Updated research framework For the Archaeology of Wales: Palaeoenvironmental

Compiled by Tudur Davies

Working Panel Contributors

Rhiannon Philp, Tomos Jones, Jacqui Mulville and Elizabeth Walker.

Reviewers

Martin Bates, Martin Bell, Astrid Caseldine, Wendy Carruthers, Rhiannon Comeau, Andrew Davidson, Toby Driver, Fiona Grant, Seren Griffiths and Richard Madgwick.

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1. Introduction

This document provides a review of the more recent research undertaken in Wales relating to themes provided in previous research framework documents. The review included a detailed examination of published and grey literature sources relating to environmental research relevant to Wales undertaken since the previous review of June 2017. This includes publications on major excavation works, such as at Llangorse Crannog (Lane and Redknap 2019), South Wales Gas Pipeline (SWGP - Darvill *et al.* 2020), Parc Cybi (Kenney *et al.* 2021) and Five Mile Lane (FML - Gilbert *et al.* 2024) to name but a few. As part of the review undertaken by the working group, a call was made to professionals working in the UK via the Association for Environmental Archaeology (AEA) discussion forum to provide information on relevant grey literature reports.

Great advances have been made in the field of palaeoenvironmental archaeology since 2017, particularly in the field of isotope analysis on animal bone (e.g. Madgwick *et al.* 2019) and crop assemblages (Treasure *et al.* 2019) that demonstrate the need for more widespread use of this analysis. Ryan *et al*. (forthcoming) have verified the feasibility of undertaking sedaDNA analysis for palaeoenvironmental construction on peat deposits from Traeth Mawr in Bannau Brycheiniog National Park, which should have widespread applications in the future. Detailed reviews of pollen studies for the early and later medieval periods have also been published (Davies 2019, 2022a), that demonstrate the complexity of environmental changes across Wales and the potential value of similar reviews for other periods. Despite this, there continue to be gaps in provision of certain types of analysis. For example, in McKenna's (2020a) review of the charcoal from Parc Cybi, she critiques the lack of detailed work on charcoal in Wales, which is largely limited to the identification of species for radiocarbon dating. There is an absence of systematic approaches across different organisations and projects, and an inconsistency in sample recovery methods for different biota/ecofacts. Geoarchaeological analysis is specifically rare, especially in developer-led archaeology. In many cases in commercial archaeology, pollen analysis is also lacking where waterlogged deposits are impacted by road schemes or pipeline routes (with the exception of the SWGP and the Burbo Bank windfarm pipeline). Our knowledge of animal husbandry and exploitation of wild animals in the early medieval period has recently benefited from the completion of research on three significant sites (Llangorse - Mulville et al. 2019, St Patrick's Chapel - Hadjikoumis and Maccarinelli 2022, and Five Mile Lane - Calis 2023), but our understanding

of animal domestication and developments in animal husbandry is still lacking in many other periods, caused by the poor preservation of unburnt animal bones across much of Wales. This demonstrates the need for targeted excavation work in areas with base-rich soils across Wales (e.g. southeast Wales, northeast Wales, Anglesey, Pembrokeshire), that have the potential to increase the number of animal bone assemblages to address key research issues. There is also a worrying trend that environmental analysis (and scientific analysis overall) is becoming increasingly rare within final site publications. It is acknowledged that some authors have felt the need to place the detailed results of environmental analysis online for projects that produce very large archives. However, it isn't always easy to locate these detailed reports, and concerns remain relating to the longevity of digital archives given a lack of consistency in use of centralised digital repositories for archaeological projects in Wales. Although the Archwilio and Coflein websites do provide access to digital reports, full digital archives are not always submitted to these platforms. In the near future, a new digital repository for radiocarbon data will be launched - training materials and infrastructure for standardised reporting of radiocarbon data will be provided (Griffiths *et al*. 2023).

Despite the problems noted above, they can be addressed. As is noted in the recommendations section at the end of this document, there is a need for scientific archaeological advisors in Wales, especially for palaeoenvironmental/environmental archaeology (geoarchaeology included), to advise practitioners, curators, consultants and developers. The provision of such a post for Wales is vital to ensure that we do not continue to fall behind on standards in comparison with other nations within the UK, and more broadly across Europe.

2. Environmental Context and Landscape Change

2.1 How was the human presence in Wales during the Palaeolithic related to environmental conditions?

As part of a review of fauna from Welsh and other British sites, Dinnis *et al*. (2016) have re-examined the radiocarbon dating evidence from the mid-to-late Marine Isotope Stage (MIS) 3 and early MIS 2. Their results indicate that from 34 ka cal. BP, the range of taxa found from cave sites with carnivorous fauna is more restricted, coinciding with climate deterioration noted in ice cores and other terrestrial sources.

Several recent geomorphological and climate studies have also examined environmental conditions and modelled ice sheet development across Britain and further afield (Gibbard *et al.* 2017, Bickerdike *et al.* 2018, Glasser *et al.* 2018, Zhang *et al.* 2018, Harrison *et al.* 2021, Clark *et al.* 2021), providing better understanding of the development of Palaeolithic landscapes.

A greater understanding of deglaciation in Wales has been provided by the work of Bickerdike *et al.* (2018) Glasser *et al.* (2018), Clark *et al.* (2021) and Harrison *et al.* (2021). Clark *et al.*'s (2021) research examines the extent of the ice during the Late Glacial Maximum (LGM) across Britain by comparison of previously dated sites and new, purposefully collected suite of cores. Their research correlates well with the work of Glasser *et al.* (2018), which examined deglaciation in Wales from new geomorphological and geochronological information. It shows that the Irish Ice Sea Stream was receding by c.26.7 kBP and that deglaciation of the Cambrian Mountains was in progress by c.19.6 kBP. By around 14.9 kBP, the Aeron valley was likely to be free of ice, but the northwards retreat of the Teifi glacier halted in the Tregaron area. By c.13.5 K BP, during the Windermere Interstadial, the whole of Wales was ice free (Glasser *et al.* 2018). A slightly earlier date for a westward retreat of the ice cap from the southern Cambrian Mountains towards the Teifi Valley is suggested by Harrison *et al.* (2021), who researched solifluction sheets in British upland contexts. They indicate that this withdrawal was complete by c.16-17 kBP but note that ice had withdrawn from some of the most prominent upland ridges by around 19 kBP. Bates (pers. comm.) indicates that future work to determine the extent of the LGM ice sheet in Pembrokeshire would be specifically beneficial as its margins is yet to be fully understood in that area.

On a more local level in south Wales, recent investigations by Palmer *et al.* (2021) on the lake sediments of Llyn Syfaddon (Llangorse lake) record the presence of sequences contemporary with the late-glacial Windermere

interstadial in parts of the lake, when warmer conditions led to the deposition of nekron mud (gyttja). Furthermore, this work demonstrated that there are also marl deposits of equivalent date at shallower depths around the margins of the lake basin (Palmer *et al.* 2021: 284). Additional research on these deposits is planned for the future.

In Bickerdike *et al.*'s (2018) review of geomorphological studies across Britain, they provide estimates of the extent of the Loch Lomond Stadial's glaciation (c.12.9–11.7 k BP) at a regional scale. Although robust dating evidence is problematic, the current data suggests glaciation in Wales occurred only in upland sites, especially in Brycheiniog and Eryri.

Greater understanding of changes in sea levels in the late glacial and early Holocene for Britain is provided by Garrow and Strutt's updated (2017) models, which enables more nuanced contextualisation of human activities during those periods. Shennan *et al*.'s (2018) research on sea level changes since the LGM also contributes to our understanding of these changes. However, it should be noted that specific research on sea level change in Wales is rare and is based on very few sea index points (Bates pers. comm.)

2.2 *How did the availability of resources influence Mesolithic occupation?*

Mesolithic remains in Wales relating to human occupation are extremely rare and ephemeral in nature (cf. Little 2015) and are only rarely found in association with pollen sampling sites. Consequently, detailed analysis of Mesolithic archaeobotanical or zooarchaeological data produced since the last review is very scarce. The Mesolithic pit group at Four Crosses in Powys represents one of the few analysed sites to be published, where charred remains consisted only of a vetch seed and fragments of hazel charcoal (O'Brien 2023: 60). Analysis of plant macrofossils at Burry Holms, Gower, also provided some indication of human consumption and processing of hazelnuts and lesser celandine tubers. However, the source of wood charcoal at the site is ambiguous, for it could originate either from domestic fires and/or woodland clearance activities so the anthropogenic activity on the site cannot be interpreted from these remains (Jones and Challinor 2021). It is well recognised that hazelnut consumption continues into later periods. As such, Mesolithic features are not easily identifiable unless hazelnuts are subject to radiocarbon dating. The importance of dating such remains is demonstrated by work undertaken for the SWGP (Rackham 2020) and at Gwernvale (Caseldine 2021), where hazelnut shell found associated with

later material was only recognised as being Mesolithic through radiocarbon dating.

Pollen studies on sequences dating to the Mesolithic period have been published, but the majority of these studies are from environments where woodland or wetland taxa predominate the pollen assemblage, with little evidence for anthropogenic influences (e.g. Crawcwellt Core 1 - Crew 2022; Llangorse Crannog – Pardoe 2019; Parc Cybi Area G Core 1 – Geary *et al.* 2020). That said, possible evidence for human influence from microcharcoal is present at cores taken from Porth Neigwl (Caseldine *et al.* 2016b) and Waun Llanfair (Caseldine et al 2017c), whilst the environment surrounding Llangorse in the Mesolithic period does indicate the presence of open ground and evidence of grazing by wild animals – this may have contributed to the attraction of the lake to potential hunter gatherers, who may have been drawn to the lake for fishing and fowling activities (Pardoe 2019: 156-157).

Mesolithic grazing by wild animals is likely reflected in the pollen record from intertidal peats at Port Eynon off the Gower peninsula, where ribwort plantain (*Plantago lanceolata*) pollen has been identified alongside other grazing/disturbance indicators in a relatively open environment (Philp 2018: 187, 190, 192). Footprints found in the Late Mesolithic (5300-4990 cal. BC) peat deposits at Port Eynon also shows that human adults and children shared that environment with a number of wild taxa, including aurochs (juvenile), red deer, roe deer, wild boar and dog/wolf (Philp 2018: 161). This evidence compliments the results of fieldwork in the Severn Estuary, which has recorded over 500 footprints of birds, deer, aurochs recording Mesolithic intertidal sites at Goldcliffe (Barr 2018, Bell pers. comm.). Both studies provide evidence for the range of wild fauna available for human hunter gatherer communities in the Mesolithic period.

Recent fieldwork has also produced the first evidence of wood fish traps in the British Mesolithic dated 5310-4912 cal. BC (Bell et al. 2025). There is also a new phase of research by Scott Timpany, Nigel Nayling and Rod Bale and David Smith on the palaeoecology of Mesolithic and Neolithic intertidal woodland at Goldcliff, which is linked to the creation of a database of intertidal sites and palaeoenvironmental evidence (Bell pers. comm).

It is hoped that our understanding of Mesolithic communities in Ceredigion will soon be enhanced by the results of the Portalis project, which sought to understand the earliest connections between Ireland and Wales. As part of that project, cores have been analysed for pollen analysis from wetland habitats near archaeological remains of Mesolithic date in the Aeron Valley

and coastal peat deposits (Bates pers. comm.).

2.3 What were the environmental conditions in the immediate area and surrounding region of Neolithic and Bronze Age funerary and ceremonial monuments?

It is often difficult to understand the local environment surrounding archaeological sites. Taphonomic processes will invariably bias the results of archaeobotanical analysis because of the selective transport and utilisation of plants that reach the archaeological record, whilst deposits that are suitable for pollen analysis do not often survive (or are not sampled). Nevertheless, some information about the surrounding landscape is possible. For example, evidence of the range of plant resources available in the past was possible at Parc Cybi (McKenna 2020a&b), Hindwell Cursus (Caseldine and Griffiths 2018), Five Mile Lane (Carruthers 2024) and Gwernvale (Caseldine 2022) based on the results of archaeobotanical analysis.

At Parc Cybi, Holyhead, an Early Bronze Age ceremonial complex was identified, including a cemetery, enclosure, ring ditch and standing stone (Kenney *et al. 2021*). Unfortunately, although wetland areas were located nearby, no deposits contemporary with the ceremonial sites could be investigated through palynology, but charcoal analysis undertaken on the site from multiple periods appears to have relatively consistent results, providing an understanding of the composition of local woodland.

Oak charcoal appears most dominant, with a smaller range of other species utilised (McKenna 2020b: 512-513). In their analysis of charcoal from Hindwell Cursus, Caseldine and Griffiths (2018) found that it was uncertain whether wood charcoal identified at the site represented wood from clearance burning or selected for domestic fires. Charcoal was relatively scarce, largely consisting of hazel and lower quantities of oak, suggesting that clearance activities prior to the construction of the cursus did not involve the use of fire, or that the pre-existing environment consisted of a relatively open landscape (Caseldine and Griffiths 2018).

The evidence from Bronze Age 'ritual sites' (sic) along the south Wales gas pipeline identified a number of plants that might be associated with ceremonies undertaken at each site (e.g. raspberry, sloe, haws, acorn, and hazelnuts), but it is unclear over what distance the site's inhabitants may have transported those items to the site (cf. Rackham 2020:159). Hazelnut shell was a common feature in many deposits at the site of a Neolithic post-

pit alignment and cremation found as part of the FML Development in the Vale of Glamorgan (Carruthers 2023), suggesting a local abundance. At Gwernvale Neolithic Long Cairn there is pre-cairn evidence for the exploitation of arable, scrub and woodland from the archaeobotanical evidence (Caseldine 2022), but it is still difficult to appreciate the full nature of environmental conditions in the surrounding area from site records.

More success in examining the local environment surrounding Neolithic and Bronze Age ceremonial/funerary sites has been possible at Porth Neigwl and Waun Llanfair because of the application of palynological techniques to study the sites. At Porth Neigwl, it was possible to combine the use of archaeobotanical and pollen analysis of deposits associated with the burnt mound (Caseldine *et al*. 2017b) as well as pollen analysis of nearby intertidal peats (Caseldine *et al.* 2016b). Whilst the charcoal assemblage is dominated by alder, the pollen evidence suggests that the immediate environment surrounding the site prior to its construction consisted of hazel woodland, with alder carr nearby. There is also "tentative evidence for the presence of livestock in the vicinity of the mound" from fungal spores that can be indicative of animal dung, though this possibly reflects the wider area rather than any functional relationship with the mound (Caseldine *et al.* 2016b: 35).

Caseldine *et al.*'s (2017c) work at Waun Llanfair represents an equally exemplary case study, where the pollen record of palaeosols beneath the standing earthworks of burnt mounds and cairns were compared to peat cores taken within c.500m of the archaeological remains. The pollen record from the Neolithic and Bronze Age buried soils indicate that the monuments constructed at the site were built in an open landscape, with evidence for grazing in the immediate environs of the site and possible cultivation activity nearby. Conversely, the evidence from peat deposits to the west of the earthworks (Waun Llanfair 1 and 2) indicates that woodland dominated their immediate contemporaneous environment. However, to the east (Waun Llanfair 3), peat deposits of Bronze Age date were far more open than those to the west, more in common with the record from palaeosol deposits, with evidence for an open landscape with grazing and arable activities nearby.

2.4 To what extent is there evidence of continuity of land-use and subsistence strategies from the Romano-British to the early medieval period?

A review of pollen evidence dating to the early medieval period in Wales has

shown evidence for landscape abandonment and a downturn in the farming economy, based on widespread instances of increased woodland and heath pollen in combination with reduced pastoral and arable indicators (Davies 2019: 180-184). A smaller number of sites in north Wales show reduced woodland taxa, which may indicate shifts in settlement locations. The evidence for landscape abandonment and reduced farming intensity has been interpreted as either reflecting a reduced demand for farming surplus at the end of the Roman Empire, or as changes in settlement and farming decline in response to climatic downturn at around the same time, observed by several studies (Rippon 1997; Charman *et al.* 2006; Büntgen *et al.* 2011; Barber *et al.* 2013). However, it should be noted that there are still geographic biases in the distribution of pollen sampling sites in Wales. Studies in lowland areas of south west Wales, the Welsh borderlands and Anglesey would be especially valuable for comparison with the current dataset.

A number of large early medieval charred seed assemblages have recently been published from commercial archaeological work in Wales, including Parc Cybi (McKenna 2020c) and FML (Carruthers 2023). This evidence largely consists of charred grain from corn drying kilns – a feature which has been the subject of a large-scale comparative analysis across Wales by Comeau and Burrow (2021). Their work indicates diachronic variations in the most common type identified in such features across the early medieval period. Cereal assemblages from the medieval period cannot be precisely dated on the basis of the crop or weed species present though they are distinguishable from Romano-British assemblages where hulled wheats (primarily spelt) are almost always dominant. In the absence of dateable artefacts, the radiocarbon dating of cereal grains is required in order to understand multiple- phased sites. Only three of the twenty-six grain drying kilns from FML were radiocarbon dated, though it is hoped that further work on this will take place in the future. The large-scale analysis of kilns by Commeau and Burrow (2021) suggests that barley becomes increasingly dominant among charred cereal grains from the 4th century, overtaking wheat in the 5th century. Later in the early medieval period, oat percentages in archaeobotanical assemblages increase in the 7th century, becoming highly dominant in the 8th century AD.

2.5 Is there similar evidence across the Iron Age/Romano-British boundary?

Several recent commercial archaeological projects have also recently published the results of archaeobotanical analysis on Iron Age and Romano-British archaeobotanical assemblages that have included cereal crops (Tai Cochion – Caseldine *et al.* 2016a; Parc Cybi - McKenna 2020c; FML – Carruthers 2023), though only a few of these studies had material to compare both the Iron Age and Romano-British periods. At FML, limited material was available from both periods and Carruthers (2023: 40) observes that there were no apparent changes in crop types in from the Iron Age up to the Romano-British transition. Caseldine's (2018) observations on Iron Age farming activity across Wales indicates that there is a large variation in crop types across the Iron Age, but that there was a trend towards increased cultivation of spelt. Possible reasons for this change might be that it was specifically selected as a main crop, or that with more extensive farming, it may have out-competed emmer if sown as a mixed crop (Caseldine 2018). Furthermore, Caseldine also notes that the pollen record for Wales in the Iron Age suggests increased woodland clearance as well as agricultural expansion, followed by a further possible expansion during the Romano-British period.

2.6 *What were the environmental conditions associated with wetland sites?*

The study of wetland sites in Wales has recently been the focus of increased research from commercial driven and academic projects. Rhiannon Philp's PhD thesis (2018) focussed on examining human response to sea level changes during the Mesolithic and Neolithic periods from an examination of intertidal peat deposits off the Gower peninsula. As noted elsewhere in this review, her work identified a new set of Mesolithic footprints from humans and animals, demonstrating the range of fauna sharing that environment with humans in the Mesolithic period, as well as establishing what the contemporary environmental conditions were with those remains. Additional research has also been undertaken in Ceredigion, where palaeoenvironmental sequences from multiple periods in coastal and inland settings were researched as part of the Portalis project (Bates *et al.* forthcoming). Radiocarbon dating of samples from these sites span the Upper Palaeolithic through to the early medieval period, which will potentially provide a comprehensive understanding of landscape change over time associated with these coastal wetlands.

Commercial archaeological work has also examined wetlands in north Wales. As part of the cable route for the Burbo Bank Windfarm near the north Welsh coast by Rhuddlan, drainage ditches, radiocarbon dated to the fifth to sixth century AD, were identified cutting through freshwater clays (Gregory *et al.* 2018). The authors suggest that these ditches reflect an episode of wetland reclamation originating in the early medieval period, possibly instigated by a minor north Welsh kingdom. If correct, such an enterprise would be unprecedented in the post-Roman period in Wales prior to the later medieval wetland reclamation on the Gwent Level (Rippon pers. comm.). Indeed, it would also be earlier even than the reclamation of the Fens in Norfolk, believed to have been undertaken in the 10th century (Rippon 2001: 145-149).

2.7 Is there any discernible difference in the environmental and biological evidence for land use across the interface between Welsh and English dominated parts of Wales and the marches in the early medieval and medieval periods?

Recent pollen reviews across Wales (Davies 2019, 2022a) indicate a sparse number of studies in 'anglicised' lowland areas in comparison to the mountainous uplands of Wales that withheld against English rule into the 13th century. This issue is partially addressed as part of the 'Manifestations of Empire' project (Davies *et al.* forthcoming), which has analysed pollen in lowland cores from south east Wales dated to the early and later medieval period.

Comeau and Burrow (2021) state that there is an increase in the number of corn drying kilns in Wales following the establishment of new Norman urban centres. However, they also state that this also coincides with the medieval warm period, population growth and development of market structures (Comeau and Burrow 2021: 133). Therefore, it is not possible to definitively associate any changes in crop processing practices or arable intensity to areas of Norman settlement. An increasing number of archaeological sites are being identified from both the early and later medieval period, which have the potential to determine geographical variations in land use in the future.

2.8 How did upland and lowland landscape use change through time?

A low number of pollen studies from non-coastal lowland settings make it

difficult to compare changes in land use between the upland and lowland zones. The preliminary results of the South Wales Gas Pipeline indicate that Early Neolithic cultivation may have occurred on the upland and plateau lands (Rackham 2020:155), which contrasts to previous assertions that Early Neolithic agriculture was concentrated in valley bottoms (Brown 1997).

Spatial variations in the pollen record from Penllyn in north Wales indicates landscape specific farming practices in the medieval period, with pastoral farming focussed on the uplands and arable cultivation at lower elevations (Davies 2015, 2019, 2022a). This pollen signature is consistent with what would be expected from transhumance agriculture, but this is difficult to verify palynologically (Davies 2015). The later medieval pollen record also suggests widespread woodland reduction at the turn of the 14th century that may reflect lowland deforestation orchestrated by Edward the 1st, which may also have contributed to upland depopulation (Davies 2022a: 32-35).

At FML, where three of twenty-nine corn drying kilns were dated from the eighth to the 11th century, Carruthers (2023:42) indicates that the high levels of free-threshing wheats contrasted with those from upland context recovered from the SWGP where the principal crops were barley and oat (cf. Rackham 2020). These results also contrast with expected principal crop types from corn drying kilns in Wales from the 8th century onwards, as Comeau and Burrow's (2021) review suggest would be oat rather than wheat (see section 1iv). However, we should consider the unique characteristics of the FML assemblage both from a geographic and cultural perspective. Its fertile, base rich soils are very different to those of the acidic upland soils seen across the majority of Wales. Additionally, the FML kilns appear to be part of a food rent collection site for a powerful high-status monastery, where the documented provision of wheat in its food rents probably reflects particular food preferences and hospitality requirements (Comeau, Shiner and Seaman 2024: 223, 236). Therefore, the crop assemblages FML potentially represents a very particular socio-economic phenomenon that may also have characteristics specific to this geographic zone. Consequently, the evidence here needs to be treated with care and warrants comparison with crop assemblages from other sites of early medieval date currently being excavated in the Vale of Glamorgan (Seaman and Davies forthcoming; Young and Lane forthcoming).

2.9 *Is there evidence for changing landscape use to increase productivity in the Early Iron Age?*

Caseldine's (2018) review of Iron Age landscape development indicates that the pollen record in Wales shows variations in clearance activity with some instances of woodland regeneration in the early Iron Age that would indicate landscape abandonment rather than an intensification of farming activity. Furthermore, she indicates that there are, in general, lower quantities of charred cereal evidence during the Late Bronze Age and Early Iron Age in Wales, that might support reduced productivity. Conversely, a review of pollen studies undertaken within Bannau Brycheiniog national park indicates that increased percentages of arable indicators are observed at some sampling sites in the Early Iron Age in the eastern, lower lying end of the park, that may be related to a re-organisation of the landscape and establishment of hillforts to control agricultural production (Davies 2022: 46). Similar evidence for possible increased productivity in the Early Iron Age is seen in the recent pollen work at both Waun Llanfair (Caseldine *et al.* 2017c) and Whitland (Core 2 – Caseldine *et al*. 2022: 48-64), where woodland clearance is observed at both sites and an increase in the percentages of pastoral and disturbance indicators is seen at Whitland

2.10 How does the palaeoenvironmental record from, for example, pollen, seeds, bones, charcoal and tree-ring studies compare with the documentary record for agriculture and land use for the medieval and post-medieval periods?

The later medieval pollen record in Wales has recently been subject of a comprehensive review (Davies 2022a). Prior to c.1300, the regional pollen record is similar to that of the later centuries of the early medieval period (cf. Davies 2019), with almost an equal number of sites showing woodland regeneration and decline, and similar fluctuations in arable and pastoral indicators. These observations were also noted in a review of pollen studies in Bannau Brycheiniog, but episodes of woodland regeneration appeared to correspond with areas close to or within the 'Great Forest of Brecknock', established in the late eleventh century (Davies 2022b: 48). At around the turn of the 14th century, widespread woodland decline is observed and is believed to represent documented deforestation by the order of Edward I after the conquest of Wales (Davies 2022a). Alongside this decline in woodland, an increase in farming indicators is observed at the majority of pollen sampling sites - this is believed to represent increased productivity

resulting from the peace that followed the English conquest of Wales. Observations of the spatial differences in the pollen record in Penllyn indicate woodland clearances specifically in lowland contexts alongside upland heath regeneration and decreased microcharcoal concentrations (Davies 2015). These changes have been interpreted as the cessation of heath burning activities following upland abandonment and population movement to newly cleared woodland lowland areas.

Critical examination of the pollen record in relation to the locations of monastic granges in Wales appears to contrast previous interpretations that their establishment led to increased landscape exploitation (cf. Turner 1964; Morriss 2001). Out of the nine study sites located either within or near monastic granges in Wales, only the studies at Cors Caron, Ceredigion (Turner 1964; Morriss 2001) and Bryn Mawr, Radnorshire (Buckley 2000) show convincing evidence of increased farming productivity. Furthermore, upon an examination of the spatial relationships between pollen studies near Strata Florida (Turner 1964, Morriss 2001), the increase in arable activity noted by previous studies may in reflect activity beyond the boundaries of the monastery rather than evidence for farming practices within its lands (Davies 2022a: 31). The review of medieval pollen records also examined the evidence for any landscape changes associated with the Great Famine (1315-22), Black Death (1348-49) and revolt of Ywain Glyndwr (1400-1415). In many cases, pollen sampling intervals and chronological frameworks from previous pollen studies are not detailed enough to distinguish whether any environmental changes might relate to any of these three events. Nevertheless, evidence for landscape abandonment and declines in farming intensity do appear to occur contemporaneously with these events in the pollen record at some sites. However, these factors do not appear to have long term impact on the development of the medieval farming economy, which appears to recover relatively quickly from any negative effects (Davies 2022a: 35-36).

3. The Development of Agriculture and Changing Agricultural Practices

3.1 *When and where did cereal cultivation and animal husbandry begin during the Mesolithic/Neolithic transition in Wales?*

Poor survival of unburnt animal in Wales continues to hamper investigation into the origins of animal husbandry. Consequently, focussed research on the origins of animal husbandry should be undertaken in the areas of Wales with base rich soils that have favourable preservation conditions for animal bone.

The onset of cultivation in Wales has recently been investigated by a review of the dating evidence by Treasure *et al.* (2019), who indicate its widespread uptake following its introduction at around 3700 cal. BC. However, an even earlier radiocarbon date has been obtained on an emmer wheat grain excavated at Gwernvale, dating to 3885-3705 cal. BC (93% probability) (Caseldine 2021: 125-126). Pollen evidence from the SWGP also indicates a relatively early date for cereal introduction at the Aber-gelli-Fach (FTP0) sampling site near Swansea. Here, cereal-type pollen was found alongside an elm decline, though the date for this evidence is not specified (cf. Rackham 2020).

Despite this encouraging research, it should be noted that very few direct radiocarbon measurements on cereals have been produced from Wales - it is highly likely that we are underestimating the earliest presence of these resources (Griffiths 2018). Furthermore, few coring sites for pollen analysis are located in non-coastal lowland contexts, which might have specific value for developing our knowledge of early Neolithic activity in Wales (cf. Bell 2007). These lowland zones have been subject to more targeted research for later periods (Davies et al. 2015, Davies et al. forthcoming), but need more directed research to examine the origins and development of prehistoric farming practices in Wales. Such work will need to be undertaken with a robust chronological framework using relevant scientific dating techniques. There is also potential scope to utilise geochemical analysis as a useful proxy for environmental changes associated with the onset and changes in agricultural practices in Wales.

3.2 What was the nature of subsistence strategies during the Neolithic and earlier Bronze Age in Wales?

Several studies have contributed to our understanding of Neolithic to Bronze Age agriculture in Wales in recent years. As reflective of the acidic soils found across the majority of Wales, the evidence for farming largely consists of charred plant remains from excavated sites (cf. Caseldine and Griffiths 2018; Caseldine *et al.* 2017c, O'Brien 2023, Gregory *et al.* 2018, Grinter 2020; McKenna 2020c; Caseldine 2021 and Lopez-Doriga 2021) and pollen from off-site sampling sites (cf. Caseldine *et al.* 2016b; Caseldine *et al.* 2017b; Caseldine *et al.* 2017c; Rackham 2020; Jenkins *et al.* 2021 and Caseldine *et al*. 2022) rather than any zooarchaeological data.

Although charred plant remains represent the most commonly identified evidence of Neolithic farming, charred cereal from this period remains relatively scarce, consisting of only a few charred grains in many cases. As noted above (section 2i), such remains have been the subject of a major review in recent years by Treasure *et al.* (2019), who have summarised the evidence for cultivation activity in Wales from the Neolithic to Early Bronze Age based on charred plant assemblages. They indicate that the main crop types observed across early Neolithic sites largely consist of emmer wheat, with lower numbers of hulled and naked barley and rare quantities of oat and einkorn, which is broadly comparable with Ireland, and central and southern Britain (Treasure *et al.* 2019: 209). The uptake in cereal cultivation appears to have been widespread, though it continued alongside the exploitation of wild plants, especially hazelnuts. Establishing the most common crop type becomes more problematic from the Mid Neolithic because of lower numbers of charred cereals, but barley and wheat grains (emmer and indeterminate in the Late Neolithic, naked wheat in the early Bronze Age) are recorded from the Mid Neolithic to Early Bronze Age with oat also recorded in the late Neolithic. However, a possible gradual shift towards preference of barley cultivation may be reflected in the evidence from some sites. Weed species recorded amongst cereal grains of Neolithic date include a range of habitat types, including disturbed ground, grassland, freshwater or moorland and woodland edge. A marked decrease in the number of sites with cereals and the quantity of cereals present is observed in the Late Neolithic (as consistent with elsewhere in Britain), which may reflect taphonomic processes – i.e. a low number of samples from Late Neolithic settlement sites (Treasure *et al.* 2019: 213). Treasure *et al.*'s review also undertook stable isotope analysis of emmer wheat and barley grains from four Early Neolithic sites. The $\delta^{15}N$ values for 91% of the emmer wheat indicated either low or no manuring,

which contrasts with the results from similar analysis undertaken in other northern European areas (Treasure *et al.* 2019: 214).

The more recent archaeobotanical studies support these trends. Charred grains are often low in number (Grinter 2020; McKenna 2020c; Lopez-Doriga 2021; O'Brien 2023) or even entirely absent (Caseldine *et al.* 2017a). More abundant quantities of grain have been recovered from excavations at Gwernvale (Caseldine 2021), but this assemblage conforms with Treasure *et al.*'s (2019) results, showing lower frequencies of cereals and in the range of cereal types present from the Neolithic to Early Bronze Age. It is also interesting to note the recovery of flax from Gwernvale, which may have been cultivated as food, for its oil or fibre (Caseldine 2021: 130). Wild food types continue to be identified at sites of Neolithic date, with hazelnuts dominating the material in pits of Neolithic date found along the Llangefni Link Road (Lopez-Doriga 2021) – a carbonisation study of the hazelnut fragments indicates whole nut carbonisation occurred on between a third and one half of the assemblage. Although no charred grain was identified in association with the Hindwell cursus, other foods are represented by charred remains of apple, hazelnut and acorn (Caseldine and Griffiths 2018). At Parc Cybi, hazel nut fragments are consistently present throughout the Neolithic period, interpreted as a possible continuous exploitation of hazel nuts as food sources (McKenna 2020c: 660).

Recent pollen studies with Neolithic to Early Bronze Age sequences include the intertidal peat deposits at Porth Neigwl (Caseldine *et al.* 2016b), cores from peat deposits and monoliths from Waun Llanfair (Caseldine *et al.* 2017c), samples from geotechnical pits along the route of the Burbo Bank windfarm pipeline (Gregory *et al.* 2018), samples collected for the SWGP (Rackham 2020) and monoliths from excavations of Bronze Age deposits from Mynydd Parys (Jenkins *et al.* 2021). Although the Neolithic sequence in intertidal peat deposits at Porth Neigwl contains very rare grains of ribwort plantain, indicative of grazing activity (Caseldine *et al.* 2017c), these grains are also present in deposits of probable Mesolithic dates, suggesting that it is reflective of grazing by wild animals rather than pastoral activity. However, evidence for Neolithic grazing activity is stronger at Waun Llanfair, where samples beneath late Neolithic cairns contained *Sordaria* spores, indicative of animals grazing in amongst the cairns (Caseldine *et al.* 2017c). This local grazing is likely reflected in the additional presence of ribwort plantain pollen within the palaeosols beneath the cairn, whereas cereal-type pollen present within these samples possibly reflects cultivation activities in the local area. Early Bronze Age deposits analysed by Gregory *et al.* (2018) near Rhuddlan

shows contemporary evidence for woodland clearance and both pastoral and arable indicators. At Mynydd Myddfai, along the route of the SWGP, Rackham (2020) reports evidence for cultivation and woodland clearance in the Neolithic period, but does not specify the exact date for these activities. Furthermore, Rackham indicates that the evidence from the SWGP indicates possible evidence for upland cultivation rather than previous assumptions that early Neolithic agriculture was concentrated in valley bottoms (Rackham 2020: 154-155). The pollen evidence retrieved from the Bronze Age mines at Mynydd Parys suggests a relatively open landscape surrounding the site, with evidence for grazing activities alongside the mining work in the surrounding landscape (Jenkins *et al.* 2021: 275-6).

3.3 When did changes in agricultural practices occur and what was the nature of these changes?

Limited information is available on changes in agricultural practices in most periods, as the range of evidence at a given site does not often cover consecutive periods of time. The scarcity of preserved animal bones across Wales again makes it especially difficult to examine changes in animal husbandry.

However, as noted above (section 2ii) an understanding of early developments in crop husbandry from the Early Neolithic to Early Bronze Age can be gained from Treasure *et al.*'s (2019) review of agricultural practices during these periods. Furthermore, the excavated evidence from the FML development does provide information on crop types from the Iron Age to Romano-British period (Carruthers 2023) and an understanding of changes in crop selection from the Romano-British to medieval times may be discerned from Comeau and Burrow's (2021) study of corn drying kilns in Wales. The crop assemblages from FML indicates the introduction of spelt in Late Iron Age or Early Romano-British period and subsequently becomes the main crop type in the Roman period (Carruthers 2023: 40). This conforms with observations by Comeau and Burrow (2021) that spelt and emmer dominated grain assemblages from corn drying kilns in the Romano-British period. After the Roman period, barley becomes most dominant in the fifth and sixth century AD, though oat becomes increasingly dominant from the seventh century onwards (Comeau and Burrow 2021: 14; see also section 1viii). As well as changes in crop types, the FML evidence also indicates changes in crop husbandry practice, with early medieval weed assemblages indicating an expansion in the types of soil being cultivated, possibly linked

with the introduction of temporary outfield cultivation (Comeau 2024 in Gilbert *et al*. 2024: 235-6).

3.4 What was the economy of later medieval and post-medieval farms in the uplands and to what extent did climatic and other environmental changes contribute to farm abandonment and changes of agricultural regime?

As noted above (section 1x) the review of later medieval pollen sequences in Wales (Davies 2022a) suggests widespread changes in upland farming at around the turn of the 14th century. Widespread woodland clearances are observed that can be demonstrated to focus on lowland landscape contexts in some cases (Davies 2015). This may have contributed to the abandonment of upland environments when they were abandoned in favour of lower lying, better quality soils (Davies 2015, 2022a). Prior to this time, the pollen record in Penllyn in Meirionnydd demonstrates that upland farming focussed on pastoral activities whilst lower lying areas had a higher focus on arable agriculture (Davies 2015). Similar evidence for a focus on pastoral activities in upland areas has been identified in Bannau Brycheiniog from the Early Iron Age, where arable activity largely focussed on lower lying areas in the east of the national park (Davies 2022b).

3.5 What is the relationship between the Roman army and native populations in terms of agricultural supply, particularly at such sites as Caerleon?

Direct evidence for agricultural supply to the Roman military has been examined by Madgwick *et al.* (2019). Their work undertaking strontium analysis of animals from a military store building at Caerleon indicates animals that were likely reared in the local area as well as from a significant distance from the fort – likely being transported from the chalklands of southern England and the granites of south west England (Madgwick *et al.* 2019). Romanised areas in south east Wales are currently being researched study as part of the 'Feeding the Roman Army in Britain' project to examine agricultural supply strategies (Guest *et al*. 2023). Elsewhere in Wales it is difficult to establish when agricultural produce is intended as supplies to the Roman military. It has been suggested that the settlement at Tai Cochion may have functioned as an intermediary for culture and trade between the local populace and the Roman military (Hopewell 2016: 106), but questions remain whether the settlement would have supplied agricultural products

directly to the Roman fort of Segontium or merely supported its own needs. The charred plant remains recovered from the excavation are consistent with civilian and military contexts elsewhere in north west Wales. Spelt wheat dominates grain assemblages with small quantities of bread wheat, barley and oat. Crop weeds identified at the site suggests that crops were grown on a mixture of sandy and heavier soils, suggesting the use of the mouldboard plough. The cereal and chaff identified at Tai Cochion indicate that the crop assemblages are associated with the final cleaning and or drying of grain before food preparation or storage (Caseldine et al. 2016a).

Pollen research for the *Manifestations of Empire Project* in south east Wales, in one of the more Romanised areas of the country will contribute to debates relating to supply to the Roman military in the near future (Davies *et al.* 2018).

3.6 What was the relationship between Roman towns and the surrounding regions?

No recent work has been produced on any of the major Roman Towns in Wales, though work is in progress on publishing Richard Brewer's excavations from the 1980's with new work being undertaken on environmental samples. As mentioned above (Section 2v), Tai Cochion may have functioned as an intermediary between Segontium and the wider civilian population. Hopewell (2016: 105) also suggests that the site may have been classified as a 'local centre' (cf. Hingley 1989) or 'small town' (cf. Burnham and Wacher 1990). The fact that the crop assemblages retrieved from the site were in their final state of cleaning may indicate that earlier stages of crop processing were undertaken offsite and brought to Tai Cochion. Given its proximity to Tai Cochion, the Romano-British remains found along the Llangefni Link Road (Saunders 2021) could well have represented one of the rural settlements supplying produce to Tai Cochion. Its crop assembly is comparable to Tai Cochion, consisting largely of spelt wheat and barley, with some emmer and lower numbers of either wild or domestic oat (Doriga 2021). One sample from the site was dated to cal. AD 260-410, possibly representing a "transitional" assemblage that included rye. The date obtained for this sample is remarkably early as rye was previously thought to have been introduced to Wales in the early medieval period (Doriga 2021: 25). Moreover, like Tai Cochion, cultivation from excavations of the Llangefni Link Road also appears to have been undertaken on a mixture of heavy and light soils, indicating the possible use of the

mouldboard plough.

The archaeological remains at Llangefni also included a rare assemblage of animal bone from Romano- British features. Higbee's (2021) zooarchaeological analysis on this material suggests that whole carcases were present at the site and that slaughter, butchery and consumption occurred locally to the site. Cattle and sheep represent the most identifiable elements with some pig and a few horse, dog, domestic fowl, goose, eel and whiting. Cattle appear to have been managed for beef, with dairying playing some part of the husbandry strategy. Higbee concludes that from the limited evidence available from Anglesey, 'the Romano-British livestock economy on Anglesey was one based primarily on cattle farming' (Higbee 2021: 20).

Excavations in Cowbridge in the Vale of Glamorgan also recovered charred plant remains (Morgan 2018). No detailed report on these remains has been published, but the summarised account of the excavation indicates the presence of brome seeds and chaff. Romano-British remains had previously been identified in the town that might include civilian and military occupation. The site's excavators indicate that the range of evidence found during the more recent excavations suggests that it is located at a peripheral location in relation of any Romano-British settlement (Morgan 2018: 57).

3.7 *What is the evidence for the development of horticulture in Wales?*

Evidence for horticultural activity in Wales and elsewhere in Britain is very rare. This largely stems from preservation bias as waterlogged conditions are usually required for the preservation of horticultural crops (cf. Van Der Veen 2014; Treasure and Church 2016). The rarity of the evidence from Wales in the Romano-British period may also derive from a comparative lack of excavation on Romanised urban or military sites, where they were most prominently consumed (Van Der Veen 2014: 7). However, evidence for horticultural activity in the Romano-British period has been identified off Wonastow Road in Monmouth (Jones and Davies 2019). The evidence consists of a series of parallel gullies of Roman date, similar in character to those used to grow grapes at Wollaston in the Neane Valley (cf. Brown and Meadows 2000), with evidence for root penetration and posts cut into the base of the cultivation gullies. Post excavation analysis is yet to be completed to establish the crop grown at the site, but the archaeological evidence indicates one of the most westerly examples of Romano- British horticultural activity in Britain. Recent excavations at Priory Street in Carmarthen have

also identified the presence of charred legumes (Vicia faba var. minor – Celtic Beans), beet and fennel from deposits associated with a fire dated tightly to 170 AD. Celtic Bean is known to have been cultivated in Britain in prehistory (Treasure and Church 2016) and has been recorded elsewhere in Romanised contexts from Caerleon (cf. Jones 2015). However, it is believed that that these may be the earliest examples of beet and fennel identified in Wales (Philp *et al*. 2023). Unfortunately, it could not be ascertained whether these plants had been grown locally or imported to the site (Carruthers 2022: 233-236).

The analysis of charred material from the early medieval sites of Llangorse Crannog and Portclew has also identified the presence of beans *(Vicia faba* L.) (Caseldine and Griffiths 2019; 2024). This evidence is highly significant, as the occurrence of legumes from the early medieval period in Wales had only previously been identified from Rhuddlan (Williams 1987). Indeed, given the Anglo-Saxon association of the legumes from Rhuddlan, the evidence from Llangorse and Portclew represents evidence of 'native' cultivation of legumes, that may be indicative of more widespread horticultural activity in Wales during the early medieval period. Charred plant remains belonging to the pea family were identified among charred cereal grains in the fills of corn drying kilns at Parc Cybi, but only identified to genus level and might therefore belong to wild variants (McKenna 2020c).

3.8 What was the role of hunting, fishing and wildfowling in agricultural societies in Wales?

The study of early medieval faunal remains has benefited significantly in recent years by the completion of analysis on three significant archaeological sites (Llangorse Crannog – Mulville 2019; St Patrick's Chapel - Hadjikoumis 2022 (mammals and birds), Maccarinelli 2022 (fish); FML– Calis 2023).
n.b. Meredith Hood's PhD on the animal bone from Llanbedrgoch has recently been completed, but could not be examined as part of this review).
Prior to these studies, only Roberta Gilchrist's (1988) examination of the animal bone assemblage from Dinas Powys had been undertaken to modern standards, and the value of her results is diminished by the selective retrieval of bones by the original excavation (cf. 1963). Therefore, these three new studies represent a significant contribution to our understanding of early medieval zooarchaeological data. The work on material from Llangorse is particularly significant in relation to the exploitation of wild resources as an atypically high number of deer bones (particularly red deer)

were identified from the site. The evidence suggests only a minor exploitation of wild birds or fish from the site and those identified cannot be excluded as intrusive to the animal bone assemblage (Mulville *et al.* 2019: 184-6). The results on material from FML contrasts significantly with the animal bone assemblage from Llangorse as only a very small number of bones of deer and other wild animals from early medieval contexts (Calis 2023). Bird bones are extremely low from the early medieval contexts at FML, whilst fish bones are entirely absent. It is possible that the low numbers or absence of fish bones in these two early medieval assemblages may in fact be representative of low fish consumption during the early medieval period. Based on the comparative analysis of $\delta^{13}C$ and $\delta^{15}N$ isotopes from early medieval human burials in western Britain, Hemer *et al.* (2017) indicate the consumption of terrestrial protein sources rather than marine (i.e. fish and shellfish), though this does not negate the possibility that these populations consumed freshwater fish. However, the zooarchaeological evidence from St Patrick's Chapel contrasts with the isotopic analysis from both Hemer *et al.*'s (2017) regional study as well as Hemer's (2022) own isotopic analysis from human remains at St Patrick's Chapel itself. The isotopic analysis from St Patrick's Chapel again suggests that the diets of those interred at the site in the 8th century focused on animal, terrestrial protein rather than marine resources. Despite this, Maccarinelli's (2022) examination of fish bones from the site concludes that although the sample size from the site was relatively small, the variety and type of edible species demonstrates the consumption of marine fish (Maccarinelli 2022: 289). Remains of cuttlefish, marine molluscs and crab were also noted within the animal bone assemblage (Hadjikoumis 2022: 277). A relatively abundant quantity of wild bird remains, particularly thrush, also indicates their consumption prior to deposition at St Patrick's Chapel (Hadjikoumis 2022: 279).

3.9 What is the evidence for changes in animal husbandry through time?

Studying changes in animal husbandry in Wales is limited by the lack of unburnt bone preservation in many areas, particularly during the prehistoric period. This is also especially problematic for key transitional periods such as the Iron Age to Romano-British and subsequent transition to the early medieval period (Madgwick pers. comm.). Martyn Allen's review of pastoral activities across Roman Britain has observed similar preservation biases across different areas of Britain, with preservation generally better in areas

of southern and eastern England, though the larger proportion of commercial excavations in these areas may also be a contributing factor (Allen 2017: 138-9). Given this preservation bias, it is difficult to know how trends observed elsewhere in Roman Britain might apply to Wales, but some of the conclusions made in Allen's analysis, especially in relation to rural contexts, may be useful as a model for changes in animal husbandry in Wales.

In general Allen's (2017) dataset suggests that there are regional variations in livestock production, but that there is a general trend towards an intensification of pastoral farming in the Roman period. This is seen by the increase in the proportion of cattle in Late Roman animal bone assemblages that may be driven by the demand for beef by urban populations or for military procurement. Changes in cattle slaughter patterns are also observed, whereby cattle are maintained into adulthood in far greater numbers than in the Late Iron Age. This has been interpreted as possibly representing a supply of meat from retired dairy cattle, or possibly also the increased use of animals for traction, associated with more intensive arable exploitation (Allen 2017: 139). These changes would certainly conform with the pollen record for Wales, which indicates extensive clearances in the Iron Age continuing into the Romano-British period (Caseldine 2018) and case studies that indicate a pronounced increase in pastoral landscape exploitation (e.g. Cass Troggy – Brown 2010, 2013; Penllyn - Davies 2015). Changes in pig and sheep husbandry are also noted by Allen, particularly in their slaughter age. Like cattle, sheep appear to be slaughtered at an older age, whilst the opposite is seen for pigs. This may represent the growing importance of the trade in wool and textile for sheep and an increase in the amount of meat available for pigs, alongside more intensive management practices to supply urban markets (Allen 2017: 139-141).

Comparative studies of animal bone assemblages for earlier and later periods have not been undertaken in respect to Wales, though the FeedSax project has examined changes in cattle husbandry in Anglo-Saxon England (Holmes 2022). Holmes' analysis indicates an increase in production from the seventh century coinciding with a steady increase in slaughter age. This plateaus in the 8th century alongside increased numbers of males - a subsequent peak in cattle slaughter age is observed in the tenth century. These changes have been interpreted as a potential increase in focus on secondary products, including traction, linked to increased arable activities and the adoption of the heavy mouldboard plough (Holmes 2022: 87-107). These changes are also reflected in the review of medieval pollen studies in England by Forster and Charles (2022), who also note an increase in both

pastoral and arable land use at around the eighth century. Furthermore, they note a general shift towards arable agriculture from the Romano-British to the late medieval period with an increased focus on pastoral activities on more 'marginal' land. Similar trends are observed in the Welsh pollen record during the 'long 8th century', when an increase in taxa indicative of pasture and arable land is observed (Davies 2019). It is difficult to establish whether similar geographical shifts in land use might be observed in Wales given a comparative lack of lowland pollen studies. However, given the upland nature of the majority of land in Wales, a similar focus on pastoral activities in these areas is likely

3.10 What were the environmental effects of transhumance and lesser transhumance in both upland and coastal wetland environments, and did the practices attested in historic periods have prehistoric origins? How extensive is the evidence (both geographically and chronologically)?

Evidence for Bronze Age transhumance involving the seasonal use of saltmarsh habitats has been examined through isotope analysis from Redwick and Peterstone (Britton and Muldner 2023). It has been suggested that prehistoric transhumance activities occurred in the Vale of Glamorgan (Calis 2023: 93), but this has yet to be verified by any scientific analysis. Spatial variations in land use consistent with transhumance has also been established for the medieval period in Penllyn by pollen analysis, though such a practice cannot be verified by palynological research (Davies 2015, 2019, 2022a).

4. Social Organisation and Belief Systems

4.1 *What is the environmental evidence for social organisation both at a site and a regional level?*

Evidence for social organisation is difficult to establish in the environmental record. However, the zooarchaeological record from both Llangorse Crannog (Mulville *et al.* 2019) and FML (Calis 2023) may reflect evidence of social status or organisation. At Llangorse crannog, there is a higher proportion of pigs and deer compared to other British medieval sites, which has been interpreted as reflective of the high status of the site. Furthermore, the age profiles for animals identified at the site is strongly reminiscent of animals given as food render towards the end of their useful lives (Mulville *et al.* 2019: 184-185). Likewise, at the Whitton Crossroad site of the FML development, the animal bone assemblage has been identified as having similar evidence for high status consumption as at Llangorse (Calis 2023: 70; Comeau *et al.* 2024). Although there are fewer numbers of pig and deer in comparison with Llangorse, the assemblage suggests that carcasses were being brought to site from a nearby location after being raised elsewhere. Some of the carcass appear to have been consumed elsewhere, with some parts taken off site. A comparison of the archaeological evidence at the site in comparison with documentary evidence in the *Life of St Cadog*, suggests that Whitton Crossroads may have been the location of an assembly site where tribute to the monastery at Llancarfan may have been collected (Comeau *et al.* 2024). The high number of corn drying kilns associated with the site may also have been associated with processing food render.

4.2 What is the evidence for ceremonial activity and belief systems?

Evidence for the use of plants in ceremonial activity has been found at excavations of the Four Crosses bypass in Powys. An Early Bronze Age burial pit at the site contained remains of false oat-grass tubers, which are frequently associated with cremation contexts throughout the British Isles, though for uncertain reasons (O'Brien 2023: 63). Similar evidence for the use of plants as possible tribute items in funerary contexts has been found in Wales at Fan Foel (Caseldine and Griffiths 2013), Pant y Butler (Caseldine 2013) and Buttington Cross (Daffern 2014) based on high concentrations of meadowsweet pollen – similar circumstances of floral tribute have been found at Bronze Age funerary sites in Scotland and England (Whittington 1993; Tipping 1994; Clarke 1999; Fyfe and Perez 2016; Davies forthcoming). Therefore, future excavations of Bronze Age funerary contexts in Wales

should include sampling for pollen as part of environmental strategies work to assess the popularity of this practice.

4.3 What is the relationship between different types of site and sites of different social status during the later medieval period, e.g. rural farmsteads, castles, ecclesiastical sites, towns etc., and how is this reflected in the palaeoenvironmental record?

The scarcity of well excavated sites of late medieval date in Wales (especially those of "low" status) makes it extremely difficult to compare the environmental record relating to sites of different status. Maltby and Hambleton's examination of deer remains in later medieval contexts has previously shown a higher proportion of deer at sites of higher status (Maltby and Hambleton 2014: 195), but note that additional analysis would be valuable. More recent excavations of late medieval sites in Wales include work at the medieval moated site of Dolgarn at Llanddowror (Carmarthenshire), part of the investigations along the A477 improvement scheme. Here environmental analysis was undertaken on waterlogged insect, plant remains and pollen from a ditch from the site (Hart and Alexander 2018). The detailed results of this work have not been published, but the information available indicates that local area was an open landscape with evidence for pasture and arable farming. However, such minimal information makes comparison with other sites extremely difficult

4.4 What was the reason for the construction of burnt mounds and have they had different uses?

Several recent studies have examined environmental remains relating to burnt mounds in Wales. It is notable that many of the burnt mounds excavated as part of the SWGP contained extremely low quantities of charred plant remains. Rackham (2020: 158) concludes the lack of any evidence for the consumption of food supports a non-domestic function for these sites as proposed by Hart *et al.* (2014). Furthermore, Rackham suggests that they may have been used as washing places, saunas or possibly even coming of age sites (Rackham 2020: 158, Hart 2020: 181). However, at Nant Farm on the Llŷn peninsula, Smith *et al.* (2017) indicate that there was an unusually high quantity of charred cereal remains (including chaff). This highlights the possibility of a relationship between the burnt mound and cereal remains, including possible use for cooking, the use of chaff as fuel, brewing or even a multifunctional use (Smith *et al.* 2017: 39). The discovery of alder seeds

from the site amongst the plant remains may also indicate its season of use in the autumn or winter after the seeds were dispersed in the autumn. Furthermore, pollen analysis for the site provides tentative evidence for pastoral activities close to the mound, though this possibly reflects activity in the wider area rather than a functional relationship with the burnt mound (Smith *et al.* 2017:38; Caseldine *et al.* 2017b). It should also be noted that the chronology of the sites sampled in the SWGP (Hart et al. 2014) demonstrates that these structures were used in different locations between c3000-500 cal BC. Therefore, attributing a single class of use to these structures - beyond the thermal aspects - may be overly simplistic (Griffiths pers. comm.).

5. Mining Activity and Industrialisation

5.1 What was the impact of metal-mining on the environment from the Bronze Age through to the medieval period?

As briefly mentioned above (section 2ii), palaeoenvironmental evidence from deposits associated with Bronze Age mining from Mynydd Parys has provided information relating to the environment surrounding the site. Pollen analysis has shown that the landscape surrounding the mine was largely open, with areas of heathland, wet grassland and pools of open water (Jenkins *et al.* 2021: 273-4). There is also evidence for agricultural activities, particularly grazing, occurring alongside the mining work. At sampling site S3, a permanent decline in woodland was recorded, specifically affecting oak percentages. The authors note that this evidence contrasts with the evidence from other Bronze Age mining sites in Wales and Ireland, where the surrounding woodland was not significantly cleared (Jenkins *et al.* 2021: 274-5). However, Timberlake (2016) suggests a relationship between Bronze Age vegetation clearances and the identification of areas suitable for copper extraction in central Wales. With the onset of rapid woodland clearance and expansion of pastoral farming, the loss of soil cover may have exposed mineral deposits that were subsequently targeted for mining.

Palaeonvironmental data from other mining sites recently excavated are relatively limited, with published analysis focussing on the identification of charcoal for radiocarbon dating purposes (cf. Timberlake and James 2018; Timberlake and Haylock 2018). Ballatyne (2018) records the presence of oak, hazel and honeysuckle charcoal at excavations of mines from Cwmystwyth, noting that they are also represented in the pollen record from Copa Hill (Mighall *et al.* 2002). Soil chemistry analysis at Penmarc in Cwmystwyth recorded enhanced metal concentrations associated with ancient spoil layers of between x4 to x14 in comparison with unmineralised subsoils (Timberlake and James 2018: 94). Similar geochemical analysis may be valuable in the future.

5.2 What was the impact of iron-working on the landscape from the Iron Age to medieval times?

Although no recent work has examined the palaeoenvironmental impact of iron working, Crew and Mighall's (2013) analysis at Llwyn Du in Snowdonia has established careful management of local woodland associated with 14th century iron works. Some of the pollen sampling sites examined by the

SWGP are also located near the industrialised areas of south Wales (cf. Rackham 2020), providing the potential for examining the impact of more recent iron-working activity.

5.3 What is the evidence for silver mining in Wales?

Timberlake's (2016) review of Bronze Age mining activity in Britain indicates that there is no definite evidence of silver or lead mining in Britain in the Bronze Age, though it is possible that silver bearing lead appears to have been deliberately removed as part of the copper mining activities at Copa Hill (Timberlake 2016: 721). Lead smelting activity is likely to have occurred at Erglodd, Llangyfelen in the late prehistoric period, but there is no definite evidence for the extraction of silver (Page *et al*. 2012). It is also known that the lead mines of north east Wales were exploited by the Romans almost immediately after they took control of those areas, and that silver was extracted from lead by the Romans (Williams 2012; Silva-Sánchez and Armada 2017). This does suggest the possibility of a more extensive pre-Roman lead industry in Wales and feasibly that silver was also extracted from those ores (cf. Williams 2012: 35). Williams (1992: 36) also suggests the possibility that silver extraction took place from lead ores in north east Wales during the early and later medieval period, prior to the documented silver production in the post-medieval to early modern era. However, as yet, there is no direct evidence to confirm any prehistoric, Roman or medieval silver extraction in Wales.

5.4 What is the evidence for industrialisation and more recent pollution from agricultural activities and the significance of this in relation to conservation and upland management?

Although no recent work has been identified relating to this research question, several earlier studies have identified increased concentrations of metal contaminants (e.g. copper, lead, zinc, arsenic) in the upper, more recent deposits of lakes and peat deposits relating to mining activities (cf. Jones *et al.* 1991; Mighall 2013). Furthermore, peat humification and macrofossil studies at Mynydd Llangatwg (Chambers *et al.* 2007) and Twyn Mwyalchod (Chambers *et al.* 2013), have demonstrated that the bog surfaces have degraded in the 19th and 20th centuries, likely because of changes in grazing regimes, burning of the bog surface or industrial pollution.

5.4 *Did early miners/metallurgists destroy, modify or manage woodlands?*

As noted above (section 4i), there is evidence that woodlands were cleared contemporary with the use of the Bronze Age mines at Mynydd Parys (section 4ii; Jenkins *et al.* 2021: 274-5). However, these woodland clearances may not be directly related to the mining works and could equally relate to the contemporaneous developments in land use and agriculture observed elsewhere.

6. Urban Studies

6.1 What were the living conditions of people in Welsh towns through the ages?
6.2 What were their diets?
6.3 What industries were based in urban contexts?
6.4 What were the trades and trade networks of Welsh towns?
6.5 Is there evidence for the importation of soils?
6.6 How variable were the diets of townsfolk and how were they different from rural populations?

The potential for palaeoenvironmental studies to contribute to the development of town life in Wales has previously been highlighted by previous research agendas (Caseldine 2004, 2010, 2014, 2017). However, this field of research is still hampered by comparatively few archaeological excavations in urban areas in comparison to other British nations. Recent work in Carmarthen (section 2vii, Carruthers 2022; Philp *et al*. 2023) has demonstrated the range of food crops available to residents in the Roman town, including legumes (Celtic Bean), beet and fennel. Work at Tai Cochion (section 2v; Hopewell 2016: 106) also provides some information about subsistence strategies relating to smaller sized Roman towns in Wales, but our understanding is limited by the small scale of excavation work undertaken at the site to date. The forthcoming publications of environmental analysis of remains from excavations at Roman Caerwent (Brewer forthcoming) is expected to contribute to this theme.

Ongoing research excavation at Llanbadarn Fawr (Llantwit Major) in the Vale of Glamorgan (Young and Lane pers. comm.) will also provide an environmental perspective to the development of medieval towns and monastic communities in Wales.

7. Climate Change

7.1 What was the relationship between climate change and successive human communities?
7.2 How did climate change influence human colonisation during the late-glacial period in Wales?
7.3 What is the evidence for climatic change during the Holocene?

Evidence for climate change is evident in numerous pollen studies undertaken in Wales. As part of the review of medieval pollen studies, Davies (2022) notes that there does not appear to be a significant signal in pollen taxa relating to the warmer conditions experienced during the 'medieval warm period' (c. AD 1100-1300 – cf. Parry 1985; Lamb 1995; Ward 1997; Davidson *et al.* 2017). Some pollen studies do show evidence for an increase in farming intensity during this timeframe, but this does not appear widespread or in relation to geographic variation. However, there is an increase in the number of sites showing increased percentages of wetland taxa during the 'Little Ice Age', when colder temperatures and increased precipitation are observed globally (cf. Lamb 1977; 1995; van Loon and Rogers 1978; Büntgen *et al.* 2011). Incidentally, there is a higher proportion of sampling sites showing an increase in wetland indicators in north Wales in comparison to the south, which has been interpreted as potentially representing an increased susceptibility to climate variation at higher latitudes (Davies 2022a: 32).

Previous research in the Severn Estuary there is widespread evidence for the setback of sea walls as the result of erosion (Rippon 1997), although precisely when this occurred and how it relates to secular climate change is seldom clear. Current fieldwork at Peterstone revealing wood and stone structures on the foreshore indicates significant setback in the late medieval and early post-Medieval period (Bell and Nayling pers. comm). The effects of the 1606 flood are currently being investigated by Rose Hewlett as part of the Living Levels Project and for a Bristol University thesis. A Sector Adaptation Plan for Wales, launched by Cadw and partners in 2020, aiming to raise awareness of risks and opportunities for the historic environment sector in Wales relating to climate change (HEP 2020).

The CHERISH project is of particular interest to the influence of climate change in Wales, which seeks to further understand the impacts of climate change and effects of extreme weather events on cultural and natural heritage in the Welsh and Irish sea region (https://rcahmw.gov.uk/about-us/our-recording-

work/cherish-climate-change-and-coastal-heritage-eu-funded-project/). As part of this work, the collaboration between Aberystwyth University and the Royal Commission on the Ancient and Historical Monuments of Wales has enabled the study of a series of cores from coastal regions in Wales. These include study sites along the western coast of Anglesey (Llyn Coron, Llyn Maelog and Rhuddgaer), Gwynedd (Dinas Dinlle and Warren beach, Abersoch), Ynys Englli (Bardsey Island), Ceredigion (Ynyslas) and Pembrokeshire (Dinas Head, Newgale Sands, Castlemartin Cors) (Driver pers. comm.).

8. Alluviation in non-tidal river valleys

8.1 What has been the influence of river channel and floodplain development on the archaeological record, i.e. settlement, land-use, ritual practices and landscape, from the Palaeolithic to the present?
8.2 What is the relationship between river alluviation, erosion episodes, climate change and land use change?

Several previous studies of Welsh rivers have contributed to our understanding of alluviation of river valleys (e.g. Foulds *et al.* 2014a, Foulds *et al.* 2014b; Jones *et al.* 2010, 2012; Macklin and Coulthard 2011, Macklin *et al.* 2012). LiDAR datasets of increasing detail continue to be produced to support such research and is freely available in Britain (https://environment.data.gov.uk/survey). This data was successfully utilised by Davies *et al.* (2021) in a geomorphological study of alluvial processes in relation to Offa's Dyke by the River Camlad near Trefaldwyn (Montgomery). Here, Offa's Dyke is seen to have been partially covered by floodplain sediments, though is still visible as a low earthwork. The analysis of the LiDAR data demonstrated that the course of the Camlad has migrated significantly over time in the vicinity of the dyke. A palaeochannel visible in the LiDAR data appears to represent the original location of the Camlad, c.200m north of its current location, when the dyke was built. A course correction to the dyke immediately to the south of the valley appears to have been purposefully aligned to meet the Camlad at a bend on this palaeochannel, implying that it was designed to bridge the river at this point. The potential presence of a bridge at this location suggests that there was a walkway on top of the dyke and that it might therefore have been a patrolled frontier along its top (Davies *et al.* 2021: 26-28). Further use of LiDAR data for comparable studies and the general application of geoarchaeological techniques in general across Wales should be encouraged.

9. Coastal Alluviation and Sea-level Change

9.1 What role have human communities played in changing coastal environments compared with 'natural' factors?
9.2 At what date and in what environmental circumstances did human communities in the various regions of Wales first start to modify the coastal environment by digging drains and building sea- banks?
9.3 The besanding of settlements is well known but more precise chronologies need to be established for dunes in Wales.
9.4 Is there evidence for increased coastal dune-building and sanding-up during the Little Ice Age, AD1550-1850, and other episodes of climatic change?

Establishing accurate chronologies for besanding events or the establishment of dunes in Wales still needs further work. Rees-Huches *et al.*'s (2021) study of dune systems at Llanbedr in Gwynedd using ground penetrating radar suggested that formation started in the 14th century, as seen elsewhere in north Wales, but did not obtain any supporting dating evidence. Nevertheless, the potential of such sand dune systems to conceal archaeological remains is significant, as demonstrated by the locations of the early medieval settlement and field system at Rhuddgaer on Anglesey (Hopewell and Edwards 2017) and the early medieval cemetery at St Patrick's Chapel in Pembrokeshire (Murphy and Hemer 2022), both of which were largely covered by dune systems. Nevertheless, we should not assume that all such sand dunes are medieval in date, as besanding events have been dated to numerous periods along the coast of Wales (Smith *et al.* 2017: 40). Future approaches to the study of these processes should have specialist geoarchaeological input and use OSL, radiocarbon and/or other scientific dating techniques as appropriate.

9.5 How did marine transgression and regression phases affect human activities, especially in prehistory?

Research conducted between 2014 and 2018 (Philp 2018; section 1ii) has provided new archaeological, palaeoenvironmental and chronological data from two intertidal sites in South Wales (Broughton Bay and Port Eynon on the Gower Peninsula) in order to identify localised effects of sea level change on the landscape and the people who inhabited it during prehistory. At Broughton Bay, deep deposits of sedge dominated fenland with pockets of alder carr were identified, the upper layers of which dated to the early Neolithic period (4150-3950 cal. BC). At Port Eynon, the

palaeoenvironmental evidence indicated five direct episodes of marine transgression on the site, between 5480-5320 cal. BC and 5300-4990 cal. BC. This was seen as intermittent mud flat and salt marsh accretion. Each of these transgressions was followed by vegetation succession from salt marsh to reed swamp, to fenland and carr woodland, representing regressive periods of sea level change. A short period of higher energy tidal influence, evidenced by alternating sand and clay sediment deposits, followed the final transgression. A similar environment to that identified at Broughton Bay, dating to the Early-Mid Neolithic (3970-3790 cal. BC) was identified in the upper deposits at Port Eynon, with some evidence that the sequence continued to develop from fenland to raised mire in the upper most deposits. The fluctuating environment apparent at Port Eynon points to frequent changes in sea level during the Mesolithic period, with an apparent drop moving into the Neolithic period, allowing freshwater environments to reform and even become precipitation rather than groundwater driven. The explanation for this is unclear, it could indicate highly localised sea level changes, or it may be indicative of the breaching of a local sand bar system, though no evidence of this kind of formation exists within the vicinity of Port Eynon Bay. A large exposure of human and animal footprints was recorded at Port Eynon that were found to be within a peat deposit dating to the Late Mesolithic Period (5300-4990 cal. BC). The footprints represented both adults and children, as well as animals including aurochs, wild boar, red and roe deer and a potential wolf. The demography of the group is very similar to that identified at other intertidal footprint sites in Wales, including Goldcliff in the Severn Estuary and Lydstep in Pembrokeshire. The mix of species identified in the animal prints, coupled with the pollen evidence indicating a fenland edged by woodland, suggests a landscape rich in resources for the inhabitants to exploit. The dating of the deposit in which they were situated places them within the period following nearly 500 years of environmental turbulence at the site including marine transgressions and it is possible that further instability occurred represented in now eroded deposits. The chronology of the sequence has allowed the identified environmental change to be used to contextualise previously known archaeological evidence from the Mesolithic and Neolithic periods on Gower. For example, human remains in the caves at Foxhole and Paviland Cave appear to have been buried within the same period of environmental instability as has been identified at Port Eynon.

Further remains from Foxhole and Red Fescue Hole also align with the dates from the later Neolithic deposits. It is possible that the people who made the

footprints at Port Eynon had links those buried at these cave sites, who may also have exploited the rich resources on offer within the surrounding wetland landscape. More detailed geoarchaeological input should be applied to future research in this field and use multi-modal chronometric techniques on inter- and sub-tidal deposits to developing our understandings of marine transgressions over the Holocene. Studies of intertidal sequences should also take into account the complexity of sedimentary processes in such landscape contexts and that that sequences can have different ages at similar elevations across a single beach (Bates pers. comm.).

9.6 How did humans adapt to the coastal environment?

9.7 What is the evidence for the seasonal use of coastal wetlands in later prehistory and what was the nature of the economy practised?

The human footprints recorded at Port Eynon on Gower (Philp 2018; section 1ii, 8v), were likely to have been formed in the late summer after an extended warm period for the deposits to be stable enough to hold their form prior to burial. This was also true of previously investigated footprints at Goldcliff (Bell 2007), but counters seasonality models that place people in the uplands during the summer months and lowlands in the winter (Jacobi 1980; Simmons 1996). This may be further evidence for Bell's theories that a subset of society (including the children) remained in the lowlands during the summer months, or that an early return to the lowlands allowed for travel and resource collection before winter storms set in. The abundant animal footprints present and supporting palaeoenvironmental evidence indicative of fenland and woodland edge might suggest an economy of hunting and wild resource collection within this landscape.

9.8 ***What was the relationship between wetland settlements and those on dry land?***

10. Recommendations (all sub-themes)

- An appropriate level of radiocarbon dating, along with the application of statistical analysis, is essential to enable the following which are priorities:

- To enhance the chronological framework for human activity and the environmental record both for the Pleistocene and Holocene periods;

- To refine the chronological framework for environmental data.

- Radiocarbon dating on peat deposits should ideally attempt to identify 'short life', single entity plant macrofossils for dating analysis, but if none are identified, reports should always note the peat fraction targeted for dating analysis (i.e. humic/humin content).

- Selecting samples for radiocarbon dating should also be undertaken with a clear understanding of potential radiocarbon reservoir effects.

- Geoarchaeological modelling is required to identify topographic and sedimentary sequences which might yield archaeological and environmental data, particularly important are coastal and riverine contexts in relation to the Palaeolithic and Mesolithic periods. These need to be accompanied by ground-truthing to enable characterisation of sedimentary sequences.

- The scientific dating and investigation of new sedimentary sequences in caves or open-air sites, including Pleistocene sediment exposures in valleys and coastal locations, is a priority for the Palaeolithic though, for example, the sedimentary context of later archaeological material in caves is also important.

- The potential for palaeoenvironmental studies of Mesolithic sites is especially high where known sites adjoin wetland as in coastal areas of South Wales and riverine and coastal areas of Pembrokeshire. Such contexts deserve particular attention.

- Palaeoenvironmental studies should be encouraged in areas where there has been little or no work to fill in gaps. In general, there have been more pollen studies in the uplands rather than the lowlands and investigations in lowland areas where there are potentially suitable deposits should be a priority (e.g. Davies *et al.* 2015).

- The early Neolithic tombs of south west Wales have attracted interest as pioneer communities and the evidence for environmental relations in these areas would repay attention.

- The tracking of bacterial ancient DNA in pollen and archaeological sediments could be used as an indicator of human presence in the past.

- Application of computer modelling to pollen data to reconstruct past land cover.

- A range of techniques, including multi-element analyses (e.g. Brown *et al.* 2016), need to be applied to the investigation of burnt mounds. The formation processes also need to be considered (Hart *et al.* 2014).

- Radiocarbon dating of cereal grain is essential to date the beginnings of agriculture in Wales and changes in crop husbandry, e.g. how sudden were the changes across the Roman/early medieval period boundary? When was spelt wheat introduced? This is especially important to understand the timing of the introduction of four key arable crops in Wales (free-threshing wheats, bread wheat (*Triticum aestivum*) and rivet-type wheat (*Triticum turgidum*-type), spelt wheat (*Triticum spelta*) and rye (*Secale cereale*)).

- Environmental sampling should be undertaken on all sites to advance archaeobotanical and archaeozoological studies in Wales. This is important in identifying regional differences and similarities in farming practices and, for example, identifying the adoption of new foods and cultural practices and trade networks, for example, during the Roman period.

- Charred grain occurs on a range of Neolithic and Bronze Age sites indicating agricultural and domestic activity and potentially the presence of settlements. The application of stable isotope analysis to charred grain to identify the use of manuring practices may help to determine whether there were small, permanent cultivation plots or shifting agriculture and how this relates to the archaeological evidence for settlement. Analysis of grain from more ephemeral settlement sites should be undertaken.

- Priority should be given to medieval sites with good documentary records and assemblages of biota to permit comparative studies.

- The wider application of biomolecular techniques offers particular potential for certain investigations. For example, the application of collagen peptide mass fingerprinting (ZooMS) to unidentifiable bone fragments to determine the species (e.g. Buckley *et al.* 2014, Charlton *et al.* 2016) has particular potential for the investigation of the transition from foraging, fishing and hunting to agriculture.

- DNA analysis should be used to target specific questions such as to distinguish domestic from wild animals and to identify genetic variation in animals.

- Stable isotope analysis of bone, as well as providing information about the diet of and use of resources by humans and population movement, is equally important in understanding animal diet and animal movement and can therefore inform such issues as the nature of agricultural regimes and trade networks. Animal isotope analysis is also important in the interpretation of human isotope data in the same geographic area.

- The application of stable isotope analysis to cereal grains can indicate cultivation practices such as manuring. Whilst this has been undertaken a small number of Neolithic charred cereal assemblages from Wales (Treasure *et al*. 2019), its application on a more widespread basis should be encouraged.

- Radiocarbon dating is a priority to date the beginnings of mining/metallurgy in Wales and the impact on the environment.

- Stable isotope analysis of tree-rings from submerged forests has the potential to provide palaeoclimatic data and needs to be explored further. This should be combined with dendrochronological and radiocarbon studies to produce 'wiggle matches' to accurately estimate environmental events..

- Geochemical analyses have an important role to play in palaeoclimatic studies, for example storminess, and further studies should be undertaken.

- Prehistoric footprints are increasingly reported from the coast of Wales and it is important that when located they are fully recorded, their sedimentary and environmental context and date are established if the full value of this new source of evidence is to be realised.

- What is the environmental context and economy of Romano-British sites on the Gwent Levels? Can the dating of the various phases of drainage, particularly Roman drainage be clarified.

- An awareness of the danger of the use of analogy when recording intertidal sites is needed. The intertidal evidence around the Welsh coast varies in date and the environment it represents. Investigation on a site-by-site basis, rather than assuming links with nearby evidence will greatly improve our understanding of prehistoric lowland landscapes and their archaeological potential, and also provide localised evidence of past sea level change.

11. Recommendations (general)

- There needs to be a palaeoenvironmental/environmental archaeology advisor (geoarchaeology included) to advise archaeological practitioners, curators, consultants and developers in Wales.

- There needs to be consistency in palaeoenvironmental strategy for developments such as wind farms, coastal defences etc.

- Where there are not resources immediately available to fund environmental work, or funding only permits initial assessment, the existence of samples for analysis and research should be made known via a central source.

- Work with commercial organisations as partners rather than simply as recipients needs to be encouraged. Sediment core data should be made available for research purposes if no longer required by commercial organisations and consideration given to housing these in a central national repository. There should be the inclusion of sediment-core data as appendices, if allowed by client.

- There needs to be greater awareness of the potential of sediments (including peat) by planning and curatorial staff and importance raised at desk-based assessment stage.

- The importance of isolated features, for example pits and charcoal spreads, where there is no artefactual material but environmental and dating evidence may potentially be extremely valuable needs to be highlighted.

- There needs to be easier access to detailed environmental reports in the grey literature. Environmental specialists should receive a copy of the draft publication for comment before a report is published.

- Development control should ensure that sampling guidelines are included at the project design stage and implemented and routine sampling undertaken. All developments that involve cross-landscape coverage (e.g. pipelines, road schemes) should pay particular attention to wetland areas for their palaeoenvironmental potential.

- Developers should be encouraged to consider funding offsite as well as onsite work where it will significantly enhance the investigation results.

- Day schools should be held to train and update archaeologists on sampling strategies and new developments in environmental archaeology.

- Greater awareness is needed of the potential for Palaeolithic archaeology and Pleistocene environments. 'Natural' deposits should always be investigated to ensure that such remains do not go unrecognised.

- There needs to be greater consideration given to the potential of environmental sampling of more recent deposits, for example post-medieval deposits, particularly in urban situations.

- Advantage should be taken to recover environmental samples when opportunities arise, e.g. damage to monuments resulting in the exposure of suitable environmental deposits.

- Radiocarbon data should be deposited via Heneb with the Project Radiocarbon repository at the ADS.