/Gulley Infill");
 };
};
```

House 5

```
Plot()
 {
  Outlier_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");
  Sequence("Sequence House 5")
  {
   Boundary("Start House 5 Early Features");
   Phase("House 5 Early Features")
   {
    R_Date("SUERC-97912: 4098", 3181, 29);
    R_Date("SUERC-97913: 4102", 3116, 29);
    R_Date("SUERC-97914: 4042", 6023, 29)
    {
     Outlier();
    };
   };
   Boundary("End House 5 Early Features");
   Phase("Context 4030")
   {
    R_Date("SUERC-97911: 4030", 3120, 29);
    R_Date("House 5 GU 3137: 4030", 3260, 50)
    {
     Outlier("Charcoal", 1);
    };
   };
   Boundary("End House 5 Use");
```

```
  R_Date("House 5 AA 8788: 4106", 1520, 65)
  {
   Outlier("Charcoal", 1);
  };
 };
};
```

House 7

```
Plot()
 {
  Outlier_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");
  Sequence("Sequence House 7")
  {
   Boundary("Start Pre-House 7 Use");
   R_Date("GU 3171: 1024", 5320, 190)
   {
    Outlier("Charcoal", 1);
   };
   Boundary("Start House 7 Primary Use");
   Phase("House 7 Primary Use")
   {
    R_Date("GU 3167: 1116", 2270, 60)
    {
     Outlier("Charcoal", 1);
    };
    R_Date("GU 3163: 1124", 2220, 80)
```

```
    {
     Outlier("Charcoal", 1);
    };
    R_Date("SUERC-97917: 1116", 2202, 29)
    {
    };
    R_Date("SUERC-97922: 1090", 2154, 29)
    {
    };
    R_Date("SUERC-97923: 1110", 2142, 29)
    {
    };
    R_Date("SUERC-97924: 1068", 2203, 29)
    {
    };
   };
   Boundary("End House 7 Primary Use");
   R_Date("GU 3161: 1045", 2070, 90)
   {
    Outlier("Charcoal", 1);
   };
   Boundary("End House 7 Use");
  };
  Difference("Span House 7 Primary Use", "End House 7 Primary Use", "Start House 7
Primary Use");
 };
```

***R_Combine* legacy and new dates**

```
Plot()
 {
  R_Combine("Combine 3185")
  {
   R_Date("SUERC-87275: 3185", 3196, 24);
   R_Date("GU-3162: 3185", 3380, 100);
  };
  R_Combine("Combine 3665")
  {
   R_Date("SUERC-87278: 3665", 3272, 24);
   R_Date("GU-3310: 3665", 3390, 90);
  };
  R_Combine("Combine 3100")
  {
   R_Date("SUERC-87276: 3100", 3020, 24);
   R_Date("GU-3555: 3100", 3100, 110);
  };
  R_Combine("Combine 3111")
  {
   R_Date("SUERC-87277: 3111", 3096, 24);
   R_Date("GU-3166: 3111", 3260, 70);
  };
  R_Combine("Combine 4030")
  {
   R_Date("SUERC-97911: 4030", 3120, 29);
```

```
 R_Date("GU-3137: 4030", 3260, 50);
};
R_Combine("Combine 1024")
{
 R_Date("SUERC-97915: 1024", 2176, 29);
 R_Date("GU-3169: 1024", 2140, 90);
};
R_Combine("Combine 1124")
{
 R_Date("SUERC-97921: 1124", 2501, 29);
 R_Date("GU-3163: 1124", 2220, 80);
};
R_Combine("Combine 1116")
{
 R_Date("SUERC-97917: 1116", 2202, 29);
 R_Date("GU-3167: 1116", 2270, 60);
};
};
```

AG3/19A *P_Sequence*

```
Plot()
 {
  Outlier_Model("General",T(5),U(0,4),"t");
  P_Sequence("AG3/19 Humic Acid Dates", 1,2 , U(-2,2))
  {
   Boundary("Start")
   {
    z=210;
   };
   R_Date("SUERC_88397", 9154, 30)
   {
    Outlier("General", 0.05);
    z=200;
   };
   R_Date("SUERC_92863", 8931, 25)
   {
    Outlier("General", 0.05);
    z=187;
   };
   Date("LPAZ B")
   {
    z=180;
   };
   R_Date("SUERC_88393", 7872, 30)
   {
```

```
 Outlier("General", 0.05);
 z=175;
};
R_Date("SUERC_92862", 8765, 24)
{
 Outlier();
 z=162;
};
Boundary("Stratigraphy Change 1");
Date("LPAZ C")
{
 z=155;
};
R_Date("SUERC_88392", 6626, 30)
{
 Outlier("General", 0.05);
 z=150;
};
R_Date("SUERC_92858", 5247, 22)
{
 Outlier();
 z=137;
};
R_Date("SUERC_88391", 5550, 30)
{
 Outlier();
```

```
 z=125;
};
Date("LPAZ D")
{
 z=124;
};
R_Date("SUERC_92857", 5713, 24)
{
 Outlier("General", 0.05);
 z=112;
};
Boundary("Stratigraphy Change 2");
R_Date("SUERC_88390", 5266, 30)
{
 Outlier("General", 0.05);
 z=100;
};
Date("LPAZ E")
{
 z=96;
};
R_Date("SUERC_92856", 5276, 24)
{
 Outlier("General", 0.05);
 z=87;
};
```

```
R_Date("SUERC_88389", 4851, 30)
{
 Outlier("General", 0.05);
 z=75;
};
Date("LPAZ F")
{
 z=70;
};
Date("First cereal pollen")
{
 z=68;
};
R_Date("SUERC_92855", 4672, 23)
{
 Outlier("General", 0.05);
 z=62;
};
R_Date("SUERC_88388", 4168, 30)
{
 Outlier("General", 0.05);
 z=50;
};
R_Date("SUERC_92854", 3852, 22)
{
 Outlier("General", 0.05);
```

```
 z=45;
};
Date("LPAZ G")
{
 z=44;
};
R_Date("SUERC_92853", 3270, 22)
{
 Outlier("General", 0.05);
 z=40;
};
Boundary("Stratigraphy Change 3");
Date("LPAZ H")
{
 z=36;
};
R_Date("SUERC_92852", 3274, 24)
{
 Outlier("General", 0.05);
 z=35;
};
Date("Final cereal pollen")
{
 z=34;
};
Date("LPAZ I")
```

```
  {
   z=32;
  };
  R_Date("SUERC_92848", 1940, 24)
  {
   Outlier("General", 0.05);
   z=30;
  };
  R_Date("SUERC_88387", 566, 30)
  {
   Outlier("General", 0.05);
   z=25;
  };
  Date("Post_1950", U(1950, 2020))
  {
   z=15;
  };
  Boundary("End")
  {
   z=10;
  };
 };
 DT=(Post_1950-SUERC_88397)/185;
 DR=185/(Post_1950-SUERC_88397);
 Difference("span", "End", "Start");
};
```

As above without accumulation rate:

```
Plot()
 {
  Outlier_Model("General",T(5),U(0,4),"t");
  P_Sequence("AG3/19 Humic Acid Dates", 1,2 , U(-2,2))
  {
   Boundary("Start")
   {
    z=210;
   };
   R_Date("SUERC 88397/LPAZ A", 9154, 30)
   {
    Outlier("General", 0.05);
    z=200;
   };
   R_Date("SUERC 92863", 8931, 25)
   {
    Outlier("General", 0.05);
    z=187;
   };
   Date("LPAZ B")
   {
    z=180;
   };
   R_Date("SUERC 88393", 7872, 30)
   {
```

```
 Outlier("General", 0.05);
 z=175;
};
R_Date("SUERC 92862", 8765, 24)
{
 Outlier();
 z=162;
};
Boundary("Stratigraphy Change 1");
Date("LPAZ C")
{
 z=155;
};
R_Date("SUERC 88392", 6626, 30)
{
 Outlier("General", 0.05);
 z=150;
};
R_Date("SUERC 92858", 5247, 22)
{
 Outlier();
 z=137;
};
R_Date("SUERC 88391", 5550, 30)
{
 Outlier();
```

```
 z=125;
};
Date("LPAZ D")
{
 z=124;
};
R_Date("SUERC 92857", 5713, 24)
{
 Outlier("General", 0.05);
 z=112;
};
Boundary("Stratigraphy Change 2");
R_Date("SUERC 88390", 5266, 30)
{
 Outlier("General", 0.05);
 z=100;
};
Date("LPAZ E")
{
 z=96;
};
R_Date("SUERC 92856", 5276, 24)
{
 Outlier("General", 0.05);
 z=87;
};
```

```
R_Date("SUERC 88389", 4851, 30)
{
 Outlier("General", 0.05);
 z=75;
};
Date("LPAZ F")
{
 z=70;
};
Date("First cereal pollen")
{
 z=68;
};
R_Date("SUERC 92855", 4672, 23)
{
 Outlier("General", 0.05);
 z=62;
};
R_Date("SUERC 88388", 4168, 30)
{
 Outlier("General", 0.05);
 z=50;
};
R_Date("SUERC 92854", 3852, 22)
{
 Outlier("General", 0.05);
```

```
 z=45;
};
Date("LPAZ G")
{
 z=44;
};
R_Date("SUERC 92853", 3270, 22)
{
 Outlier("General", 0.05);
 z=40;
};
Boundary("Stratigraphy Change 3");
Date("LPAZ H")
{
 z=36;
};
R_Date("SUERC 92852", 3274, 24)
{
 Outlier("General", 0.05);
 z=35;
};
Date("Final cereal pollen")
{
 z=34;
};
Date("LPAZ I")
```

```
  {
   z=32;
  };
  R_Date("SUERC 92848", 1940, 24)
  {
   Outlier("General", 0.05);
   z=30;
  };
  R_Date("SUERC 88387", 566, 30)
  {
   Outlier("General", 0.05);
   z=25;
  };
  Date("Post-1950", U(1950, 2020))
  {
   z=15;
  };
  Boundary("End")
  {
   z=10;
  };
 };
};
```