ScARF Scottish Archaeological Research Framework

Perth and Kinross Archaeological Research Framework

Chapter 9. Palaeoenvironment and Science

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HISTORIC ENVIRONMENT SCOTLAND

SCOTLAND'S ARCHAEOLOGY STRATEGY

Contents

9.1 Introduction

A panel of specialists working in environmental archaeology and archaeological science was brought together to develop aspects of the PKARF relating to archaeological and environmental science. While it was originally planned that these contributions would be incorporated into each period chapter, once drafted it was felt more beneficial for them to be retained as a separate chapter.

The aim was to:

- provide a broad but non-exhaustive summary of the extent of current knowledge including a critical review of how environmental and scientific techniques have been applied to archaeological research across the region;
- produce short glossary-style method summaries which provide brief explanations – for a lay audience – of each environmental/ scientific technique covered by the Panel;
- create short glossary-style value statements for each environmental/scientific technique covered by the Panel highlighting why it is important/how it can be applied;
- identify 'gaps' where techniques haven't been applied in the region but have potential to contribute to future research;
- suggest methodological refinements or improvements that could be made to cater for regional distinctiveness or to better integrate techniques within future research agendas;
- give case studies that characterise best practice application of techniques in commercial, academic and community-led contexts and the types of information that can be achieved;
- develop future research questions and a techniques matrix that details the techniques available and the types of research question they can help to answer.

This chapter has sought to broadly consider the ScARF Archaeological Science Framework themes of chronology, Human and Animal Sciences, Understanding Materials, and People and Environment.

9.2 Palaeoenvironment

By Althea Davies

9.2.1 Regional Overview

The distribution of palaeoenvironmental evidence for landscape and land use dynamics in the area is patchy in space and time. Detailed insights into land use history are available for a few locations and periods. These are best viewed as vignettes which can be used to derive hypotheses about the pattern and nature of human use of natural resources, rather than generalisations. This is most detailed for Glen Shee where work focused on the first millennium AD (Strachan et al 2019), and Loch Tay which focused on around the last 400 years and the full Holocene (Hamilton et al 2009; Atkinson 2016). In the latter case, it is unfortunate that the palynological investigations associated with excavations on the north shore remain almost entirely in the grey literature (Tipping et al 2009a; 2016). In contrast, the broad sweep of glacial and Holocene vegetation history can more readily be set into wider context through reference to regional glacial and biogeographical trends (Tipping 1994). The region has to some extent fallen between the gaps in previous regional reviews of vegetation history, such as those published in a special issue of the *Botanical Journal of Scotland* in 1997. This may reflect the ecotonal location of the area, which spans the central-eastern lowlands and Highland fringe.

Pollen analysis is the most commonly used palaeoenvironmental and -ecological proxy throughout the Holocene. Most pollen records derive from peat; studies of lake sediments are limited (eg Caseldine 1980; Milburn 1997), with a cluster from Loch Leven, where the diatoms and macroscopic plant remains detail the impacts of changing land use over the last 200 years (eg Salgado et al 2010; Bennion et al 2012). Plant macrofossils, carbonised or waterlogged, are most frequent in on-site contexts, while sources like soil micromorphology (eg McKenzie and Simpson in Atkinson 2016) and dendrochronology and -ecology are scarce (Crone 2014). More recent developments, like biomolecular techniques such as lipids, bone isotopes, sedimentary or ancient DNA (eg Gigleux et al 2017; Mackay et al

2020) and non-pollen palynomorphs (eg dung fungi; Farrell 2015; Davies 2019), appear to be absent. Wider review of the literature on these proxies is required to evaluate the scope for future research to add detail, depth and colour to the archaeological heritage of this region.

As indicated above, this review focuses on the off-site, landscape record. It does not consider climate change or on-site sampling of environmental remains in any depth. On-site plant macrofossil and wood remains offer valuable additional insights into vegetation diversity and species associations to complement and extend pollen stratigraphic sequences. This is because many species found on-site may be under-represented or absent due to poor pollen dispersal or taxonomic limitations on identification. For example, insect-pollinated hawthorn, rowan, bramble and raspberry all belong to the Rosaceae family and are difficult to identify to genus or species level from their pollen, but may be identified through seed or wood remains. Archaeobotanical samples can also offer closer insight into husbandry and processing techniques based on the remains of crops and their weed assemblages (eg Miller and Ramsay in Atkinson 2016). Soil sampling for micromorphology or pollen has been applied in few contexts (eg Caseldine 1983; Carter in Rideout et al 1996; Simpson and Davidson 1998; Simpson and McKenzie in Atkinson 2016). These on-site contexts are compared with off-site pollen records to help understand spatial variability in past landscapes.

Climate change is best reconstructed through climate-sensitive proxies (eg chironomids, beetles, dendroclimatology, lake or peatland watertables). While some records from this area provide potential contributions to broader reconstructions of climate change, no studies in the Perth and Kinross area focus specifically on climate reconstruction. The scale of PKARF precludes a review of regional to national level palaeoclimate evidence. The importance of high quality palaeoclimate data, that is, high temporal resolution with clarity over which elements of climate are being reconstructed (eg temperature, precipitation, seasonality), cannot be underestimated, however. Inferences of settlement marginality in the archaeological record may be overly influenced by modern perceptions and reference to general or outdated climate data. Studies focused on sea level and glacial change (eg Cullingford et al 1980) are also outwith the scope of this review.

Research Priorities across all periods

Improved understanding and comparison of upland/lowland environments and landuse dynamics through time. Although the topography of Perth and Kinross is characterised by Highland/Lowland divide, most studies have focused either on lower altitude sites and settings (eg Hulme and Shirriffs 1986; Milburn 1997) or higher ground (eg Tipping et al 1993; Tipping 1995) rather than working across altitudinal gradients. Two exceptions are the PhD research of Caseldine (1980) in eastern Perthshire, which lacks a secure chronology and the loch shore to montane distribution of sites in the Ben Lawers project (Atkinson 2016; Tipping et al 2009a). With these exceptions, there is currently limited integration of palaeoecological records to assess spatio-temporal differences in vegetation composition and human activity across low/high ground. As Dalglish (2012) comments, this can lead to an overly simplistic separation of highland and lowland zones which reflects value judgements of the authors more than the complexity and diversity of life and agriculture in each zone. There is clear opportunity and value in addressing this gap in future work.

Research Questions

PKARF Qu 9.3: What were the push/pull factors that operated across upland/lowland communities?

9.2.2 Late Upper Palaeolithic and Mesolithic

Vegetation cover was highly dynamic over these periods, responding to broad controls like climate change, soil development and postglacial species migration and establishment. It is therefore an interesting but complex period to understand human responses to this varied and changing landscape. When the first anthropogenic impacts on vegetation appear is a long-standing topic of interest and debate, particularly where archaeological evidence is absent. Although burning, erosion and woodland opening are the main palaeoecological indicators used to infer disturbance, there are no unambiguous indicators of human disturbance (Tipping 1994). Natural factors and deliberate modification can produce the same signal in the palaeoecological record, for example charcoal associated with short-

lived woodland canopy reduction may originate from enhanced flammability of biomass under climatic aridity or through deliberate fire-setting.

natural disturbances such as erosion and canopy opening (Tipping 1995; Milburn 1997; Edwards and Whittington 1998a).

Projected environment in lowland Mesolithic Perth © Perth and Kinross Heritage Trust

In Scotland, emphasis has focused on fire as a potential indicator of Mesolithic activity. Although Mesolithic fire-setting has been proposed (Hulme and Shirriffs 1986), separating human and natural ignition at single sites is difficult (Caseldine 1980; Milburn 1997). Several analyses have focused on multi-site comparisons, including sites in neighbouring Fife, to differentiate climate-driven burning, which may be expected to be more widespread and synchronous in flammable vegetation types, from human modification, which may be more localised and diachronous in nature. Multiple sites show elevated charcoal abundance in the late glacial (Upper Palaeolithic) and the later Mesolithic (around 7000 cal BP) (Edwards and Whittington 2000; Edwards et al 2000; Tipping and Milburn 2000). Support for human ignition of fires remains uncertain in most cases, however, with the authors emphasising the need to interpret fire signals in the context of climate regimes. Most analyses in Perth and Kinross have been single site studies, and authors repeatedly recognise that human impacts may be within or below the range of variability of

As a result, evidence to support or refute Mesolithic impacts on vegetation cover remains equivocal. These issues remain relevant into the Neolithic, when causality for burning remains unclear, particularly at sites where cereal pollen is absent (eg Milburn 1997).

Research Priorities

Priority 1: Make fuller use of advances in modelling to understand landscapes of the Neolithic. Uncertainties about the extent and palynological visibility of landscape change during this period can be further explored using pollen modelling to test ideas about the spatiality of the Neolithic. As has been shown by work from the Neolithic 'timber hall' at Crathes in Aberdeenshire (Tipping et al 2009b) and the earliest clearances and elm decline in central Ireland (Caseldine and Fyfe 2006). These scenarios help to facilitate dialogue between palaeo and archaeological communities, and can be used to communicate landscape dynamics and the challenges involved in reconstructing our past to wider, non-specialist audiences (Bunting et al 2018).

Research Questions

PKARF Qu 9.1: Does the limited visibility of Neolithic arable activity in the palaeoenvironmental record reflect the small or limited scale of cultivation?

9.2.3 Neolithic

Woodland cover in Scotland reached its peak extent around 5800 cal BP (Tipping 1994; Edwards et al 2019), so the landscape of the early Neolithic was dominated by trees, with the likely exception of exposed summits and ridges and active floodplains. In Perth and Kinross, this consisted of mixed deciduous woodland, often dominated by oak with hazel and elm, but with variations in species abundance reflecting the mosaic of exposure, altitude and soil type. Hence pine is suggested to have colonised some areas, such as the upland Edradour Burn at Carn Dubh (Tipping in Rideout et al 1996), but not lowland catchments like North Mains, Rae or Stormont Lochs. There species like oak and elm were stronger competitors (Caseldine 1980; Hulme and Shirriffs 1986, Edwards and Whittington 1998a). The dominance of oak and elm also varied between low-lying, mid-slope and higher ground in eastern Perthshire (Caseldine 1980). The palisaded enclosure at Forteviot indicates that the woods included mature trees, yielding large oak timbers (Brophy and Noble 2020).

Edradour Burn, Carn Dubh © HES

Two key features of the palaeoecological record around the start of the Neolithic are a decline in the abundance of elm and the appearance of cereal pollen. Accumulated evidence has overturned the idea that the elm decline is synonymous with the start of the Neolithic. Instead, multiple elm declines are recorded over a protracted period. For instance, in Perth and Kinross the dates for this transition vary widely, from around 6500 cal BP at North Mains (Hulme and Shirriffs 1986) to 5300 cal BP at Creag na Caillich (Tipping et al 1993). Often the elm decline coincided with reductions in the abundance of other tree species, such as at Edradour Burn (Tipping in Rideout et al 1996), Heatheryhaugh and Loch Maraich (Caseldine 1980), and Rae Loch (Edwards and Whittington 1998a). Some elm declines were accompanied by the appearance of disturbance indicators (pastoral or charcoal) as at Rae Loch (Edwards and Whittington 1998a), but this is not universal. At Edradour Burn, sustained, low intensity grazing may have prevented regeneration, generating a decline in elm from around 5800–5600 cal BP, since more intensive pastoral activity does not occur until around 5600–5300 cal BP, after the main reduction in elm (Tipping in Rideout et al 1996). Overall, the evidence suggests that the attrition of elm was a successive, not synchronous, process driven by multiple factors (Parker et al 2002).

Creag na Caillich Neolithic stone axe factory © HES

The first farming communities were established in a generally well-wooded landscape, even at higher altitudes (eg Caseldine 1980; Tipping 1995). However, the age, distribution and extent of settlement is difficult to detect in the pollen record because of the abundance of tree 'pollen rain' and poor dispersal of cereal pollen, possibly from initially small fields. For instance, taking two lowland sites, cereal pollen was present during the Neolithic from North Mains (Hulme and Shirriffs 1986) but was not detected

at Methven bog (Milburn 1997). Spatially patchy evidence for arable activity in the early Neolithic may reflect a combination of real variations in the spatial distribution and extent of cultivation and the proximity of activity to sampling sites for pollen that is very locally dispersed. In contrast, the absence of cereal pollen and potential arable 'weeds' throughout the Neolithic from upland sites like Creag na Caillich and Carn Dubh, where the records are primarily local in extent, may indicate the real absence of higher altitude cropping (Tipping et al 1993; Tipping 1995). These areas did not remain unexplored, however, with evidence for low intensity grazing from around 5800 cal BP at Carn Dubh. In contrast, the first phase of quarrying for axe manufacture around 4700 cal BP at Creag na Caillich, by Ben Lawers, appears to have taken place without grazing. This indicates a complex mosaic of landscape access and settlement (Caseldine 1980).

Soil pollen samples need to be interpreted with care due to suboptimal preservation conditions and limited dating controls. When these blurred snapshots are combined with more secure 'off-site' pollen sequences, they can provide tantalising indications of finer-scale dynamics in the landscapes around Neolithic and Bronze Age monuments. For instance, soil pollen evidence for a mosaic of grazed grass-heath and secondary cover from the land surface below the Cleaven Dyke earthen bank contrasts with the dominance of mixed deciduous woodland in the catchments of Rae and Stormont Lochs during the first half of the 6th millennium BP and approximately 4km away (see The Cleaven Dyke Case Study). This suggests that open ground was relatively limited in extent or only just becoming visible in the wider pollen record at the time of construction, raising questions over visibility and motivation (Edwards and Whittington 1998a and 1998b; Noble 2017). Limited local ground preparation is also indicated by soil micromorphological analysis of land surfaces beneath the monument, since the samples do not indicate extensive ground clearance (eg woodland clearance, burning) prior to construction (Simpson and Davidson 1998). Although cereal pollen only appears at Rae Loch around 5040 cal BP, the presence of pollen from taxa often thought of as 'weeds' of arable and pastoral ground from around 6010 cal BP and soil erosion from around 5360–5090 cal BP could suggest earlier adoption of arable within a largely forested setting within which the monument was constructed (Edwards and Whittington 1998a). Similar insights into spatio-temporal dynamics come from North Mains, where there is evidence for prolonged cultivation during the Neolithic, pre-dating barrow construction (Hulme and Shirriffs 1986). Local cereal cultivation is also indicated post-henge construction at Moncrieffe House. There was a possible period of abandonment between the timber henge and stone circle phases, which allowed secondary woodland growth, before mixed but pastoral dominated agriculture was re-established, possibly in the Bronze Age (Caseldine 1983). Data from multiple sites of different sizes within a region can be used to explore issues of landscape heterogeneity and land use visibility, and access to pollen data from multiple sites allows alternative scenarios to be explored.

9.2.4 Chalcolithic and Bronze Age

The Chalcolithic and Bronze Age is marked by fluctuating and often declining woodland, attributed to pastoral and mixed agricultural land use, but interspersed with periods of tree regeneration. Some sites are poorly dated or lack chronological controls (eg Caseldine 1980) so cannot be confidently placed within the existing archaeological framework. Where dating is sufficient, there is evidence for progressive and substantive incursions into woodland cover, particularly for grazing at upland sites like Carn Dubh (Tipping in Rideout et al 1996). The pollen signal for farming, especially cultivation, remains low or sporadic. Nonetheless, Edwards and Whittington (1998a) suggest that, as in the Neolithic, 'forest farming' may have taken place during the Bronze Age (around 4520–3210 cal BP), consisting of small openings, possibly near the shore of Rae Loch and contributing to soil erosion.

Rae Loch © Alan Reid (CC BY-SA)

Phases of apparent forest regeneration are common but can be difficult to interpret in terms of settlement and land use, since some sampling sites may have supported a fringe of tree cover. These may therefore produce a very local signal of tree growth, rather than indicating that trees colonised hillslopes. Hillslopes are more likely to have been the focus of land use, and some areas of human activity may have remained relatively small and difficult to detect in the pollen record, as indicated for the Neolithic.

On a broader scale, comparative analysis of a network of sites in eastern Perthshire allowed Caseldine (1980) to suggest that local tree growth persisted into later prehistory in the high ground at Loch Maraich but not on the lower hills around Alyth, which appear to have supported more intensive and continuous land use. It is unfortunate that these records are undated. The lowland catchment around Rae Loch remained predominantly wooded until 3120 cal BP (Edwards and Whittington 1998a). Overall and similar to the Neolithic, this suggests a dynamic and heterogeneous landscape. This could be in keeping with the interpretation offered at Blackford, of a fluid and shifting social and physical landscape of construction, use, discontinuity and reuse over multiple human generations (O'Connell and Anderson 2021). There is, in contrast with long-running academic debate (Armit et al 2014; Turney et al 2016), no evidence for extensive climate-driven abandonment of upland areas in the late Bronze Age (Tipping 1995).

9.2.5 Iron Age

The Iron Age appears to be a period of somewhat counter-intuitive contrasts. Increased marked activity is inferred in some upland areas (Caseldine 1980). In the Edradour Burn, for instance, the only period of intensive grazing and sustained cereal cultivation occurred around 3000–2600 cal BP (Tipping in Rideout et al 1996). In contrast, larger-scale mixed agriculture was not established in the fertile lowland Strathmore valley until the early first millennium AD, around 1970 cal BP (Edwards and Whittington 1998a). This contrasts with agricultural expansion in the central Scottish lowlands during this period (Tipping and Tisdall 2005). Well-dated sites remain too scarce to establish whether, as Edwards and Whittington (1998a) suggest, the comparatively late expansion of arable at Rae Loch should be regarded as a locally-specific record, rather than representative of agricultural trends for this region.

Peat core sample from Moredun © Perth and Kinross Heritage Trust

Research Priority

Priority: A more comprehensive understanding of late Iron Age land use in Perth and Kinross. Studies in neighbouring Fife and Central Scotland raise important questions about the dynamics and controls on the mosaic of agriculture and tree cover during the late Iron Age and Romano-British period, particularly across the upland-lowland terrain that characterises this area (Whittington and Edwards 1993; Dumayne-Peaty 1998; Tipping and Tisdall 2005; Given et al 2019).

Research Question

PKARF Qu 9.2: How heterogeneous was the landscape pre/during/post Roman occupation and what can this tell us about the dynamics and controls on woods and agriculture across the upland/lowland terrain?

9.2.6 Early Medieval

Regrettably, there are few examples of integrated archaeological and palaeoecological studies for this period. The research at Lair, Glen Shee, offers an example in which the various proxies are sympathetically combined and used to generate broader hypotheses about the relationships between climate and upland agriculture during the early medieval period. The pollen record suggests that cultivation was as central to the upland economy from the 7th to 10th centuries AD, as it was in the adjacent lowlands around Blairgowrie (Paterson and Tipping 2019). Cultivation at 350–400m above sea level may have been facilitated by climatic amelioration, which Strachan et al (2019) suggest could even have stimulated a 7th century AD agrarian resurgence over much of Scotland. This suggests that communities responded to opportunity as much as stress, based on good multiproxy evidence. The duration of the cereal pollen record also corresponds strikingly with the chronology for the Pitcarmick tradition at this site, raising the possibility that byre-houses served to concentrate manure for arable fields. More attention needs to be paid to the agricultural economy in the adjacent lowlands to understand possible drivers for the end of this tradition, but there is no suggestion that cessation represents the 'failure' of upland farming (Strachan et al 2019). In contrast, pastoral disturbance remained the dominant signal around Carn Dubh during this period (Tipping 1995), which emphasises the value of having independent vegetation histories to set archaeology in context and cautions against over-extrapolation between upland settings.

Peat core for pollen sample at Lair, Glen Shee © Perth and Kinross Heritage Trust

Research Priority

Conduct systematic meta-analysis of key trends to evaluate the quality of the evidence for synchronous and time-transgressive transitions in landscape and land use. The work of Strachan et al (2019) provides an example, exploring 7th-century AD interrelations between climate and land use. This gives a broader and more outward-looking perspective that can be used to explore wider connectivity and bigger 'grand challenge' questions in palaeoecology and archaeology. This is needed to firmly place regional archaeologies within broader research culture and debates (eg Kintigh et al 2014; d'Alpoim Guedes et al 2016).

9.2.7 Medieval

Upland cultivation is frequently suggested to have been limited by climate, which made conditions 'marginal' for agriculture, but these inferences are almost as often rejected by palaeoecologists and historians. Well-established examples of this debate exist for the Bronze Age/Iron Age transition (Armit et al 2014, Turney et al 2016) and the medieval period (Tipping 2002; Dodgshon 2004; 2006; Dark 2006). For instance, on Ben Lawers, an upward shift in the limits of cultivation is proposed during the 12th and 13th centuries AD and attributed a 'climatic optimum' (Atkinson 2016). This inference is made with reference to older palaeoclimate literature and without reference to pollen data from adjacent to the

excavation site. This data instead shows continued scrubby woodland growth until the 16th century AD, when grazing was intensified, possibly in response to either economic or climatic drivers (Tipping et al 2009a; 2016). This uncomfortable contrast does not accurately reflect the availability of evidence and can be contrasted with the integrated discussion in Strachan et al (2019) for Glen Shee (see Early Medieval). It highlights the potential and need for more interdisciplinary, data-driven approaches to key questions in upland history.

neighbouring Argyll that combine detailed pollen studies with historical archives offer more nuanced insights into the tensions over tree management and the management legacies that shape the distribution and composition of surviving 'ancient' woodlands.

The work of Sansum (1995) demonstrates that 'core' woodland areas survived last millennium against a wider process of loss, but not without significant change. During the late medieval period, old-growth woods were possibly transformed into more open stands used for pasture and domestic wood supply.

View southwest from Ben Lawers © Michal Klajban

9.2.8 Post Medieval

The apparent invisibility of first millennium AD and medieval rural, non-elite, settlement is being addressed (eg Atkinson 2016; Strachan et al 2019). The palaeoecology of the medieval and postmedieval has much to contribute to the archaeological and environmental history of the document-aided period. Three clusters of studies indicate the potential to connect high-resolution palaeoecology with documentary, archaeological, land management and conservation records. These include studies of the environmental history around Loch Tay (Hamilton et al 2009; Tipping et al 2009a) and Loch Awe (Sansum 2005; Davies and Watson 2007) over the last 400–1000 years as well as the palaeolimnology of Loch Leven over the last 200 years (Salgado et al 2010; Bennion et al 2012).

The value and meanings of trees and woodlands are recurring themes in prehistory, palaeoecology and contemporary science, management and policy (Smout et al 2005; Noble 2017; Bastin et al 2019). Palaeoecological studies commonly document extensive millennial-scale reductions, in which humans often played a significant role (Tipping 1994). Studies from western Perth and Kinross and

Loch Tay © Phillip Capper (CC BY-SA)

This regime prevented trees from maturing and may have depleted more browsing-sensitive species, raising questions over the longer-term sustainability of these uses. In closer proximity to farm townships, pre-industrial woods were certainly a source of tension between landlords and tenants. Trees were owned by the estate, but used for small timber and as sheltered grazing by tenants, for whom animals were often the main source of income and rent (Davies and Watson 2007). Pollen sequences from

small infield and shieling sites on Loch Tay offer a closer insight into how these dynamics played out. Around AD 1400, a birchwood developed around the upper head dyke on the township of Leadour, reaching its maximum extent around AD 1560–1600 (Hamilton et al 2009). Grazing and cultivation continued throughout, suggesting that the trees were deliberately protected, in accordance with estate policy. Court records leave little room for doubt that the estate strongly objected to the destruction of this wood between AD 1614–1620. Grazing records, albeit fragmentary, suggest that from at least the mid-17th century, the farmer was investing in cattle, possibly to supply the growing trade with England. Intensified grazing is recorded on the shieling grounds belonging to this farm, as well as those on the north side of Loch Tay (Tipping et al 2016) and in Glenorchy (Davies and Watson 2007), over the course of the 17th century. It may be testament to a shift in farmer, as opposed to landlord, values. Both economics and climate may have played a role in the types and longevity of land use at higher altitudes on Ben Lawers (Tipping et al 2009a).

Woods were not the only resource whose history demonstrates economically-driven management impacts. Hanley et al (2008) show a strong correlation between rising market prices for livestock and the loss of diversity over the last 400 years in pastures and shielings/hill grazing across multiple estates, including Breadalbane lands on Loch Tay and in Glenorchy. If viewed simplistically, this fits into a narrative of grazing-led 'degradation' of the uplands. However, there was certainly no universal or synchronous trend in plant diversity, indicating complex interactions between local ecological conditions, management choices and economic incentives, within which grazing continues to have an important role.

The period from 1700 benefits from the availability of good and relatively cheap chronological controls in the form of spheroidal carbonaceous particles (SCP) derived from combustion of fossil fuels, and radionuclides from natural (e.g. lead ^{210}Pb) and anthropogenic sources (eg americium ^{241}Am and caesium ^{137}Cs from nuclear weapons testing and the Chernobyl explosion), which jointly span the last 70–250 years. Tree pollen from afforestation and landscape design with non-native and non-local species can also be used to provide approximate dating controls where there are good records of planting dates and species.

Commercial interests also became the dominant factor in the Breadalbane woodlands around AD 1700–1900, with the establishment of an intensive harvest rotation to meet strong economic incentives for a valuable double crop: charcoal for iron smelting and bark for tanning (Sansum 1995). In some woods, oak may have been deliberately selected and lower value competitor trees removed. The intensive woodland management during the 18th and 19th centuries contrasts with limited use, except for grazing, in the last 100 years, when the currently dominant oaks have matured. This overtopping process led to the exclusion of shorter-lived and less shade-tolerant species, and generated large and often gnarled oaks that are erroneously considered to be an ancient characteristic in contemporary conservation.

Breadalbane woods, Glen Lochay © Steve Garvie (CC BY-SA)

Taking an interdisciplinary approach to environmental history allows palaeoecology to test for potential

biases or blind spots in documents written (on the whole) by estate managers and 'improvers'. For instance, palaeoecology and some farm-level vignettes from written sources show that farmers were very much involved in and potentially leading efforts to improve productivity and economic returns from farms around Loch Tay during the later 18th and 19th centuries. These contrast with descriptions of later 18th century agriculture as backward and in need of 'improvement' (Hamilton et al 2009; Tipping et al 2009a).

Palaeoecology also contributes to conservation concerns in lowland Kinross. Loch Leven is the largest shallow nutrient-rich freshwater lake in Scotland. While palaeolimnological studies from this site focus on changes in plant, algal, nutrient and sediment conditions within the water, they highlight the sensitivity of the lake ecosystem to management in the surrounding catchment (Salgado et al 2010; Bennion et al 2012). The data cover around the last 200 years in order compare modern monitoring with a pre-industrial reference state which is used as to define 'good ecological status' in the EU Water Framework Directive. The lake sediment results from Loch Leven can be combined effectively with accounts from naturalists, which survive from the 1820s onwards, to document compositional changes and species losses. These result from the combined effects of lake level change from the natural, gradual erosion of outflow channels and abrupt lowering to reclaim land for agriculture in the 1830s, and nutrient enrichment from agriculture, sewerage and industry, beginning around 1850 and accelerating in the 1950s. Management efforts since the 1980s have only partially reversed these impacts, highlighting the imprint of Anthropocene legacies in this apparently serene rural setting.

9.3 Geoarchaeology

By Vanessa Reid, with Lynne Roy

9.3.1 Regional Overview

Geoarchaeological work across all periods is lacking. There is significant potential to increase our understanding of settlement and landscape changes if geological and soil science techniques are integrated into research and developer-led projects, but to date few examples exist. Detailed below are a number of ways in which geoarchaeological analysis could be utilised more effectively. However, the primary message is that there needs to be greater awareness of its potential and more collaborative engagement at the early stages of research design.

Proxy Indicators and Integrated Approaches

Evidence from Perth and Kinross formed the basis of early engagement with issues related to the soil environments of prehistoric settlements and the effects of agriculture on Scottish soils (eg Romans and Robertson 1983b). There has been little work of this type since then and this region has fallen behind other areas of Scotland, such as Orkney and the Western Isles. There is considerable potential to revisit this type of analysis and incorporate a range of additional environmental and geochemical techniques. For example, biomolecular analyses, including lipid biomarker analysis and DNA analysis, could be employed in situations where it would be beneficial to identify dung and/or decomposed plant materials to the species level (ScARF Science Section: 2 Human and Animal Sciences).

There is need to better understand the nature of settlement in the region, including the spatial organisation of structures and how buildings changed in function and form throughout time. Floor surfaces hold great potential to provide information on the activities undertaken by past communities but have proven notoriously difficult to identify (Strachan et al 2019). In structures where floor surfaces prove elusive, micromorphology should be used to identify and exploit preserved deposits. It should also be used to elucidate whether their poor clarity is the result of cultural practices (eg reuse, maintenance practices, use of floor coverings) or post-depositional transformations in the buried environment as identified through micromorphology at Moredun Top (Roy 2018). Integrated geoarchaeological work at Lair (see PKARF Early Medieval section; Reid forthcoming) will begin to address these issues. It would benefit from similar studies across various preservation environments in the region to evaluate the optimal suite of techniques required for detailed interpretations. Understanding processes of degradation and the resulting sediments from building abandonment will greatly aid such efforts, and the abandoned rural crofts and townships of Perth and Kinross hold considerable potential for

experimental research.

Turf has been used as a construction material for much of the region's settlement history but continues to prove difficult to identify in the record. Soil science techniques, such as micromorphology and phytolith analysis, can be used to identify turf and need to be more widespread when looking for settlement in rural areas (Huisman and Milek 2017; Romankiewicz 2019, 138–9). Multi-element analysis conducted on the region's late medieval and early modern settlements (eg Wilson et al 2005, 2008, 2009; Abrahams et al 2010) also offers a methodology for identifying rural agricultural settlements in locations where surface evidence of turf structures no longer survives.

Perth and Kinross has a wealth of nationally significant sites; however, very few have been subjected to detailed micromorphological analysis. As a result, vital information regarding their preservation and/or formation has been missed. There is real opportunity to revisit sites and acquire additional profile samples which will bolster existing archaeological interpretations, enhance archives and provide broader narratives for the region. Such programmes of work should make use of old excavation trenches, resulting in workloads that are small, inexpensive and minimally intrusive. This would permit their use even on Scheduled Monuments. Such efforts would aid the identification of relic deposits not observable during excavation and help to answer heritage management questions regarding the preservation of sites, current and future threats and the impact of excavation on site integrity.

Issues of Preservation

Acidic soils, a significant number of which are highly podzolised, have resulted in poorly preserved and/or adversely altered archaeological stratigraphies and organic artefact records across the region. This has produced inherent biases in the location and type of material/sites recovered, and the extent to which we can meaningfully interpret sites reliant on organic materials (eg turf constructions). Understanding of the extent of these biases, however, is limited. There are currently very few detailed characterisations of these conditions at the site-level, which requires addressing through multi-disciplinary approaches that include geological and soil science data.

More detailed understandings of taphonomy and post-depositional transformations, and investigations of the close linkages between soil-type, geology and land use through time, will allow us to predict areas of good preservation and site survival. Alternatively, they can be used in heritage management to identify sites most at risk of further alteration. For example, work on historic loch drainage (Stratigos 2016, 2018) could be combined with environmental and soil studies to assess changes in hydration that influence the preservation of waterlogged material.

Sites would benefit from monitoring site preservation conditions in the wake of human-induced climate change and natural environmental changes. There is currently very little baseline understanding of preservation conditions across archaeological sites in the region and such an effort would produce a valuable resource for archaeological interpretations and risk mapping. Recent work by Bowes (2019) at Loanleaven and Blairhall has identified a serious threat to archaeological sites from erosion by ploughing and has devised a means of modelling where sites are most at risk and this could be employed more widely across the region. Work by Davidson and Wilson (2006) has highlighted the role of soils in the preservation of cultural landscapes and the potential of soil science to identify preservation changes.

Deposit Modelling

The term 'deposit modelling' describes any method used to make visual representations of the spatial and stratigraphic relationships between sediments. Such methods provide an effective strategy for investigating the subsurface stratigraphy and the potential for the preservation of associated palaeoenvironmental and archaeological remains (see Carey et al 2018).

There is a vast untapped resource of existing information held in geotechnical reports such as those prepared for flood alleviation schemes and road schemes and held within borehole logs archived by the BGS. This information could be used more widely on both a site specific and broader landscape scale to map and understand distribution and depths of below ground deposits and thus allow us to better target archaeological investigations and sampling strategies. Bowler's (2004) summary of

archaeology within Perth uses the results of borehole investigations, excavation and watching briefs to map deposit depth across the city. The results of archaeological investigations can then be built into pre-existing deposit models allowing for their ongoing refinement and for a better understanding of the archaeological and paleoenvironmental potential of specific deposit types across the region. Deposit modelling guidance released by Historic England (2020) includes a range of examples of applications that would be useful in Perth and Kinross as well as more widely across Scotland and which would help co-ordinate data to help answer some of the queries outlined below.

Collaborative Research

Though multi-disciplinary studies are increasing, more collaborative work between archaeologists and geological/soil scientists is needed. To ensure samples are collected correctly and from appropriate contexts, geoarchaeological expertise need to be consulted and integrated at an early stage in the research design.

Research and developer-led projects have produced a wide range of environmental evidence for the region, using a number of different techniques and analytical strategies. Finding this information and pulling it together for local and regional areas can prove challenging and would benefit from more centralised collation. Previously excavated blocks, cores or bulk samples that have been stored but not analysed should be sourced and made available for additional research projects.

There is a need to develop more detailed and nuanced understandings of landscapes and landscape changes through collaborative projects involving archaeologists, geologists, soil scientists, ecologists, historians and ethnologists. This can help address questions such as:

- Why are sites located where we find them and what are the biases involved?
- How and where should we prospect for new sites?
- What are the major threats to site survival?
- How have the natural and cultural landscapes of the region influenced architecture, land use and settlement patterns and how has this changed through time?
- How effectively can we identify the indicators of settlement (infield/outfield divisions, territorial markers etc) and how far back in time does this extend?
- Can we identify lowland/upland contrasts in site survival, settlement patterns and agricultural practices?

Research Questions

PKARF Qu 9.19: To what extent has preservation and land use influenced our understanding of the archaeological record in Perth and Kinross?

PKARF Qu 9.20: Why are sites located where we find them and what are the biases involved?

PKARF Qu 9.21: How have land use changes and post-depositional processes influenced settlement signatures?

PKARF Qu 9.22: How and where should we prospect for new sites?

PKARF Qu 9.23: How have the natural and cultural landscapes of the region influenced architecture, land use and settlement patterns and how has this changed through time?

PKARF Qu 9.24: How effectively can we identify the indicators of settlement (infield/outfield divisions, territorial markers etc.) and how far back in time does this extend?

PKARF Qu 9.25: To what extent can geoarchaeological techniques contribute to the prospection of sites and the analysis of activity areas?

PKARF Qu 9.26: Can we use existing information such as geotechnical reports and boreholes archived by the BGS to produce preliminary deposit models which will help us to better understand archaeological preservation and potential?

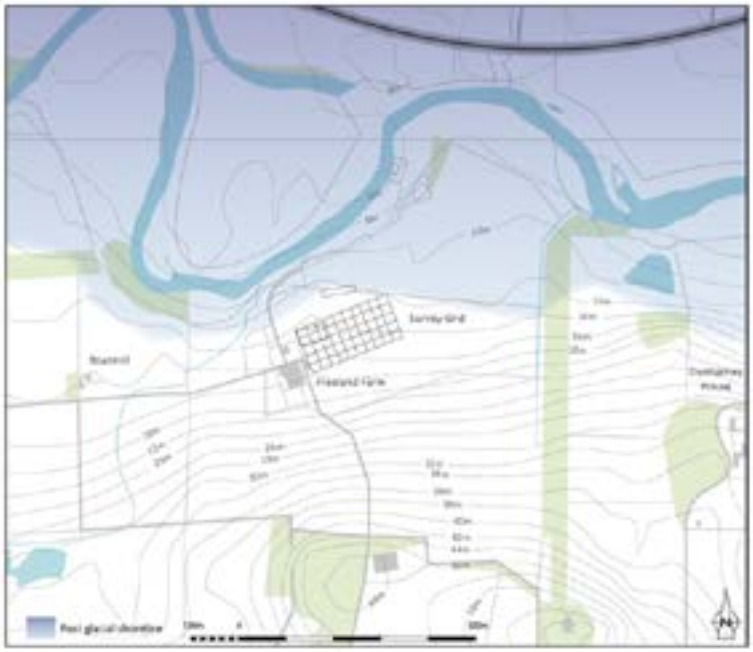
PKARF Qu 9.27: Can we identify lowland / upland contrasts in site survival, settlement patterns and agricultural practices across all archaeological periods?

PKARF Qu 9.28: What are the major threats to site survival?

PKARF Qu 9.29: What impacts are likely to be experienced as a result of climate change and how do we approach this threat?

9.3.2 Late Upper Palaeolithic and Mesolithic

British Geological Survey (BGS) mapping provides a good starting point for understanding site distribution in the Mesolithic as indicated by mapped extents of raised tidal flat and marine deposits. Detailed stratigraphic evidence from a sequence of buried estuarine deposits, buried peat and overlying estuarine deposits at Wester Rhynd in Lower Strathearn suggests the occurrence of two brief marine incursions between the abandonment by the sea of a buried estuarine flat, probably the Low Buried Beach, at about 8765 ± 75 BP, and around 8500 BP. The marine diatom, lithostratigraphic and radiocarbon evidence together are consistent with a storm, storm-surge or tsunami origin for these events (Cullingford et al 1989). The Main Holocene Transgression in the region occurred towards the end of the Mesolithic period (Ballantyne and Dawson 2003) and was associated with a rapid rise in relative sea level which led to a rise of 9–12m (Cullingford et al 1980; Dawson and Cressey 2010).



Maximum inundation at the time of the Main post-glacial Transgression at Freeland Farm site © Archaeology Reports Online, 2019

A post glacial shoreline study undertaken by Dundee University used height data and find spots to accurately plot the water level of the lower sections of the rivers Tay and Earn (Dawson et al 2014). This study was used as a basis for fieldwalking as part of the Tay Landscape Partnership scheme to target areas around the Tay estuary affected by shoreline displacement during the Mesolithic period. Areas targeted include Pitroddie and East Inchmichael Farm north of the estuary, Easter Clunie and Freeland Farm towards the south, and Scone Estate, north-east of Perth, approximately 2km from the River Tay. The study of the lithics recovered revealed distinct patterns in the extent to which the artefacts had been abraded by water. Those retrieved from lower lying sites were more likely to be abraded, and to pre-date the Main Holocene Transgression, than those from sites at higher elevations (Nicol and Ballin 2019).

Research Questions

PKARF Qu 9.4: How could the integration of microstratigraphy and geoarchaeological techniques (as in Mithen et al. 2015) aid the identification and timing of Mesolithic activity in Perth and Kinross?

PKARF Qu 9.5: How can we use existing resources (BGS boreholes, geotechnical reports) to enhance our understanding of the landscape at the start of the Holocene period to better understand the distribution of archaeological sites in the region?

9.3.3 Neolithic

Integrated phosphate studies and micromorphological analysis of buried soils beneath the North Mains mound have provided key insights into human-induced soil evolution and the longer-term effects of subsistence agriculture on favourable lowland soils. These contribute, to broader narratives for north-west Europe (Romans and Robertson 1983a; 1983b; Macphail et al 1990). Agriculture and domestic husbandry were represented by cultivation ridges and a gleyed fossil topsoil with phosphate enrichment; the stability of the soil profile indicated an agricultural system in which nutrient output and input were balanced. This would have been achieved through a transfer of fertility from outfield to infield via careful stock management – a conclusion which has been supported by comparison with buried soils in the nearby Roman fort at Strageath (Romans and Robertson 1983b, 140).

Micromorphological analysis at Cleaven

Dyke identified that brown forest soils supporting deciduous woodland were prevalent at the time of monument construction (Simpson and Davidson 1998; see Cleaven Dyke Case Study). Brown forest soils have also been identified in the buried deposits beneath other monumental sites across Perth and Kinross (North Mains, Beech Hill House), as well as Dalladies in Aberdeenshire. This indicates that the brown forest soils likely represent a widespread Neolithic fossil landscape (Romans et al 1973; Romans and Robertson 1975, 1983b; Carter 1995). A gradual evolution to acid brown soil is noted to have occurred throughout time, indicating that deforestation was followed by regular subsistence cultivation and/or grazing (Romans and Robertson 1975; 1983b, 140).

The Cleaven Dyke © ScARF

Topographic survey of the landform upon which an oval enclosure at Burnside, Blairgowrie is located, suggested that the landform had been eroded through the dual actions of weathering and ploughing. Micromorphological analysis of deposits from within the enclosure ditch indicated that this topographic reduction/erosion had likely occurred prior to the excavation of the ditch. Some of the pits had silt-based basal deposits which suggest they were left open for a period allowing accumulation of a thin layer of silt after which the pits were backfilled. Other pits, by contrast, were filled with single deposits of sandy silts and gravels representative of the composition of the natural subsoil and were backfilled within a relatively short time (Ellis 2017).

At Forteviot, soil characterisation in the prehistoric complex provided key insight into post-depositional processes and the influence physical and chemical transformations have on the geophysical detection of archaeological remains (Cuenca-García 2013; 2019). This has important methodological implications for site prospection in both Perth and Kinross and beyond.

Research Question

PKARF Qu 3.6: To what extent can significant differences in Neolithic practices, traditions and settlement patterns be identified between the upland and lowland areas of Perth and Kinross and how might such differences be explained?

PKARF Qu 3.8: To what extent is the apparent upland/lowland divide influenced by differential preservation and visibility of archaeological remains?

9.3.4 Chalcolithic and Bronze Age

Micromorphology has provided evidence for the deliberate movement and deposition of cremation deposits at Na Clachan Aoraidh (Ellis and Ritchie 2018), as well as the phased construction of the mound at North Mains (Romans and Robertson 1983a). Phosphate analysis conducted at the same site was able to indicate the likelihood that the barrow had covered burials but was not supported by further investigation and alternative inputs of organic material could not be excluded (Pare 1983).

Na Clachan Aoraidh stone circle, Blair Atholl © HES

9.3.5 Iron Age

As with other periods, the geoarchaeological analysis of Iron Age remains across Perth and Kinross is limited. Thin-section analysis formed the basis of early studies into the effects of agriculture at Strageath Roman fort (Romans and Robertson 1983b). It has also been employed in the characterisation of ditch deposits and buried soils at Dalginross Roman camp (Carter 1993).

Micromorphological analysis at Moredun fort revealed evidence for background human activity on the hilltop prior to, or contemporary with, the construction of the earliest ramparts. Analysis of deposits from within the monumental roundhouse excavated within the fort revealed a series of trampled occupation surfaces containing fragments of charcoal, charred peat, bone and slag. The upper part of this sequence was bioturbated suggesting that burnt and unroofed interior of the roundhouse was left abandoned and exposed before a later collapse of wall material sealed the deposits. Comparison between the soil features at Moredun to those from other micromorphological studies indicates that it could have taken anywhere between 40–200 years to develop the level of bioturbation observed (Roy 2018).

Geophysics at Black Spout, Pitlochry © Perth and Kinross Heritage Trust

9.3.6 Early Medieval

During the excavations at Pitcarmick, inorganic phosphate analysis was conducted to assess whether additional traces of domestic farming settlements could be identified in the landscape (Banks 1996). Phosphate distributions caused by the upstanding settlement were readily apparent, but areas of enhancement were also identified in downslope soil layers. This indicated that additional remains may also have existed in the vicinity but had subsequently been removed by cultivation. Whether such structures related to the early medieval period remains unclear. It is likely that the upstanding remains do not represent all of the occupation of the immediate landscape, and that other settlement remains buried within the fields of later phases of occupation (Banks 1996, 231). This offers significant opportunity for future research.

A programme of integrated geoarchaeological work on occupation layers from Lair is currently underway as part of PhD research. This incorporates assessments of pH, electrical conductivity, magnetic susceptibility, organic matter content, multi-element analysis and micromorphology. It is designed to identify activity areas within the interior of the structure and characterise the post-depositional processes affecting early medieval settlement remains in the region. The results from Lair will produce the highest resolution integrated geoarchaeological evidence for any archaeological building in Scotland and serve as a crucial evaluation of the ideal combination of techniques for reconstructing aspects of daily life and living conditions. Results of the project will be released as a series of published papers, with the final thesis expected in 2022 (Reid forthcoming).

Excavation of house structures at Lair, Glen Shee © Perth and Kinross Heritage Trust

Research Questions

PKARF Qu 6.9: To what extent can episodes of abandonment and reoccupation/reuse be observed in the early medieval structural record?

PKARF Qu 6.10: To what extent can geoarchaeological techniques such as phosphate surveys enable the identification of settlement?

PKARF Qu 6.11: Is the general lack of floor layers observed across early medieval structures the result of natural or anthropogenic processes?

PKARF Qu 6.16: To what extent is the 'upland/lowland divide' the result of differential monument survival?

9.3.7 Medieval

Micromorphology, integrated in the Ben Lawers Historic Landscape Project, has aided the reconstruction of complex medieval settlement activity at Kiltyrie but has been little used elsewhere (McKenzie and Simpson 2016; Simpson and McKenzie 2016a; 2016b).

Medieval structure being excavated at Kiltyrie in 2004 © GUARD Archaeology Limited

Bowler's review of the archaeology of Perth (2004) included consideration of the depths of archaeological deposits with reference to elevation of the underlying geology. Bowler produced spot maps of deposit depths as well as distribution maps of midden deposits and preserved wood. An extension of this approach to include the results of subsequent interventions (both geotechnical and archaeological) in a GIS digital database would provide a broader and more useful base for modelling deposit depths and distribution. This in turn would aid understanding archaeological potential across the city.

Research Questions

PKARF Qu 9.7: To what extent is the upland/lowland divide the result of preservation and the differential survival of archaeological remains?

PKARF Qu 9.11: How and to what extent can geoarchaeological techniques identify evidence of cultivation and the modification of soil?

9.3.8 Post Medieval

Multi-element analysis conducted on soils at Duallin township, Ben Lawers, has highlighted the potential of geochemistry to identify new sites of post-medieval activity across the region (Abrahams et al 2010). When subjected to discriminant analysis, the evaluation of soils by x-ray fluorescence spectrometry (XRFS) revealed significant differences in the chemical composition of soils collected from areas of settlement and arable agriculture. It suggests such areas can be identified according to their chemical signatures. Given the elusive nature of settlement prior to the early 18th century, further applications are likely to be particularly effective in identifying locations where the surface remains of perishable turf dwellings are no longer visible.

Geoarchaeological soil survey conducted across the remains of turf banks and enclosures in Glen Devon was undertaken in an attempt to infer functions of the enclosures. There was no evidence for tillage disrupting soil profiles or for cultivation-induced soil erosion and accumulation and it was thus concluded that the enclosures were likely built for managing livestock (Murray 2007). Micromorphology, integrated in the Ben Lawers Historic Landscape Project, has also permitted commentary on the intensity and possible seasonality of occupation (Simpson and McKenzie 2016c).

Excavation of a post medieval structure at Balnasuim
© GUARD Archaeology Limited

The anthropogenic deepening of soil for agriculture is a widely recognised practice across Scotland and geoarchaeological investigations have identified these soils and interpreted them with reference to both rural and urban settlement evidence (Carter 2001). Combined geoarchaeological and historical studies of manuring practices across Scotland have been undertaken by Mackenzie (2006) and Oram (2011). Mackenzie uses soil survey records as both a direct and indirect indicator for the location of deep anthropogenic topsoils. Both studies reference documentary evidence from Perth and its rural hinterland from the late 1600s onwards, evidencing varying practices of manuring across the region. In Perth, waste was gathered into a central midden for licensed waste collection and transported to farms up to 15km away. Despite extensive documentary evidence, neither study involved fieldwork within the region. Deep organic soils overlying organic midden material has been recorded across Perth (Bowler et al 1995; Coleman 1996, 2004; Bowler 2004; Perry and Coleman 2016). These deep organic soils are complex deposits which contain remains of occupation. Better understanding of their nature, development and distribution through detailed micromorphological analysis and extension of initial mapping undertaken by Bowler (2004, 52) could increase our understanding of the growth and development of Perth and its rural hinterland.

Though still limited in application, a significant proportion of geoarchaeological analysis in Perth and Kinross has been conducted on its late post-medieval and early modern remains.

Abandoned rural townships, such as Balnreich and Tombreck, have provided a particular focus for multi-element analysis. Studies have assessed past manuring practices (Davidson et al 2007), patterns of elemental enhancement across functional areas (Wilson et al 2005), the site specificity of soil elemental signatures (Wilson et al 2009), and comparability between sites (Wilson et al 2008). There has also been a comparison of analytical methodologies (Entwistle and Wilson 2007). The identification of distinct elemental signatures for infield/outfield systems has significant implications for the prospection of similar sites in the region, particularly in locations where perishable turf materials have been used and no surface remains survive. Future work should look to build upon and exploit this foundational body of research. Micromorphology, integrated in the Ben Lawers Historic Landscape Project, has also aided the identification and characterisation of occupation surfaces at Tombreck (Simpson and McKenzie 2016d). Whilst commercial studies have used the technique to characterise the formation of field dykes (MacGregor and Crystall 1999).

Research Questions

PKARF Qu 9.12: Building on the body of work in multi-element analysis, how can abandoned rural townships be further utilised as a means of identifying settlement and agricultural activity?

PKARF Qu 9.13: Building on the documentary evidence for manuring practices throughout the region, can we identify physical evidence for this practice through geoarchaeological investigation of soils in rural areas?.

PKARF Qu 9.14: Building on Bowler's initial mapping of deposit depths across Perth. Can we map in order to better understand the underlying geology and elevation archaeological potential?

PKARF Qu 9.15: Can we analyse backland deposits more critically and with an understanding of post-depositional processes to identify their nature and origin?

PKARF Qu 9.16: Where else can the integrated methodologies used in the Ben Lawers project be applied?

PKARF Qu 9.17: Building on the body of work in multi-element analysis, how can abandoned rural townships be further utilised as a means of identifying settlement and agricultural activity?

PKARF Qu 9.18: To what extent can these abandoned townships contribute to the broader development and validation of environmental methodologies?

9.4 Archaeobotany

By Mhairi Hastie

9.4.1 Regional Overview

Collation and synthesis of the available published and unpublished macroplant data recovered from Perth and Kinross is currently much needed as part of a regional overview. There is a need to better understand changes of the macroplant/ archaeobotanical data within the region, both throughout the different periods and geographically, to allow investigation of changes overtime, differences between areas, site types and situations within the varied landscape of the region.

The importance of synthesis of archaeobotanical data is highlighted in recent research by Bishop et al (2010; 2013), who investigated the published and unpublished macroplant remains recovered from early prehistoric sites across Scotland. This research has provided a wealth of information on the quality and quantity of the current macroplant data from this early period, identifying general trends in terms of crops cultivated and wild plants gathered, and highlighted areas that were lacking in the early prehistoric data. While earlier work by Dickson and Dickson (2000) went a step further, bringing together key environmental data from across Scotland from the earliest periods to the medieval period, and set out future research areas.

The work by both Bishop et al (2010; 2013) and Dickson and Dickson (2000) have indicated that synthesis of the macroplant/archaeobotanical data from Perth and Kinross is vital. It not only allows the identification of regional trends and true gaps in the data, it also enables us to take steps towards providing comparable data to investigate Scotland as a whole and to feed into regional and national frameworks. Given that the work by Dickson and Dickson is now 20 years old, it is reasonable to suggest that there is an urgent need for Scottish archaeobotanical evidence both regionally and on a national level to be revisited so as to consolidate the current available data and to establish clear baselines.

9.4.2 Late Upper Palaeolithic and Mesolithic

Only a small number of early hunter-gatherer sites have been uncovered in the region in recent times and there is a general lack of non-charcoal macroplant remains, represented by remains of seeds, fruit stones, nutshell etc, recovered from these sites. This absence largely reflects the often sparse and rare early prehistoric archaeobotanical finds recovered across Scotland, where direct evidence for specific plant utilisation is often scarce and, in some areas, non-existent. Uncovered early prehistoric deposits tend to be the remnants of shell middens or scatters of flint tools/remains of tool making, rarely with associated structures/deposits where macroplant remains are likely to survive. Whilst over the years there has also been a general lack of systematic sampling from early prehistoric sites, with small sample sizes being the norm on the occasion that samples have been taken and processed (Bishop et al 2014).

By far the most common recovered macroplant remains from early Scottish prehistoric sites are fragments of charred hazelnuts and their shells, examples of particularly large assemblages of hazelnut shells having been recovered from neighbouring regions. These include Morton, Fife (Dickson and Dickson 2000), Cramond, Edinburgh (Hastie 2013) and Slackbuie, Inverness (Hastie 2003). Although no such large Mesolithic nutshell assemblages have been uncovered so far in Perth and Kinross, a small assemblage of nutshell dated to the Mesolithic has recently been recorded at Blackford (O'Connell and Anderson 2021).

Although there has been a general lack of early prehistoric sites recorded in Perth and Kinross, investigations by the *Ben Lawers Historic Landscape project* and more recently by the *Early Settlers Project* (Tay Landscape Partnership Scheme) have uncovered several early prehistoric sites in the region.

Oblique aerial view of the Blackford landscape © HES

Elsewhere Mesolithic dwellings have been found around the Forth estuary, at Castlehill, Rosyth and Echline, South Queensferry (Robertson et al 2013), while recent research has uncovered evidence for Mesolithic upland occupation in the Cairngorms (Wickham-Jones et al 2020). With the increasing evidence for Mesolithic activity being uncovered within Perth and Kinross opportunities are likely to arise for greater sampling and recovery of macroplant remains from in situ contexts in the future.

Research Priorities

Sampling of any charred or waterlogged material from in situ early prehistoric contexts associated with human activity should be a priority, with samples targeting deposits which offer the potential for the preservation of Mesolithic archaebotanical/ macroplant remains.

Where plant remains are generally scarce or only found in low densities (ie from early prehistoric sites, esp. Mesolithic and Neolithic deposits) there is a need for larger samples to be taken, where deposits allow. Overall, samples need to produce sufficient qualities of macroplant remains to allow detailed analysis and comparable macroplant data to investigate changes over time, and differences between areas, site types and situations within the varied landscape of Perth and Kinross.

Research Questions

PKARF Qu 9.30: What other plants were being collected and utilised other than hazelnuts during this period?

PKARF Qu 9.31: What evidence is there for the deliberate collection and use of tubers and roots as a food source from Scottish Mesolithic sites?

PKARF Qu 9.32: What evidence can be gleamed from plant remains on the seasonality of Mesolithic sites?

PKARF Qu 9.33: What was the extent of the contribution of plants to the Mesolithic diet?

9.4.3 Neolithic

There is macrobotanical evidence for the cultivation of emmer wheat, barley and flax from Hallhole Farm; for emmer wheat, bread wheat and barley from Claish; and for barley (including naked barley) from Carsie Mains (Bishop et al 2010). However, this list is not exhaustive. Bread wheat is a rare find from Neolithic sites in Scotland, being found only in Early Neolithic contexts (Bishop et al 2009). It is thought that its use declined as the farmers adapted their agricultural regime to the environments of Scotland.

Cropmarks at Carsie Mains © HES

With developer-funded work and the increase in collection and processing of bulk soil samples, there has been an increase overall in the amount of carbonised plant remains recovered from a range of Neolithic sites throughout Scotland. These include most notably the rich assemblages of carbonised plant remains recovered from a number of Neolithic timber long houses,

including Lockerbie (Kirby 2011), uncovered in the Scottish Borders; Claish Farm (Barclay et al 2002), from Stirlingshire; and Balbridie (Fairweather and Ralston 1993) and Crathes (Murray et al 2009), both from Aberdeenshire. These have greatly increased our understanding of the types of crops cultivated in Scotland during this period, including a hint that flax was likely cultivated on a small scale.

Recovery of large rich macroplant assemblages from Neolithic sites in Scotland is, however, still rare. Perth and Kinross is no exception, with Neolithic plant assemblages recovered from the region consisting principally of small amounts of charred cereals grains recovered from posthole and pit fills. Emmer wheat, barley and bread wheat have all been identified in small amounts, along with occasional cereal chaff fragments and some arable weed seeds (for example Miller and Ramsay 2004b – Carsie Mains and Robertson 2020 – Bertha Park). The carbonised macroplant remains indicated the presence of these cultivars but have generally not so far been recovered in sufficiently large enough quantities to reconstruct different agricultural practices at different sites or within the region.

One exception from the region is the notable Early Neolithic pit uncovered at Inchture (Rees 2004). In this instance the plant assemblages recovered from this site have provided tangible evidence for early farming activity and cereal production in the region.

At Inchture a large and rich assemblage of charred cereal grains was recovered from a pit; the assemblage is dominated by emmer wheat with lesser quantities of naked barley and some charred fragments of emmer chaff (spiklets and glume bases). The archaeological record suggests that the cereals and chaff remains had been apparently dumped into the pit. The grains were found together with fragments of burnt daub, which Miller and Ramsay (2004a) suggested could indicate that the grains were discarded remains from a cereal drying kiln or grain storage pit. Naked barley is frequently recorded on Neolithic sites throughout Britain and van der Veen (1992) suggests that this may be due in part to slightly better climatic conditions during this period.

The transition between the Mesolithic and Neolithic periods is an important period with regard to subsistence, with the shift from hunting and gathering economy to the adoption of agriculture. There is no doubt that cultivated cereals and collected wild foods contributed to the diet of Neolithic people in Britain. What is less certain is the relative importance of these two dietary components and the extent to which this can be determined from the archaeobotanical record (Jones 2000). Bishop et al (2010) note that the nature of Neolithic subsistence strategies has been debated in Britain. However, there is yet little consensus, some have favoured the idea of settled agriculture as the main subsistence, with cereals being widely consumed and forming the basis of the domestic economy. In contrast, others have argued for communities living in temporary settlements, focusing on the use of wild resources, and that cereals were 'special' foods consumed rarely and in 'ritual contexts' (Jones and Rowley-Conwy 2007).

To gain a better understanding of the cultivation and use of cereal grains and other plant remains throughout the Neolithic period, both in the region and across Scotland, there is a necessity for carbonised plant remains to be recovered from variety of Neolithic sites. Given the general low levels of carbonised plant remains recovered from Neolithic sites in the region, it is considered that there is an overall need for greater sampling, with larger soil samples being retained from sites, especially where settlement sites are uncovered.

Research Priorities

Sampling of well-preserved settlement remains and deposits for macroplant remains should be a priority. Sites where both Mesolithic and Neolithic remains survive should be targeted and widely sampled (see Upper late Palaeolithic and Mesolithic priorities for further information).

Recovery of dated macroplant remains from the period is key to both the understanding of the onset of crop cultivation in the region, and the spread of crops and use of gathered resources throughout this period and within the region.

Research Questions

PKARF Qu 9.34: What evidence is there to indicate the extent Mesolithic hunter-gatherer subsistence practices continued into the Neolithic period and did this vary within the region?

PKARF Qu 9.35: What evidence is there for the importance of cultivated and gathered foods, as an indicator, of changes in the diet throughout this period?

PKARF Qu 9.36: What evidence can integrated studies of animal and macroplant remains provide on the balance between domesticated animals and cultivated crops during the period and how this might vary within the region?

PKARF Qu 9.37: What evidence can be provided by detailed analysis of well-preserved weed seed/wild taxa assemblages provide on crop husbandry and farming practices throughout the period? Is there any evidence for different farming practices within the region or in different landscapes (i.e. upland and lowland areas)?

PKARF Qu 9.38: What differences can be identified between the Neolithic and Bronze Age in terms of crops cultivated, farming practices and foods gathered?

9.4.4 Chalcolithic and Bronze Age

The recovery of archaeobotanical remains from Early Bronze Age sites within the region has been very limited; this is a reflection of the general lack of settlement remains dating to this period uncovered in Perth and Kinross.

A rare example of analysis of early Bronze Age archaeobotanical remains was carried out in 1997 on samples from the area of a funerary pyre at Sketewan, Balnaguard (MPK5380; Mercer and Midgley 1997). The assessment identified three burnt grains of emmer wheat, which suggests that the pyre had been set down immediately upon the cultivated surface.

Excavation of the cairn at Beech Hill House © HES

Excavation of the funeral cairn at Sketewan © HES

Similarly, macroplant remains were recovered from an old ground surface uncovered below the remains of a burial cairn at Beech Hill House (MPK5042; Stevenson 1995), Coupar Angus. Soil thin analysis (Carter 1995) suggested that the ground surface was likely a cultivated soil and that there had been considerable disturbance of the area prior to the construction of the cairn. Some poorly preserved cereal grains of barley and emmer wheat, along with seeds of cultivation and fragments of nutshell were recovered from samples of the old ground surface. Boardman (1995) suggests that either the charred plant remains may have been produced while the site was cleared of scrub, initially for agricultural purposes and then subsequently for the development of the funerary monument. Alternatively, the plant remains originated from dumped midden material used to manure the soil.

An extensive sampling strategy employed during recent excavations of a number of roundhouses discovered at Kirkton Farm, near Blackford (O'Connell and Anderson, 2021) recovered a wealth of carbonised macroplant remains dating to the Middle Bronze Age. The charred plant remains recovered not only indicated that arable farming was being practised at the site throughout the Middle Bronze Age, but extensive sampling of deposits from each roundhouse allowed the spatial distribution of the plant remains across the site to be assessed. Naked barley was the most common cereal identified with

lesser quantities of bread wheat and emmer wheat grains, with some emmer chaff; together with a weed seed assemblage that was typical of arable fields; the plant assemblages are typical of Scottish Bronze Age sites. Within a number of roundhouses, the charred plant remains were found to be accumulated in post-holes and ditches at the edges of the structure, suggesting that central areas were likely being swept clean during occupation. A large concentration of carbonised cereal grains recovered from the southwest corner of a ditch of a palisaded enclosure was interpreted as the possible remains of a destroyed corn store with a proportion of the grain surviving with attached rachis and grains fused together. While other grain assemblages from pits outside the roundhouses suggested that grain was being processed outside the buildings (Hastie 2021). Similar evidence has been uncovered at Kintore in Aberdeenshire (Holden et al 2008) and at Blackford. Those at Kintore illustrate that well-sampled settlement can provide a wealth of macroplant remains which give us valuable insight into the storage and processing of cereal crops at Bronze Age sites. As further well-preserved settlements are uncovered throughout the region, comparable macroplant data can be collected and collated to increase our knowledge of subsistence practices during the period.

A few Late Bronze Age sites from the region have yielded evidence for cereals and other macroplant remains. Of note, are the excavations of the series of roundhouses at Carn Dubh in the early 1990s (Rideout 1995), and more recently at Blackford (O'Connell and Anderson 2021). Structures and activity on both sites were found to span the Late Bronze Age to Early Iron Age periods. In both cases the amount of macroplant remains were found to be generally low and spread throughout many of the different deposits and features.

The cereal assemblages at Blackford were dominated by barley with small amounts of emmer and spelt wheat, while the assemblages from Carn Dubh were dominated by barley (6-row variety) with low amounts of oats. Interestingly, small amounts of rye were recovered from a post ring (Structure 1D) at Blackford. There is little evidence to date for the specific cultivation of rye during the Late Bronze/ Early Iron Age periods and it is suggested that the small amount of rye identified, at the site, were likely weed seeds of the barley crop (Hastie 2021).

The archaeobotanical remains from Carn Dubh were recovered principally from hearth deposits. Boardman (1995) suggests that the spatial distribution of the plant remains probably indicates that the bulk of this material has come from cooking deposits. Similar results were noted at Blackford, where the very abraded nature and general poor preservation of plant remains from the Late Bronze Age / Early Iron Age features likely indicated that the plant remains were re-worked and diluted food debris burnt during daily activities (Hastie 2021).

Spatial analysis of the plant remains from Carn Dubh indicated that the internal areas of the roundhouses were generally devoid of plant remains suggesting that the houses were being kept clean throughout their use (Boardman 1995). A similar pattern was noted with the Middle Bronze Age structures at Blackford (see above) where charred plant remains were found accumulated in features at the edges of the roundhouses suggesting that central areas were kept clean. The results could indicate that use of internal areas continued to be similar throughout both periods.

Other plant remains of note from the roundhouses include apple pips from a ring ditch (Area H) at Blackford (Hastie 2021) and seed-bearing fruits from heather at Carn Dubh (Boardman 1995). The recovery of such remains indicates that wild resources were continuing to be utilised throughout this period. The heather was likely collected for bedding or flooring material, and the apples gathered as a supplement to the cultivated crops.

Although only small amounts of plant remains were recovered from the Late Bronze Age/Early Iron Age structures at Carn Dubh and Blackford, both sites have shown that extensive sampling of deposits, from across such settlement sites, is crucial. Such sampling enables analysis of the distribution of the plant remains which can provide information on day-to-day activities within the roundhouses. Sampling for macroplant remains from future sites will continue to enhance our understanding of the organisation of daily life during this period.

9.4.5 Iron Age

In contrast to most Iron Age sites in Scotland, where only small amounts of charred plant remains are recovered, a wealth of information has been gained from the excavation of waterlogged deposits at Oakbank crannog, Loch Tay (Miller 1997), one of the oldest dated crannogs (Dickson and Dickson 2000).

The waterlogged deposits recovered from the site were found to contain a wealth of macroplant remains, both charred and uncarbonised, associated with daily activity. As with the excavations at Blackford (see Bronze Age section) the comprehensive sampling of deposits from the crannog site allowed detailed spatial analysis of the macroplant remains recovered and to assign categories to the plant remains indicating their potential uses on the site.

The main cereals cultivated were found to be emmer wheat and hulled barley, while grains of spelt wheat were also recovered. The recovery of spelt was at the time the earliest such finds for Scotland (Clapham and Scaife 1998; Miller 1997); it indicated that this wheat variety was being cultivated earlier in the Highlands of Scotland than previously thought. As emmer and spelt wheat require longer ripening periods, they are autumn sown and Miller et al (1998) argues that the inhabitants of the crannog must have planted their wheat crops in the autumn and the barley in spring. The majority of barley grown from the Late Bronze Age onwards in Scotland is the hulled variety (van der Veen 1992), which tolerates cooler, wetter growing conditions and is well suited to the Scottish weather. The introduction of hulled barley has been argued to be partly a result of a climatic shift towards increased rainfall and cooler, shorter, growing seasons during the Late Bronze Age to Early Iron Age periods (Jones 1981; van der Veen 1992; Dickson and Dickson 2000).

Spatial analysis of the macroplant assemblages from Oakbank allowed the identification of different household contexts within the dwelling: daily piecemeal processing of cereal ears for consumption (daily processing of stored crops); mixed hay and animal dung within floor deposits interpreted as fodder layers (a mix of hay fodder and cereal processing waste) and general occupation floor layers with little or no plant remains. Miller (1997) suggests that these indicated that specific areas within the dwelling were used for different functions, including food processing, sleeping, animal care and general living.

Waterlogged remains of Oakbank Crannog © Michael Stratigos

The well-preserved arable weed seed assemblage recovered at the site also provides some evidence on harvesting techniques. Hillman (1984) noted that the weed assemblage contained a large number of seeds from low lying taxa suggesting that the crops were being reaped low on the culm (stalk). While the remains of a wooden ard recovered from the site indicates that the cultivated soils were being tilled (Dixon 1984b); this gives us some insight to late prehistoric crop husbandry.

A high prevalence of wild plant remains, including seed fruits and nuts, were also recovered from the Oakbank samples, highlighting the continued importance of gathered foods throughout the prehistoric periods, including wild berries and hazelnuts. Of significance was the identification of cloudberry seeds (*Rubus chamaemorus* L.) at the site. Not only was this the earliest find of the berry in British prehistory (Miller et al 1997) but the plant has a very limited habitat restricted to areas of deep peat at altitudes above 700m and would not have grown locally around the crannog site. Its presence indicates that the inhabitants of the crannog travelled great distances from the dwelling to collect resources (Miller et al 1997). The berry is high in Vitamin C and

it contains benzoic acid which means that the berries can be preserved by being crushed in their own juices and stored in a cool place without the need for added sugar (Wild berries: cloudberries'. Arctic Flavours Association. 2014).

Plant remains recovered from Roman deposits from the region are particularly rare, and the only Roman deposits that appear to have been sampled in Perth and Kinross is the waterlogged remains found at the Roman Fortress at Carpow (Dores and Wilkes 1999). Here, the sample from the inner ditch of the fortress was found to contain twigs, bark, heather flowers and cereal straw along with the seeds of chickweed, blinks, elderberry and pond weed. The pond weed suggesting that the ditch was filled with standing water.

Preserved logboat from Carpow © Perth and Kinross Heritage Trust

9.4.6 Early Medieval

Little is known about early medieval crop husbandry, agricultural practices and plant exploitation within the region as until recently, early medieval settlement remains have been largely unknown, and the main dated site was the fort at Dundurn (Alcock et al 1984). Recently, sites have been identified and investigated, including upland settlements such as Lair, Glen Shee (Strachan et al 2020), Bertha Park (Engl 2020), the enclosure at Upper Gothens, Meikleour (Barclay 2001) and a corn-drying kiln at Kinross High School (Cachart 2008; Hastie 2008). Other sites, such as the Black Spout monumental roundhouse (Strachan 2013) and Shanzie souterrain (Coleman and Hunter 2002), have revealed evidence that suggests these late Iron Age sites were re-used during the early medieval period.

Unfortunately, sampling for macroplant/ archaeobotanical remains has not always been systematically carried out at all of these. Where remains have been recovered, however, they have provided tantalising information on early medieval crop processing, agricultural practices and use of wild plants.

- Analysis of large macroplant remains at Dundurn fort (Dickson and Brough 1989) recovered rare organic remains from midden deposits, dating between 550 and 650 AD. The deposits contained fragments of bracken, moss and wood chippings which were likely used as flooring or bedding. Occasional cereal grains of barley (both naked and hulled variety being present) and oat were recorded, along with hazelnuts and raspberry seeds. Of note, was the recovery of a conglomerate of wild cherry stones, which were thought to have come from human coprolite material suggesting that excrement had been present in the midden deposits. Dickson and Brough (1989) suggest that the plant assemblage show that the local environment was less wooded than today, with meadow and riverside environments being exploited for wild nuts and fruits.

- Although only two samples were assessed for macroplant remains from the recent excavations at Lair (Strachan et al 2020), both were found to include small amounts of charred oat and barley grains (Ramsay 2020). The recovery of this small quantity of charred cereal grains together with a fragment of a rotary quern indicates firstly that some crop processing or food preparation was undertaken at the site. It also suggests that there is potential for further macroplant remains to be recovered from this early medieval site.

- The charred plant assemblage from Bertha Park contained a mix of grains of six-row and two-row barley, glume wheat (emmer/ spelt) and oat (Robertson 2020). Robertson suggests that the two-row barley may have been specifically grown for use in brewing as it has a high sugar content. Emmer/Spelt wheat are more commonly

recovered from prehistoric sites. However, its presence at Bertha Park indicates that the cultivation of glume wheat continued into the early medieval period on a small scale (Robertson 2020).

- The early medieval kiln (dated from 430–620 AD) uncovered at Kinross High School (Cachart 2008) contained a rich assemblage of carbonised cereal grains with both hulled barley and oats present. These were interpreted as being the remnants of a 'maslin' or 'mixed crop' for bread making (Hastie 2008). High concentration of weed seeds were recovered from the possible collapsed dome of the kiln and it is likely that the seeds originated from turfs used to construct the upper section of the kiln (Hastie 2008). No other known corn-drying kilns have been found that date to this early period and its presence indicates that grain was being grown and processed at the site at this time. A second kiln, dating to the later medieval period, was also uncovered at the site (see later medieval section). Interestingly both kilns were very similar in construction demonstrating that there had been little advancement in grain-drying technology on the site between these periods (Cachart 2008).

Aerial view of Dundurn hillfort © Perth and Kinross Heritage Trust

Evidence of early medieval settlement is being identified more frequently in Perth and Kinross. Investigations of these sites in the future will provide increasing information on settlement during this period. It will also add to our understanding of transition between the self-sufficient later prehistoric/early medieval periods to the trade and surplus of the later medieval period. The evidence recovered from the investigations at both Bertha Park (Engl 2020) and Kinross High School (Cathcart 2008) indicates that macroplant remains from these sites can provide a wealth of information on crop husbandry, agricultural practices and day-to-day activities from this period. To gain a full understanding of the agricultural economy at the time it is crucial that sampling and analysis for macroplant remains, from these sites, is undertaken routinely as part of environmental investigations. Sampling of well-preserved early medieval deposits and features should be a priority.

Aerial view of Bertha Park © HES

Research Priorities

Sampling of any charred or waterlogged material from insitu early medieval settlement remains/ sites should be a priority, with samples targeting deposits offering potential for the preservation of early medieval archaeobotanical/macroplant remains.

Research Questions

PKARF Qu 9.47: What differences can be identified, if any, between the later prehistoric period and early medieval period in terms of crops cultivated, farming practices and foods gathered?

PKARF Qu 9.48: What evidence is there for the introduction of new plants, and can this identify new trade links during this period?

PKARF Qu 9.49: What differences can be identified between the crops cultivated and agricultural practices between lowland and upland areas within the region?

9.4.7 Medieval

Excavations particularly within the urban centre of Perth have uncovered rich assemblages of both carbonised and waterlogged plant remains, especially relating to the earlier part of the period – 12th–13th centuries). These include sites on High Street (Moloney and Coleman 1997; Fraser 2012; Smith 2012), Canal Street (Coleman 1996), Horse Cross (Cox 2007), South Street (Stronach 2003). Due to the frequent flooding of the Perth an array of waterlogged plant remains, which are rarely found at other Scottish sites, have survived and these have provided a wealth of information on plants that would not normally be preserved. The good anaerobic preservation has allowed macroplant remains to be recovered from many different everyday features and deposits, including cess pits/latrines, floor deposits, middens, ditch and pit fills and layers of dung, etc. They supply invaluable evidence of the types of plants that were being brought to Perth and used on an everyday basis, those that were likely growing on or near the site and imported goods brought into the royal burgh.

Cereals, which formed the staple diet for the greater part of the medieval population, included oats and barley with smaller quantities of wheat. The composition of the cereal remains from Perth is consistent with assemblages recovered from other excavated urban centres across Scotland. Exotics included dried figs, grapes and walnuts; these must have been imported from the Continent and southern England.. Evidence of more locally grown fruits included bramble, raspberry, blaeberry, glean or wild cherry and apple. A large portion of the plants recovered, however, were waste ground species, such as nettles and docks, that were likely growing locally around the settlement, and cornflower or stinking mayweed, possibly brought to site in animal dung.

Waterlogged remains preserved in situ at Perth High Street © HES

Other plant remains recovered suggest links between the burgh and its hinterland. For instance, hazelnuts found in backland ditches must have been harvested in the countryside in autumn. While collection of other organic materials, such as moss for rope, bedding and toilet hygiene and cereal straw for roofing and animal fodder, also demonstrates exploitation of the rural hinterland (Fairweather 1997).

Fraser (2012) and Smith (2012) have brought together the results of the archaeobotanical analysis from the 1970s High Street excavations with documentary evidence, including the Perth Guildry Books (1400–1600 AD), to provide context to the macroplant remains recovered. This has proved effective and indicates that combining documentary and archaeological evidence, where available, informs us about late medieval diet and trade throughout the region.

Whilst the excavations within Perth have provided a mass of information on late medieval plant remains, there is a distinct lack of macroplant remains from other small town or rural sites within the region. Although small town sites have been excavated over the years, few samples have been retained

and processed for environmental remains. More evidence is particularly needed from these sites to inform us about their status and economy and to study the supply of cereals and other food resources to the towns.

Some information on the nature of rural agricultural practices in the later medieval period has been gleaned by excavations of corn-drying kilns uncovered at Abercairny (MPK1519: Gibson 1989; Fairweather 1989) and Kinross High School (MPK17086: Cachart 2008; Hastie 2008). Both kilns date to the 11th–13th centuries. The first, at Abercairny, contained deposits of burnt six-row barley recovered from the floor of the kiln flue. These grains showed signs of having started to germinate, while the weed seed assemblage indicated that the barley crop was grown on enriched damp ground (Fairweather 1989). The second kiln, at Kinross High School, only containing small amounts of poorly preserved cereal grain and was noted to be of crude construction, suggesting a temporary or short-lived structure (Cathcart 2008). These excavations indicate the potential of such structures to provide a wealth of information on the crops grown, cultivation techniques employed and crop processing practices throughout the region during the late medieval period.

Tantalising evidence for the use of garden pea in the region has also been identified from a late medieval rural site recovered during excavations at Inchture (Miller and Ramsay 2004a). Dickson and Dickson (2000) notes that peas and beans were imported into Scotland during the 13th and 14th century and the evidence from Inchture could potentially indicate movement of such goods from the urban centres out to rural areas.

The recovered plant remains from the above medieval rural sites, although currently limited, does indicate that a wealth of information on later medieval plant remains can be uncovered at these sites. The sampling of deposits from rural settlement sites should be priorities when the opportunities arise.

Research Priorities

One of the main objectives of this period is to study the relationship between towns and the countryside and to establish how towns were provisioned. Sampling for the recovery of charred and waterlogged macroplant remains, from a range of medieval sites across the region, should be a priority, ie from small towns, monastic sites, castles and especially rural settlement sites.

Further detailed sampling of well-preserved waterlogged macroplant remains from Perth will add to our understanding and knowledge of the crops and garden plants cultivated, imported goods and crafts involving plants.

Archaeobotanical evidence, where available, should be considered in conjunction with documentary resources as these provide additional information about and aid interpretation of the macroplant material.

Any in situ deposits associated with specific industrial activities, such as cloth working, brewing and tanning, should be sampled for recovery of macroplant remains.

Research Questions

PKARF Qu 9.50: What evidence can be provided from integrated studies between environmental data, (including macroplant remains and animal bones), artefacts and structural remains on variations of diet, living conditions and status across the region?

PKARF Qu 9.51: What changes and improvements occurred in crop husbandry and farming practices throughout the period and within the region?

PKARF Qu 9.52: What crops and garden plants were being cultivated and is there any difference within the region or between different landscape areas?

PKARF Qu 9.53: What evidence is there for the intensification of agriculture throughout the period?

9.4.8 Post Medieval

Little archaeobotanical analysis has been carried out on post-medieval sites within the region, yet those that have been undertaken have provided a snapshot into everyday use of plants within the rural communities.

However, an excellent example of integrated analysis of both macroplant remains and thin section analysis has been carried out at Sunnybrae Cottage, Pitlochry

(Holden and Walker 2012). The acquisition of the cottage by Historic Scotland in 1998 provided the rare opportunity to study in detail the development of a late 18th-century cottage that would have been common throughout the Highlands of Scotland during the post-medieval period.

Sunnybrae Cottage © HES

No surviving macroplant remains were recovered from floor deposits or internal features of the cottage. Unfortunately no early hearth deposits were uncovered; however, surviving under the corrugated iron roof of the cottage were the remains of an earlier thatched roof, including intact turf layers and remnants of the cereal straw surface. Archaeobotanical analysis of the thatch revealed that the lowest courses of the eaves were formed by twigs of broom, with subsequent courses comprising alternative layers of turf and rye straw, with bracken used to repair the ridges. The rye straw had been threshed and cleaned of weeds, while oat tippets had been used to repair the thatch. Together the archaeobotanical and soil thin analysis showed that the thatching turfs were cut either from an area of heavily grazed pasture or from a previously stripped piece of ground with one to two years regenerative growth.

This work illustrates how sampling of macroplant remains from well-preserved post-medieval settlements/buildings, when uncovered, have the potential to reveal a wealth of information. These remains potentially provide evidence on diet, living conditions and status, whilst also giving information about the introduction and use of foods and other traded materials, particularly New World introductions and their spread throughout the region.

The Cromwellian Citadel in South Inch, Perth (17th century) © HES

Excavations in 2002 at the site of the Cromwellian Citadel (Roy 2002) uncovered a large and rich assemblage of cereal grains. This consisted almost entirely of wheat grains, and it was evident that the charred remains represented a cleaned crop; the large amount of burnt grain likely a result of some sort of accident concerning processing or storage (Hastie 2002). During the 18th century there was a rapid growth of town populations and an increased demand for supplies in their centres. Improvement in agricultural practices allowed greater crop yields and improved infrastructure made it easier to transport corn to the markets in the urban centres. This led to the decline in rural corn mills and a move to larger mills situated closer to town and city centres (Gauldie 1999). During this period the main route

into Perth from the south was re-directed so that it ran through South Inch and across the Cromwellian fortification. The large assemblage of burnt grain uncovered in this area suggests direct evidence of a store or mill situated on the outskirts of Perth during the 18th century.

To the author's knowledge, there has been no dedicated archaeobotanical work on 20th century sites in Perth and Kinross.

Research Questions

PKARF Qu 9.54: To what extent can macroplant remains provide information on the diet, living conditions and status of rural and urban communities during this period?

PKARF Qu 9.55: What changes and improvements occurred in crop husbandry and farming practices?

PKARF Qu 9.56: What new cultivars and plant species were introduced during this period?

PKARF Qu 9.57: What evidence is there for the availability of New World imports to different communities?

9.5 Zooarchaeology

By Catherine Smith

9.5.1 Late Upper Palaeolithic and Mesolithic

Sites of this date are rare in the lowlands of Perth and Kinross, Freeland Farm in Lower Strathearn being the notable exception (Nicol and Ballin 2019). Recent work at Tarradale on the Black Isle located in an estuarine/coastal environment on the Beauly Firth similar to that of the Tay Estuary has shown that animal bones from the Late Mesolithic/Neolithic period can survive well, given the right waterlogged conditions (Smith 2019b). Large cattle, thought to be close to the true wild aurochs in ancestry, wild boar, pine marten and red deer, all typical of this early period (Yalden 1999, 72–8), were identified at Tarradale. At Howburn, South Lanarkshire, survey has recovered Late Upper Palaeolithic, Mesolithic and Neolithic stone tools from an area once known to have been a small loch. While animal bones did not survive, the tools were evidence of hunting, presumed to have been of reindeer (Ballin et al 2018).

Part of a biserial antler point (spear or harpoon) at Tarradale © Tarradale Through Time

Tarradale split leg bone of sheep or deer, possibly for piercing or boring © Tarradale Through Time

These sites have shown that evidence of early prehistoric activity can be found along river valleys and former, now drained low-lying lake environments and targeting these areas in future may prove fruitful. Estuarine environments were also clearly important. At Morton in Fife, near the mouth of the Tay, an important assemblage of the late 7th millennium BP was recovered including red deer, roe deer, wild boar, aurochs, hedgehog and possible bank vole, as well as sea birds such as gannet and guillemot and fish, principally cod (McCormick and Buckland 1991, 90). Whale strandings along the Firth of Forth (McCormick and Buckland 1991, 90) were probably an important resource for Mesolithic people during periods of marine transgression. It is not impossible similar evidence may be found in future for the Tay.

Animal bones, probably of deer species and beaver, recovered from marl extraction at Marlee Loch in the

late 18th century are likely to represent a Mesolithic/ Neolithic fauna (Canmore site NO14SW3). Local museums contain bones supposedly recovered from marl pitting but as Culture Perth and Kinross states in the accession data for the beaver skull reportedly found in 1788, the attribution of the 'current specimen may be in doubt' (Object no 1881.925).

Research Priorities

- Find sites with right conditions for preservation of faunal evidence are rare, so require special consideration when encountered *in situ*.
- Importance of waterlogged sites (eg Edramucky; upland).

Research Questions

PKARF Qu 9.58: Freeland Farm and other Tay Landscape Partnership Scheme sites: might future excavation produce environmental (including faunal) evidence?

PKARF Qu 9.59: How can we locate sites with surviving animal bone, similar to Morton or Tarradale?

PKARF Qu 9.60: Might future fieldwalking along river terraces locate further sites with environmental potential?

PKARF Qu 9.61: Are there whale stranding sites along the Tay estuary similar to those from the Forth?

PKARF Qu 9.62: Can we determine the nature of human activities involving animals in the absence of bone evidence, using artefacts/lithics as a proxy?

9.5.2 Neolithic

Most of the existing evidence from this pivotal period for animal husbandry in our area comes from animal remains deposited with human burials and cremations, and therefore tends to be of highly fragmented and burnt bone. Survival of unburnt bone is rare. Where it does survive, smaller bones such as carpals, tarsals and sesamoids serve as evidence of the species present. Pig bones seem to have been deposited with human remains perhaps as a ritual offering for the dead, or as the remains of celebratory meals for the living. Examples are the remains of a right pig foreleg and a possible cattle rib from the barrow at North Mains, Strathallan, dated to the early 2nd millennium BC (Barnetson 1983a, 231). At the North Mains henge, pig and ovicaprid fragments, dating to between the Neolithic to Early Bronze Age, accompanied a burial, and pig bones and large artiodactyl, probably cattle, came from a ring feature at North Mains (Barnetson 1983b, 178).

Excavation at North Mains © HES

Research Priorities

The evidence for the boundary between the Mesolithic 'hunter-gatherer' and the Neolithic 'settled farmer' is not present and is an area for further investigation if such sites emerge.

Research Questions

PKARF Qu 9.63: Where and when was the transition? How long was its duration?

PKARF Qu 9.64: Is there evidence for upland farming at this period?

PKARF Qu 9.65: Does the evidence for transhumance exist in the uplands?

PKARF Qu 9.66: Are surviving animal bones in burials a good proxy for animal husbandry?

9.5.3 Chalcolithic and Bronze Age

Early Bronze Age activity in our area again tends to be represented mainly through burial sites. Pig bones have been found accompanying an Early Bronze Age adult inhumation at Almondbank (Stewart and Barclay 1997, 27); Cist burials at Gairneybank, Kinross

and at Muirhall Farm contained sea urchin spines, which are possibly evidence for the exploitation of an oyster bed (Stewart and Barclay 1997, 43).

Muirhall Farm © Rob Burke (CC BY-SA)

Bone was important as a raw material. Close-Brooks (1985, 142) has described two bone toggles and a pin, the species of origin unknown, among the contents of a cinerary urn excavated at Moncreiffe, located on the north side of the Phase 3 stone circle. While work on the urns from Kilmagadwood is ongoing, a burnt bone toggle has been identified along with the cremated remains of a child (Urn 7), antler or bone bead fragments in Urn 8 and possible sheep remains (Urns 8, 15, 19). There is also some evidence that animal skins had been used to cover the urns (Sheridan et al 2018, 11; 13).

Excavation of Kilmagadwood © Mark Hall

At Sketewan, Balnaguard, a cairn of the Early Bronze Age, the cremated remains of a child included two trout vertebrae, which were possibly part of the stomach contents of the deceased (McSweeney 1997, 318). The central cist at this site also contained animal foreleg remains, possibly of red deer (McSweeney 1997, 318).

Research Priorities

Sites other than those associated with human burials are not found and evidence for animal husbandry is scant.

Deposition of animal remains with those of dead humans is relatively common and these are ripe for further study.

Research Questions

PKARF Qu 9.67: How can we find occupation sites with evidence of animal husbandry?

PKARF Qu 9.68: Is there evidence of animal deposition at Kilmagadwood?

PKARF Qu 9.69: Is pig deposition a continuation, refinement or parallel practice to those first encountered in the Neolithic? Does it continue into the Iron Age?

9.5.4 Iron Age

Early Iron Age features from Blackford produced calcined animal bone of unspecified origins, as well as burnt animal dung (O'Connell and Anderson 2021, 125; 113). The acidic soils are cited as 'one of the major reasons why inhumation burials are not a common feature in the Scottish archaeological record' (O'Connell and Anderson 2021, 125) and the same can be said for animal remains of this, and all other, periods.

A wide range of monument types is represented in the Iron Age of the area (PKARF Iron Age section). None, unfortunately, has yielded the quality or quantity of faunal assemblages as recovered from broadly contemporary sites elsewhere in Scotland, such as Broxmouth fort, East Lothian (Barnetson 1982; Armit and McKenzie 2013). Only small fragments of calcined bone were found at forts recently excavated by the SERF project (Smith, unpubl. archive). The excavation of the forts of Moredun and Castle Law,

Abernethy have produced larger assemblages of burnt and unburnt animal bones (Cook et al 2014; Cook et al 2018; Nicol et al 2017). In addition, the work at Castle Law, Abernethy has seen an important review of the bone assemblage recovered from the cistern in the 1890s excavation (Strachan et al forthcoming).

Castle Law hillfort, Abernethy © James Allan (CC BY-SA)

Cattle teeth were recovered from crannogs on Loch Tay during underwater excavation by Dixon. Dixon (1982, 19) also notes animal droppings, probably sheep, from Fearnan (Oakbank) Crannog.

Monumental roundhouses, such as Aldclune, have produced some unburnt material. McCormick (1997, 446) reported that cattle dominated a small assemblage at Aldclune which also included pig, horse, red deer and sheep/goat. Spindle whorls attest to spinning. Presumably of wool; though it should be noted that flax and nettle fibres are also a possibility. Scarcity of bone was again attributable to soil acidity (McCormick 1997, 456). A similar site at Black Spout, Pitlochry produced a small assemblage of cattle and possibly sheep (Smith 2013, 49).

The dense concentration of souterrains within the area has produced little bone. At Newmill, Bankfoot, burnt cattle bones were present as well as a horn core (species not stated) suggested as having been pushed into a wall (Watkins 1980). Burnt bone was reported in the primary fill of Shanzie souterrain, Alyth but was presumably unidentifiable (Coleman and Hunter 2002, 84).

Excavation of the souterrain at Newmill, Bankfoot © HES

Roman sites are also relatively free of direct evidence of animals. Secondary evidence can be seen, for example at Flavian Inchtuthil where a dog paw print is preserved in a tile, and through the horse trappings from Ardoch (McCormick and Buckland 1997, 102; Anderson 1898). While a few small bags of bone, reportedly from Carpow, exist in the collections of the McManus Galleries, Dundee, it is not certain whether these originated from the 1961–76 excavations.

Research Priorities

The Crannog Centre may hold examples of faunal remains including animal droppings recovered from Loch Tay.

Roman sites such as Carpow may have produced overlooked faunal evidence.

Research Questions

PKARF Qu 9.111: Might re-evaluation of crannog material provide insight into Iron Age animal husbandry?

PKARF Qu 9.112: Is lipid analysis of stone/bone spindles possible? Is sheep lanolin present?

PKARF Qu 9.113: Might existing remains be re-evaluated in absence of published report? Or do such reports exist in archive?

9.5.5 Early Medieval

At Bertha Park the striking ritual interment of cattle remains in a pit have been dated to between the late 8th century and the 10th centuries AD (Engl 2020, 9). At Lair, Glen Shee, a collection of unburnt cattle bones, comprising several 'associated bone groups' represented a calf and three older cattle, were also deposited within a pit. These are perhaps the remains of a foundation celebration (Smith 2019a, 106).

Cattle bones preserved in a pit at Bertha Park © Rob Engl

Research Priority

Finding faunal evidence from lowland early medieval sites which are scarce.

Research Questions

PKARF Qu 6.8: Can the re-evaluation of museum collections, for example, Hurly Hawkin, Angus, provide insights relevant to Perth and Kinross.

PKARF Qu 9.70: Can we locate more sites of Early early Medieval medieval date in the lowlands?

PKARF Qu 9.71: Can some faunal remains of this period be considered as ritual deposits?

9.5.6 Medieval

This period is most conveniently considered in two parts: the urban sphere of the burgh, and its rural hinterland.

Urban

While animal bone can be a frequent find on excavations, in Scotland their survival depends on factors such as soil acidity, and waterlogging. Perth, an urban area with a high water table and a local river with a propensity to flood, has excellent conditions for the preservation of organic materials in, for example middens, which can retain their characteristic smell after centuries have passed. The Tay and its tributaries have flooded the burgh repeatedly over the medieval period and since (Bowler 2004). Substantial animal bone and molluscan assemblages have been retrieved from excavations here. The most abundant which was 75–77 High Street, one of the earliest to be investigated and carried out in advance of development in the 1970s (Hodgson et al 2011). Leather remains, textiles and textile working tools, themselves evidence of activities involving animal products, were also abundant finds (Dransart 2012; Thomas 2012).

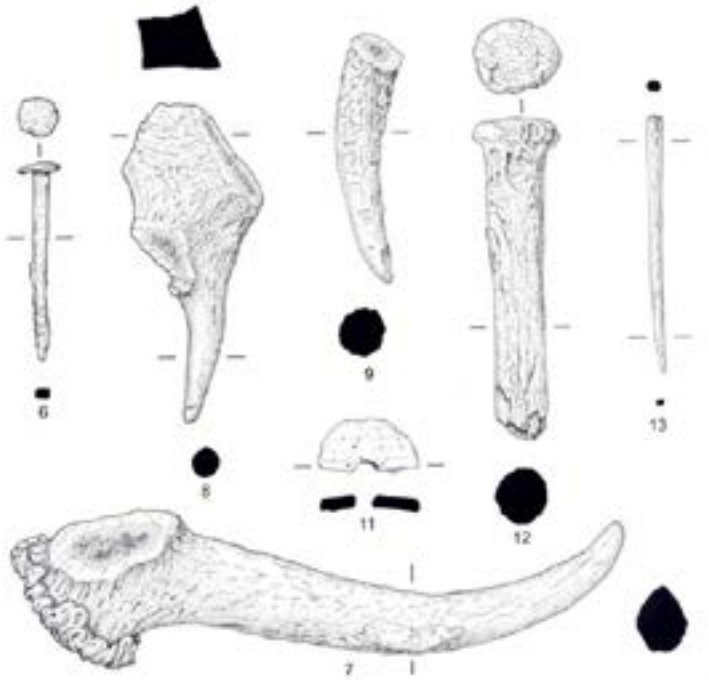
Leather shoes from St. John's Square, Medieval Perth © Perth Museum and Art Gallery

Similar assemblages have been recovered through subsequent archaeological work in Perth. Being led by urban development the location of the sites excavated has not been driven by specific research questions such as targeting the foci of animal-based activities. Industries which produced noxious smells (tanning, skinning) or were fire hazards (tallow rendering) were likely to be located on the edges of the burgh. An example is the area around Curfew Row which was historically known for tanning due to its proximity to the town lade where water could be sourced and effluent disposed of. Opportunities to excavate have tended to be on sites within the core of the burgh, with only a few, such as Whitefriars (Tullilum) outwith its bounds.

Notable sites where large, well-stratified animal bone assemblages have been recovered include 80–86 High Street (Moloney and Coleman 1997), King Edward Street, and Mill Street (Bowler et al 1995), Kirk Close (Holdsworth 1987), and Scott Street and Meal Vennel (Cox 1996). Notably South Street remains relatively unexplored with only one major development leading to full scale excavation within recent decades (Stronach 2003). Canal Street and South Methven Street on the outer edges of the burgh have also seen investigation and the retrieval of useful bone assemblages (Blanchard 1983; Holdsworth 1987; Coleman 1996). Smaller but still important assemblages are associated with the friaries of Perth including Blackfriars (Bowler et al 1995) and Whitefriars (Stones 1989; Hall forthcoming).

Bone assemblages from such sites are not without interpretation problems. The results can raise as many questions as are answered, partly due to the ad hoc nature of excavation in response to development. An extended watching brief in St John's Square produced abundant animal remains, along with other finds, from piling holes and trenches (Perry and Coleman 2016). The faunal remains provided glimpses of antler- and leather-working (Perry and Coleman 2016).

Skinnergate, once the main access route to the medieval town via the North Port, has seen significant development over the last two decades. This area is known from documentary sources and its name to have been the focus of the Glover Incorporation's activities. It is one example of the clustering of members of particular crafts or callings. The Fleshers were located mainly in South Street, which as noted has not seen the same level of recent development and therefore archaeological investigation as the High Street. A map of watching briefs carried out in Perth shows how few small-scale interventions have been recorded in South Street (Smith et al 2016). We might look in future to this area for answers to questions about the fleshing craft. Other small-scale industries based on animal resources were carried out by workers not yet admitted to the Glover craft. For example, we know that there are foci for the skinning of small animals, mainly cats and dogs, for their pelts in the High Street (Hodgson et al 2011) and that antler working took place in St John Street (Smith 2016). Deposits of cattle horn cores are abundant at sites in the High Street, and associated with both skinning and leather-working (recognised crafts later associated with the glovers) and the less prestigious working of horns and antlers. Other significant deposits of horn cores have been found at sites further from the core of the burgh, at Canal Street and South Methven Street. This may imply the flitting of what must have been a noxious industry to the outskirts of the burgh (Smith 1996, 812–3; Smith and Hodgson 1987, 197).



Bone and antler artefacts (7-13) from St. John's Square, Perth © Archaeology Reports Online, 2016

The most abundant bone remains in Perth are those of cattle, and while sheep/goats are always present, and plentiful, the proportion of these two domesticates to each other is not always the same at every site. This may be due to retrieval bias, or to the methods used to calculate abundance. For example, large fragments are easier to see and recover, therefore there is an assumed bias towards larger animals. Also, the bones of younger animals are less densely mineralised and therefore may survive less well.

Taking factors such as differential survival into account, a picture of Perth in the 12th–15th centuries has emerged which reveals an economy firmly based on primary products derived from domestic animals, principally cattle and sheep. Documentary sources

such as the Exchequer Rolls confirm these products as hides, wool and woolfells while the Perth Guildry Book (Stavert 1993, 216) confirms the exportation of the skins of smaller animals. Horses and pigs were an important part of the faunal economy, but their use could be considered as domestic rather than commercial. The species which generated revenue in the forms of taxes and customs were cattle and sheep. The role of goats is poorly understood but they played a small but significant part in both the domestic sphere (milk and meat) and the commercial (suppliers of skins). Animals raised in the hinterlands of the burghs were therefore of prime importance to the economy not only of our area but of Scotland as a whole. A smaller number, which we can surmise by the presence of byres and enclosures or stockpens, were kept in the Perth backlands themselves (Coleman 2004, 312).

Synthetic accounts of Perth assemblages have formed part of the concluding chapter of the 75–77 High Street environmental report (Smith 2011, 81–94) and of specific animals within medieval burghs – dogs, cats and horses (Smith 1998) and pigs (Smith 2000). Recent reworking of past morphological data from 75–77 High Street has shown that previous conclusions regarding the small stature of domestic livestock in the late medieval period of Perth still hold up in the face of statistical testing (Nevin 2018). There is some scope for revisiting past animal bone assemblages and adding to the original dataset of morphological measurements made at the time of initial analysis and recording.

Besides mammal and fish bones, which are indicative of local and national trade, bird bones and mollusc shell provide important information about the local environment. Excavations at 75–77 High Street produced an abundant bird bone assemblage, indicating the importance of domestic fowl and geese, and a relative lack of evidence of domesticated ducks. Wild anatids – geese, ducks and swans, although present in relatively small numbers, do however indicate the exploitation of wetland resources, such as the estuary and its littoral. Further habitats, such as moorland and woodland were also exploited, as the presence of wild galliform species such as black grouse and their raptor predators attests (Smith and Clarke 2011). Excavations in upland areas where species such as ptarmigan originated have to date failed to provide similar information on avian remains, due probably to unfavourable burial conditions (acid soils; cremation of remains, whether accidentally or deliberately).

Large wild mammals such as red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) are found in low but persistent levels within burgh assemblages and are further evidence of the exploitation of hinterland species. Fallow deer (*Dama dama*), a later introduction, have so far not been identified. Medium-sized wild mammals such as badger (*Meles meles*) are present but uncommon; one example of badger has been found at Meal Vennel (Smith 1996, 793). Foxes (*Vulpes vulpes*), caught for their fur, are probably present at many sites in Perth, but fragments are almost indistinguishable from those of small dogs, which were also exploited for fur/skins.

Meal Vennel in Perth © Unknown (CC BY-SA)

Evidence of rabbits (*Oryctolagus cuniculus*) is also scant in Perth and so far dating their remains has been problematic due to their habit of burrowing. However, recent radiocarbon analysis of a rabbit bone from South Street, St Andrews has shown a late medieval date of AD 1320–1392 (Hall and Smith 2017, 177). Verification of a medieval date of introduction of this species to Perthshire may therefore be possible from samples already excavated. Rabbit warrens were part of the economy of religious houses such as the abbey of Coupar Angus but as yet there is no direct archaeological evidence for the practice (Coupar Angus Rental Book).

Fish bones do survive well in Perth but have probably been under-represented at sites other than 75–77 High Street (Jones 2011), in part to a lack of targeted

sieving strategies. This should be considered if further large-scale excavation is carried in the future.

Oyster shells are as abundant in late medieval Perth, as other north-east coast burghs such as Montrose, Arbroath and Aberdeen itself. Inland burghs such as Kinross and Auchterarder are less well represented in terms of their past excavation but may yield results in future. So far, we are unaware of the origin of the oysters. It may be the Forth, which was home to a flourishing shellfish industry in the later 18th and 19th centuries, but the Tay may well also have been home to oyster beds (Heppel et al 2011). Future excavation/analysis may provide further information on their origin particularly if isotopic analysis can be applied to museum assemblages such as those that still exist for Perth watching briefs (Smith et al 2016). Other marine species found in Perth are mussels, wulks, buckies and limpets. Freshwater pearl mussels have also been found at 75–77 High Street and at Horse Cross (Heppel et al 2011, 62; Smith 2007, 186), presumed to originate in the Tay or its tributaries.

Rural

In contrast to the excellent condition of urban waterlogged material, sites in rural upland areas, where the soil is thin and acidic, have produced far fewer animal remains. Typically the survival of unburnt bones in upland areas is poor and most of the information comes from bones which have been subjected to high temperatures. Cremation of both human and animal bone leads to a restructuring of the remaining inorganic material into a crystalline form more able to survive burial conditions (Mays 1998, 207–9). However, there is always so much fragmentation that only the most compact elements survive in a recognisable form. Animal bones recovered from, for example Castle Craig (Poller forthcoming), are typical of such cremated bone assemblages but which are nevertheless important indicators of livestock husbandry in the rural rather than the urban sphere.

Medieval Castle Craig, Perth © HES

Rare exceptions do however occur, however, as at Lair, Glen Shee (Strachan et al 2019). While these are of earlier date period, they do indicate the potential for survival outside of the urban centres.

Evidence of the interaction of the rural with the urban economy, for the moment, serves as a proxy for the species present within the environment of the hinterland (see Environmental Conclusions, Perth High Street Fasc 4: Smith 2011).

Zoonotic diseases

The COVID-19 pandemic has brought the importance of animals as hosts for novel viruses sharply into focus, but other classes of micro-organisms shared between humans and animals have in the past had equally catastrophic consequences. The plague bacillus (*Yersinia pestis*) is the best known, and its DNA has recently been identified in early medieval human remains from Edix Hill, Cambridgshire (Keller et al 2019). Plague has yet to be identified in skeletal material from Perth and the relationship with rodent vectors established. To date, very little real evidence of black rats (*Rattus rattus*) has been recovered from medieval Scotland. In the future, sampling strategies that are designed to recover small mammal evidence should be considered.

Tuberculosis (TB) may also have animal as well as human vectors: cattle, and less frequently sheep, are affected by *Mycobacterium bovis* which is easily transmissible to humans via droplets found in animal breath. This may have been a factor in medieval dwellings shared by humans and animals, or via infected milk (Mays 2005). A possible route for investigation would be DNA analysis of human bone

displaying potential palaeopathological evidence of TB. Several human bone assemblages exist in museum storage which could be re-examined.

Research Priorities

Burgh of Perth: There needs to be an agenda for research into future urban development areas, eg Skinnergate, which is not yet excavated, but likely to be the subject of development; There are also likely future developments in South Street possible in light of reconfigured shopping streets. While the Thimblerow development was cancelled/postponed it is likely to re-emerge. Future excavations have the potential to produce large artefact and ecofact assemblages.

Other burghs: evidence for important burghs in Perth and Kinross besides Perth itself is sparse. Scone could provide useful information: the late Dr Oliver O'Grady carried out survey and excavations that recovered a faunal assemblage, which is as yet unpublished

Rural hinterlands: Few sites of this date 'without the burgh' have produced animal bone. Deer parks might prove interesting in future.

Existing data and archives: There is no complete digital database of faunal material from Perth. There is also an ongoing demand from research students and others to know quickly and easily whether particular assemblages exist, where they are held and how to access them.

Unpublished sites: Some important sites remain unpublished where the funding stream has failed. Such assemblages are not yet archived and are therefore not available to researchers.

Scientific techniques: Isotopic analysis of urban bone material in order to determine origin of animals (burgh hinterlands or further afield?). Analysis of lipid deposits on/in ceramics has been used successfully on pottery from Perth High Street, but this technique has since been under-used. DNA testing of leather to determine species of origin has not yet been attempted.

Human health and zoonotic diseases, eg tuberculosis/ brucellosis. This is caused by *Mycobacterium tuberculosis* complex. DNA analysis of human remains may offer evidence of TB infection via animals.

Rabbits: Radiocarbon dates may be possible in future and may be used to resolve the vexed question of their introduction to Scotland.

Research Questions

PKARF Qu 9.73: How can we prepare for storage of existing and future assemblages?

PKARF Qu 9.74: How can we evaluate what to retain in the face of space shortage versus unknown scientific advances which may require samples we are tempted to discard?

PKARF Qu 9.75: Should we continually review where and what to retain?

PKARF Qu 9.76: Does the animal bone from the excavation at Scone inform the site interpretation?

PKARF Qu 9.77: Can the sites of lowland production and upland transhumance be detected in the hinterland of the burgh?

PKARF Qu 9.78: Can excavations of deer parks provide useful information regarding the exploitation of hunted animals, and the existence of hawks and hounds?

PKARF Qu 9.79: Can a database be created for existing non-digitised faunal data?

PKARF Qu 9.80: Would a secondary bibliography for all published environmental resources for Perth and Kinross, (digital and paper) be of use to researchers?

PKARF Qu 9.81: Can an openly accessible database of all environmental material held in local museums be created?

PKARF Qu 9.82: Can a priority list of important unpublished sites with no known funding stream be made?

PKARF Qu 9.83: Can isotopic analysis shed light on food supply and the economics of animal products for export (skins, wool etc)?

PKARF Qu 9.84: Can lipid analysis of pottery sherds be used to determine the origin of animal fats? Were the fats the result of dairying or of meat consumption? Which animals were milked, and in what relative proportions – cow, sheep or goat?

PKARF Qu 9.85: Can DNA analysis successfully

identify the species of origin of leather? Do species proportions reflect exports recorded in the ERS?

PKARF Qu 9.86: Can M. bovis (brucellosis) be accurately identified in human and animal remains?

PKARF Qu 9.87: What is the radiocarbon evidence for a medieval introduction for rabbits?

9.5.7 Post Medieval

Cromwell's Citadel, built 1651 and reused during the Jacobite period, unfortunately provides little evidence of animal use as there is good reason to suspect the bone material is redeposited late medieval material from elsewhere in the town (Smith 2002, 162).

Outside of Perth, Allt na Moine Buidhe excavated by Stewart, thought to have been occupied during the early 18th–early 19th centuries produced only a small quantity of burnt bone, one possibly from sheep (Smith 1999, 126).

Allt Na Moine Buidhe from the air © HES

The Ben Lawers project was similarly, and sadly, unproductive as regards animal bone of the post-medieval period (Atkinson 2016).

Evidence for the 18th to 20th centuries is sparse within urban Perth, in part due to the removal of much material during the construction of cellarage in the 18th and 19th centuries. This is unfortunate as the period of agricultural improvement saw many changes to stock breeding and management, leading to the increased height, weight and appearance of many livestock breeds and the extinction of (wrongly) undervalued native breeds. Changes in butchery practice, however, are not thought to have occurred much before the 19th century and possibly remained unchanged in rural Perthshire until after WW2.

Research Priorities

The post-medieval period in Perthshire is poorly represented in terms of faunal assemblages. Opportunities to study the faunal assemblages seem vanishingly rare.

The demolition and renovation of post-improvement farm buildings (eg steading conversions) should be closely monitored for faunal evidence.

Estate records can provide evidence.

Research Questions

PKARF Qu 9.88: Can landscape surveys obtain evidence of potential sites?

PKARF Qu 9.89: Can evidence of animal husbandry be obtained from estate records/other documentary sources?

9.6 Isotopic Research

By Kate Britton and Orsolya Czére

9.6.1 Late Upper Palaeolithic and Mesolithic

To the best of the authors' knowledge, no Late Upper Palaeolithic or Mesolithic archaeological human or animal bone has been identified to date from Perth and Kinross, or analysed for stable isotopes.

There is currently a scarcity of documented Scottish human bone or (anthropogenically-created) zooarchaeological remains dating to any stage of the Late Palaeolithic period across Scotland. However, as outlined in this section, the evidence for human activity (in the form of flint scatters, etc) is increasingly accepted. Research in other parts of Britain and in mainland Europe has highlighted the great potential for isotopic approaches in better understanding diet and mobility patterns, both of humans and the animals they relied upon, in this period, and to better understand the natural environment (eg, Richards

and Hedges 2003; Richards and Trinkaus 2009; Stevens et al 2010; Britton et al 2011; Jones et al 2018; Pederzani et al 2021). These studies confirm that in the future, materials permitting, isotopic studies could greatly enhance our understanding of this archaeologically-elusive time period. These themes dovetail with the main research agendas for this period, in particular the characterisation of the environment and the nature of landscape use. Until the discovery of well-contextualised and/or dated human or faunal remains from the period, the potential for isotope studies on archaeological remains are limited.

The Perth and Kinross landscape, taken from Dunkeld © Gunther Tschuch (CC BY-SA)

For the Mesolithic period, both human and faunal remains from archaeological contexts in Scotland have been identified and studied, including for stable isotope analysis (eg, Richards and Hedges 1999; Richards et al 2003; Richards and Mellars 2015; Richards and Schulting 2015). To date, these have largely been restricted to the islands, the north and south-west of Scotland, and have evidenced dietary changes associated with the transition to farming. In the most recent work, the generation of dietary isotope measurements (carbon, nitrogen, sulphur) have been integrated with Bayesian modelling (FRUITS) of the data, enhancing the understanding of the transition to farming, which was a lengthy an gradual process, from a dietary perspective at least (eg, Bownes 2018). To date, strontium (and oxygen) isotope analyses, which have largely been employed to explore human and animal mobility in archaeological case studies, have been underemployed in Scotland for the Mesolithic period. These methods require the preservation of teeth, as opposed to bone, and require different instrumentation and expertise, and are more costly than carbon, nitrogen and sulphur isotope analyses. However, given the recent increase in application of strontium methods across archaeology as a field; the growth of expertise in these approaches within Scotland (eg, in Aberdeen) and more broadly within the UK; and the lowering of analytical costs; it is very likely that an increase of studies will soon follow. Despite this potential, there have, however, been no known stable isotope studies of Mesolithic human or animal remains from Perth and Kinross, likely given the dearth of documented animal or human bone from the period. Were archaeological materials to be found/identified in regional or national stores as originating in Perth and Kinross, any such studies should go hand in hand with radiocarbon dating at SUERC for example, maximising the return from destructive sampling of any new finds.

Research Priorities

The identification and cataloguing of collections of Late Pleistocene or early Holocene human and animal material that may already be held within Perth and Kinross or that which may be held in other national institutions and originate from the region.

The radiocarbon dating of isolated or unclassified materials which could potentially date to this period, including human and faunal remains. This should be conducted as part of commercial work, local museum or heritage initiatives, or research projects.

Given that stable carbon, nitrogen and sulphur isotope data can be generated alongside radiocarbon dates in some institutions, for example at the Scottish Universities Environmental Research Centre (SUERC), such an approach should be undertaken to maximise initial destructive sampling of any materials identified.

9.6.2 Neolithic

To the best of the authors' knowledge, no Neolithic archaeological human or animal bone has been identified to date from Perth and Kinross, or analysed for stable isotopes.

Considering Scotland as a whole, a fairly large

amount of isotopic research focused on the Neolithic period has been conducted. These studies, which have largely concentrated on Orkney and other islands, have examined the nature of the Mesolithic-Neolithic transition. Overall, they have contributed to the broader debate by evidencing either a short sharp shift in diet or conversely more gradual changes depending on the area/study in question (eg, Richards et al 2003; Bownes 2018). They have added to our understanding of marine resource use during the Neolithic period itself (eg, Montgomery et al 2013). Studies on Neolithic fauna have also been conducted, both to better understand human diet, but also to reconstruct past animal husbandry practices (eg, the practice of seaweed foddering and shorefront grazing in Neolithic Orkney and other Scottish islands, see Balasse et al 2006; Jones and Mulville 2016). Studies of human and faunal mobility also have great potential in this time period, as a means of understanding lifetime movements, human population mobility and the trade and circulation of animals/animal materials (ie using strontium, oxygen or sulphur isotopes). As with earlier periods, mostly due to poor preservation or to a dearth of previous investigation/dating of suspected Neolithic human and animal bone from Perth and Kinross, there has been a lack of isotopic investigation of Neolithic material from this area. Were archaeological materials to be found, any such studies should go hand in hand with radiocarbon dating at SUERC for example, maximising the return from destructive sampling of any new finds.

Cropmarks at Littleour, a Neolithic tomb in Perth and Kinross © HES

Research Priorities

The cataloguing of collections of Neolithic human and animal material exist within Perth and Kinross or may be held in other national institutions, and originate from the region.

The radiocarbon dating of isolated unclassified prehistoric human burials in order to identify further material. This should be conducted as part of commercial work, local museum or heritage initiatives or research projects. The dating of existing museum collections, as well as new finds, should be considered a priority.

Given that stable carbon, nitrogen and sulphur isotope data can be generated alongside radiocarbon dates in some institutions (eg at SUERC), such an approach should be undertaken to maximise initial destructive sampling of any skeletons.

9.6.3 Chalcolithic and Bronze Age

A significant amount of Bronze Age skeletal material has been subject to stable isotope analyses; this is largely due to large-scale projects such as the Leverhulme-funded 'Beaker and Bodies Project'. The Beakers and Bodies project, for example, included material from all across Scotland for both dietary (carbon and nitrogen) and mobility (strontium and oxygen) isotopes. Both bone collagen and tooth enamel respectively were analysed (Pearson et al 2019). Despite the large-scale nature of this study, few samples from Perth and Kinross were included. An exception was a skeleton of a young male (17–25 years) from the site of Gairneybank (cist 3). Dating to the Early Bronze Age, this individual demonstrated a very low strontium isotope ratio – compared to values expected for individuals living in Scotland, combined with a relatively low oxygen isotope signature. These data led the researchers to conclude that this individual may have originated from a region of basaltic rocks and a typically mild climate, such as the area around County Antrim in Northern Ireland. The inclusion and discussion of these data on Canmore, alongside other details of the archaeology of the site – as well as in the overall project publications – is a demonstration of good practice, making the data and a short synthesis accessible for all. This highlights the power of isotope approaches in revealing individual life stories even where only a single skeleton is

studied from a site, as well as the mobile nature of individuals and populations in the early part of the Bronze Age (Pellegrini et al 2016). Recently, a single burial has been analysed, through a collaboration between the University of Aberdeen and Perth Museum, from the Late Bronze Age Perth and Kinross site of Lochlands Farm, Rattray for carbon, nitrogen and sulphur isotope ratios. The skeletal remains of an adult female with a perimortem injury to the lower jaw were uncovered from a cist facing W–S (Aitken, MacLaren and Scott 1962). These data, shown below in Table 2, demonstrate this individual's diet consisted of terrestrially-derived protein and a distinct lack of marine fish protein.

Sample ID	$\delta^{13}C$	$\delta^{15}N$	$\delta^{34}S$	%C	%N	%S	C:N	C:S	N:S
LF-1	-21.4	10.1	15.1	41.5	14.6	0.2	3.3	519	157

Stable carbon, nitrogen and sulphur isotope values of bone collagen from the adult female burial from Lochlands Farm, Rattra

These results are in keeping with diet in Scotland during all parts of the Bronze Age, earlier and later prehistory. Further analyses of this individual, for example, incremental analysis of their dentinal collagen for the reconstruction of dietary change during life or the analysis of their tooth enamel for strontium and oxygen isotopes to infer their childhood origin, would enhance our understanding of this individual's life history. The latter could be particularly informative given the isotopic evidence for a high level of immigration and personal mobility in Scotland and throughout the UK as a whole during the Bronze Age (Pellegrini et al 2016).

Clach na Tiompan Bronze Age chambered cairn, Perth and Kinross © MJ Richardson (CC BY-SA)

As highlighted in the above, the main research questions pertaining to isotopes in this period focus on the further characterisation of interpersonal mobility, both on a population and individual level, but also explorations of possible interpersonal and/or regional dietary variations and/or differences in the management of domestic animals. As with other periods, the analysis of childhood diet and of early-forming tissues to infer breastfeeding and weaning practices could also be illuminating in the Bronze Age as very little is known about these practices in prehistory. However, as with other, earlier, periods, further isotope studies in Perth and Kinross are restricted by the need for more detailed auditing and cataloguing of skeletal collections – both human and faunal – and by the difficulty of dating prehistoric inhumations in north-eastern Scotland without radiometric dating.

Research Priorities

The cataloguing of collections of Chalcolithic and Bronze Age human and animal material exist within Perth and Kinross or may be held in other national institutions, and originate from the region.

The radiocarbon dating of isolated unclassified prehistoric human burials in order to identify further material. This should be conducted as part of commercial work, local museum or heritage initiatives, or research projects. The dating of existing museum collections, as well as new finds, should be considered a priority.

Given that stable carbon, nitrogen and sulphur isotope data can be generated alongside radiocarbon dates in some institutions (eg at SUERC), such an approach should be undertaken to maximise initial destructive sampling of any skeletons.

Research Questions

PKARF Qu 9.90: How mobile were individuals in Perth and Kinross during the Bronze Age?

PKARF Qu 9.91: Were Bronze Age individuals consuming marine fish at all. Can the consumption be pinpointed at particular points in their lives?

PKARF Qu 9.92: What were infant feeding practices like in the Bronze Age?

9.6.4 Iron Age

As with other periods of prehistoric isotopic research, some research in Scotland has been undertaken, but has largely focused on the islands and other areas of good bone preservation. Little research has been conducted in Perth and Kinross to date. For example, a study of human burials and contemporary animal remains from East Lothian, including sites of Port Seton, Broxmouth, Winton House and Dryburn Bridge, concluded that terrestrial sources of protein such as cattle, sheep and to a lesser extent pigs were the dominant contributors to diet in the period (Dunwell 2007; Jay and Richards 2007). The data also suggest that, like Iron Age isotope and zooarchaeological data from other parts of Britain, marine fish was not widely consumed even at coastal sites. Thus, such studies have great potential to not only reveal dietary habits but also wider economic practice and even cultural preferences. Indeed, the lack of marine fish bones in British Iron Age contexts, and by extension the lack of marine fish in human diet inferred by stable isotopes in the same period, has led some to conclude that the consumption of marine fish may have been somehow prohibited, taboo or that other cultural aversions may have existed (Dobney and Ervynck 2007).

Beyond diet, and where multi-isotope methods are employed, the movement histories of individuals or groups have also been invested in Scotland in this period using isotope techniques. This period is of particular interest given the potential interactions between local populations and the Romans in the south of Scotland, and any differences in diet or movement histories that may have occurred either due to a direct or indirect 'Romanising' influence or due to a direct impact by Roman military activity. For example, the recent analysis of a group of Iron Age and Roman burials from Musselburgh in East Lothian revealed that Iron Age diet in this part of Scotland was low in marine fish but enrichment in ^{15}N led the authors to conclude that freshwater fish may have been consumed. The data from this study also indicated a high degree of individual mobility in the Roman burials compared to the earlier Iron Age individuals, and particularly of individuals who had been decapitated. While the decapitated individuals did not have a commonplace of origin, their non-local isotopic signatures highlighted that these individuals were not a continuation of a native Iron Age population. Instead they were likely to have been members of the Roman army themselves; this highlights the shared burial practice amongst the ethnically diverse Roman army (Moore et al 2020). Despite the success of analyses elsewhere in Scotland, there has been a lack of stable isotope studies conducted on Iron Age material in Perth and Kinross. As with other periods prior to the early medieval, this is a consequence of a lack of bone preservation and/or a dearth of radiometric dating of unassigned burials.

In Perth and Kinross specifically, there are examples of Iron Age human isotope data published to date, although no specific isotope research projects have been undertaken. These have instead, for the most part, been data produced through the course of radiocarbon dating. For example, from The Women's Knowe, Inchtuthil, stable carbon and nitrogen isotope data from bone collagen of one individual were produced alongside a radiocarbon date. The $d^{13}C$ and $d^{15}N$ data were -21.6‰ and 10.5‰ respectively (Winlow and Cook 2010, 55), indicating that dietary protein was terrestrial in origin (ie meat or dairy).

Research Priorities

The cataloguing of collections of Iron Age human and animal material exist within Perth and Kinross or may be held in other national institutions, and originate from the region.

The radiocarbon dating of isolated unclassified prehistoric human burials in order to identify further material. This should be conducted as part of commercial work, local museum or heritage initiatives, or research projects. The dating of existing museum collections, as well as new finds, should be considered a priority.

Given that stable carbon, nitrogen and sulphur isotope data can be generated alongside radiocarbon dates in some institutions (eg at SUERC), such an approach should be undertaken to maximise initial destructive sampling of any skeletons.

As with other periods, the analysis of childhood diet and of early-forming tissues to infer breastfeeding and weaning practices could also be illuminating in the Iron Age as very little is known about these practices in prehistory.

Research Questions

PKARF Qu 9.93: Was the consumption of marine fish universally low during the Iron Age in Perth and Kinross, and elsewhere in Scotland? Were freshwater fish being consumed widely?

PKARF Qu 9.94: Was there any Romanising influence in terms of diet in Iron Age Scotland, either directly or indirectly?

PKARF Qu 9.95: What is the evidence for interpersonal mobility in this period? Were Iron Age populations generally local?

9.6.5 Early Medieval

The early medieval period saw the political and cultural transformation of Scotland with the development of emerging centres of political power (Fraser 2009; Noble et al 2019). These changes could have had profound impacts on social structures, economies and agricultural practices and cultural norms, which themselves may have manifested as differences in human lifeways that isotopic approaches could help to reveal and better understand.

Reconstruction of Blair Atholl man by Hayley Fisher © Perth and Kinross Museum and Art Gallery

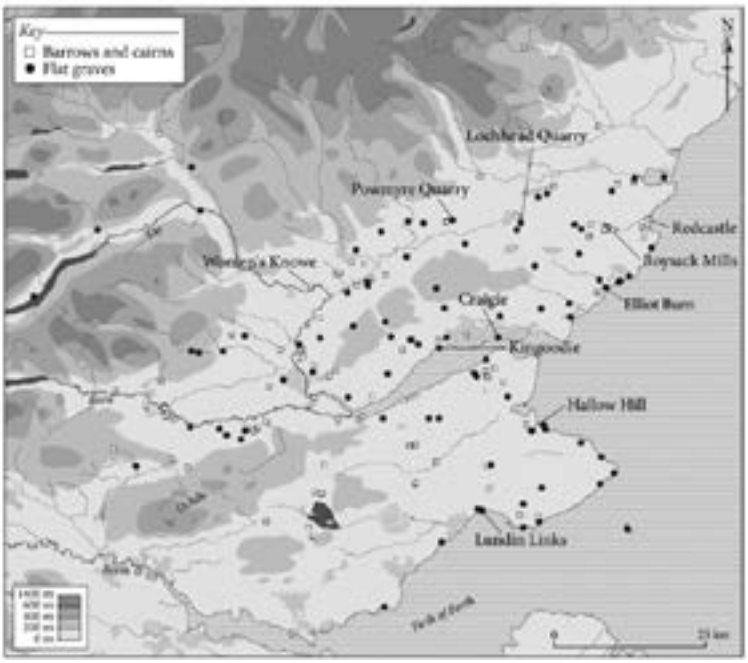
The remains of an adult male were uncovered in a West-East facing long cist grave at Bridge of Tilt in 1985 and the individual became known as the Blair Atholl man. The 5th–6th century burial has recently been subject to advanced study as part of a commercial, community and academic partnership, enabling the employment of multi-isotope approaches to gain insight into the diet ($d^{13}C$, $d^{15}N$) and early life mobility ($d^{18}O$, $^{87}Sr/^{86}Sr$) of this individual (see Czére et al in press).

Similar to previously published dietary data from early medieval/Pictish remains from Scotland (Barrett and Richards, 2004; Curtis-Summers et al 2014; Parker Pearson et al 2018; Curtis-Summers et al 2020), including those from Perth and Kinross (Winlow and Cook 2010), the carbon and nitrogen stable isotope values of bone collagen extracted from the remains indicate a diet largely focused on terrestrial food sources, with a potential emphasis on pork or other higher trophic level sources of protein (Czére et al in press). The results of strontium and oxygen isotope analyses of tooth enamel suggest a childhood spent in a more westerly location, possibly including areas of Mull, Iona, Coll, Skye or Ireland. These results are significant in that they provide direct evidence for the movement of an individual from western Scotland or even further afield into the Central Highlands during the 5th–6th century.

As well as focusing on other early medieval individuals, future studies should focus on creating appropriate faunal baselines which will enable more nuanced interpretations to be made regarding the human isotope values as well. Furthermore, utilising an incremental dentinal approach is also advised to recognise potential more short-term dietary changes through the early life of early medieval individuals.

While there have been limited, intentional, isotope studies of early medieval burials from Perth and Kinross, other isotope datasets likely exist associated with radiocarbon dates of human bone. This will likely be the case with other time periods, and efforts should be made to accumulate and analyse isotope data from such sources. For example, recent excavations at Bankhead of Kinloch conducted by AOC Archaeology Ltd led to the dating of human remains from several burial cists, including samples of human bone (see Bankhead of Kinloch case study). The carbon and nitrogen isotope data are included within the radiocarbon dating report and are comparable to that of the burial from Blair Atholl, evidencing a terrestrially-based diet albeit featuring

protein from high trophic level animals. It highlights the commonalities in diet across the region in this period.



Location of 'monumental' graves (barrows and cairns) and 'flat graves' (long cists and dug graves). Distribution map by Sarah Winlow, based on the original prepared by Ingrid Shearer, courtesy of the University of Glasgow

For example, isotopic analysis may aid our understanding of dietary changes or differences in individual and population level movements. In recent years there has been renewed interest and considerable investment in research into this period, eg, the Northern Picts/Comparative Kingship Project at the University of Aberdeen. This, and other, research (Maldonado 2011; 2013; Mitchell and Noble 2017) has led to a better appreciation of both human and animal skeletal collections from this period in Scotland and – in many cases – their chronometric dating. It has included Pictish burials from Perth and Kinross (Winlow 2010). The work on Pictish burials across Scotland has paved the way to isotopic studies, notably the HES and AHRC funded doctoral study, the *Dark Ages Diet* project. This project sought to characterise the dietary changes in Scotland from the early to late medieval period, leading to the extensive sampling of human and faunal skeletal material from across Scotland, particularly northern and eastern parts. One human individual was studied from Perth and Kinross, while no faunal remains were sampled from the area from this period (Czére 2020). A small number of isotope analyses have been conducted on other early medieval skeletal remains from Perth and Kinross as part of other studies, mostly through the course of radiocarbon dating. For example, a female individual from 5th/6th century Kingoodie long cist cemetery had carbon isotope ratios of -20.9‰ and a corresponding nitrogen isotope value of 11.1‰, indicating that protein in the diet was predominantly terrestrial in origin (Winlow and Cook 2010).

Research Priorities

The identification and sampling of early medieval faunal, as well as human, skeletal materials within Perth and Kinross or may be held in other national institutions, and originate from the region.

The radiocarbon dating of isolated unclassified prehistoric human burials in order to identify further material. Given that stable carbon, nitrogen and sulphur isotope data can be generated alongside radiocarbon dates in some institutions (eg at SUERC), such an approach should be undertaken to maximise initial destructive sampling of any skeletons.

The cross-checking of existing/recent radiocarbon dates for associated stable isotope data, and the analyses of these data specifically for dietary analyses. For example, these digests could be added to Canmore or provided to institutions where collections are held.

Following on from the work at Blair Atholl, other already identified early medieval human remains (eg those at Bankhead of Kinloch) could be analysed further (eg for strontium and oxygen isotopes), particularly to assess geographical origin and explore the prevalence of high personal mobility at the time. This could be coupled with the incremental analysis of dentinal collagen, in order to assess dietary changes during life.

Alongside further human studies, faunal samples from this region/period should be samples for carbon, nitrogen and sulphur isotopes as a means of better understanding baseline isotopic values for the region/period. Depending on sample availability, this could lead to studies of fauna explicitly to explore early medieval animal husbandry and management.

Research Questions

PKARF Qu 9.96: How did urban and rural diets in Perth and Kinross compare differ in the Medieval medieval period?

PKARF Qu 9.97: The vast collection of faunal unearthed from Perth would allow for a more in-depth focus to be placed at the medieval faunal remains, to explain the provisioning of the royal burgh and contemporary animal husbandry strategies.

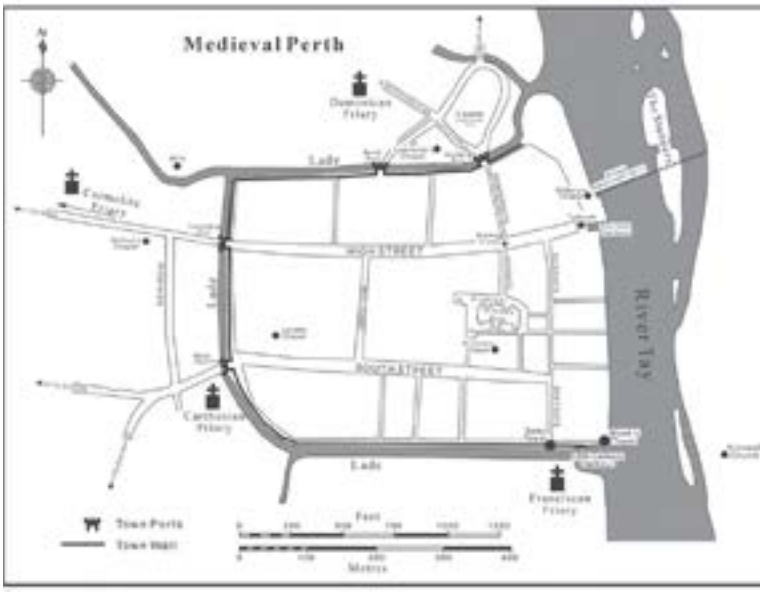
PKARF Qu 9.98: How did diet change during life-course?

PKARF Qu 9.99: What was the lifetime-time mobility of individuals living in Perth and Kinross during the Medieval medieval period? How were the cities and urban environments connected?

PKARF Qu 9.114: What were breastfeeding and weaning practices like in Perth compared to other royal burghs and elsewhere in Britain during the medieval period?

9.6.6 Medieval

Over the past 15 years, there has been a significant growth in stable isotope studies in historic periods, and perhaps one of the biggest growth areas in Britain has been the application of stable isotope approaches to explore medieval lifeways. This has included explorations of dietary differences with religion, status and site type (eg Müldner and Richards 2007; Müldner et al 2009; Müldner 2016; Curtis-Summers et al 2020), mobility histories (eg Müldner et al 2009; Lamb et al 2012), and infant feeding practices (eg Burt 2013; Britton et al 2018). As part of University of Aberdeen's HES/ AHRC funded *Dark Ages Diet* project stable isotope approaches were utilised to investigate the dietary variability in three major developing medieval urban centres of Scotland: Aberdeen, Perth and Edinburgh (Czére 2020). Easy access to sea routes was a crucial factor which gave an advantage to the trading cities situated on the east coast of medieval Scotland, many of which developed into royal burghs, with exclusive rights to engage in international trade (Booton 1988). Although not a coastal settlement, along with Aberdeen and Edinburgh, Perth also became a royal burgh and it was a crucial Scottish port. Thus the merchants of Perth were actively trading overseas, and in direct contact with their counterparts in Aberdeen, Dundee and Edinburgh in particular (Whyte 2014). To explore the dietary landscape of this formative period within these medieval urban centres, including Perth, stable carbon, nitrogen and sulphur isotope analytical techniques have been employed on human and faunal skeletal remains from local medieval sites (Czére 2020).



9.6.7 Post Medieval

To date, and to the best of the authors' knowledge, no human or faunal post-medieval skeletal remains from Perth and Kinross have been subject to stable isotope analysis. However, materials almost certainly are in existence, housed in regional or national museums.

The utility of stable isotope analyses in gaining insight into the life and diet of populations through time has been widely demonstrated and utilised in England (eg Henderson et al 2014; Bleasdale et al 2019; Dhaliwal et al 2020). However, there have been very few isotopic studies in Scotland addressing dietary transitions from the medieval to the post-medieval period (but see Lamb et al 2012; Britton et al 2018). No post-medieval skeletal assemblages from Perth and Kinross have yet been isotopically analysed. Nonetheless it would be most valuable to conduct dietary and mobility studies within the area in order to characterise the influence of the various socio-economic transformations which affected the local population after the Reformation. Using stable

carbon and nitrogen isotope analyses, it is also possible to investigate breastfeeding and weaning customs as a potential indicator of changing societal norms (Britton et al 2018), which could be applied to the city of Perth were sufficient materials identified. Furthermore, the silting of the River Tay at the end of the 16th century must have had a considerable impact on the local population, both of the city, as well as its rural surroundings (Ditchburn 1988; Bowler et al 2004). Characterising this time period isotopically would help researchers gain insight into the changing lifeways of the local population during a transformative time period.

Rural Perthshire © HES

In addition to analysing suitable human skeletal remains it would be crucial to create a post-medieval faunal baseline. Comparing post-medieval faunal isotope data to medieval patterns would allow the identification of possible changes in animal husbandry practices, which in turn would influence the local population.

Post-medieval Queen Street, showing Coupar Angus Abbey © Perth and Kinross Heritage Trust

The Anglo-Scottish treaty of Union of 1707 was perceived to offer opportunities for economic expansion, and the coming century accompanied by the parallel industrial and agricultural revolutions would have undoubtedly impacted the lifeways of the Scottish population. In studies in England, the developmental and health differences between urban and rural populations have been well demonstrated from a palaeopathological perspective (eg Newman and Gowland 2017; Gowland et al 2018; Newman et al 2019). Lifestyle changes associated with the increasingly industrialised society can also be observed in the dietary trends, as well as changing breastfeeding practices of these populations (Nitsch et al 2006; 2011). Furthermore, utilising incremental analysis of dentinal collagen it has also been possible to characterise changes in early life diet and potentially identify significant events of nutritional stress in this period, such as the Irish Famine (Beaumont et al 2013). However, in Scotland, the isotopic analysis of assemblages from this time period has been so far neglected. The exploration of the isotopic patterns associated with increasing societal, political and economic transformations would be of great value.

Research Priorities

Considering the lack of isotopic data available from the period from Perth and Kinross, the main priorities should be:

1. Identifying suitable assemblages for stable isotope analyses. In addition to the study of post-medieval human remains it is crucial to sample local and contemporary faunal material to appropriately characterise the local food web.

2. Considering the stable carbon, nitrogen and sulphur isotopic output of the radiocarbon dating process, samples should be selected accordingly, to maximise the information gained via a destructive sampling method.

3. Radiocarbon-dated skeletal material from the period should be identified, the stable carbon, nitrogen (and possibly sulphur) isotope data produced during the RC dating process should be collected and analysed (human and fauna alike).

Were sufficient materials to be obtained, the following questions could be approached using stable isotope analyses.

Research Questions

PKARF Qu 9.101: How did the increasing urbanisation of Perth influence the dietary lives of the contemporary urban versus the rural population?

PKARF Qu 9.102: Can the early influence of the River Tay at the end of the 16th century be observed in the dietary and mobility patterns displayed by the people of the burgh city of Perth?

PKARF Qu 9.103: Is there evidence of changing breastfeeding and weaning patterns from the medieval to the post-medieval period in the city of Perth (as observed in other Scottish burghs)?

PKARF Qu 9.104: What are the isotopic characteristics of post-medieval animal husbandry practices in Perth and Kinross?

PKARF Qu 9.105: How did the increasing industrialisation of the Scottish cities affect the dietary lives of the urban and those of the rural population?

PKARF Qu 9.106: Did new dietary patterns develop in the cities and rural areas of Perth and Kinross associated as a result of the industrial and agricultural revolutions? Can we see evidence of imported or exotic foodstuffs (eg maize, sugarcane), or other 'global foods'?

PKARF Qu 9.107: What was the influence on lifetime mobility and diet of the local inhabitants of the expanding economic horizons following the Anglo-Scottish Union?

PKARF Qu 9.108: Do breastfeeding and weaning patterns indicate societal change from the post-medieval to the early modern period influencing these practices in both urban and rural areas?

PKARF Qu 9.109: What are the isotopic characteristics of early modern animal husbandry practices in Perth and Kinross? Do we see evidence of agricultural intensification?

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