
The Palaeoenvironment in Wales

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1. Relevant Research

Archaeological sites where environmental work has been undertaken and pollen sites are listed according to the main themes previously recognised in the Research Framework for Wales. Included in the lists and the bibliography are sites where the initial work was undertaken more than five years ago but the work has only recently been published, or where there has been a further publication. The bibliography is based primarily on published work but also includes some unpublished work. The lists also include some on-going work.

Environmental Context and Landscape Change

Goldcliff East, Redwick, Kenfig, Llandevenny, Peterstone, Cas Troggy, Wentwood, Nant Hall (Prestatyn), Melyd Avenue (Prestatyn), Parc Cybi (Ty Mawr), Abercynafon, Fan Foel, Corndon Hill, Dyffryn Lane, Llangynfelin, Craig y Dullfan, Caer Seion, Gors Fawr, Afon Goch, Cors Wern Goch Moel Rhiwllug (Mynydd Hiraethog), River Clettwr (Dyfi Estuary), Moel y gerddi, Talley, Llyn Pencarreg, Traeth Mawr, Castell Henllys, Llyn Llech Owain, Gors Fawr, Esgyrn Bottom, Esgair Ffraith, Moel Llys y Coed, Hirwaun Common, Mynydd Llangatwg, Drygarn Fawr, Brownslade, Menai Straits, Minchin Hole Cave, Bacon Hole Cave, Giant's Grave, Clawdd Mawr, Crugyn Bank, Upper Short Ditch, Short Ditch, Buttington Cross, Milford Haven, Nant Farm, Castellior, Abercynafon, Boncyn Ddol, Barland's Farm, Dolaucothi-Pumsaint, Ardudwy,

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Mynydd Myddfai, Cors Caron, Llyn Cororion, Llandegai, Beaumaris Castle, RAF St. Athan.

The development of agriculture and changing agricultural practices

Most of the sites listed above plus Bishop's Palace (Bangor), Lliart Yspytty (Tremadog), Bryn Bachau, Gwinllan Glan Morfa, Goldsland Caves, Dyffryn Lane, Felindre – Tirley gas pipeline, Rhiwgoch, Maenclochog, Laugharne, Cwm Meudwy, Newport ship, Llanmaes, Llandeilo, Troedyrhiw, West Angle, Meusydd, Berry Hill, Ffynnonwen, Llanfor, Womaston, Hindwell, Whitford Dyke (Holywell Racecourse), Ty tandderwen, Llangorse, Park Hall Estate (Carmarthen), Lower Luggy, Wern Goch, Abergwyngregyn, Borrass Quarry (Wrexham), Tesco Supermarket Development (Pool Road, Newtown), Scottleton Street (Presteigne), Bluestone Holiday Park (Pembrokeshire), Newhouse Park (Chepstow), Princess Way (Swansea), Goat Street (Swansea), Skenfrith Castle, Parc Bryn Cegin (Llandygai, Tremadog, Castle Street Car Park and Ewers' Garden (Abergavenny), Borrass Quarry (Wrexham), Newhouse Park (Chepstow) Clynnog Fawr, Llanerchaeron, Dryslwyn Castle, Newton (Llanstadwell), Carmarthen Castle, Arddleen..

Mining Activity and Industrialization

Nant y Bai and Carn Wen (Rhandirmwyn), Craig y Mwyn Mine, Llangynfelin (Erglodd), Borth bog, Llancynfelin, Llwyn Du, South Hook.

Urban studies

Newport ship, Princess Way (Swansea), Goat Street (Swansea), Carmarthen Castle

Climate Change

Cors Wern Goch, Talley Lakes.

Alluviation in non-tidal river valleys

Usk, upper Severn, Dee, Teifi, Towy and Dyfi.

Coastal alluviation and sea-level change

Goldcliff East, Redwick, Kenfig, Llandevenny, Peterstone, Nant Hall (Prestatyn), Nant Farm, River Clettwr (Dyfi Estuary), Sudbrook, Barland's Farm, Milford Haven.

2. Relevance to the research framework priorities

Recent work is considered under the broad themes and questions previously identified in the 'All Wales Final Document' in the Research Framework.

Four key questions were highlighted which were as follows:

- How were the environment and economic activities related during the Mesolithic, especially in the coastal zone?

Recent research relevant to this is discussed in the 'How did availability of resources influence Mesolithic occupation?' and the 'Coastal alluviation and sea-level change' sections

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- Did Neolithic populations become more sedentary with the development of agriculture?

Studies relevant to this are discussed under the 'Nature of farming activity during the Neolithic and earlier Bronze Age in Wales?' and 'When and where did cereal cultivation and animal husbandry begin during the Mesolithic/Neolithic transition in Wales?'

- How did practices in animal and plant husbandry change?

Recent work relating to this topic is discussed in the 'Development of agriculture and changing agricultural practices' section.

- In what periods is it possible to recognise seasonal exploitation or transhumance?

Recent investigations which are particularly relevant to this question include studies to do with the availability of resources during the Mesolithic and the economy of medieval and post-medieval farms, discussed below.

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

Environmental studies from archaeological sites which provide further information about the environment and climate contemporary with different periods of human occupation during the Palaeolithic include reports within the final report currently being prepared on Pontnewydd Cave. These provide environmental evidence indicating the conditions tolerated by Neanderthals at the north-western edge of their range.

Much of the other recent work has focused on obtaining new dates as part of the AHOB research programme to provide a more accurate chronological framework for human colonisation and faunal and environmental change. This includes new thermal ionisation mass spectrometric (TIMS: uranium/thorium) age determinations on stalagmites from Bacon Hole and other British sites to provide a better understanding of the chronological framework of Late Pleistocene faunal change during the earlier part of the Late Pleistocene (Gilmour *et al* 2007). Re-dating by radiocarbon using ultra-filtration techniques of the red Lady of Paviland has led to a reconsideration of what the burial means in terms of colonisation and climate change (Jacobi and Higham 2008). Woolly rhinoceros bones from Goat's Hole (Paviland) and Coygan cave have been re-dated as part of an investigation to determine the extinction of woolly rhinoceros in Britain (Jacobi et al 2009) and targeted re-dating has resulted in a detailed reassessment of the last Glacial fauna from Coygan Cave. Wild horse from Cathole Cave has also been re-dated as part of the investigation of humans and animals during the Lateglacial (Jacobi and Higham 2009). Re-dating of humanly modified bone is taking

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place at Kendrick's Cave as well as Cathole Hole Cave.

Studies independent of archaeological work which provide information about the environment and landscape change include dating and correlating Late Pleistocene and Holocene alluvial sequences in Welsh river catchments (Jones *et al* 2006,). and modelling of relative sea-level change and deglaciation of the British-Irish ice sheet (Hubbard *et al* 2009). Lateglacial pollen studies have included a reconsideration of the events recorded at Traeth Mawr and the suggestion that they can be related to the five-fold subdivision of Greenland Interstadial 1, the survival of two oscillations being attributed to the climatic and ecological sensitivity of the site (Walker 2007).

- How did the availability of resources influence Mesolithic occupation?

The multidisciplinary studies undertaken by Professor Martin Bell (2007) and colleagues in the Severn Estuary and at Prestatyn in north Wales have contributed greatly to our understanding of the environment and exploitation of resources in the coastal zone during the Mesolithic. This includes important dendrochronological work in refining the chronology of coastal change in the late Mesolithic and Neolithic (Nayling and Manning 2007). The studies in the Severn estuary have also added to our understanding of seasonal exploitation, including evidence for the use of plant resources (Dark 2007) which is rare in a British Isles context, during this period. Investigation of the annually laminated sediments containing footprint tracks also indicate seasonal activity (Dark and Allen 2005). As part of studies such as the Arfordir project currently being undertaken by Dyfed Archaeological Trust in conjunction with Pembrokeshire National Park and RCAHMW, and the West Coast Submerged Land Project being undertaken by Birmingham University, further areas and sites may be identified for detailed investigation.

Other palaeoenvironmental investigations which indicate the environmental conditions, and hence the resources available for exploitation, include a study of the sea-bed in the Menai Straits by Mike Roberts at Bangor University. Investigations have also taken place in Milford Haven by Martin Bates and colleagues.

Investigation of the environmental conditions away from the coast include pollen studies at Gors Fawr and Esgyrn Bottom in Pembrokeshire (Fyfe 2007), Esgair Ffraith in mid Wales (Walker *et al* 2006) and Moel Llys y Coed, Denbighshire (Grant 2007).

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

A number of pollen studies have been carried out which include the Neolithic and Bronze Age periods and hence provide an environmental context for funerary and ritual monuments in the surrounding area.

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Several pollen investigations have been undertaken in relation to the survey carried out during the Funerary and Ritual Project as well as in association with follow-up excavations. They have included the analysis of pollen from nearby peat deposits, such as Craig y Dullfan (Caseldine and Griffiths 2009), and/or buried soils associated with monuments, for example Fan Foel (Caseldine and Griffiths 2006), Corndon Hill round barrow (Britnell *et al* 2008) and Waun Llanfair (Caseldine in prep.). Charcoal and plant macrofossil evidence add to the environmental record at the latter sites. Other integrated archaeological and environmental investigations include those undertaken in the Strumble- Preseli region (Darvill *et al* 2006, Fyfe 2005, 2007) and as part of the Aber Revelations Project (Fyfe and Law 2008). A pollen site at Moel Llys Coed (Grant 2009) was investigated as part of the Uplands Archaeology Initiative.

Recent charcoal studies from sites of different date within the same area, for example in the Walton Basin (Caseldine and Griffiths 2009a, forthcoming a), give some indication of the environmental conditions and may indicate environmental change.

One area of research which has received more attention recently has been the environmental evidence for ritual activity. Pollen evidence from investigations at Fan Foel (Caseldine and Griffiths 2006a) and Buttington Cross (Daffern 2009) suggest the possibility of floral tributes associated with cremations. Evidence of burning activity at Fan Foel and Corndon Hill (Britnell *et al* 2008) may also have ritual significance. Equally charcoal and charred plant remains associated with a cremation urn from Llanmaes (Caseldine and Griffiths 2010a) and charcoal from a pit at Buttington Cross (Clapham 2009) may indicate ritual activity.

- Is there evidence of continuity of land-use and in the types of crops grown from the Romano-British to the early Medieval period.

A number of recent pollen studies (e.g. Cors Caron (Lomas–Clarke and Barber 2007), Talley Lakes (Yates-Sabren 2008), Wentwood (Brown 2009), Moel Llys-y-coed (Grant 2009)) have provided further evidence for the impact of human activity on the environment and land use changes during the Roman to early medieval period but most of these studies have been undertaken independently of any archaeological excavation. The pollen evidence from the Short Dykes project, currently in progress, is therefore of particular significance as results from the radiocarbon dating programme suggest an early medieval date for their construction (Hankinson and Caseldine 2006). The pollen record associated with the excavations at the lead smelting site and medieval trackway at Llangynfelyn also provides a record for this period (Caseldine *et al* 2007) as does the recent record from Borth Bog (Mighall *et al* 2009).

Apart from pollen, charred plant remains from several early medieval and Roman sites have provided information about the crops grown and the arable economy (see below).

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

boundary?

A number of recent pollen studies (see above) also cover the Iron Age/Romano-British boundary.

Charred plant remains from several sites have provided information about the agricultural economy during the Iron Age and Roman periods (see below).

- What were the environmental conditions associated with wetland sites?

Environmental conditions are of key significance in the interpretation of wetland sites. Several studies, involving a range of palaeo-environmental analyses, have taken place in the Severn Estuary including the Mesolithic sites at Goldcliff and Llandevenney (Bell 2007), the Bronze Age sites at Redwick and Peterstone (Bell in prep.), the Barland's Farm Romano-Celtic Boat (Nayling and McGrail 2004) and the probable Neolithic footprint site at Kenfig (Bennett *et al* 2010). Wetland site investigations elsewhere have included the shell middens at Nant Hall, Prestatyn (Bell 2007), the Neolithic site at Abercynafon (Caseldine and Earwood 2004), the lead smelting and medieval trackway site at Llangyfelyn (Caseldine *et al* 2007, Smith *et al* 2007) and the burnt mound site at Nant Farm (Caseldine and Griffiths 2009b, Caseldine in prep.).

The development of agriculture and changing agricultural practices

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

The pollen records from Goldcliff East (Dark 2007, Timpany 2007), Redwick (Timpany 2005), Llandevenney (Brown 2007) and Prestatyn (Taylor and Caseldine 2007) and others, for example Moel y Gerddi (Innes *et al* 2007) and Moel Llys y Coed (Grant 2007), have provided further data for the later Mesolithic and early Neolithic. However, because of the difficulties associated with cereal pollen it is evident that the only way to establish with any degree of certainty when cereal cultivation commenced in Wales is by the dating of charred cereal grain. The dating of charred grain from an early Neolithic house at Parc Bryn Cegin, Llandygai (Kenney 2008, Schmidl *et al* 2008) is therefore of significance not only in terms of dating the building but in helping to determine the establishment of cereal cultivation in Wales.

Following on from earlier work at Parc le Breos Cwm, Gower (Richards 1998) and a number of cave sites in Wales, stable isotope studies of human skeletons from Prestatyn and Gop Cave (Schulting and Gonzalez 2007) have provided further evidence that Neolithic people had a largely terrestrial diet, with only limited evidence for the use of marine resources compared with the Mesolithic.

- What was the nature of farming activity during the Neolithic and earlier Bronze Age in Wales?

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The investigation of charred cereal remains from Neolithic settlements, along with animal bone if it survives, to determine the nature of farming activity is also of importance in the consideration of how sedentary or mobile Neolithic populations were. Environmental evidence from recent excavations such as Parc Bryn Cegin, Llandygai (Kenney 2008, Schmidl *et al* 2008) contributes to this debate while analyses from sites such as Parc Cybi (Kenny 2007) and Borrás Quarry (Grant and Jones 2009) may add further evidence in the future.

The survival of animal bone is generally poor on prehistoric sites in Wales. Hence the recovery of a substantial assemblage of animal bone along with Neolithic pottery as part of the Goldsland Caves research Project (Aldhouse-Green and Peterson 2007) is of particular value. The possibility that parts of certain animals were deliberately incorporated within the burial deposits is also being examined. The survival of animal bone and footprint tracks in the clays and silts of the Severn Estuary, for example at the Bronze Age sites of Redwick and Peterstone, also provide useful assemblages (Bell in prep.).

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

A number of archaeological sites have yielded archaeobotanical evidence over the last five years. All of this evidence contributes to our understanding of continuity of agricultural practices, when changes in crop husbandry occurred and the nature of the changes. Multiperiod sites, e.g. Parc Bryn Cegin (Kenney 2008), or investigations of sites of different date within an area, e.g. sites investigated as a result of the A497 improvement (Berks *et al* 2007) and the gas pipeline from Felindre to Tirley (environmental analyses associated with the latter are still in progress, e.g. Carruthers 2008a), are particularly useful in determining changes within an area. Along with the archaeobotanical evidence the palaeoenvironmental evidence (e.g. Walker and Jones 2007a) from the gas pipeline excavations should make a major contribution to the investigation of past agriculture and land use in south Wales. The investigation of defended enclosures in south Ceredigion and north Pembrokeshire has provided archaeobotanical evidence from the Late Bronze Age/early Iron Age through to the Roman period in that area (Caseldine and Griffiths 2007a, 2009c, 2009d), while detailed analyses of charred grain assemblages from Llanmaes in the Vale of Glamorgan may provide information about the status of different crops from the early Bronze Age through to the Romano-British period (Caseldine and Griffiths 2005a, 2006b, 2010a). Other sites which have yielded information about crops during the Roman period include Llandeilo Roman fort (Caseldine and Griffiths 2007b) and a corn drier at Tremadog (Kenney 2005). Current excavations at Caerleon include the recovery of charred plant remains from Roman and post Roman deposits.

Information about the nature of arable farming during the early medieval

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period in Wales has been recovered from several sites, including sites such as Afon Wen (Berks *et al* 2007) and Parc Bryn Cegin, Llandygai (Kenney 2008, Schmidl *et al* 2008) in north Wales and West Angle (Caseldine and Griffiths 2007c) Newton (Caseldine and Griffiths 2004a), South Hook (Carruthers forthcoming) and Maenclochog Castle (Carruthers 2008b) in south Wales. Changes hinted at during the Roman period become clearly established during the early medieval period.

Favourable soil conditions at Llanmaes in the Vale of Glamorgan have permitted the survival of a large bone assemblage, of importance because of the poor bone preservation, as noted previously, on most Welsh prehistoric sites. The bone assemblage, apart from providing information about the agricultural economy, is also of particular value in the interpretation of the social importance of the site (Lodwick and Gwilt 2005). Another site in the Vale of Glamorgan which has yielded both charred grain and animal bone is the late Iron Age and Roman farmstead at St Athan (Barber *et al* 2006).

One area of palaeoenvironmental investigation which has received little attention until recently is environmental work associated with field systems. Work is currently in progress as part of the Early Prehistoric Fields Project undertaken by Gwynedd Archaeological Trust.

- What was the economy of 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?

Recent pollen studies such as those at Ynys Ettws (Caseldine 2006), Moel Rhiwllug (Grant 2007), Moel Llys-y-coed (Grant 2009), Craig y Dullfan (Caseldine and Griffiths 2009e), Hirwaun Common and Mynydd Llangatwg (Chambers *et al* 2007a, 2007b) provide information about changes in grazing practices in the uplands and cereal cultivation. Environmental evidence for cereal cultivation from deserted rural settlement sites in the uplands remains limited but includes that from Ynys Ettws where charred cereal and waterlogged plant remains, as well as cereal pollen, indicated cultivation in the area. The evidence from Ynys Ettws and the post-medieval settlement of Tro'r Derwlyn also contributes to the debate about transhumance and seasonal occupation.

Mining Activity and Industrialization

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

There has been further progress in identifying prehistoric and historic mining activity, notably at Rhandirmwyn, Carmarthenshire (Mighall *et al* 2007, Craig y Mwyn Mine, Llanrhaeadr-ym-Mochnant, Powys (Mighall *et al* 2008), and at several sites at Borth bog including Llangynfelin lead smelting site, near Erglodd Roman fort, (Caseldine *et al* 2008, Mighall *et al* 2009), in a central core from Borth Bog and a site close to Llancynfelin mine (Mighall *et al* 2009).

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- What was the impact of iron-working on the landscape from the Iron age to Medieval times?

Combined archaeological and palaeoenvironmental studies (charcoal, geochemistry, pollen) at a 14th century bloomery, Llwyn Du, in Snowdonia has made an important contribution to our understanding of the possible impact of iron-working on the surrounding woodland through fuel supply and woodland management (Mighall and Crew 2005, Mighall *et al* 2009, Crew and Mighall 2010). Mineral magnetic measurements were used to detect ironworking activity in the peat cores (Mighall *et al* 2009). An analysis of the charcoal from early medieval iron smelting furnaces at South Hook demonstrates the fuel used and hence indicates the woodland resources available (Challinor forthcoming). This study is of particular value because of the rarity of metal working sites of this date in Wales.

- What impact did post-medieval industrialisation have on the surrounding environment and what is the longevity of its environmental signature?

Recent work on blanket mires and raised bogs has involved the investigation of factors influencing vegetation change and mire degradation. Studies of blanket mire degradation have demonstrated a major vegetation change, i.e. an increase in *Molinia*, post-dating the industrial revolution. The results suggest that as well as other factors, atmospheric pollution from industrial activity in the South Wales valleys may have been responsible (Chambers *et al* 2007a, 2007b). The encroachment of *Molinia* and *Betula* on raised bogs in Wales during the twentieth century is thought to relate to pollution from agricultural activities and the combustion of fossil fuels (Hughes 2005, Hughes *et al* 2007). Changes in *Sphagnum* moss species at Cors Caron may be a response to airborne pollution, grazing or fertilization of the bog surface by *Betula* litter.

Recent work at Talley Lakes also suggests that increases in copper, zinc and lead may represent atmospheric pollutants from the metal smelting areas of south Wales, although it could relate to more local mining activity (Yates-Sabren 2008).

Urban studies

- What were the living conditions of people in Welsh towns through the ages?
- What were their diets?
- What industries were based in urban contexts?
- What were the trades and trade networks of Welsh towns?

Recent studies have included the preliminary assessment of the plant macrofossil remains from the Newport Ship (Caseldine and Griffiths 2006c). Other studies within towns include examination of plant and animal remains from a probable late 15th century building in Presteigne (Priestly 2006, O'Brien 2005, Hancox 2005) and plant remains from the

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moat at Carmarthen Castle (Caseldine and Griffiths 2004b) and the outer bailey ditch of Swansea Castle and occupation deposits, including middens, at Goat Street, Swansea (Griffiths 2009).

Climate Change

- What was the relationship between climate change and successive human communities?
- How did climate change influence human colonisation during the Late-glacial period in Wales.

New radiocarbon evidence from Gough's Cave in south-western England for the Magdalenian re-colonisation of the British Isles has been compared with the evidence for interstadial warming from Llanilid (Walker *et al* 2003) in south Wales (Jacobi and Higham 2009). Re-dating of humanly-modified fauna from sites in Wales is taking place as part of the AHOB investigation of re-colonisation and climate change.

Late-glacial studies have included a reconsideration of the events recorded at Traeth Mawr and the suggestion that they can be related to the five-fold subdivision of Greenland Interstadial 1 recorded in the GRIP event stratigraphy (Walker 2007a). The survival of two oscillations at Traeth Mawr is attributed to the climatic and ecological sensitivity of the site. A recent development has been the investigation of Late-glacial and early Holocene climate and environment from stable isotopes in Welsh tufa (Garnett *et al* 2006).

- What is the evidence for climatic change during the Holocene?

Recent studies which provide evidence for climate change include changes in peat stratigraphy, for example at Cors wern Goch, Coedd Aber NNR (Hughes and Grant 2005, 2006), while the demise of *Sphagnum austinii* (*S. imbricatum*) moss at Welsh peat sites, as well as at other sites in Britain, may be a response to climate change (Hughes *et al* 2007). Later changes in the pollen and sediment chemistry records from Talley Lakes have been attributed to the 'Little Ice Age', as well as other historical events (Yates-Sabren 2008). Studies of river response to environmental change have also been attributed to climate change (see below).

Alluviation in non-tidal river valleys

- 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?
- How far has river channel and floodplain development influenced the archaeological record from the Palaeolithic to the present.
- What is the relationship between river alluviation, erosion episodes, climate change and land use change?

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Recent work has included an investigation of Holocene river development in the lower Usk Valley with particular reference to Caerleon (Johnstone *et al* 2008). Research by Professor Mark Macklin and colleagues into river dynamics and environmental change has also continued in a number of other catchments in Wales (Johnstone 2004, Jones 2007, Brewer *et al* 2009, Jones *et al* 2010) and includes current investigations in the Tywi Valley as part of the Exploration Tywi! Project. Of particular note in the investigation of the relationship between river behaviour, climate change and anthropogenic activity is the development of a data-base of radiocarbon-dated Holocene fluvial deposits in Great Britain (Macklin *et al* 2005, 2010, Johnstone *et al* 2006).

Coastal alluviation and sea-level change

- What role have human communities played in changing coastal environments compared with 'natural' factors?
- The besanding of settlements is well known but more precise chronologies need to be established for dunes in Wales.
- How did marine transgression and regression phases affect human activities, especially in prehistory?
- How did humans adapt to the coastal environment?
- What is the evidence for the seasonal use of coastal wetlands in later prehistory and what was the nature of the economy practised?
- What was the relationship between wetland settlements and those on dry land?
- 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?

Work has continued on modelling relative sea-level changes since the Last Glacial Maximum for the British Isles (Shennan *et al* 2006). Recent investigations in the Severn Estuary have led to a revised sea-level curve being suggested for the area (Bell 2007), as well as evidence for resource exploitation and the relationship between wetland and dry land settlements, not only for the Mesolithic period (see above, Bell 2007) but also for the Bronze Age (Bell in prep.). Further investigations of fish traps have indicated the importance of fishing during the medieval period in the Severn Estuary (Brown *et al* 2008). Other studies in the Severn Estuary have focused on factors involved in much later events, namely the flood event of 1607 and whether a storm surge or tsunami may have been the cause (Horburgh and Horritt 2006, Lewis 2007, Bryant and Haslett 2007, Skellern *et al* 2008). Further west an investigation of lithostratigraphic and chronostratigraphic evidence from sites in the Loughor estuary has focused on sea-level change in the last 2000 years and the processes involved (Edwards 2006). Investigation of the peats and clays associated with probable Neolithic footprints at Kenfig Sands near Porthcawl

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indicated the changing conditions prior to and the conditions contemporary with the formation of the footprints (Bennett *et al* 2010). Human and animal footprints are currently under investigation at Lydstep in Pembrokeshire.

In north Wales recent research has included elucidating the nature of Holocene sea-level and coastal change in the Menai Straits by Mike Roberts as well as the relationship between late Mesolithic and early Neolithic shell middens and sea-level change in the Prestatyn area and the resources available for exploitation (Bell 2007, Armour-Chelu *et al* 2007).

- Is there evidence for increased coastal dune-building and sanding-up during the Little Ice Age, AD1550-1850, and other episodes of climatic change?

The use of OSL to date Welsh dunes is still very limited but recent work has included the dating of deposits near Harlech (Duller pers. comm.).

3. Amendments to priorities

In general it was felt that the priorities previously identified in the 'Main Document' (see also National Seminar Paper) remain important, although there are a few amendments.

Environmental Context and Landscape Change

Dating of pollen records from speleothems (secondary cave calcite deposits) using thermal ionisations mass spectrometric (TIMS) U-Th dating offers the possibility of producing well-constrained palaeoenvironmental records beyond the ~40kyr limit of ¹⁴C dating. The tracking of bacterial ancient DNA in pollen and archaeological sediments could be used as an indicator of human presence in the past. The contribution of charcoal analyses to environmental reconstruction, particularly where other evidence such as pollen and molluscs does not survive, has been under-valued and needs greater emphasis.

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?

There is a need for increased use of Geographical Information Systems in environmental reconstructions in Wales.

Ritual activity

Ritual activity was not identified as a separate theme in the 'All Wales Final Document' although it was in the 'National Seminar Paper'. The role of pollen and other analyses in providing information about ritual activity, as well as the environment, needs greater emphasis.

The interpretation of cereal and wild plant food remains from pits, i.e. whether they represent domestic waste or have some special ritual significance, requires further investigation.

The development of agriculture and changing agricultural practices.

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Charred cereal grain needs to be dated to determine the arrival and spread of different crops in Wales from the Neolithic onwards.

The interpretation of cereal and wild plant food remains from pits, i.e. whether they represent domestic waste or have some special ritual significance, requires further investigation.

Stable isotope analysis of charred grain to determine whether manuring has taken place.

The relationship between the Roman army and native populations in terms of agricultural supply, especially the relationship between Caerleon and the surrounding region, requires further investigation. The same applies to Roman towns in Wales.

Archaeobotanical evidence for the development of horticulture during the Roman period is generally lacking in Wales.

Mining Activity and Industrialization

Work on metal mining has focussed on copper in the Bronze Age and lead in Roman and later times. Lead isotopes can help to discriminate between different ore sources, although British lead ores have overlapping isotopic signatures and further work is required. Little is known about silver mining though there are some well-known silver lead mines in central Wales.

Pollen studies concerned with the impact of industrialisation, as well as more recent pollution from agricultural activities, on vegetation communities are also of particular importance in relation to conservation issues and management of the uplands.

Coastal alluviation and sea-level change

There needs to be increased emphasis on inter-tidal and offshore survey, e.g. the West Coast Submerged Land Project undertaken by Birmingham University, and further detailed studies in the future.

4. How the Research Framework has been used

The main use of the Research Framework has been by the Welsh Trusts and other organisations in grant proposals to Cadw and other funding bodies (e.g. NERC). The Research Framework has also been important in ensuring that environmental archaeology is adequately factored into development control assessments and briefs.