An aerial photograph of a coastal landscape. In the upper right, a body of water (the sea) meets the shore. A river flows from the bottom left towards the sea, winding through a green landscape. The river has a rocky bed in some sections. To the left of the river, there are several large, irregularly shaped ponds or wetlands, some with small islands in the middle. The land is a mix of green grass and brownish patches, possibly mudflats or reeds. In the upper left, there is a small settlement with several buildings, including a church with a spire. The overall scene is a mix of natural and human-made features.

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edited by
Catherine Barnett
Thomas Walker

Environment, Archaeology and Landscape

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Professor Martin Bell

edited by
Catherine Barnett and Thomas Walker

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Front cover: Goldcliff Pill and Lagoons, Gwent Levels, 2010. The lagoons are shallow freshwater and saline ponds created in the 1990s and form the eastern part of the Newport Wetlands National Nature Reserve. The area shows traces of a medieval landscape, with the Monks Drain, to the east of the lagoons, perhaps being constructed in the thirteenth century. Goldcliff Point on the coast is the focus of much prehistoric, Roman and medieval activity. See Chapters 1, 2 and 18 for discussion of this area of Wales (photo: T. Driver; © Living Levels).

Back cover: Martin with his iconic 'Red foreshore box', April 2021. The intertidal zone at Goldcliff has been Martin Bell's principal focus of research for the last 30 years. Evidence of human presence from the Mesolithic onwards has been found, and is one of the best-known areas in Britain for human footprints, a topic explored in Chapter 2 of this volume (photo: T. Walker).

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Editors' foreword

This volume reflects on some key current research themes in archaeology and landscape: coastal and intertidal archaeology, mobility and routeways, experimental archaeology, sustainability, nature conservation, rewilding and community engagement. They are all themes which have featured in the research of Martin Bell and the volume has been assembled to mark his retirement in 2021 as Professor of Archaeological Science at the University of Reading.

The papers presented reflect Martin's remarkably varied but interwoven interests, each has been written specifically for this book and collectively they showcase the research directions and recent developments in archaeology, environmental and landscape studies to which Martin has contributed. When we asked potential authors whether they would like to be involved in this project, they jumped at the chance. We did not 'commission' the papers but left each contributor to decide how best they wished to reflect Martin's varied interests. It was difficult to select just a few of his colleagues and friends, and we apologise to the many who might also have been asked to contribute, but space is limited.

There is however one paper notably missing. Martin's great friend, collaborator and advocate of the hand lens, Professor John Allen, who sadly passed away soon after we started this journey. We know he would have contributed a splendid paper if he had been able, and also that he would have appreciated the solid science-led basis of the papers presented.

This book includes the work of Martin's former students, colleagues and, importantly, from those involved in significant initiatives and projects outside traditional academia which he has innovated or supported, including the Living Levels Project and Butser Ancient Farm, or those where he has supported a meld of academics, professional archaeologists, ecologists and policy makers such as the Kennet Valley Predictive Mapping Project and Somerset Wetlands Research, ensuring real world relevance and use to the approaches and outputs.

The book opens with a brief review of Martin's life and career, written by his friend and former colleague Professor Mike Walker. They collaborated in 1992 to produce *Late Quaternary environmental change: physical and human perspectives*, the second edition of which, published in 2005, remains a standard reference work on environmental archaeology. We have then divided the book into three broad themes, with an attempt to span Martin's wide-ranging interests and those of his colleagues, whose collective approach crosses disciplines and ways of thinking to great benefit.

The first theme, **FROM LAND TO SEA: COASTAL AND INTERTIDAL ARCHAEOLOGY**, explores the dynamism and opportunities offered through time by the marine, coastal and intertidal zones to people who settle or exploit these challenging environments. Recognition of the periodic, sometimes catastrophic nature of flux in areas prone to sudden shifts in location or submergence is important in the context of current global challenges and sea level rise. Geoarchaeology and environmental archaeology has a key role to play in measuring and characterising that change over the long term and in exploring the mechanisms of adaptation (or not) by people and processes such as food acquisition and transport.

Steven Rippon opens the theme with a discussion of how access to the Severn Estuary wetlands has changed over time from simple resource procurement in prehistory to modification and then transformation as the coastal marshes were reclaimed during the Roman and medieval periods. **Kirsten Barr** describes her work on the footprints of Mesolithic people and fauna at Goldcliff, bringing movement and gathering of resources in prehistory to life. **Michael Grant and colleagues** return to Westward Ho! in Devon, a site Martin investigated in the early 1980s, where stratified organic deposits and evidence of submerged forests associated with archaeological remains continues to be a source of interest and an opportunity to test emerging geoarchaeological techniques. **Thomas Walker** explores

the changing landscape during prehistory and beyond with establishment of precarious agricultural land in the context of shifting sand dunes at Gwithian in Cornwall. **Scott Timpany** explores the timing and pattern of submergence and settlement at two coastal sites through analysis of pollen and wood remains associated with re-exposed submerged forests and peats in Southern England and the Outer Hebrides. **Richard Bradley** explores how our changing coastlines have influenced maritime movement and landing places in prehistory in comparison to the medieval period, elegantly drawing together key evidence. This theme closes with **Johan Linderholm and colleagues** report their geoarchaeological investigations of Oslo Harbour, Norway, revealing massive delta front slumping during the medieval period. Their work highlights the need for detailed analytical work to identify the complex formation processes of the maritime archaeological record and at the same time provides evidence of maritime pollution in the medieval period.

Theme two, **PATTERNS IN THE LANDSCAPE: MOBILITY AND HUMAN-ENVIRONMENT RELATIONSHIPS**, is deliberately a broad one, enabling our contributors to explore and elucidate human activity in the full suite of terrestrial, riverine and estuarine landscapes. Movement, flexibility in settlement and mobility is a key strategy for humans to both overcome environmental adversity and exploit opportunities. Archaeological investigation, coupled with detailed palaeoenvironmental studies allows us to examine past patterns, successes and failures to adapt and make the most of our environment. Our allied disciplines have much to offer in providing a context for current global challenges and in informing future choices in this context.

Richard Brunning begins, demonstrating the dynamism of the Somerset Levels inter-tidal mudflats, peatlands and many frequently overlooked islands of hard geology through palaeoenvironmental investigation. He considers and contrasts investigation of wooden structures exposed in the inter-tidal zone with attempts to preserve and record the prehistoric trackways, ritual structures and wetland settlements of the inland moors. **Keith Wilkinson and colleagues** remain in the Levels, using geoarchaeological and multi-proxy palaeoenvironmental techniques to elucidate the Early–Middle Holocene of the River Parrett, examining the potential of these deeply buried deposits for informing our understanding of landscape change and Mesolithic–Neolithic settlement in the area. **Michael Allen** looks at the geoarchaeological record of wetland and dryland sites on the South Downs, Sussex, as revealed by a series of three small-scale investigations on dry chalk, highly localised wetlands, and the foreshore. **Catherine Barnett and colleagues** discuss the detailed investigation and mapping of patterns of late glacial and early Holocene landscapes in the Kennet valley and of the exceptional concentration of Upper Palaeolithic and Mesolithic sites. They discuss how those investigations can inform future methodologies, modern nature conservation, environmental management and development control agendas. **Jim Leary** closes this theme, providing a rich, experiential paper that discusses different modes of movement through varied landscapes and the influence of weather on human perception and experience.

The final theme, **ARCHAEOLOGY IN OUR CHANGING WORLD: HERITAGE RESOURCE MANAGEMENT, NATURE CONSERVATION AND REWILDING**, explores the relevance of archaeology to contemporary challenges of heritage management and environmental sustainability. It includes some of the topics brought to the fore by Martin's most recent research, several being highly relevant to tackling present day problems. As archaeologists, geoarchaeologists and palaeoecologists we have the tools to provide insights into, for instance, landscape evolution, feedback mechanisms, degradation and preservation of remains and to inform management strategies, introduce environmental resilience and support efforts to steer the course of habitat protection or regeneration.

Rowena Banerjea explores how geoarchaeology helps us to understand the frontier landscapes of the Middle Ages with reference to 'castlescapes' and how we might project that understanding into the establishment of geoparks and heritage and tourist trails, this concept of routeways being a particular interest of Martin's. **Jen Heathcote** discusses the shifts in the way in which Historic England and others have targeted and used research over the past 40 years to understand the processes that pose a risk to

the long-term preservation of archaeological and palaeo-environmental remains in wetland areas, including climate change, and those related to land management practices. **Petra Dark** explores the variability and the influence of human activity in past woodland development in Southern England using palynological and macrofossil analysis, and discusses what that knowledge means for approaches to landscape conservation and restoration currently so heavily influenced by the concept of ‘rewilding’ with an implicit return to a more ‘natural’ state. **Terry O’Connor** considers the problems associated with ‘passive wilding’ to allow land and biota to find its own trajectory versus ‘interventionist wilding’ by which species and landforms are actively restored, the latter potentially informed by the establishment of baselines using landscape-scale environmental archaeology giving a series of different snapshots through time, as exemplified by molluscan evidence from northern England. He explores critical themes such as developing an understanding of the time-depth of today’s ‘natural world’, the rate and complexity of changes and encouraging public appreciation of our environment. **Chris Speed** reviews his experimental work in the Butser Ancient Farm Project (see also Milton, this volume). Sites like Butser play a significant role in education and heritage outreach. This chapter also demonstrates that reconstructed structures can play an valuable part in understanding formation processes and that understanding can also feed back into, and enhance, their educational mission. Such studies demonstrate how patterns of soil chemistry and micro-artefact distribution can aid interpretation of archaeological sites and patterns. Our final paper, by **Alison Offord**, gives a wonderful, personal view of the important work of the Living Levels Project in Gwent, in reconnecting people to the heritage, wildlife and wild beauty of the Gwent Levels in South-east Wales, thus bringing us neatly full circle back to our first papers, by looking at the area of Britain that has been closest to Martin’s research and heart for the last 30 years or so.

Between these chapters, we have included pictorial exemplars of work in which Martin has been involved at numerous sites, some historical, some showing a side of Martin not often revealed. All are connected in one way or another to his research interests.

When we first conceived this collection of papers we asked each contributor for a paragraph detailing their connection to Martin. These **Personal reflections** have been collected together at the end of the book, and demonstrate the regard in which Martin is held by his friends and colleagues, both personally and in the academic world.

Finally, we offer a **bibliography** of Martin’s remarkable academic output. Of course, this only includes published material, and cannot hope to take account of the vast number of lectures he has given at national and international conferences, nor presentations to learned bodies and organisations. However, Martin has also contributed to numerous television programmes and series, and these are listed at the end of the bibliography.

Thank you to all our contributors; you have been a pleasure to work with and we have thoroughly enjoyed reading your work. To our readers, welcome and we hope you find the breadth and direction of inter-disciplinary research included here interesting and thought-provoking.

The image shows two handwritten signatures in black ink. The first signature, on the left, is 'Cathie' written in a cursive, flowing style. The second signature, on the right, is 'Tom' written in a more straightforward, slightly cursive style.

Editors' acknowledgements

It would have been impossible to produce this *Festschrift* without the unstinting help of many people, who we wish to acknowledge here. It is inevitable that there will be omissions, and for those we offer our apologies.

First, we thank Hella Eckart who, with Jennifer Foster, thought that a book would be a fitting way to honour the occasion of Martin's retirement. We humbly thank them both for inviting us to edit the work.

As editors, we faced the daunting task of selecting a small number of Martin's numerous friends and colleagues whom we asked to contribute. We could have filled a book many times the present size without difficulty, but we made our choices and we hope our selection meets with approval. We thank all those who have so willingly given their time to write the papers included in this book, and can only apologise to those not included but who may feel they should have been!

Next, we offer thanks to all those who responded to our call for photographs which we have used for our pictorial pages; including Mike Allen, Richard Brunning, Jennifer Foster, Sarah Lambert-Gates, Jonathan Last, Fergus Milton from Butser Experimental Farm, Sarah Orr, Alison Offord and the Living Levels Team and Sarah Orr.

We would particularly like to thank Michael Grant and Jen Heathcote who have offered invaluable assistance in bring this work to publication.

Special thanks go to Jennifer Foster who not only so capably proof-read all the papers, somehow without letting her husband know what she was doing, but also prepared the Index, such a vital part of any publication.

A draft of this book was presented to Martin at his retirement gathering. He has since offered helpful suggestions and personal insights to the authors on a number of the papers, which have been incorporated in addition to those stemming from review. We, the editors, and the authors thank him for his sage advice and input.

Finally, we thank David Davison at Archaeopress who generously agreed to publish this volume, and Mike Schurer who took on the role of putting it into print.

Martin Bell: a personal appreciation

Mike Walker¹

Professor Martin Bell.

Sir Mortimer Wheeler, one of the most famous British archaeologists of the twentieth century, once remarked that ‘.... archaeology is a science that must be lived, must be “seasoned with humanity.” Dead archaeology is the driest of dust that blows.’ This description of the subject is no better exemplified than in the career of Martin Bell who, while adopting a science-based approach to the archaeology of historic and prehistoric environments, has invariably retained as his central theme the activities of people in these landscapes of the past. Indeed, the leitmotif running through all of Martin’s work has been the bringing alive of past human communities to show how they have interacted with each other and with their surroundings. No-one who reads Martin’s books and research papers, or listens to his lectures, or spends time with him in the field, could regard his archaeology as being ‘dead’. It is, and always has been, ‘seasoned with humanity’.

Martin Bell was born in Brighton in 1953. He went to school in Rottingdean and then attended Cardinal Newman Secondary School in Brighton. In 1972 he was accepted to study Environmental Archaeology at the Institute of Archaeology in London and graduated with a First Class Honours Degree in 1975. He then worked for a year as a Research Assistant in the Institute before beginning his doctoral research on valley sediments and prehistoric land-use in the dry valleys of the South Downs and was awarded his PhD in 1981. He was employed for two years (1978–80) as a Part-time Lecturer in Archaeology at North London Polytechnic, before taking up research posts (Research Assistant and then Research Fellow) in the Department of Geography at Bristol University. In 1983, he was appointed to a position in the University of Wales, Lampeter, initially as a Lecturer in the Department of Geography and subsequently in the newly-created Department of Archaeology, where he became a Senior Lecturer in 1993. He left Lampeter in 1997 to take up a Senior Lectureship in the Department of Archaeology, University of Reading, and was awarded a Personal Chair in 2002. He was Head of Department from 2010–2013, before finally retiring in 2021. He was elected a Fellow of the Society of Antiquaries of London in 1984 and, in 2009, his contributions to Archaeology were recognised by his election to a Fellowship of the British Academy.

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Martin's research career began in Sussex where, as a member of the Sussex Archaeological Society and the Brighton and Hove Archaeological Society from a very early age, he directed excavations at Newhaven and Bishopstone while still at school and during his time as an undergraduate (Bell 1977). Although his research activities have subsequently taken him into other parts of Britain, he has maintained his connections with south-eastern England and is currently President of the Sussex Archaeological Society. After moving to Bristol and then on to Lampeter, Martin's research interests turned to the Severn Estuary, embarking first on an extensive programme of excavation and survey at Brean Down on the north Somerset coast (1984–1987). This is probably the best-preserved Bronze Age settlement sequence in southern Britain, and the site contains an abundance of artefactual and palaeoenvironmental evidence, which is described in a comprehensive monograph published by English Heritage (Bell 1990). In the 1990s, he turned his attention to the northern shores of the Severn Estuary where interbedded peats and muds which are often extensively exposed at low tide had long been known to contain a record extending back into prehistory. Previous work, although piecemeal, had revealed the rich archaeological and palaeoenvironmental potential of the 'Severn Estuary Levels', and Martin began a systematic investigation of these intertidal sediments that was to occupy him for the rest of his research career. The principal focus was Goldcliff to the south-east of Newport where recurrent episodes of inundation separated by periods of alluviation have preserved extensive waterlogged archaeological and environmental sequences that contain Mesolithic, Bronze Age and Iron Age settlement sites, brushwood trackways and roundhouses, rectangular timber buildings and fishtraps. Other archaeological finds include lithics and animal bones (some of which show signs of butchery) and shell middens. Perhaps most remarkable of all has been the discovery of human footprints, the earliest dating from the Mesolithic around 7500 years ago, while animal footprints of deer, aurochs, wolves and cranes have also been recorded. These extraordinary discoveries have been described by Martin and his co-researchers in a series of papers and monographs (e.g. Bell 2007a, 2007b, 2013, 2018, 2019; Bell *et al.* 2000), while the Severn Levels footprints and trackways have led to a wider consideration of these and other related features in a recently-published book (Bell 2020).

But Martin's research activities have continued beyond the confines of the Severn Estuary. For example, his deep knowledge of the archaeology of the chalklands of southern England and his expertise in molluscan and associated sedimentary analyses have been applied in the excavation and interpretation of the enigmatic Bronze Age pond barrow site of Wilsford Shaft on Salisbury Plain (Ashbee *et al.* 1989); in the analysis of the Neolithic monument complex at Hambledon Hill, Dorset (Bell *et al.* 2008); and in modelling anthropogenic erosion of loess on the South Downs (Favis-Mortlock *et al.* 1997). His long-standing interests in experimental archaeology have seen him involved in excavations at Butser Ancient Farm in the South Downs National Park, at Fishbourne and Wroughton Earthworks, and at the Wareham and Overton Down experimental earthworks projects (Bell *et al.* 1996; Macphail *et al.* 2003). Indeed, he has long been involved in experimental archaeology and archaeological methodology (e.g. Banerjee *et al.* 2015a, 2015b; Bell 2012, 2014). He has also been a leading contributor to the Vale of Pewsey Neolithic project, to the Kennet Valley Mesolithic project, and to investigations on the Somerset Levels into the Mesolithic of the wetland edge (Bell *et al.* 2016; Jones & Bell 2013). Somewhat further afield, he has contributed to a Moroccan-based project on the Epipalaeolithic of North Africa (Barton *et al.* in press). His extensive research activities have resulted in a publications portfolio of 12 books and monographs and more than 100 research papers.

Inter-tidal fieldwork at Goldcliff, Severn Estuary Levels, South Wales.

Martin's research has evolved in tandem with his teaching. In many ways, Martin is 'old school' in regarding teaching and research as going hand-in-hand; moreover, he is a great believer in getting students out into the field where they could learn the practical aspects of archaeology at first hand. He was strongly supported in this approach by his archaeological colleagues in Lampeter, Dave Austin, Barry Burnham, Julian Thomas and Rob Young who, along with Martin, spent six seasons (1984–1989) variously directing a training excavation and survey on the

Iron Age hillfort of Caer Cadwgan that overlooks the Teifi Valley near Lampeter. Apart from a short paper in *Current Archaeology* (Austin *et al.* 1988), the excavation details are otherwise contained in a series of interim reports (Austin *et al.* 1985, 1986, 1987, 1988, 1989), but a comprehensive *Strategic Archive Report* has now been prepared for deposition with Cadw (the Welsh equivalent of English Heritage: Burnham 2020). In many ways the excavation proved to be a model of what could be achieved both as a collaborative exercise between colleagues with differing backgrounds and as a high-quality teaching and training project. The other strand to Martin's teaching is, of course, laboratory work, and he has always been keen for students to develop their laboratory skills, which often led through to a final year dissertation. He was assisted in the laboratory by Astrid Caseldine who, in 1987, was appointed as Environmental Archaeologist for Wales, which was a Cadw-funded position (that had been initiated and negotiated by Martin) to provide archaeobotanical and palaeobotanical support to the four Welsh Archaeological Trusts. Part-funding of the appointment by the university, however, enabled Astrid to contribute to the undergraduate, and eventually postgraduate, teaching programmes in environmental archaeology.

As soon as Martin arrived in Lampeter, it was clear that he and I had much in common and that my Quaternary interests formed a perfect fit with his environmental archaeology expertise. It seemed logical, therefore, to build a new degree scheme around this partnership and so came into being the Single Honours degree in *Archaeology and Environmental Studies* (later to become simply *Archaeology and Environment*). The rationale of the degree was to meld together landscape and environmental archaeology with cognate areas of physical geography, and it worked! We never had a large cohort of students, but those that took the course were enthusiastic and encouraging, and had a learning experience that took them from the lecture room and laboratory to the landscapes of west and south Wales, as well as to Exmoor and even to Mallorca. Martin was very much the leading player in this course and ran the degree programme for several years.

But something else came out of our teaching collaboration. Martin and I had always been influenced by Karl Butzer's magisterial book: *Environmental archeology: an ecological approach to prehistory* (1971) which drew together elements of Pleistocene geology and climate, geochronology, and ecological and landscape change, to generate a synthesis of Pleistocene environments and people from both the 'Old' and 'New' Worlds. We felt that something similar, albeit more 'modern', was possible, and the outcome was our jointly-written book *Late Quaternary environmental change: physical and human perspectives* (1992) with a second edition appearing in 2005. We were gratified that the books appeared to be well received, but others will judge whether we ever came close to matching Butzer's seminal volume!

Left: Martin talking about the foreshore at Goldcliff, September 2018.

Right: Living Levels Intertidal Archaeology Training Course, Peterstone, April 2019.

Several other aspects of Martin's teaching should also be mentioned. One of his most significant achievements in the Archaeology Department at Reading was the design and delivery of the MSc course: *Geoarchaeology/Environmental Archaeology*, a programme for which he was Director for several periods. The course was established in 1999 and since then has trained over 140 geoarchaeologists, many of whom now work in archaeological units or in universities. Martin has been an energetic and supportive research supervisor having, over the course of his career, seen 18 PhD students through to completion, and he has also been External Examiner for 16 PhDs and Internal Examiner for a number of higher degrees at Reading. In addition, he has served as External Examiner for undergraduate degrees in the universities of Bournemouth, Cambridge, Oxford, Sheffield and Queens, Belfast,

Martin's wider contribution to archaeology has been substantial. He has been a Council Member of the Prehistoric Society and the Society of Antiquaries of London; a member of the NERC Science Based Archaeology Committee, the NERC Terrestrial Sciences Peer Review Committee, and the NERC Archaeological Science Strategy Group; and a member of the Council for British Archaeology Science Committee, where he was also convenor of the CBA Working Group on Science Training in British archaeology. During his time in Wales, he was a member of the University of Wales Board of Celtic Studies Committee and of the Archaeology Committee of the National Museum of Wales, and was for a period Treasurer for CBA Wales. He has subsequently been a member of a number of Advisory and Working Groups of English Heritage. He served as Small Grants Officer for the British Academy and was a trustee and non-executive Director of Wessex Archaeology. For many years, Martin was an active member of the Severn Estuary Levels Research Committee and was Secretary of the Group in the 1990s. More recently, he has been involved in an advisory capacity for several major research projects, including the NLF-funded CITiZAN Community Coastal Archaeology project, and EBB and Flow (the Leverhulme-funded Oxford University-based project). Last, but by no means least, he has appeared in several television programmes, including *Landscape Mysteries: Wilmington* (BBC/OU); *Time Team: Goldcliff* (Channel 4); *Meet the Ancestors: Goldcliff* (BBC2); *Coasts: Goldcliff* (BBC1/ OU); *History of Ancient Britain* (BBC); and *Countryfile* (BBC1).

It would be inappropriate to conclude this appreciation without reference to Martin's family. His wife Jennifer, who he met on their first day at university and is also a distinguished archaeologist in her own right, has been a tower of strength throughout his career, and has been actively involved in many of his field campaigns. The same is true of their daughters, Eleanor and Sarah, who made their archaeological debuts on the Brean Down excavations (1983–86) and subsequently found themselves immersed in mud when Martin began digging at Goldcliff in 1992. It is maybe not surprising that neither of them followed their parents into an archaeological career! But I am sure that they will take great pleasure in this Festschrift for their father, which is a fitting tribute to the man and his achievements. However, knowing Martin, I am also sure that he is not yet ready to hang up his boots. The great jazz musician Louis Armstrong once remarked 'Musicians don't retire; they stop when there's no more music in them'. And I am absolutely certain that there is still a great deal more archaeology left in Martin Bell!

End of work for the day maybe, but not the end of a research career

ACKNOWLEDGEMENTS

I would like to thank Cathie Barnett and Tom Walker for inviting me to write this biography of Martin as an introduction to the Festschrift; Sarah Lambert-Gates and the University of Reading for the photograph of Martin; and Chris Harris, Gavin Jones and their colleagues at the Living Levels Partnership for permission to reproduce the three images from Goldcliff. I am particularly grateful to Jennifer for background information, for providing the final photograph, and for her helpful comments on an earlier version of the text.

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BISHOPSTONE, SUSSEX

Martin 'cut his teeth' at Bishopstone in Surrey and which led to the publication of his first book *Excavations at Bishopstone* in 1977 for the Sussex Archaeological Society.

Surveying the entrance to the Iron Age enclosure, 1968.

Excavating a Romano-British corn dryer, 1969.

*Iron Age enclosure cut by an Anglo-Saxon house, 1975
(photo: B. Westley).*

The Iron Age enclosure ditch, 1975 (photo: B. Westley).

Iron Age skeleton, 1974 (photo: B. Westley).

Anglo-Saxon grubenhaus, 1975 (photo: B. Westley).

**PEOPLE AND THE SEA:
COASTAL AND INTERTIDAL
ARCHAEOLOGY**

MESOLITHIC FOOTPRINTS – A PROTOCOL

1. Arrive at the seaside at high tide, and wait for the sea to disappear.
2. Go down onto the foreshore and look around.
3. Have a film crew on hand to give advice.

4. Select a suitable area and discuss – today it's with Neil Oliver.
5. Empty the Severn Estuary onto the silt to clean off the footprint.
6. If that doesn't work, use a pressure pump.

7. Find a footprint and record it.
8. Ask your wife to make a cast of it.
9. Get off the foreshore before the rain sets in.

(photos: T. Walker).

Chapter 1

Battling the tides: Severn Estuary wetlands during the prehistoric, Roman and medieval periods

Stephen Rippon¹

ABSTRACT

This paper will review how human communities changed from simply exploiting the rich natural resources of the Severn Estuary's wetlands during the prehistoric period, through to modification and then transformation as the coastal marshes were reclaimed over the course of the Roman and medieval periods. This intensification of wetland utilisation can in part be accounted for by a 'push in the margins' driven by expanding population and the need for more agricultural land, but it was also affected by other social and economic factors that sometimes prevented reclamation, such as the rich natural resources of intertidal marshes occasionally being more highly valued than agricultural land. Indeed, the model of wetland exploitation, modification, and transformation is itself in need of revision as we become increasingly aware that the history of human endeavour in wetland landscapes has not been one of unilinear success. Instead, periods of extensification (the reclamation of new land) and intensification (such as increased arable cultivation) have been interspersed with episodes of retreat when reclaimed land was abandoned and the estuarine tides recovered some of what they had lost.

Keywords: *prehistoric; Romano-British; medieval; Severn Estuary*

INTRODUCTION

The Severn Estuary, and its adjacent wetlands, is a remarkable landscape. With the second largest tidal range in the world, large areas of land are exposed twice a day only to be covered once again by the Severn's muddy waters. Rising sea levels since the last Ice Age have laid down a deep sequence of sediments comprising a series of alluvial clays interspersed with layers of peat representing periods when freshwater vegetation colonised what had previously been intertidal mudflats and saltmarshes. Similar sequences of Holocene sediments are found around many of our major estuaries, but one of the things that makes the Severn Estuary so special is how its large tidal range and vast intertidal zone provides a window into how past human communities made use of this landscape from prehistory through to the present day.

Another reason why the Severn Estuary is so important is its long history of archaeological investigation. The excavations of the Iron Age 'lake villages' at Glastonbury and Meare, in Somerset, were amongst the first sites in Britain to reveal just how remarkably well-preserved structural remains and material culture could be in wetland landscapes (see Coles & Minnitt 1995 for a reflective discussion). The truly inspirational Somerset Levels Project – directed by John and Bryony Coles – revealed the vast array of prehistoric evidence that was preserved within the deep peat sequences of the low-lying inland 'backfens' (summarised in Coles 1989), and from the 1980s the potential of the intertidal zone also started to be appreciated. This came about through the fortuitous coming together of various strands of fieldwork which included the remarkably perceptive observations of geologist John Allen who made sense of the Holocene sequence, the recognition of archaeological sites by local bird-watcher Derek Upton, and growing interest on the part of professional archaeologists – including Martin Bell – in the face of the potential impact of a proposed tidal power barrage.

And so began over 30 years of fieldwork in the Severn Estuary wetlands, and its impressive series of research publications that includes the Severn Estuary Levels Research Committee's (SELRC) annual report *Archaeology in the Severn Estuary* and a series of Council for British Archaeology Research Reports (Bell 2003, 2007; Bell *et al.* 2000; Nayling 1998; Nayling & Caseldine 1997; Nayling & McGrail 2004; Rippon 1996, 2006). The cumulative result of this and other research has been a remarkably detailed understanding of the changing ways in which human communities have interacted with the Estuary, exploiting its rich natural resources and – over time – gradually changing the natural environment in order to intensify its productivity.

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Figure 1. Schematic model for the increasing intensity with which human communities initially exploited the rich natural resources of coastal wetlands, and then modified and transformed them in order to increase agricultural productivity. This was first published in Rippon 2000a, but we now have a better understanding of how reclamation is not a unilinear progression and that there were also periods when nature retook control with previously reclaimed areas reverting to intertidal environments as sea walls were set back in the face of coastal erosion (hence the 'Retreat' stage bottom-right has been added) (graphic: S. Rippon).

EBB AND FLOW IN THE USE OF WETLANDS: EXPLOITATION, MODIFICATION, TRANSFORMATION, AND SET-BACK

The rapid rise in post-glacial sea levels led to the formation of intertidal saltmarshes and mudflats all around the Severn Estuary, and one of the most exciting early examples of intertidal archaeology was the recording of Mesolithic human footprints exposed within the intertidal zone (e.g. Aldhouse-Green *et al.* 1992; Bell 2007). More recent work has mapped large numbers of similar lines of footprints, showing how small groups of humans were walking in consistent ways across the mud around Goldcliff island (Bell 2020: 90–101). One reason why people were trudging through the mud was to hunt for food, with the footprints of many animal and bird species are also preserved (Allen *et al.* 2004; Barr 2021: this volume, Chapter 2; Barr & Bell 2017).

Wild animals and birds – a potentially rich source of food – are not the only natural resources afforded by the intertidal environments around the Severn Estuary: fish could be caught in the tidal waters, domesticated animals were grazed on the higher saltmarshes, and salt can be produced by gently heating the estuary's water (e.g. Bell 2013; Rippon 2006). This simple exploitation of natural resources is therefore the first, and simplest, way that human communities utilised coastal wetlands not just around the Severn Estuary but across north-west Europe (Rippon 2000a: figure 1). Over time, however, as population rose and there was a need to produce more food, human communities started to intensify how they used the Severn Estuary wetlands, for example by digging drainage ditches and building low embankments to try and prevent summer flooding and improve the quality of the grazing, that can be termed 'summer dikes'. Examples have been excavated both on the Caldicot Level (e.g. Meddens

& Beasley 2001) and the North Somerset Levels (Rippon 2000b, 2006). All around the British coast this phase of wetland ‘modification’ dates to the Roman period, and represents the second way that human communities utilised the Severn Estuary (Figure 1).

During this ‘modification’ phase the environment remained essentially intertidal: the drainage ditches and embankments will have helped prevent unseasonally high summer flooding, but palaeoenvironmental analysis of the water in the ditches shows that it was still brackish. The Severn Estuary appears to have been the only part of Roman Britain to then see a further intensification in how its wetlands were used, when the landscape was transformed by full-scale reclamation whereby more substantial sea walls were constructed that changed the ecology from brackish to freshwater. This was a high cost, high risk, but high return strategy towards utilising a landscape. The initial capital cost in digging the drainage ditches and building the sea walls, and the subsequent recurrent costs associated with maintaining those flood defences, will have been considerable, while the risk of flooding due to storm surges was ever-present. What must, therefore, have been critical was that the agricultural productivity of a reclaimed wetland was far higher than an unreclaimed marsh (Rippon 2000a). Excavated examples of this transformative approach towards wetland management have been found on both sides of the Estuary, although in different contexts. On the Wentlooge Level it is likely to have been undertaken by the army based at the legionary fortress at Caerleon (Fulford *et al.* 1994), while in Somerset reclamation appears to have been within the context of civilian villa-based estates (Rippon 1995, 2006).

This model of intensification of wetland utilisation that progressed through exploitation, modification, and transformation should, however, now be revised in part to reflect what happened after the Roman period. The relationship between human communities and wetland environments was not a unilinear one, but instead saw episodes of retreat. In the early medieval period most of the reclaimed Roman landscapes appear to have been abandoned and flooded, with freshwater soils being buried under estuarine alluvium (e.g. Meddens & Beasley 2001; Rippon 2000b, 2006). In these areas the reclaimed landscape of today represents a second phase of reclamation that in Somerset dates to the late first millennium AD, while in Gwent it probably dates to shortly after the Norman Conquest (Rippon 1996, 2008a). The late medieval period saw another phase of retreat, as sea walls all around the Severn Estuary had to be set back in the face of increased coastal erosion, and this is reflected in how the modern sea wall cuts diagonally across some fields (Figure 2) (Rippon 2002).

Figure 2. Aerial view of the coastal part of Redwick parish showing how the modern sea wall has been set-back to its present location such that it cuts diagonally across earlier fields (photo: S. Rippon).

MARGINALITY: STILL A USEFUL CONCEPT IN LANDSCAPE STUDIES?

Studying particular landscapes is integral to archaeological research but in order to understand a place it must be seen in its wider context. The integration of techniques for mapping the physical structure of the landscape, alongside palaeoenvironmental analysis that allows us to reconstruct ecologies, vegetation cover, and land-use, means that palaeogeographical reconstruction is becoming increasingly sophisticated. This allows the different strategies towards wetland utilisation to be compared across both time and space, and one reason why the Severn Estuary wetlands are so important is that the change from exploitation, through modification, to transformation helps us understand wider trends within past societies. Developments during the Roman period are a very good example. It is noteworthy that all of the major coastal wetlands within Roman Britain see a gradual intensification of their use in the 1st and 2nd centuries AD and this reflects trends seen across most lowland areas where the number of settlements was increasing (Allen *et al.* 2017; Smith *et al.* 2016). This wetland use was, however, restricted to the exploitation of natural resources and the modification of some landscapes such as in Fenland, with the large-scale transformation of coastal wetlands being restricted in both time (the mid-3rd to mid-4th centuries) and space (some, but not all, of the wetlands around the Severn Estuary). At first sight this late Roman reclamation would seem curious as across most of Britain the numbers of rural settlements were in decline (Smith *et al.* 2016), and as such this is a good example of why studying one type of landscape – in this case coastal wetlands – that occurs in lots of different places is so interesting as they act as barometers for a variety of socio-economic processes.

The idea that the intensity of landscape exploitation reflects a variety of factors is not new, and it lay at the heart of Michael Postan's (1972) 'population-resource' model. This argued that as population and demand for food increased during the High Middle Ages (the 12th and 13th centuries) there was an expansion of settlement in previously less favoured landscapes – the 'journey to the margins' – and that in the late medieval period, when population and demand for food fell, it was followed by a 'retreat from the margins'. This model of 'marginality' has been prominent in both the medieval period and prehistory (e.g. Tipping 2002; Young & Simmonds 1995), but has been challenged on various grounds (e.g. Bailey 1989; Dyer 1989; Mills & Coles 1998). In particular, Postan's emphasis upon population growth and arable cultivation is questionable as we now have a better understanding of the productivity of mixed and predominantly pastoral economies, while the role of environmental factors in shaping landscape change has also come under close scrutiny. While it remains true that the rigidity of 'environmental determinism' should continue to be rejected, we are becoming increasingly aware of how the natural environment shapes human behaviour and landscape character over time (e.g. Rippon 2006, 2008a; Williamson 2003, 2013).

FORCING BACK THE TIDE: THE INCREASING INTENSITY OF WETLAND UTILISATION IN THE ROMAN PERIOD

The late Roman period saw a marked 'push into the margins' in some – but not all – of the coastal wetlands around the Severn Estuary, and the physical uniformity of these natural environments (alluvial marshland) allows us to explore the reasons why different communities chose to exploit the same type of landscape in different ways. On the English side of the Estuary, the extensive coastal marshland in north Somerset and the northern part of the Central Somerset Levels (the area that in the medieval period was known as 'Brent Marsh' to the north of the now silted-up river *Siger*) were both embanked, with the resultant change in ecology from brackish/intertidal to freshwater (Figure 3) (Rippon 1995, 2000b, 2006). These landscapes had clearly been transformed through reclamation, and in each case there was a Roman villa at the centre of the reclaimed area (Wemberham in north Somerset, and Lakehouse Farm near Brent Knoll). There is no reason to suppose that the decision to reclaim these marshlands was not on the initiative of these villa owners, and this fits in with the emerging picture of agricultural prosperity in this region during the late Roman period (the southern part of what has been termed Roman Britain's 'Central Belt': Smith 2016). This 'push into the margins' can therefore be seen as a socio-economic phenomenon: the contemporary perception must have been that the initial capital cost of building flood defences, the recurrent costs associated with their annual maintenance, and the potential risks of flooding, were outweighed by the perceived economic return on that investment.

The situation was, however, very different in the southern part of the Central Somerset Levels (the Brue Valley, between the *Siger* and the Parrett Estuary) where the landscape was left as intertidal saltmarsh and used for salt production. In part there may be an explanation for this in the character of the natural environment: the coasts of both the North Somerset Levels and Brent Marsh were protected by belts of natural sand dunes, although extensive embankments will still have been required along the tidal rivers. The open coast to the south of the *Siger* was not, in contrast, protected by sand dunes but embanking this area would not have been an enormous task as there were a series of bedrock islands – notably Huntspill and Pawlett – that could simply have been linked by relatively short

Figure 3. The extent of marshland reclamation in Somerset and Gwent during the Roman period (graphic: S. Rippon).

stretches of sea wall. It is instead likely that this area of marshland was left unreclaimed because its natural resources – most notably the opportunity to produce salt – were so highly valued. In this respect it is very striking that no evidence for salterns has been found on the Welsh side of the Estuary, which is curious as the Gwent Levels lay close to the legionary fortress at Caerleon whose non-agriculturally productive military and civilian populations will have required large amounts of salt to preserve food. The wetlands in the immediate hinterland of Caerleon appear to have been embanked and used for grazing animals (Beasley & Meddens 2001; Fulford *et al.* 1994), and so another area will have been required for salt production. There is in fact a direct link between Caerleon and the marshlands south of the *Siger* and in particular the port at Crandon Bridge besides the Parrett Estuary (Rippon 2008b). Crandon Bridge appears to have formed part of a major supply route for the military garrison at Caerleon, with a large amount of its pottery having been brought there from Poole Harbour in south-east Dorset before being loaded onto larger vessels that could cross the Severn Estuary and sail to Caerleon. Surely it is no coincidence that the only late Roman salt industry around the Severn Estuary was next to Crandon Bridge and this supply route for the military establishment? The Caldicot Level – directly south of Caerleon – was used extensively for grazing and no evidence has yet been found for salt production: perhaps the estuarine waters this far up the estuary were not sufficiently salty?

What we see on the Somerset side of the Severn Estuary in the Roman period is, therefore, a divided landscape with the marshland south of the *Siger* responding to the demands of military procurement – the command economy – while to the north of the *Siger* the market economy saw civilian landowners invest in reclamation. That the Second Augustan Legion drew resources from across the south-west of Britain is well known (Fulford 2006), and their presence on the southern coast of Devon in the late 2nd century – long after the legion withdrew from Exeter in c. AD 80/85 – is confirmed by the clearly genuine stamped legionary tile from Seaton (Warry 2021: 403–6). What we therefore see around the Severn Estuary in the Roman period is that there was a ‘push into the margins’ in one sense, as the use of its wetlands intensified dramatically, but that this was in practice a far more complex process than Postan’s population-resource model envisaged. In north and central Somerset north of the *Siger* there does indeed appear to have been wetland reclamation driven by market economics: the production of surplus agricultural goods that could be sold in order to pay taxes and procure goods and services (such as the specialists employed to build the villa at Wemberham with its mosaic pavements). Yet elsewhere around the Severn Estuary – south of the *Siger*, and on the Gwent Levels – the same type of landscape (alluvial coastal marshland) was used in different way due to the dominance of a non-market based economy dominated by military controns and/or procurement. This led to the ‘normal’ trajectory of landscape intensification – increased population leading to increased arable production – being skewed by socially embedded factor such as the demand of a dominant landowner for non-arable resources such as salt.

BATTLING THE TIDES: MEDIEVAL RECLAMATION AND RETREAT

In the 5th century the shift from wetland exploitation, through modification, to transformation was reversed with widespread flooding all around the Severn Estuary. By the 12th century recolonization of the Severn Estuary’s wetlands was well underway, and while in many respects this represents a classic ‘push into the margins’ we once again see that in places the logical progression of reclamation was prevented by socially-embedded factors. The clearest example is Caldicot Moor, a vast tract of saltmarsh at the eastern end of the Caldicot Level that went unreclaimed until the 19th century. Different communities, and different landlords, could chose different ways to manage their land, and in the case of Caldicot Moor this involved retaining traditional common grazing on an intertidal saltmarsh while their neighbours were embanking and draining their lands.

Figure 4. Aerial view of the island and medieval monastery of Muchelney, in Somerset, during the freshwater floods of 2014 (photo: D. Grady, Historic England Archive, NMR 27898_005).

Caldicot Moor shows how highly valued saltmarshes were as grazing land, but even when reclaimed these wetlands will have been inhospitable places in winter, and it is likely that much of the livestock would have been driven onto higher ground. Martin Bell (2020) has recently pulled together a wide range of evidence for the movement of people and animals across prehistoric landscapes, and the Roman and medieval countryside will have been just as busy. For the Roman period there appears to be a major road leading south from the Caerwent to Caerleon road down to the major tidal inlet at Magor Pill where there was clearly some form of Roman settlement (Rippon 1996: 32). What is striking about this road is that it appears to have continued north to the forested upland of Wentwood, as is the case with several other more sinuous droveways that are presumably of medieval date. These reflect how the grazing of livestock on the Levels will have been a seasonal activity, especially in the case of cattle whose considerable weight meant that they would poach the soft ground very easily. There are documentary references to ‘summerways’ on the Gwent Levels (Rippon 1996: 56), reflecting how cattle will have been driven down onto the wetlands during the summer months.

By the 12th and 13th centuries the coastal marshes all around the Severn Estuary were mostly embanked and drained, although the lower-lying inland ‘backfens’ were mostly unenclosed common pasture and very vulnerable to flooding from freshwater running off the surrounding high ground (Figure 4). When assessing population densities and agrarian prosperity across different landscapes it is therefore important to differentiate between the permanently settled agricultural lands in the coastal districts, and sparsely or just seasonally utilised backfens. Unfortunately the Gwent Levels are poorly documented in the medieval period, but Somerset has a large number of documentary sources that allow us to compare the wetland and dryland economies. Domesday Book shows that in the late 11th century the settled coastal claylands of the Somerset Levels had densities of both population and ploughteams that were comparable to the adjacent dryland areas, while for the period 1250–1349 other sources suggest that the reclaimed coastal marshes supported an average to high population density, and a high to very high assessed wealth (Rippon 2021: appendix 2.1: see top of table for sources used). Quite simply, although the recurrent costs of maintaining the drainage and flood defence systems on the Levels were high, and there was an ever-present risk of flooding, the high agricultural productivity of these wetlands more than made up for the costs and risks.

But risks there were, and in the late medieval period the tides started to turn. It is all too easy to assume that the great earthen embankments (sea walls) that protect the Severn Estuary Levels today date back to this era of medieval prosperity, but it is increasingly clear that this is often not the case. In many (most?) cases our present sea walls are no older than the late medieval period, having been set-back to their current location in the face of increased storminess and the resultant coastal erosion. A good example is the sea wall at Redwick, on the Caldicot Level (Figure 2) that clearly cuts diagonally across several fields in a way that suggests it has been set back to its present location having once been further out into the Estuary.

CONCLUSIONS

This paper has reviewed how human communities gradually intensified the ways in which they utilised the Severn Estuary wetlands. In prehistory communities simply exploited the region’s rich natural resources, while in the Roman period modifications of the landscape allowed greater agricultural production by limiting the amount of flooding. In places reclamation brought about a complete transformation of what had once been intertidal environments, with the freshwater flora and fauna in the drainage ditches being very similar to those seen today. This intensification of wetland utilisation appears to have been carried out by land-owners who were wealthy enough to build well-appointed villas, and this transformation of the landscape can in part be accounted for by a ‘push in the margins’ driven by expanding population and the desire for more agricultural land. There were, however, other social and economic factors at play in the Roman and medieval periods that led to some areas of intertidal marsh being retained, suggesting that their rich natural resources were more highly valued than agricultural land. This is one instance of how the model of wetland exploitation, modification, and transformation is in need of revision as we become increasingly aware that the history of human endeavour in wetland landscapes has not been a unilinear one from low intensity hunting, fishing, grazing, and salt production through to intensive arable farming. Another example of how the creation of today’s historic landscape was not one of progressive improvement is that periods of agricultural intensification were interspersed with episodes of retreat when the estuarine tides recovered some of the lands that they had lost. These set-back sea walls around the Severn Estuary are, therefore, in part monuments to human achievement – in holding back the tides and creating our reclaimed wetland landscapes – but also reflect the pragmatism required when it becomes apparent that nature has other plans.

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FOOTPRINTS AT GOLDCLIFF, SEVERN ESTUARY

Martin has been investigating the intertidal zone on the Severn Estuary for many years. A particular interest is in the human footprints and their trails made during the Mesolithic and Neolithic periods (see following paper by Kirsten Barr). These are created in the fine laminated sandy/silt sediments laid down over many years. Good 'impressed' human prints are very infrequent, but excellent bird prints are a common finding

Human and crane footprints in the Mesolithic silts at Goldcliff (photos: M. Bell).

It is not practical to lift the prints, as the soft sediment will not remain intact, so casts can be created on site using dental alginate. From these moulds hard Plaster of Paris casts are made and used for analysis and teaching.

Martin and Kirsten Barr making a cast of bird footprints with dental alginate (photo: T. Walker).

Chapter 2

Walking beside our ancestors

Kirsten Barr¹

ABSTRACT

Footprint-tracks can provide information about the footprint maker, including species, age, sex, and height. Combined with other datasets this can contribute to our interpretation of animal exploitation, population dynamics, seasonality and site usage. This study focuses on the Late Mesolithic intertidal site of Goldcliff East, Severn Estuary. Metric dimensions and morphology of modern human footprints are used as analogues to help understand the age, stature and sex of the prehistoric humans. The formation of modern footprints upon clayey silt sediment was studied. 177 participants were involved, aged between 3 and 71 years old. The relationship between footprint length, footprint width, age, sex, stature and weight was explored. Between 2001 and 2017, 322 Mesolithic human footprint-tracks were recorded at Goldcliff East, a further 177 were possibly human, poorly eroded mammal or localised sediment disturbance. The footprint-track trails of nine people were identified and combined with a further 12 from Scales' study (2006). Stature equations suggest that the average height of an adult was 166.5cm. Sex could only be determined as male in footprint-track trails with footprints over 30cm. It was not possible to identify a difference in foot length between adult females and children over 10 years old. Footprints from the older, lower sites (N, M and O) were made by humans walking north-east and south-west, taking them towards and away from Goldcliff Island and a palaeochannel. Archaeological and ethnographic evidence is presented alongside the footprint data, with the conclusion that Site N was used as a 'pathway' by children and possibly adult females to walk to a fishing area. Footprint-tracks can provide us with evidence of people going about their daily lives, rather than viewing them as skeletal remains or associated artefacts, and thus gives us a more personal way of interacting with them, enabling us to walk beside our ancestors.

Key words: *Severn Estuary; footprint-tracks; Mesolithic; patterns of movement*

INTRODUCTION

In every continent around the world, excluding Antarctica, trace fossil footprints have been found preserved in a variety of sediments (Ashton *et al.* 2014; Bennet *et al.* 2009; Huddart *et al.* 2008; Inoue & Sakaguchi 1997; Leakey & Hay 1979; Mietto *et al.* 2003; Scales 2006, 2007; Webb *et al.* 2006). Footprint-tracks are the individual traces made by people and animals, the entire three-dimensional body of sediment disturbed by the descent of the foot and subsequent sedimentary processes (Bell 2020). The Severn Estuary, Wales, is a site that is rich in archaeology, with the intertidal areas being of particular interest. It is these liminal zones where footprint-tracks are often preserved.

The Holocene prehistoric sediment sequence found upon the Severn Estuary is the Wentlooge Formation, named after the Wentlooge Level in Gwent (Allen & Rae 1987). The sediments in the Wentlooge Series are predominantly uniform grey clayey silts (Rippon 1997). The Wentlooge Formation is found beneath the Severn Levels, with Holocene sediments covering an area of about 840km², and 10–15m in total thickness (Allen 2005). Evidence of footprint-tracks can be found in these Holocene sediments. The Wentlooge Formation represents the remains of a wetland environment, consisting of salt marshes and intertidal silt mudflats during the marine phase, and reed marshes, woodland and peat bogs in the terrestrial phase.

Prehistoric human, bird and mammal footprint-tracks can be found on banded silts between the basal Mid Holocene and middle Wentlooge peats. The banded laminae have been observed to be on a submillimetre to millimetre scale (Allen 2004), and are visually distinctive, with the fine textured clayey silt overlain by sandy silt.

At the Late Mesolithic estuarine laminations at Goldcliff East there were 322 human footprint-tracks recorded between 2001 and 2017, as well as 270 bird and 67 mammal footprint-tracks; a further 177 were possibly human, poorly eroded mammal or localised sediment disturbance.

¹ Independent researcher.

Figure 1. Excavated Mesolithic occupation sites (a) and the axes of Mesolithic movement indicated by footprint-track sites; (b) stratigraphic section indicating occupation sites in relation to footprint-track sites (Bell 2020; graphics: J. Foster).

During 2001–2004 footprint-tracks were discovered upon laminated banded sediments; these were assigned the site identification of Site C, Site E and Site H (Figure 1). These sites were low in the tidal frame at -3.1m to -4.4m OD (Bell 2007: 48). The footprint-tracks were preserved in estuarine sediments which overlay the lower peat at Sites B, D and I, when the submerged forest and lower Peat was inundated c. 5650 cal BC (Bell 2007: 49). The estuarine sediment was then sealed by the formation of the upper peat and submerged forest, which formed c. 4700 cal BC. The lower peat is divided into two areas by the erosion of a later palaeochannel, which is 240m wide between sites I and D. Within this there are a number of other intersecting channels representing various stages in the migration of the palaeochannel. The footprints recorded on Sites C, E and H are in the laminated sediments which fill this channel. Further footprint-tracks recorded on Sites M, N, O, R and S during 2014–2017 (Figure 1), and the wood structure at Site T (now interpreted as a Mesolithic fishtrap: Bell *et al.* forthcoming), are all within this palaeochannel feature. The palaeochannel is capped by the main peat and is of later Mesolithic date.

METHODS

The methodology and footprint-track terminology established by Allen *et al.* (2003) and Scales (2006) were used as a guideline in recording the prehistoric and modern footprints.

The footprint-track areas at Goldcliff are exposed during only a short tidal frame, the Ordnance Datum heights at which they occur ranging from about -3m OD (top of Site C) down to -5.31m (Site S). The highest footprint-track sites will be exposed for about 2 hours at the best during spring tides and the lowest (Site N and S) only for about 1½ hours. Under average muddy conditions much of this time will be spent locating footprint-tracks and washing off mud and sand before recording can begin.

At the Mesolithic site of Goldcliff East, the laminations are fragile and must not be cleaned with excessive force, such as by using trowels or spades, as this would cause damage (Scales 2007: 140). It is most effective to use water gently to clean the area; one approach is to use buckets of seawater to wash off small areas which mimics erosion caused by the tide, rather than using tools which may harm the fragile laminae. The use of buckets depends on the presence of a nearby body of water and a slope which does not have sand, which will simply wash onto what you are trying to clean.

Due to the unpredictability of working within the intertidal zone when recording the Mesolithic sites, and working with children when recording modern data for a comparison, the method had to remain flexible. Each footprint was given a number for identification, photographs were taken, and the lengths and widths of each were recorded. Lengths were made from the tip of the hallux (big toe) through the medial longitudinal arch, to the tip of the pterion (heel). The width was measured at the widest point at the ball of the foot.

Footprint-track trails provide convincing evidence of human activity. A trail is a sequence of footprint-tracks which have been made by one individual's feet coming into contact with the substrate. A trail of footprints can assist in an understanding of the direction in which an individual was walking and the length of their stride, which can lead to inferences about stature, gait and direction of movement. Pace was measured between the top of the hallux of a footprint and the hallux of the foot behind or in front of them in the trail, e.g. left-right-left. Stride was recorded from the end of the hallux of a left foot to the end of the hallux of the next left foot in the trail; the same was measured for the right side.

The use of multi-image photogrammetry in this experiment involved prepared targets set up on the sediment near the footprint-tracks as ground control points (GCP). The GCP positions were recorded using handheld GPS or differential GPS depending on availability. The distance between each GCP was measured and a sketch plan was created to enable the area to be analysed if the differential GPS failed, which was a problem experienced multiple times during the fieldwork period.

A 10cm scale was placed by the footprint-tracks for size reference. The images were taken by hand, as the unstable and uneven sediments were not appropriate for mounting tripods and they caused damage to the laminations. Taking the photographs by hand rather than using a tripod was a time-effective method (Rüther *et al.* 2012). Multiple images of the footprint-tracks were taken, at a different position for each image, using a full framed camera with a fixed angle lens (Bennet *et al.* 2013; De Reu *et al.* 2013). This ensured that photographs were taken from as many angles as possible, with at least a third of overlap between each.

The data obtained by photogrammetry produces the principle output of a point-cloud consisting of x, y and z co-ordinates. The software package *Agisoft Photoscan Professional* was used to create the point-cloud, allowing the creation of a 3D model. This program uses a combination of algorithms such as stereo-matching and Structure from Motion (SfM) (Agisoft LLC 2018). The first step is SfM, where all the photographs are loaded into the software and aligned. The software allows for markers to be placed; one was placed in the centre of each of the ground-control points and the distance between each marker measured during initial recording was manually entered. The software identifies these markers as points of interest and tracks them around the movement of the image, the images are then aligned again to ensure all GCPs are in the correct area. This produces a sparse point-cloud, with the position of the cameras and the calibrations given for each image. The sparse point-cloud can then be used to build geometry and a textured model and mesh, resulting in a three-dimensional representation of the footprint-track, footprint-track trail or footprint area (Figure 2). The ability to view the full extent of the footprint-track trails in this way meant that the relationship between the footprint-tracks could be more fully understood and analysed.

Figure 2. (a) Multi-image photogrammetry point cloud model of footprint-track 2015:6 and 2015:7; (b) digitised outline of the footprint-tracks; (c) multi-directional hillshade model; (d) digital elevation model. Note that the scale is not absolute OD heights; the OD height of this trail is -5m to -5.14m OD (graphics: K. Barr).

MODERN HUMAN FOOTPRINTS

This study recorded the footprints made by 177 individuals aged between 3 and 71 years old. Of these, 89 adults aged over 16 years were involved, 30 were male aged between 19 and 71 and 59 were female aged 17 to 70. A total of 88 people aged between three and 16 years were studied for estimations of stature utilising footprint data. Of these, 46 were female and 42 were male, although two males and one female withdrew from the study before any data except age and sex could be established. This sample size is relatively small; however, it is large enough to allow general trends to be observed. Children aged between three and six years were one of the main focuses of this study, as there have been very few studies regarding this age group before (Anderson *et al.* 1956; Scales 2006).

Children younger than three were not considered, as before this age a child is still a ‘toddler’ and has a gait that does not resemble that of an adult. They tend to walk on their toes and have a gait that is broad and short; their legs also are more rotated than an adult (Anderson *et al.* 1956). Due to these factors the relationship between their footprint length and height would not be expressed in the same way as children above this age.

Only those with good foot health were involved in this study. Volunteers suffering from infections such as Athletes foot were not asked to take part in the footprint experiment, although people with recent foot breaks, a child suffering with plantar fasciitis, several women suffering with hallux valgus, a child with a missing toe and a woman who was seven months’ pregnant were included within this study.

Within forensics, footprints are often recorded using ink and measurements recorded from specific landmarks or using geometric morphometrics (Domjanic *et al.* 2013; Kanchan *et al.* 2012a, 2012b; Krishan 2008a, 2008b; Moorthy *et al.* 2014a, 2014b; Robbins 1985). These methods were not appropriate for this study, as sediment is malleable and is often lacking in clear landmarks, unlike that of a static or two-dimensional ink footprint or those made on firmer sediments. The present study utilised sediments taken directly from banded clay silt laminations near areas where Mesolithic footprint-tracks have been found at Goldcliff East. These laminations were obtained from an area where it was unlikely that prehistoric footprint-tracks would survive, due to the high levels of erosion and churned up sediments. An aluminum tray, 2m in length and 1m in width, was made for this experiment. To enable footprints from a variety of people to be recorded this tray was made this size so that it was easily portable.

The tray was placed within a shallow depression with the same dimensions as the tray, providing a tight fit and preventing the tray from moving. The edges of the tray were level with the rest of the ground surface, removing the need for a step to enter the footprint tray, which would have altered gait. Estuarine sediment was added to the footprint area; this sediment was compressed as much as possible using a plastic plastering trowel, so that the

whole of the tray was evenly filled by the sediment. After recording, the sediment had to be compressed and spread across the tray. Constantly spreading and compressing the sediment prevented the preservation of footprints under the surface of the clay, which would alter the footprint data.

Each volunteer was assigned a number to retain anonymity. The height in centimetres and the weight in kilograms were recorded for each volunteer. They were then asked to walk barefoot through the sediment in the tray. Each was required to set their gait by starting at least four metres away from the footprint tray.

Due to the unpredictability of working with very young children the methodology had to be flexible, simple and quick to perform. Once out of the footprint trap, the footprints were photographed and measured. Multi image photogrammetry was attempted when time allowed.

Due to the similarities in male and female footprint lengths the argument that will be presented is that it is not forensically accurate to suggest that the sex of a child can be established through the length of a footprint. The age of an individual can be estimated from a footprint, though it is important to note that accuracy will be within a broad age range rather than a specific age due to variations in growth, genetics and nutrition (Table 1).

Table 2 shows the differences in foot size expressed in both sexes. There is a large overlap in the footprint data between males and females. In this experiment the largest shoe size a female was wearing was a UK size seven, however these individuals often had footprints similar in size to males who wore a UK size ten.

Individuals with footprints over 30cm or smaller than 15cm were the easiest to identify; in all other cases there was a relative amount of overlap. Footprints that were 20cm or less belong to children aged under ten, which will be an indication of children from within the archaeological footprint-track record.

Footprint length (cm)	Age	UK shoe size
<15	4 or younger	Child 7 to child 10½
<20	10 or younger	Child 11 to child 13
>20	10 to adult female	Adult 1 to adult 7

Table 1. Age estimation utilising footprint length.

Footprint length (cm)	Sex	UK shoe size
20 to 24	Adult female/pubescent child of unknown sex	3 to 5
24 to 30	Either sex	5 to 10
>30	Adult male	11 to 12½

Table 2. Sex estimation utilising footprint length.

Table 3 provides the regression equations created for both female and male left and right footprints made within this study. These equations assist in determining the stature of an individual. All of the equations were calculated by using the lengths of each footprint from the modern human data set and calculating the relationship between the footprints (independent variable) and the stature of the person (dependant variable). Complications can arise in archaeological datasets as the sex of an individual is unknown. In these situations, a footprint trail can assist in identifying the gait, which may indicate male or female, and then these specific equations can be utilised. Footprints can be indistinct, and where the left or right foot and the sex is not identifiable, a combined regression equation can then be used to estimate stature.

Sex and footprint side	Regression equation	Standard error of estimate
Male left	$y = 82.48 + 3.53x$	8.3
Male right	$y = 89.24 + 3.31x$	8.5
Female left	$y = 95.05 + 2.78x$	6.0
Female right	$y = 92.4 + 2.90x$	6.18
Combined	$y = 60.3 + 4.3x$	7.3

Table 3. Regression equation establishing heights for adult males and females, y = height, x = footprint length, to be used on footprints larger than 20cm.

Research demonstrated that identifying the sex of children from a footprint is not accurate, as there is too much variation in children of both sexes; however, identifying the stature of a child from a footprint is possible. This research took into consideration children aged 10 and younger, as after this point many children were of a similar height to adults and produced results with adult dimensions. Only if a footprint is under 20cm, indicating a prepubescent child, should these equations be utilised (Table 4).

Footprint side	Regression equation	Standard error of estimate
Child left	$y = 41.32 + 4.13x$	9.14
Child right	$y = 36.22 + 4.42x$	8.12
Combined	$y = 38.82 + 4.27x$	8.59

Table 4. Regression equation establishing heights for children, y = height, x = footprint length, to be used on children with footprint lengths under 20cm.

The regression equations that were created for males had a higher standard error than for females. More participants of the male sex may have provided results that were strongly correlated. Most individuals in Table 1 were from the same geographical region, ethnicity and even occupation. Many of them were in a similar age bracket; these factors may have influenced their foot growth or morphology.

MESOLITHIC FOOTPRINT-TRACKS

The Mesolithic footprint-tracks from Goldcliff East provide an insight into the daily lives and activities of this hunter-gatherer-fisher population (Figure 3). Often the Mesolithic people of Britain are invisible in the archaeological record; there are few Mesolithic skeletal assemblages resulting in very little existing information on demographic diversity. The footprint-track trails are therefore especially informative as they provide insight into the population dynamic, patterns of movement, age and stature (Table 5).

HEIGHT AND SEX

The footprint-tracks made at Goldcliff East were made by people who ranged in height, from a young juvenile under four years old with an approximate height of 97.5cm (3' 2") to an adult male with an estimated height of 198.5cm (6' 6"). The average height of those aged over 10 years old was 166.5cm (5' 5"). Due to the large overlap between possible male and female footprint sizes (Table 2), as well as the issue caused by data from pubescent children who were still growing, an average height was not determined for males and females. It is evident that there were tall individuals within the population; at least four of the footprint-tracks were likely made by individuals taller than 182cm (5' 11").

Figure 3. Footprint-tracks recorded by Scales (2006, 2007); (a) footprint of Person 13 (6215), scale 10cm; (b): footprint of Person 13 (6204); (c): footprint trail, small divisions 1cm; (d): footprint of Person 6 (6160a), small divisions 1cm (photos a, b, d: E. Sacre; c: M. Bell).

Footprint-track number	Foot size average (cm)	Age (years)	Sex	Height (cm)	Walking speed (kph)	Running speed (kph)	No. of footprints in trail	Site	Seasonality of use
2015:1 to 2015:5	26	Adult	Either	161.3	7.05	6.91	5	M	-
2015:114 to 2015:115	26	Adult	Either	172.1	6.08	7.92	2	C/E	Spring/Summer
2015:116 to 2015:117	22	10+	Pubescent child/ Female if adult	154.9	2.77	3.34	2	C/E	Spring/Summer
2015:160 and 2105:163	24.3	10+	Pubescent child/ Female if adult	164	7.2	9.9	2	M	Spring/Summer
2015:17 to 2015:20	25	10+	Either	167.2	5.97	7.74	3	N	Autumn/Winter
2016:50 to 2016:56	23.9	10+	Pubescent child/ Female if adult	161.9	5.25	6.8	7	N	Autumn/Winter
2016:73, 2016:75, 2016:100	23.2	8 to adult	Pubescent child/ Female if adult	161.1	5.346	6.84	3	R	Spring/Summer
2016:108 and 2016:103	16.3	4 to 7 (4 to 5 probable)	Either	108.3	3.3	4.14	2	S	Spring/Summer
2017:10 and 2017: 11	13.8	4 or younger	Either	97.75	1.51	1.54	2	S	Spring/Summer
Person 1	22.1	10+	Pubescent child/ Female if adult	155.3	4.42	5.4	16	H	Spring/Summer
Person 2	28.2	Adult	Either	181.5	3.13	4.28	9	E	Spring/Summer
Person 3	29.3	Adult	Either	186.2	4.32	3.7	7	E	Spring/Summer
Person 4	31	Adult	Male	191.8	2.98	3.7	8	E	Spring/Summer
Person 5	30.2	Adult	Male	189.2	2.88	-	9	E	Spring/Summer
Person 6	27	Adult	Either	176.4	-	-	4	E	Spring/Summer
Person 7	27.8	Adult	Either	179.8	3.34	4.17	4	E	Autumn/Winter
Person 8	23.8	Adult	Pubescent child/ Female if adult	162.6	-	-	3	E	Autumn/Winter
Person 10	18.6	5 to 8	Either	118.2	-	-	2	E	Autumn/Winter
Person 11	16.1	4 to 7 (4 to 5 probable)	Either	107.5	-	-	108±10	C/E	Spring/Summer
Person 12	21.9	11 or younger	Either	132.3	-	-	57±10	C/E	Spring/Summer
Person 13	22.3	10+	Pubescent child/ Female if adult	156.1	-	-	2	C/E	Spring/Summer

Table 5. Age, sex, and stature estimates of individuals who made footprint-track trails at Goldcliff East. The footprint-track size, number of footprints in the trail and likely seasonality are also included. Persons 1-13 are from Scales' data (2006, 2007) and reanalysed using age, sex and stature estimates from the current study. The other footprint-tracks are all from within this study. Persons 14-18 are omitted from this reanalysis due to lack of data regarding full trails.

THE ROLE OF CHILDREN AT GOLDCLIFF EAST

Within this study children are considered to be aged 10 years old or under, with a footprint length less of than 22cm, due to the number of modern adult females who also made footprints of between 22cm and 25cm when walking on clayey silt sediment. In total, 63% of modern females within this study had footprints an average of between 22cm and 24cm in length. 56% of children aged between 10 and 15 years old also fell into these measurements, plus a further 5% of individuals aged 10 to 15 years old who made footprints with an average length under 22cm.

Overall, between the current study and that performed by Scales (2006), there have been 381 possible human footprint-tracks recorded at Goldcliff East between 2001 and 2017, 183 (48%) of which are similar in length to children, as defined by the author.

Previous research (Scales 2006, 2007) has suggested that there was a high percentage of children living in the area of Goldcliff East that is now part of the intertidal zone; the current research also suggests this. Smaller footprint-tracks were observed less often in a footprint-track trail during this study, with trails generally made by footprint-tracks 20cm or larger, which may be related to a preservation bias, though this was evidently not the same experience for Scales' research (2006, 2007), as half of her footprint-tracks were two trails of footprints made by children (Person 11 and Person 12).

In every footprint area recorded between 2014-2016 at least 20% of the footprints were made by children aged 10 years or younger. The only exception to this was Site M, where 18% of those recorded belonged to young people.

During the research period 2014–2017 there were no child footprint-track trails discovered which contained more than three footprints, so a comment cannot be made about their activity (e.g. playing or prey stalking); however, juvenile footprint-track trails recorded by Scales (2006) indicated that children were moving in a way that suggested mud larking or play. However, an inference can be made about the individuals at Site N; 69% of footprint-tracks recorded from Site N between 2014 and 2017 were made by children and adult females. The other 31% may have been made by small adult males, adult females or children aged over 10 years old. The footprint-tracks within this area were all orientated on an axis which led from the edge of the former Goldcliff island across a palaeochannel within which were wood structures interpreted as the remains of fish traps (Figure 1: Sites T). This may indicate that these children were not just using the saltmarsh environment to play or learn as suggested by Scales (2006), but were actively participating in fishing activity, which would require them to check the traps at least twice a day at low tide.

PATTERN OF MOVEMENT

There were similarities in the direction of movement for the individuals at both Sites C/E and R. There was a high proportion (28%) heading in a north-west direction; however, there was also a high proportion heading west (24%), as well as 28% of footprint-tracks where the direction of movement was unclear. The final 20% of footprint-tracks were heading north (8%), north-east (4%), east (4%) and south (4%).

Figure 4. Plan showing the extent of the footprints in Site N and their direction of movement. Sites recorded between 2011 and 2016 (graphic: M. Bell & J. Foster).

The pattern of movement suggests that these individuals were all heading to a specific static area. Areas of activity have been recorded at Goldcliff Island (Bell 2007), where there was a wooden structure (Site T) recorded during this study on the same axis as the footprint-tracks from Site N. A further 26% of footprint-tracks were orientated in a north-east direction, away from Goldcliff Island, likely to be heading out from the areas of activity where they had been based. Sites M, N and S are on different laminations and suggest that these footprint-tracks were laid down on successive laminations over multiple years, with individuals returning to a similar area and moving along the same axis, year after year.

The footprint-tracks made on the lower laminated sites (M, N and S), had an evident direction of movement, with 26% of individuals heading in a north-east direction, and a further 4% of footprint-tracks orientated in an east direction away from Goldcliff Island. Just 4% of footprint-tracks were orientated south, and a further 50% of footprint-tracks were heading south-west towards Goldcliff Island, to the same area that the east and north-east footprint-tracks were heading away from. Only 3% of individuals were directed to the west-north-west, and 7% were heading north-west. Within these areas 6% of the footprint-tracks had an indistinct direction of movement. Half of the footprint-tracks recorded were heading in a south-west direction, towards Goldcliff Island. The footprint-tracks recorded between 2010 and 2014 were all moving in a north-east and south-west direction, at right-angles with a palaeochannel (Figure 4).

CONCLUSIONS

The Mesolithic footprint-tracks at Goldcliff East provide archaeologists with an interesting snapshot of the lives of these hunter-gatherers. One of the most important aspects of this site is the prevalence of juveniles. The prehistoric footprint-tracks at Goldcliff East indicate that young children were present in the intertidal zone, as were adolescent children, adult females and, to a lesser extent, adult males. Sites C/E and M are the only areas where footprint-tracks were clearly male. Though smaller footprint-tracks could also have been made by males, it does indicate that children and adult females were predominant within this site and perhaps comprised the majority of the population in the seasonal island edge fisher-hunter-gatherer groups.

Site N was a small area (16m x 6m) that was walked over multiple times, over multiple years, always heading in a similar direction, indicating that these individuals were walking to perform a routine activity at a static place. These individuals were children and possibly adult females, suggesting this was an activity that only certain members of Goldcliff East society were performing. Given the proximity to the palaeochannel it is highly possible that these individuals were involved in fishing.

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Chapter 3

Prehistoric activity on the Atlantic coastline: Westward Ho! submerged forest

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ABSTRACT

The submerged forest of Westward Ho!, north-west Devon, has witnessed keen archaeological interest since the 19th century, attracting some of the most prominent archaeologists and palaeoecologists of their time to investigate the site. Since 1983, Martin Bell has been actively involved in two phases of excavation, along with repeated visits and monitoring of this important site as it has slowly been eroded by Atlantic storms. The site's importance stems from the fact that it contains Late Mesolithic activity in the form of a shell midden and extensive lithic and charcoal spreads, overlain by Early Neolithic activity in the form of a series of stake alignments, with an on-site palaeoenvironmental record provided by the organic submerged forest beds. This fortuitous combination of stratified organic deposits with archaeological remains has resulted in this becoming one of the best dated submerged forest sequences in the region and continues to be a key testing ground for new and innovative archaeological science techniques.

Keywords: *submerged forest; Mesolithic; palaeoenvironment; radiocarbon*

INTRODUCTION

The Atlantic coastline of Devon and Cornwall contains a number of notable sites where extensive lithic scatters have been discovered covering the Early and Late Mesolithic periods (e.g. Cave 1985; Johnson & David 1982; Jones *et al.* 2018). The discovery of a number of these Mesolithic sites has been driven by coastal erosion, either through the exposure of scatters within eroding cliff faces, or the erosion of low-lying deposits as evident at Constantine Bay and Westward Ho! It is within these low-lying deposits that important geoarchaeological deposits are preserved, permitting insights into the environmental context of the sites, demonstrating the exploitation of a variety of environmental and landscape contexts, as well as more precise dating of the organic deposits preserved at them.

The 'submerged forest' at Westward Ho!, at the mouth of the Taw-Torridge Estuary, is the best known and most intensely studied intertidal deposit along the Atlantic coastline. The peats are normally covered by beach sands, but periodically exposed and eroded during storm events. The site is important because it contains an intertidal land surface which had, prior to erosion, a Mesolithic 'kitchen' midden deposit, containing charcoal, lithics, bones and shells, covered by peat and associated with a submerged forest. This site is of particular importance as it is the only surviving remnant of a wetland occupation site of the 6th millennium BC in south-west England (Hosfield *et al.* 2007: 41–42). The site consists of three areas, as defined by Balaam *et al.* (1987) (Figure 1):

- Area 1 (inner peat; Figure 2B and C): extensive surface of peat commonly exposed by relatively minor episodes of tidal scouring. To the north of the peat is an area containing a variety of estuarine deposits with a series of stake alignments and exposures of animal bone. These have been radiocarbon dated to the Late Romano-British to Early Medieval period, 330–650 cal AD (1560±80 BP; HAR-6513⁴) and 250–620 cal AD (1600±80 BP; HAR-6440) respectively. It is assumed the peat is contemporary with this dated material, but no direct dating of the Area 1 peats has been undertaken;
- Area 2: located roughly midway between high and low water spring tide, containing a small area of peat overlain by grey-blue silty clay, along with some stakes. It is believed to be the same age as Area 3;

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⁴ All radiocarbon dates are calibrated in OxCal 4.4 (Bronk Ramsey 1995; 2001) using the IntCal 20 Northern Hemisphere radiocarbon curve (Reimer *et al.* 2020), with calibrated ages quoted at 2σ (95.4%).

- Area 3 (outer peat; Figure 2E and F): an area close to low water spring tide that includes the major collections of Mesolithic material including the 'kitchen' midden site and stake alignments. The site is Mesolithic in age but has also produced an Early Neolithic date from a stake.

Figure 1. Submerged Forest at Westward Ho! showing extent mapped in 2002. 19th and 20th century positions of the coastline (pebble ridge) are also shown.

DISCOVERY

The submerged forest was first reported in the winter of 1863/4 by Townsend Hall, who noted the exposure of 70–80 large trees following the winter storms that year. Hall estimated that total sediment loss at the south end of the beach was 10 feet in thickness, with the increased wave force pushing back the pebble ridge 30–50 feet. He not only provided the first description of the sedimentary sequence, dividing it into seven stratigraphic units, but also in January 1865 discovered ‘a deposit containing flint flakes and cores in abundance, with hazel nuts, calcined flints and kitchen midden accumulation, consisting principally of oyster, limpet and mussel’, along with recording numerous circular and linear stake alignments, and sought to identify the animal bones associated with these deposits (see Hall 1870). In 1866 there were also records made of flint artefacts recovered from a ‘blue clay’ layer, which was noted as lying underneath the peat or ‘forest bed’ (Bate 1866; Ellis 1866, 1867).

Periodic investigations have been undertaken throughout the twentieth century, as reported by Rogers (1908), Rogers (1946) and Churchill (1965a), with most focusing on Area 3 and the midden site. The first palaeoecological studies of Area 3 were undertaken by Clement Reid and published by Rogers (1908; Reid 1913), looking at the plant remains from the peat. Attempts to extract pollen from the peat by Harry Godwin, and subsequently his student Mrs Megaw, were both unsuccessful (Rogers 1946: 121). However, Churchill (1965a) was able to obtain pollen counts, along with plant macrofossils, through the midden deposit including the overlying peat. This study produced the first radiocarbon date from the site, with a sample of the upper peat providing a calibrated date of 5740–4950 cal BC (6585±130 BP; Q-672). After severe westerly gales in 1970 removed much of the recent beach material, revealing c. 720m² of the peat surface, exposed sections were recorded (cited in Edmonds *et al.* 1979: 111) and additional wood samples from the top of the exposed peat were collected that provided a radiocarbon date of 4050–3530 cal BC (4995±105 BP; IGS-42) (Welin *et al.* 1972: 331). Subsequent investigations by Jacobi (1979) included the first direct

dating of the midden deposits, with charcoal dated 6080–5560 cal BC (6955±140 BP; Q-1211) and bone dated 5990–5480 cal BC (6810±140 BP; Q-1212). These dates have now been surpassed by more recent precise dating of the site, using improved preparation techniques and AMS, with these earlier dates now representing misfits that do not accurately fit the expected stratigraphic position.

Figure 2. Westward Ho! Submerged forest. (a) excavation of shell midden in 1983; (b) silt-peat contact from Area 3, showing an in-situ microlith (pointed to by the trowel); (c) area 1 peats in 1983 and (d) September 2016; (e) area 1 peats in September 2016; (f) remains of the pebble ridge in c. 1809 position, west of Area 1 peats, in September 2016; (g) Section 3 from Area 3 excavated in 2002; (h) in-situ microlith in Area 3 (10p for scale) and extensive piddock burrows in September 2016.

CENTRAL EXCAVATION UNIT

In 1983, poor preservation of the peat deposits along with continued erosion and interference by visitors and holiday makers, prompted an investigation by the Central Excavation Unit (Balaam *et al.* 1987). The work confirmed the broad sedimentary sequence of silt, midden deposits, and overlying fen wood peat (summarised in Table 1 and Figure 3). Only a small area of the midden remained (Figure 2A) due to erosion; parts that survived were block-lifted for excavation in the laboratory, in which charcoal, animal bone and a number of flint artefacts were recovered (Figure 2B). Radiocarbon dating across the site, including Area 1, was also undertaken. A recent study, using archived midden material from this excavation, permitted Canti *et al.* (2015) to radiocarbon date calcite produced by earthworms present within the midden deposit, providing an age span for the midden of 290–600 years, dating to c. 5210–4730 cal BC.

Stratigraphic unit	Description	Posterior Density Interval (95.4% probability) for start (base) of unit
VIII	Silts containing wooden stakes	3940–3620 cal BC
VII	Reed peat	4300–4040 cal BC
VI	Wood peat containing large tree remains	4830–4650 cal BC
V	Occupation layer, including shell midden	5340–5080 cal BC
IV	Blue-grey silts containing charcoal	6420–5540 cal BC

Table 1. Stratigraphy for Area 2/3 at Westward Ho! (summarised from Timpany 2005: Table 9.4). Start dates are derived from a phase model containing 48 radiocarbon dates compiled from the site investigations discussed in the text.

A detailed multi-proxy palaeoenvironmental study, including analysis of molluscs, pollen, plant macrofossils, insects and vertebrate remains, indicated that the midden was situated a little back from the shore in a terrestrial woodland environment, with sand dunes located seaward. The site was within an ecotonal situation making use of the rocky shore resources immediately to the south from which mussels were obtained, the sandy shore to the west and north from which cockles and carpet shells were obtained and the resources of the muddy estuary to the north from which peppery furrow shells were obtained. In Area 3, one line of wooden stakes driven into the peat was radiocarbon dated 3780–3370 cal BC (4840±70 BP; HAR-5642), placing it within the Early Neolithic period.

Investigations of Area 1 indicated a Romano-British age for peat formation, along with a different palaeoecological signal to that from Area 3. Archaeological finds associated with estuarine silts overlying the peat included animal bones from a channel cut into the silts, one of which has been radiocarbon dated to cal AD 250–640 (1600±80 BP; HAR-6440). To the north of Area 3, additional channels also produced bones and wood structures dated to the Romano-British period (Balaam *et al.* 1987).

UNIVERSITY OF READING

Following the 1983/4 excavation, Martin Bell continued his interest in the site, repeatedly visiting it when erosion exposed new faces and archaeological material. In April 2002, another excavation was undertaken as part of the NERC funded project *Mesolithic to Neolithic Coastal Environmental Change*. Linda Hurcombe, Exeter University, investigated the lithics while Hazel Riley, English Heritage, surveyed the intertidal exposures (Riley 2002: see Figure 1). This survey permitted the extent of erosion between 1983–2001 to be quantified, confirming that the midden deposits from Area 3 had now been lost.

Scott Timpany (2005) undertook wood identification and demonstrated that the peats of Area 3 and 1 contain different woodland phases. Wood samples taken from the exposed sections (Section 1) revealed the presence of an earlier *Salix* (willow) carr woodland growing at the occupation horizon/wood peat (Unit V–VI) interface. In Section 3, a large partially charred *Quercus* stump, rooted in the peaty clay horizon overlying the occupation horizon, was present which can be inferred to date from the same period as the *Salix* carr woodland. These results demonstrate the invasion of arboreal taxa onto the wetland, initially by *Salix* and then *Quercus* (oak). Wood samples from the surface of the outer peat (Area 3) show that the *Salix-Quercus* woodland was succeeded by *Quercus-Corylus* woodland, which included a charred *Quercus* trunk on the surface. This succession of *Salix* replaced by *Corylus* *avellana* (hazel) suggests surface conditions became drier, with *Corylus* infrequently found within carr-woodlands (Rodwell 1991). This succession in vegetation shows good correlation with the pattern of wetland change recorded in pollen (Figure 4) (Grant *et al.* 2020; Scaife 1987) and plant macrofossil studies (Vaughn 1987). A third woodland

Figure 3. Section 1 and 3 from Area 3 outer peats, recorded in 2002 (graphic: S. Buckley, from Timpany 2005).

type appears on the surface of the inner peat (Area 1) consisting of *Alnus-Salix-Quercus* carr woodland, which may signal a local change back to wetter surface conditions highlighting the fluctuating hydrology of the site.

Stake samples from Area 3, which probably correlate with those identified by Balaam *et al.* (1987) in both Areas 2 and 3 and structures documented by Hall (1870), were also sampled. These were identified as *Corylus avellana* with ring-counts predominantly between 6 and 12 years. All stakes were round-wood with an average diameter of 3.5cm. The consistency in age and diameter of the stakes suggests that they were coppiced and therefore derived from managed Early Neolithic woodland.

Emma Tetlow (2004) looked at the insect assemblages from Sections 1 and 2 of Area 3, which corroborated the earlier findings of Maureen Girling (Girling *et al.* 1987). Within Section 1 the Unit VI wood peat contained an insect fauna indicative of sedge tussock or damp grassland with reedswamp nearby. The overlying Unit VII 'Phragmites peat' fauna suggested lush reedswamp with abundant rotting organic material, possibly dung and carrion. The humified reed peat fauna suggested sedge tussocks forming under significantly drier conditions, while the uppermost reed peat is dominated by a fauna indicative of species associated with muddy, damp, boggy ground and coastal locations.

By contrast, within Section 3 the insect fauna from the wood peat was associated with damp, deciduous woodland composed predominantly of *Quercus*, while the overlying reed peat indicated damp oak woodland with reed swamp and some evidence for coastal influence. This vegetation pattern is confirmed within the pollen data from monolith <100> which shows a local signal dominated by open fen communities while the wider signal contains elements of deciduous woodland dominated by *Quercus* and *Corylus avellana*, along with *Ulmus* (elm) and *Alnus glutinosa* (alder). The new radiocarbon dating of monolith <100> estimates that the sequence spans 1590–1870 years, beginning with the basal Unit IV silty-clay in 5670–5490 *cal BC*, and ending in 3940–3755 *cal BC* (95.4% probability) with the uppermost surface of the reed peat (Unit VIII). It is therefore probable that the peat surface in this location is broadly contemporary with the Early Neolithic in south-west England.

Figure 4: Summary pollen diagram and bulk organic isotopes from Monolith <100>, Section 1, Area 3. Pollen data from Grant et al. (2020). Isotope data from de Vitry d'Avaucourt (2018).

ONGOING STUDIES

Since the excavation in 2002, studies on the Westward Ho! submerged forest have continued, utilising archived material retained by Martin from the earlier excavations. The work of Canti *et al.* (2015) and Grant *et al.* (2020) collectively have contributed an additional 37 radiocarbon dates, significantly improving the age-constraints on the timing of events at the site (summarised in Table 1). New techniques have also continued to be used at the site to help resolve outstanding questions about its formation and record of human activity, the latest being isotope analysis on monolith <100>. This work, undertaken by Alice de Vitry d'Avaucourt (2018), sought to better understand the blue-grey silts (Unit IV) that underly the occupation horizons.

Churchill (1965b) and Rogers (1946) suggested that the midden formed at or near the strand line, but the investigations of the midden by Balaam *et al.* (1987) did not find any evidence for marine silt deposition within the midden, biota characteristic of a strandline assemblage, or indeed any evidence of it being in close proximity to the shore. Churchill assumed that the Unit IV silts beneath the midden were estuarine in origin, but investigations by both Churchill (1965a: 76–77) and Balaam *et al.* (1987: 178) failed to find any foraminifera, ostracods or diatoms to support this interpretation. Reid (1913) suggested, based upon the plant species present within the peat, that the assemblage indicated a brackish-water marsh such as may occur behind a shingle beach. Many submerged forests are likely to have developed in areas where a coastal barrier was present between the growing trees and the sea (Heyworth 1986). During the earliest studies at Westward Ho! a barrier was postulated as being attributed to an earlier alignment of the pebble ridge which today fronts Northam Burrows. Rogers (1908) recognised an alignment of pebbles on the foreshore as being related to a pebble ridge (Figure 2F), which Pengelly (1868) envisioned could have produced a lagoon of the Slapton Ley type, which could have encouraged the growth of peat. Ellis (1866: 81) stated that as ‘there is evidence that the pebble ridge is constantly driven inland by the sea, it is not improbable that the submerged forest bed may have been within the ridge, and been a part of the Northam Marsh.’ Churchill (1965a) suggested that the submerged pebble ridge might be contemporary with the midden. The landward migration of the pebble ridge can be mapped using historical maps and records (Figure 1), with Rogers (1908) reporting that in 1863 the ridge extended to the Area 1 inner peat.

In the absence of microfossil evidence from Unit IV, one way to test the contrasting theories over the origin of these silts is through the use of bulk organic $\delta^{13}\text{C}$ and C/N. This has been widely used to elucidate the source and fate of organic matter in the terrestrial, estuarine and coastal regions (e.g. Chivas *et al.* 2001; Harmelin-Vivien *et al.* 2008; Hedges & Parker 1976; Hu *et al.* 2006; Kuwae *et al.* 2007; Ramaswamy *et al.* 2008), with $\delta^{13}\text{C}$ providing a good proxy for salinity in some studies (Fontugne & Jouanneau 1987; Middelburg & Herman 2007; Yu *et al.* 2010; Zhang *et al.* 2007). $\delta^{13}\text{C}$ sediment values from Unit IV, at the base of monolith <100>, suggest both terrestrial and freshwater vegetation (expected marine $\delta^{13}\text{C}$ range of -26 to -20‰), with no marine vegetation (Figure 4). The C/N ratio and $\delta^{15}\text{N}$ values imply the presence of freshwater algae (expected C/N range 5–8 and $\delta^{15}\text{N}$ 4–9‰). The transition into the overlying occupational layer (Unit V) shows an increase in the presence of C3 terrestrial plants, with further changes in C/N values mirroring transitions from wet carr woodland to a fen community. The isotope analysis confirms a freshwater setting for the basal clays, rejecting the theory that the submerged forest formed over an estuarine clay, but instead formed within a freshwater environment. This suggests either sea level was below the site prior to deposition of Unit IV, or alternatively a coastal barrier was in place protecting the site and eventually leading to peat formation.

DISCUSSION

The Westward Ho! submerged forest has been an important resource for both archaeological and palaeoenvironmental studies since the 19th century. Currently it is one of the most securely dated intertidal sequences in the UK. The composition of the thin midden and two millennia timespan indicates that prehistoric activity at Westward Ho! is likely to represent short-term visits to an ecotonal site from which a range of resources represented in the midden could be exploited: those of the woodland, muddy estuary, rocky shore and sandy shore (Bell *et al.* 2009). The evidence for Early Neolithic activity (in an area with little evidence for archaeological activity at this time) on the site also highlights the importance of the submerged forest deposits for studies of the Mesolithic-Neolithic transition. Martin has previously stated that prehistoric activity at Westward Ho! should not be looked at in isolation but may be understood in a wider context by looking at important archaeological sites in the Taw-Torridge Estuary (Bell 1997). Martin has routinely visited many of these key sites, including Yelland, where an old land surface and stone row are partly buried by saltmarsh sediments (see Grinsell 1970; Rogers 1946), and Baggy Point and Woolacombe Sands, where Mesolithic sites have been found below the sands (see Bell & Brown 2008).

Martin has been a key facilitator in driving forward research into this key locality for the past 40 years, through his promotion of the application of novel geoarchaeological approaches to better understand the site's formation processes. By actively sampling and archiving the sedimentary sequences, including the now-eroded midden deposit, he has permitted new research to continue on a site now lost to coastal erosion. This demonstrates his considerable foresight that new opportunities to revisit and reinterpret a site will present themselves as the discipline continues to evolve.

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Chapter 4

Humans and their environment during prehistory at Gwithian, Cornwall

Thomas Walker¹

ABSTRACT

The relationship between humans and the environment is well demonstrated at Gwithian. The initial post-glacial woodland with a marshy river valley was capable of supporting a hunter-gatherer population, but the need for farming arose with the development of settlement. This required clearance of woodland to provide open areas for cultivation, and there is evidence for clearance on both the north and south sides of the Red River. This seems to have commenced in the Late Neolithic and was completed by the Early Bronze Age. The question of a Neolithic settlement remains to be resolved, but a farming settlement was well established by the later part of the Early Bronze Age. But humans were not in complete control of the environment. The first Bronze Age settlement became overwhelmed by sand and several hundred years passed before the land was again fully occupied, during the Middle to Late Bronze Age. Farming expanded from just the area of the settlement to take in probably the whole of the meadow on the north side of the river, with evidence of both arable and pasture. But humans were again proven unable to control the sand and by the Iron Age the valley was once more abandoned to the forces of nature.

Keywords: *Gwithian, Cornwall; Bronze Age; farming; molluscs.*

INTRODUCTION

The modern village of Gwithian lies on the east coast of St Ives Bay in north-west Cornwall. This is an area rich in archaeology, dating from the Mesolithic to the medieval period. The majority of the excavated archaeological sites lie on windblown sand to the north of the village on, or at the base of, Godrevy Towans, a rocky sand-covered outcrop rising to a height of 70m. The Red River, which arises in the hills south of Cambourne and Redruth, runs south of the Towans, opening into St Ives bay about 700m to the west. Between the Towans and the river is a gently sloping meadow 200m in width. It is on this meadow that the Bronze Age settlements are located (Figure 1).

Figure 1. Gwithian: aerial view of Godrevy Towans and the meadow north of the Red River, which flows across the lower right corner of the photograph. The site of the Bronze Age settlement is shaded. The locations of sites discussed in this paper are indicated. A: 2005 trench; B: 2012 trench; C: core used for OSL and radiocarbon dating in 2012; D: core used for the 2012 pollen analysis (photo: T. Walker).

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The archaeology at Gwithian has been very well preserved beneath wind blown sand, which is up to 7m deep at the base of the valley but as shallow as 0.40m on the upper parts of the Towans. Sand dunes are thought to have commenced forming in Britain during the last glacial period, but these are generally below modern sea level. Some onshore Pleistocene dunes are preserved as raised beaches, as at Brean Down in Somerset (ApSimon 2000; Currant *et al.* 2006), Staunton and Croyde in Devon (Campbell & Gilbert 1998) and Newquay and Godrevy in Cornwall (James 1994, 1995). Holocene dunes did not appear until the Early Neolithic when sea levels became relatively stable at slightly below present levels (Carter 1998; Shennan & Horton 2002). The old ground surface revealed in a trench excavated in 2012 at Gwithian (Figure 1: B) was dated by OSL to 3590–2630 BC (Aber-203/GWT-12-5) (Walker 2018: 129), and it is likely that sand deposition commenced around this time.

Excavations in the valley at Gwithian were led by Charles Thomas from the 1940s into the 1960s (e.g. Megaw *et al.* 1960–61; Thomas 1958) and revealed Middle Bronze Age occupation with evidence of farming and of a post-Roman industrial site on the meadows between the river and base of the Towans (Sturgess & Lawson Jones 2006). Although never formally published, the archaeological archive has been extensively reviewed and summarised by Jackie Nowakowski (2007; 2009; Nowakowski *et al.* 2007). A simplified stratigraphy for the prehistoric phases is shown in Table 1. In 2005 a small trench (4.6m x 2.0m) was opened within the Bronze Age settlement (Figure 1: A) to obtain palaeoenvironmental and dating samples. In 2012 this author led a coring study along a transect from the Red River to the summit of the Towans and the excavation of a small 2.0m x 2.0m trench in the meadow about 200m west of the Bronze Age site down to the bedrock at 1m depth (Figures 1: B and 2) (Walker 2018). Radiocarbon and optically stimulated luminescence (OSL) dates were obtained from the strata exposed in the trench and on material from one core (Figure 1: C); pollen analysis was undertaken on another core (Figure 1: D). The latter core was 9m in depth, the sediments below 6m being peat with no sand.

Phase	Period	Dating	Activity
	Mesolithic and Neolithic		Evidence of human presence in the Gwithian area, but no settlement site
Bronze Age to Romano-British			
Phase 1	Early Bronze Age	c. 1800 cal BC	Homestead and farming
Phase 2	Early/Middle Bronze Age		Blown sand with minor neglect
Phase 3	Middle Bronze Age	c. 1500–1200 cal BC	Settlement and farming
Phase 4	Middle Bronze Age		Blown sand; farming but with some neglect
Phase 5	Middle to Late Bronze Age	c. 1300–900 cal BC	Major settlement with farming, fishing, craft industry
Phase 6	Iron Age to Romano-British		Sand dune inundation; little evidence of human presence
Post-Roman			
Phase 1			Blown sand deposits with occasional turf lines
Phase 2	Early medieval	5th–7th centuries AD	Industrial features and pits
Phase 3	Early medieval	7th–8th centuries AD	Buildings and a workshop complex with at least nine buildings
Phase 4			Abandonment

Table 1. Summary chronology for human presence and activity at Gwithian in prehistory (after Sturgess 2007)

MESOLITHIC AND NEOLITHIC

Mesolithic worked flints have been found over a wide area of the Gwithian headland and Red River basin, including in the buried soil at the base of the 2012 trench (Figure 1: B), but no lithic concentrations have been discovered which may have suggested an occupation site (Nowakowski 2004: Figure 5; Roberts 1987; Thomas 1957–58, 2007: 21). There is very little evidence of Neolithic presence in the Gwithian area, although some Early Neolithic gabbroic sherds, a few lithic pieces and two fragments of greenstone axes were found in Early Bronze Age contexts indicating that there was some Neolithic activity in the vicinity (Megaw 1976; Quinnell 2007: 23).

Figure 2. Jackie Nowakowski and Martin Bell working in the trench excavated in 2012 (photo: T. Walker).

More recently some of the questions concerning the environmental history of the area were discussed by Straker and Walker (2018). This topic is now further explored, in particular to examine the human interaction with the environment. All dates presented are given to 95% confidence (2σ).

No studies have yet provided information on the local environment during the Mesolithic but, like most of Britain, it might be assumed that woodland had begun to encroach on much of the post-glacial landscape (e.g. Bell & Walker 2005: 194). The cores from the 2012 transect corresponding to the Mesolithic/Neolithic did not contain any molluscs at the deepest levels due to the very acid nature of the peaty sediments, down to pH2. This acidity did, however, permit good preservation of pollen, and evidence is now available for the Neolithic vegetation, obtained from a core at location D in Figure 1 (Batchelor 2018: 109). The basin of the Red River was fen/carr woodland of alder and willow with marsh and areas of still or slowly moving water. A fairly open mixed deciduous woodland/scrub habitat was present, with hazel, birch and oak on the dryland adjacent to the river. There may have been some saltmarsh in the vicinity but diatom analysis of a core close to the present river position showed only freshwater taxa with no marine or brackish water taxa (Walker 2018: 63). These studies indicate that marine incursion did not extend into this part of the valley.

This environment would have been conducive to human presence and activity, if not settlement, is supported by the finding of microcharcoal throughout the pollen cores, the highest concentration being at the lowest levels corresponding to the Early/Middle Neolithic. There were also numerous charcoal fragments in the sediments of the Neolithic old land surface in the 2012 trench. This latter horizon also provides tantalising evidence that some cultivation of the land took place during the Neolithic. The sediments, dated by OSL to 3590–2630 BC, contained marine shell fragments: many mussels (*Mytilus* sp.) and a few whelks (*Nucella lapillus*) (Walker 2018: 125). This suggests that seaweed may have been brought to the site from the rocky sea shore only 750m away to use as fertiliser. It is unlikely that these shells were transported with blown sand, as mussels are firmly attached to rocks by their byssus; in addition, no fragments of these marine shells were found in the blown sand in the trench which overlay the occupation horizons. No Neolithic occupation sites have been discovered in the Gwithian area – do they lie in areas yet to be excavated?

EARLY BRONZE AGE AND WOODLAND CLEARANCE

The earliest known evidence of settlement in the Red River valley is at the eastern end of the sloping meadow to the north of the river (Figure 1). Whether this site was selected because it had been established as a fertile area during Neolithic times or was a ‘*de novo*’ settlement is not known, but this location would have been ideal for those needing access to the sea and where boats could easily be beached. St Ives Bay is the most westerly sandy bay on the south side of the Bristol Channel, and would have provided a good base for any coastal transport after rounding the rocky coastline of West Penwith, including Land’s End and Cape Cornwall. This bay has two freshwater rivers draining into it, the River Hayle and Red River, but only the latter currently opens directly into the sea rather than

into an estuary. The chosen location for the settlement is about 750m from the modern outlet of the Red River, but may have been at a greater distance during the Bronze Age. And, as explained above, the river was never saline in the area of the settlement. The sand dunes would have provided good shelter from winter storms, and the gently sloping valley sides enabled access to good agricultural land.

It appears that these first residents soon modified their environment. Pollen studies from the core in the floodplain show that there was a change in the local vegetation during the Early Bronze Age. A decline in oak pollen suggests a reduction in dryland woodland coinciding with an increase in sedges/bur-reed. Batchelor (2018: 109) considered that these changes were likely the result of anthropogenic interference, based on the timing of the event, a near-contemporaneous increase in herbaceous taxa (e.g. *Chenopodium* type (e.g. fat hen) and *Plantago lanceolata* (ribwort plantain)) and relatively high values of microcharcoal. This chronology accords well with the earliest proven settlement in the Gwithian area. Charles Thomas's excavations revealed a homestead within a fenced enclosure associated with terraces and ploughed fields (Phase 1), dating to c. 1800 cal BC (Nowakowski 2009; Sturgess 2007). The implication is that these first farmers commenced clearing the Red River valley sides for agricultural purposes.

Further evidence of Early Bronze Age loss of woodland comes from mollusc studies about 1.5km south-west of the Gwithian settlement, on the cliffs opposite Strap Rocks, at the southern extent of Godrevy Bay. In 2011 Martin Bell noticed a line of large stones on the top of a 10m cliff and covered by blown sand (Figure 3). He considered that they could be part of a man-made wall, but whether prehistoric or associated with Industrial Age mine activity was unclear. Clearance of sand to obtain a mollusc column clearly showed that the stones had been laid and were entirely consistent with a man-made wall (Walker 2018: 144). The basal layers, adjacent to the wall, contained a mollusc assemblage typical of woodland/scrub, with over 50% of the shells being of taxa requiring shade. However, some open country taxa were present, including the xerophile *Xerocrassa geyeri*, a cold climate species which became extinct during the very early Holocene in all areas of Britain except at Gwithian, where it survived into the Bronze Age. Radiocarbon dating of this species from the basal sediments lying on Pleistocene Head gave a date of 2135–1940 cal BC (OxA-28970), the Early Bronze Age. Particle size analysis showed that the sediments were mainly silty, only 30% being sand.

Figure 3. The cliffs at Strap Rocks. The line of stones at the base of the dune above the rocky cliff, observed by Martin Bell, is clearly seen (photo: T. Walker).

A second specimen of *X. geyeri*, taken 0.20m above the base of the sand at Strap Rocks, gave a radiocarbon date of 1635–1500 cal BC (OxA-28971). The mollusc assemblage by this time had changed considerably, and now contained predominantly open country species, with shade species being less than 10% of the total. Particle size analysis of these sediments shows that they were still silty – it was only above this layer that sand became dominant. The conclusion is that the loss of woodland/scrub was likely to be anthropogenic and not the result of sand inundation. The wall may represent the boundary of a field system created following woodland clearance, but to date there is no evidence of any Bronze Age settlement in the vicinity of this wall, or of the extent of the hypothesised field system.

The trench (Figure 1: B) which was excavated in 2012 in the meadow about 200m west of the settlement site revealed a buried soil lying on the old ground surface and dated by OSL to 1480–710 BC (Aber-203/GWT-12-4) but containing molluscs (*X. geyeri*) radiocarbon dated to 2025–1775 cal BC (OxA-28962). The molluscs pre-date the OSL age and, assuming no re-exposure to sunlight of the layers which would have affected the OSL dates, it is likely that they were redeposited in windblown sand from a neighbouring area. The assemblage in this horizon consisted almost entirely of open country species with none requiring woodland or scrub, indicating that clearance had taken place on the banks of the Red River before the Early Bronze Age.

What can be determined about the type of farming at this time? The building revealed by the early excavations was a post-built structure, and perhaps the timbers came from the land being cleared for cultivation. There was a fenced enclosure associated with terraces and ploughed fields. Ard marks were exposed in the 2005 trench (Nowakowski 2009: 119) and cereal seeds, including *Hordeum* sp., were identified within the plough soils (Straker 2007; Straker & Walker 2018) but there is insufficient evidence to say whether cereals were grown on this site. Micromorphology analysis on samples obtained from the same trench suggests that household waste and animal dung was used as fertiliser at this time (Dev 2018), although animal bones dating to this period were not found within the trench (Hammon 2007). Enrichment of the fields would probably have been necessary to yield adequate crops on the blown sand.

FARMING IN THE MIDDLE TO LATE BRONZE AGE

Life on these dunes would always have been susceptible to the impact of sand blow which could cover both fields and buildings slowly over a period of time or rapidly in one catastrophic storm event. A period of sand inundation seems to have occurred towards the end of the Early Bronze Age (Phase 2) followed by, and perhaps causing, a decline in human activity at Gwithian, but by the Middle Bronze Age, c. 1500–1200 cal BC (Phase 3), there is again evidence of buildings and a farming community. Excavations revealed a complex stratigraphy (Nowakowski 2009; Sturgess 2007) which included a probable stone and post-built structure associated with ploughed fields with a criss-cross pattern of ard marks, but it is unclear whether these fields were purely arable or included some pasture (Straker & Walker 2018). A mollusc column from within the settlement (Spencer 1975) showed that the contemporary landscape was open country with no species representing woodland/scrub. It appears that during this phase of settlement agricultural activity was limited in extent, as further west, at the site of the 2012 trench, there is no evidence of a buried soil horizon corresponding to this period. There is neither sand nor palaeosol between the old ground surface and the Phase 5 buried soil (see below), suggesting that sediments in this area of the valley were unstable, and regularly subject to attrition by wind and/or storms.

Another period (Phase 4) of relative decline followed, with an increase in blown sand, but the lack of dating makes it difficult to determine how long this lasted. Some farming continued, with midden material used to enrich the sandy soils (Dev 2018). This period of decline probably allowed some regeneration of woodland or scrub, indicated by the mollusc assemblage from the 2005 excavation (Davies 2007). As mentioned above, there were no sediments from this phase represented in the 2012 trench which might have elucidated the environment west of the settlement site.

By c. 1300–900 cal BC (Phase 5) occupation at Gwithian had expanded considerably, there now being a major settlement with several buildings in different sub-phases (Sturgess 2007). Stone walls were constructed to enclose fields, and ard and spade marks provide evidence of arable farming (Fowler 1983: 150; Megaw *et al.* 1960–61). Domestic midden material was used for manuring (Dev 2018) in addition to the use of seaweed to enrich the soils. Evidence for the latter in the field systems of the settlement has been documented by Fowler (1983: 157). In the 2012 trench mussels and the blue-ray limpet *Patella pellucida*, a species typically living within seaweed holdfasts, were found in the sand immediately overlying the upper buried soil, supporting the use of seaweed as fertiliser.

Bones of cattle, sheep/goat, pig and deer were excavated in the 2005 trench (Hammon 2007) although no evidence of animal foot prints were found within the area of the settlement either in 2005 or during the original excavations. They were, however, discovered to the west of the settlement in the 2012 trench. Two buried soil horizons were revealed in this trench separated by 0.15m of blown sand, but both dated by OSL to Phase 5 of the settlement (Walker 2018: 129). There were cattle footprints and ard marks on the upper surface of both of these soils, few in the lower soil but abundant on the upper soil, which also showed ovi-caprid (sheep and/or goat) prints (Figure 4). Micromorphology showed some enrichment of soils particularly with hearth ashes, but there was no evidence of animal manure being used as fertiliser (Banerjea 2018).

Figure 4. The bovine and ovi-caprid footprints and ard-marks on the upper buried soil in the 2012 trench; left: scale 0.10m divisions; right: close-up of the footprints; scale 0.01m divisions (photos: T. Walker).

The mollusc assemblage in the lower buried soil of the 2012 trench consisted almost entirely of *Xerocrassa geyeri* (92% of 315 specimens), a species of open, dry, calcareous environments; its abundance and the absence of nearly all other taxa indicates that it was one of the first molluscs able to become established on the stabilising wind blown sand. In the upper soil *X. geyeri* had been largely replaced by *Cochlicella acuta*, another xerophile species, but there were also large numbers of *Vallonia excentrica* (18%), and *Pupilla muscorum* (16%), both species of open grassland, the latter being typical of newly cleared ground. *V. excentrica*, when present at this abundance, is typical of dry grazed grassland (Cameron & Morgan-Huws 1975; Evans & Evans 1995), an observation in accord with the abundant cattle foot prints on this horizon.

A core obtained between the Red River and the modern road (Figure 1: C) revealed a mollusc-rich buried soil horizon 4.91–5.06m below the ground surface. Over a third of these were of a single species, *Lauria cylindracea* (36% of 429 shells); some were also present in the immediately deeper sediment, but they were very scarce elsewhere in the core. None were present at this depth on adjacent cores in the transect (15m towards the river and 21m uphill). *L. cylindracea* is a rupestral species found in shaded habitats but is especially common on stone walls (Evans 1972: 151; Jeffreys 1904, as *Pupa umbilicata*; Kerney & Cameron 1979: 92) and the very high number in this horizon suggests the likely presence of a wall. During this part of the Bronze Age the Red River was only 15m to the south of this core, and it is therefore probable that there was a stone field boundary to contain cattle and other animals from entering the river.

There is therefore good evidence of a thriving farming community on the northern slopes of the lower Red River valley during the later Bronze Age, with active management of the landscape. The farming consisted of both arable fields and animal pasture, the former within the area of the settlement, the latter on the meadows to the west of the settlement. The limited areas of excavation make it impossible to know the true extent of either of these activities; however, if the full area of gently sloping land north of the Red River were cultivated, amounting to about 1.2ha, this would have been sufficiently extensive to support a moderate sized community.

IRON AGE AND BEYOND

The settlement at Gwithian was abandoned around 900 cal BC (Nowakowski 2007, 2009; Sturgess 2007). This seems to have been a slow demise rather than a sudden event, and inundation with sand would be the likely cause. In the 2012 trench a 0.60m horizon of clean sand containing very few molluscs covers the upper buried soil. There is a chronological hiatus due to winnowing of sand implying rapid accumulation consistent with an inclement climate. No evidence of any settlement on the river sides dating to the Iron Age or Roman period has been found.

Around the 5th century AD activity again commenced, not in the area of the previous settlement but on the dune to the south of the Bronze Age site. Initially (Post-Roman Phase 2) this was small-scale industrial activity, two pits and two industrial features having been excavated, but with no building. Around the 7th century AD (Post-Roman Phase 3) activity clearly expanded into an industrial complex with at least nine buildings, but no still with no evidence of a settlement. This continued into the 8th century, but the area was then permanently abandoned (Sturges 2007).

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Chapter 5

From coast to coast: recent palaeoecological investigations of submerged forests and intertidal peats at two coastal sites in the UK

Scott Timpany¹

ABSTRACT

Submerged forests represent the remnants of former woodlands preserved within intertidal peat deposits located around the coast of the UK from Shetland to the Scilly Isles. These once buried woodlands become exposed through tidal scouring and erosion of the peats, revealing the remains of prostrate trunks, upright stumps, roots, and branches. This paper will explore two submerged forest and intertidal peat sites from very different parts of the British Isles. Palaeoecological investigations at Pett Level, in Sussex, and Benbecula, in the Western Isles, are aiding in bringing back to life these lost lands. Survey, recording and wood identification of these trees has shown them to comprise different woodland canopies, from alder-ash-oak woodlands in Sussex, to willow-birch-pine woodlands in the Western Isles. Pollen analysis alongside other palaeoecological techniques such as palaeoentomology (beetles) and waterlogged plant remains (seeds, buds, nutlets) combine to provide important first records of the biodiversity and species richness of these native woodlands, useful information for conservation and management of today's woodlands. Burning activity of reeds is evidenced in the fire history from microscopic charcoal fragment analysis in the Western Isles, demonstrating the importance of fire in the tool kit of Mesolithic peoples for landscape manipulation.

Keywords: *submerged forest; palaeoecology; biodiversity; native woodlands*

INTRODUCTION

The coastal zone of Britain is a dynamic, ever-changing, and often beautiful place. This has been a consistent picture/theme of this liminal area, where the land gives way to the sea, throughout time. In recent years offshore borehole and bathymetry data have aided previous research in reconstructing former sea-levels to bring to life the existence of once lost areas of land where past communities would have lived, hunted, modified, and exploited. Perhaps the greatest example is the ongoing work in increasing our understanding of the palaeogeography of Doggerland, a former landmass in the North Sea, where palaeoecological evidence is revealing details on this forgotten landscape (Gaffney *et al.* 2007; Gearey *et al.* 2017; Krüger *et al.* 2017); an Atlantis re-discovered.

One does not have to go as far out as the middle of the North Sea to visit and investigate these now long-lost lands, that were once flourishing parts of Britain. The remnants of these areas are often visible at low tide in coastal locations, most strikingly in the form of the remains of stumps and trunks emerging from the sand and representing the skeletal remains of a once wooded landscape. These remnant woodlands survive within peat, which contain ideal conditions for the preservation of organic materials through their waterlogged (anaerobic) nature. As these peats become exposed through scouring by the tide, they become stripped back to expose the remains of stumps, prostrate trunks, branches, and roots, collectively known as submerged forests. These woodlands under the waves have captured the attention and imagination of people for centuries, with early recordings of these submerged landscapes known from across Britain (e.g. Pidgeon 1885; Reid 1913; Traill 1868).

Radiocarbon and dendrochronological dating of intertidal peats and tree remains have aided in demonstrating the age-range of these drowned landscapes and the often-complex stratigraphic sequence they are contained within (Timpany 2009). At locations along the Severn Estuary, such as Goldcliff East and Redwick, Martin has done a herculean amount of archaeological and paleoenvironmental investigation into revealing the importance of this dynamic landscape to former communities, submerged forests and intertidal peats which date from the Early Mesolithic through to the Bronze Age (Bell 2007, 2013). In locations such as Westward Ho!, Devon, another location Martin is intimately linked to, intertidal peats have been recorded as still being terrestrial land surfaces into the Romano British period (see Grant *et al.* 2021: this volume, Chapter 3).

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The known dates of these former woodlands represented by submerged forests, therefore, provide a direct link to Britain's native woodland often at a time when there was little direct influence by human populations on the fate and form of these woodlands. These are the 'wildwoods' spoken about by Rackham (2003) and the 'primeval woodland' discussed by authors such as Peterken (1996). Understanding the composition and character of these woodlands has the potential to not only provide information on the former landscapes traversed and exploited by prehistoric to Romano-British communities but are also a significant resource in understanding the former floristic diversity of areas of the UK's true ancient woodland. This paper will explore two areas of submerged forest and intertidal peats sites from different parts of the UK (Figure 1). Palaeoecological investigations at Pett Level, in Sussex, and Benbecula, in the Western Isles, are aiding in creating a greater understanding of such woodland communities, their resilience to disturbance and longevity.

Figure 1. Site location map.

SITE DETAILS

The submerged forest and intertidal peats at Pett Level and Benbecula are some 900km remote of each other, differing not only in landscape but also in the experience one feels at each place. The investigation of the intertidal peat at Benbecula, Western Isles, (NF 77960 49613) was conducted in 2018 by the author and members of the SCAPE (Scottish Coastal Archaeology and the Problem of Erosion) team, Jo Hambly and Ellie Graham, after being brought to their attention by the local community who regularly monitor the coastline and also aided with the fieldwork (Hambly & Timpany 2019). The intertidal peat was found to extend across an area of roughly 1km and has been found to contain not only the exposed woodland remnants of the former forest (Figure 2a) at its most seaward limits but also the archaeological remains of possible sub-circular stone buildings along with a saddle quern (Figure 2b) and a butchery site comprising of animal bone and quartz lithics nearest the dryland. The bone assemblage has undergone primary assessment by Catherine Smith and been identified as mature cattle (*Bos* sp.). A radiocarbon date from one of the cattle bones has shown that this activity took place in the Early Bronze Age at 1880–1630 cal BC (3419±34 BP; SUERC-85843), while a radiocarbon date from the surface of the peat shelf on which the butchery remains lay exposed was dated to 2140–1950 cal BC (3660±30 BP; SUERC-85844) (Table 1).

Figure 2. Submerged forest investigations. (a) Intertidal peat and submerged forest at Benbecula with pine tree remains in foreground; (b) saddle quern on foreshore at Benbecula; (c) volunteers recording submerged forest remains at Pett Level; (d) volunteer's aid with Test Pit 1 digging at Pett Level; (e) submerged forest remains at Pett Level. (photos: B: J. Hambly; C-E: T. Desalle).

Site	Laboratory number	Sample depth (cm)/ Tree number	Material	Radiocarbon date (BP)	$\delta^{13}\text{C}$ (‰)	Calibrated date (cal BC)
Benbecula	SUERC-85852	4–5	Monolith 1 Peaty sand from the top of the peat sequence – erosional contact	5170±30	-28.6	4040–3950
Benbecula	SUERC-85851	17–18	Monolith 1 Sandy peat with wood fragments. Upper submerged forest	5398±30	-28.4	4340–4080
Benbecula	SUERC-85850	49–50	Monolith 1 Sandy peat with wood fragments. Lower submerged forest	7141±30	-28.6	6070–5930
Benbecula	SUERC-85846	51–52	Monolith 1 Peaty sand with gravels, initial peat accretion	7108±30	-28.5	6050–5910
Benbecula	SUERC-85844		Peat associated with butchery site	3660±30	-29.7	2140–1950
Benbecula	SUERC-85843		Butchered animal bone (<i>Bos</i> sp.)	3419±34	-21.3	1880–1630
Pett Level	SUERC-58594	294	Bulk peat alkali-soluble fraction from TP2	5524±28	-27.4	
Pett Level	SUERC-58595	294	Bulk peat alkali- and acid-insoluble fraction from TP2	5590±28		
Pett Level		Weighted mean TP2 – 294cm	$T'=2.8$, $T'(5\%)=3.8$, $v=1$	5557±28		4460–4350
Pett Level	UBA-28260	274	Bulk peat alkali-soluble fraction from TP2	5441±37		
Pett Level	UBA-28261	274	Bulk peat alkali-soluble fraction from TP2	5348±37		
Pett Level		Weighted mean TP2 – 274cm	$T'=3.5$, $T'(5\%)=3.8$, $v=1$	5390±25		4340–4170
Pett Level	SUERC-58589	244	Bulk peat alkali-soluble fraction from TP2	5473±28		
Pett Level	SUERC-58590	244	Bulk peat alkali-soluble fraction from TP2	5427±28		
Pett Level		Weighted mean TP2 – 244cm	$T'=1.3$, $T'(5\%)=3.8$, $v=1$	5390±25		4345–4260
Pett Level	SUERC-58584	128	Bulk peat alkali-soluble fraction from TP1	4806±29		
Pett Level	SUERC-58585	128	Bulk peat alkali-soluble fraction from TP1	4911±21		
Pett Level		Weighted mean TP1 – 128cm	$T'=6.6$, $T'(5\%)=3.8$, $v=1$;	4589±21		3700–3630
Pett Level	UBA-28257	120	Bulk peat alkali- and acid-insoluble fraction from TP2	4713±28		
Pett Level	SUERC-58588	120	Bulk peat alkali- and acid-insoluble fraction from TP2	4740±29		
Pett Level		Weighted mean TP2 – 120cm	$T'=0.4$, $T'(5\%)=3.8$, $v=1$	4726±21		3640–3380
Pett Level	UBA-28252	08	Waterlogged plant macrofossils, <i>Alnus glutinosa</i> seeds and catkin from TP1	3350±38		1750–1520
Pett Level	SUERC-8692	T132	<i>Quercus</i> sp. tree remains	4483±29		3350–3020
Pett Level	UBA-28272	T11	<i>Quercus</i> sp. tree remains	3443±28		1880–1680
Pett Level	UBA-28251	T44	<i>Fraxinus excelsior</i> tree remains	3518±38		1950–1740
Pett Level	UBA-28250	T32	<i>Alnus glutinosa</i> tree remains	3491±29		1900–1700

Table 1. Results of radiocarbon dates mentioned in the text (calibrated dates are 2σ : 95% confidence).

The intertidal peat and associated submerged forest at Pett Level, Sussex, (TQ 8895 1400) was investigated initially by the author and Thomas Desalle from ORCA (Orkney Research Centre for Archaeology) in 2014 and returned to later by the author and members of the CITIZAN (Coastal and Intertidal Zone Archaeological Network) team for further sampling and recording in 2016 and 2017. Local archaeological groups and volunteers helped with the fieldwork during all three field seasons at Pett Level (Figures 2c, 2d) and their contribution was vital in the recording and sampling of >200 tree remains along with stratigraphic investigations and taking samples for other palaeoecological studies (Timpany & Band 2018). The exposure of woodland remains (Figure 2e), and intertidal peat covers an expanse of approximately 2km along the coastal zone, located on the southern extreme of the Romney Marsh depositional complex, which has seen a significant number of stratigraphic and palaeoenvironmental studies (e.g. Long *et al.* 2006; Waller *et al.* 1999), but few had investigated the submerged forest itself (Sutherland (1984) had looked at pollen from this site previously), despite observations of this woodland having been frequently reported since at least the early 20th century (e.g. Lovegrove 1966; Reid 1913; Waller *et al.* 1988; Welin *et al.* 1972), thus presenting a research opportunity. The submerged forest at Pett Level lies at the eastern end of a prominent prehistoric cliff line that once formed a great embayment at the landward edge of Romney Marsh, which was succeeded by longshore drift related gravel bar accumulation that eventually built into the cusped foreland projection of Dungeness behind which marsh deposits formed in prehistory. The present cliff line forms an extension of the former cliff bounded embayment, the submerged forest being seaward of this re-exhumed and

further eroded early prehistoric cliff. There has been little archaeological evidence discovered at Pett Level, with finds limited to flint artefacts from within a cave, part of the early prehistoric cliff, at Cliff End identified as long blades of Mesolithic age (Palmer 1972). The site at Pett Level is not very far west along the English coast from that coastal area of Sussex Martin will be very familiar with, located some 46km from the Lower Ouse Valley and Rookery Hill where Martin undertook his early work (Bell 1977).

RESULTS & DISCUSSION

The palaeoecological work at both sites is ongoing but some preliminary work can be shared here. One of the key lessons learned during my PhD studies under Martin was the importance of taking a multi-disciplinary approach to maximise the information one can gain from sites, particularly those in the intertidal zone where the resource is fragile and finite. It should therefore come as little surprise that at both these sites samples have been taken for a range of proxies similar to those utilised so successfully in the Severn Estuary (Bell, 2007, 2013; Bell *et al.* 2000), including, wood identifications, palynology, palaeoentomology, waterlogged plant remains and dendrochronology. Through taking a multi-disciplinary approach each element of these woodlands can be reconstructed allowing a greater picture of the whole. Importantly this provides a more accurate understanding of vegetational communities present than signalled by one individual method, a theme which will become apparent.

Today the Western Isles is a largely treeless landscape with only small pockets of native wet woodland located on the fringes of peat bogs and no probable ancient woodland (PAW) recorded (Forestry Commission Scotland, 2014). Waterlogged wood remains from across the Western Isles compiled by Fossitt (1996) demonstrated that Lewis likely once had a quite diverse woodland with Scots pine (*Pinus sylvestris*), alder (*Alnus glutinosa*), willow (*Salix* sp.), hazel (*Corylus avellana*), and birch (*Betula* sp.). The Uists however, have a more limited woodland assemblage of only birch and willow. Pollen analysis undertaken at Borve and An Ceòthan on Benbecula largely supports the wood information with Holocene woodland suggested to comprise mainly of birch and hazel at Borve, while willow was well-represented at An Ceòthan (Whittington & Edwards 1996; Ritchie *et al.* 2001).

The recording of all visible wood remains on an intertidal area of 30m x 60m at Benbecula showed this submerged forest to be a wet woodland composed largely of willow, with birch also prominent. What was surprising was the presence of Scots pine also within this woodland, making it the first recording of remains of this tree in the Uists. A radiocarbon date from the top of the intertidal (wood) peat suggests this woodland was present during the Late Mesolithic to Early Neolithic period at 4043–3947 cal BC (5170±30 BP; SUERC-85852). Pollen analysis from a test pit through this peat, which had a depth of 0.54m, shows the development of this woodland through the rise in willow pollen (Figure 3a), peaking at around 4338–4084 cal BC (5398±30 BP; SUERC-85851). What is noticeable in the pollen record are the small proportions of birch and pine pollen despite these trees forming part of the woodland canopy. Problems around finding a local presence of pine in pollen diagrams is one which is well-known due to the saccate nature of the pollen grain, meaning it can travel long-distances from the parent tree. Lageard *et al.* (1999) have suggested a local presence can be indicated by low frequencies of *Pinus* at around 3% of the total pollen sum. This lower total would be in keeping with the pollen results, and if it were not for having the wood identification information one would not suppose from the pollen that pine would have been present within this woodland. Insect information from the intertidal peat has aided in demonstrating the presence of pine within the willow-dominated woodland from the presence of *Olophrum piceum* in the beetle assemblage (Buhat 2020). The lower percentages of birch, an abundant pollen producer is still rather puzzling, and more light may be shed on this as analysis continues. The pollen results suggest that, by the upper levels of the peat willow-birch-pine, woodland is declining with falling willow pollen values in particular (Figure 3a) and that the submerged forest at Benbecula may represent a relatively short-lived phase of woodland growth. The pollen results indicate a ground flora of mainly wet-loving plants including sedges (Cyperaceae) and marsh pennywort (*Hydrocotyle vulgaris*), while plants such as cowbane (*Cicuta virosa*-type), ragged robin (*Lychnis*-type), and vetches (*Vicia*-type) are also present, indicating a rich diversity of plant life. Possible animal grazing within this woodland is suggested from coprophilous fungi of *Sordaria* sp. (HdV-55A/B and Hd-V205) and *Cercophora* sp. (HdV-112) although the latter can also be associated with deadwood (Perrotti & Asperen, 2019; van Geel *et al.* 2003).

Prior to the development of this woodland the pollen suggests an open probable reedswamp landscape with some maritime influence signalled by the presence of salt marsh taxa including goosefoot sp. (*Chenopodium* sp.), sea plantain (*Plantago maritima*) and Michaelmas daisy family (*Lactuca* sp.), while Foraminifera are also recorded. It is during these apparent phases of marine influence that large quantities of microscopic charcoal have been recorded (Figure 3), some retaining enough structure to indicate the burning of wood, grasses and reeds (Figure 4) in the wetland. Anthropogenic burning of reedswamp vegetation by Mesolithic communities is well-known from wetland sites across the UK (e.g. Bell 2007; Mellars & Dark 1998; Timpany *et al.* 2017), and human populations would have

Figure 3. Selected taxa pollen diagrams. (A) Pollen diagram for Benbecula, Western Isles; (B) pollen diagram for Test Pit 1 Pett Level, Sussex.

been well-established on the Western Isles by the later Mesolithic (Gregory *et al.* 2005). The timing of the increased values of microscopic charcoal values is of interest, covering the same period of intense burning activity recorded by Whittington and Edwards (1996) of possible machair vegetation, potential signalling a large-scale manipulation of different vegetation communities.

At Pett Level, Sussex, wood remains were recorded over an area of approximately 600m x 63m with the aid of volunteers (Figure 2c). Wood identifications have revealed a much different woodland to that at Benbecula with a canopy comprised largely of alder but with significant ash (*Fraxinus excelsior*), and oak (*Quercus* sp.), together with lesser components of hazel, willow, birch and yew (*Taxus baccata*). The presence of ash is significant as to date it has only been found at Langstone Harbour, Hampshire (Clapham & Allen 2000). The wood identifications revealed a diverse assemblage of trees and producing a wood plan of the trees on the area of peat shelf investigated, in much the same way as was undertaken on the submerged forest investigations in the Severn Estuary, under the supervision and direction of Martin, revealing areas where certain trees grew in small clusters (Timpany & Band 2018).

Figure 4. Microscopic charcoal of *Phragmites australis* from Benbecula with stomata evident indicating the burning of reedswamp.

One of the larger problems working on an expanse of exposed tree remains on this scale is recognising the chronology of woodland development and growth. The stratigraphy of the site is complex with up to three peat sequences present in some places, interspersed with marine transgression episodes of silty-clay, while in other parts of the peat shelf, peat accrued continuously (Timpany *et al.* 2020), a not too dissimilar situation to the Wentlooge formation in the Severn Estuary. Radiocarbon dates from the three peat layers at Pett Level have provided the following chronology (Table 1):

- The lowermost peat (Peat 3) was recorded at depths of between -1.72m OD and -4.78m OD with a maximum thickness of 0.58m and has been radiocarbon dated to forming in the Late Mesolithic between 4460-4350 cal BC (5557±28 BP) and 4340-4170 cal BC (5390±25 BP).
- The middle peat (Peat 2) was recorded at depths of between -1.22m OD and -2.32m OD, with a maximum thickness of 1.46m and has been radiocarbon dated as forming between the Late Mesolithic to Early Neolithic periods between 4330-4260 cal BC (5450±20 BP) and 3700-3630 cal BC (4859±21 BP).
- The uppermost peat (Peat 1) was recorded at depths of between -0.26m OD and -1.04m OD, with a maximum thickness of 1.98m and has been dated as forming between the Early Neolithic to Early Bronze Age periods between 3640-3380 cal BC (4726±21 BP) and 1750-1520 cal BC (UBA-28252; 3350±38 BP).

The stratigraphy then indicated that the submerged forest at Pett Level is likely to represent a long-lived woodland that was present from at least the Late Mesolithic through to the Middle Bronze Age, a much different picture to that at Benbecula. The prominent wood remains were also dated through a programme of radiocarbon dating and dendrochronology, which demonstrated that the tree remains exposed on the peat surface were not from one but multiple phases of woodland growth with oak trees dated from 3350-3020 cal BC (4483±29 BP: SUERC-58692) to 1880-1680 cal BC (3443±28 BP: UBA-28272), ash dated to 1950-1740 cal BC (3518±38 BP: UBA-28251) and alder to 1900-1700 cal BC (3491±29 BP: UBA-28250). The complexity of stratigraphy and woodland remnants are aspects of submerged forest research, that prove nothing is ever easy working in the intertidal zone.

Pollen analysis from Test Pit 1 (Figure 3b) doesn't quite capture this diversity of woodland suggested by the wood identifications, with an assemblage dominated by alder and oak with ash only a minor component. This reflects a similar issue to that seen at Benbecula and indicates that pollen samples from within these former woodland environments are only capturing a very localised and limited picture of one small area of the submerged forest with pollen spectra dominated by those trees nearest the sampling site (Bunting 2002; Calcote 1995). This is further limited in insect-pollinated trees, such as ash, whose lower pollen production and dispersal often result in their being under-represented in pollen studies (Birks 1980). Interestingly the pollen assemblage does pick up a signal from yew, while other potential woodland components such as alder buckthorn (*Frangula alnus*) and holly (*Ilex aquifolium*), which have yet to be identified among the tree remains (but would not be out of place in an alder-ash-oak woodland), have been signalled through seeds of this taxon in the waterlogged plant remains (WPR) assemblage (Reurings in prep.). The dominance locally of alder is also reflected in this assemblage with seeds, catkins and buds

of this tree abundant through the upper levels of the test pit. Birch seeds are also prominent in this assemblage, which again is of interest given the weak pollen signal for this tree type (Figure 3b). The pollen and WPR assemblages show a rich floristic diversity within this woodland of mainly damp-loving plants including, meadowsweet (*Filipendula* sp.), cowbane bedstraws (*Galium* sp.), bramble (*Rubus fruticosus*) and fine-leaved water dropwort (*Oenanthe aquatica*).

The presence of possible grazing animals within this woodland is signalled by the presence of coprophilous fungi of *Sordaria* sp., *Cecorophora* sp., *Rivularia*-type (HdV-170), and *Coniochaeta* cf. *ligniaria* (HdV-172) (Perrotti & Asperen 2019; van Geel *et al.* 2003), with high values observed in the base of the Test Pit sequence. Deadwood indicators such as *Scalariform* plates (HdV-114), which are largely reflective of alder/birch wood, and *Kretzschmaria deusta* (HdV-44) are prominent through the assemblage reflecting decaying wood on the woodland floor (Innes *et al.* 2006). The presence of deadwood is also signalled in the insect assemblage, from species such as *Pediacus dermestoides* and *Rhyncolus* spp., while there is also a slight suggestion that grazing animals may have been present through the identification of *Onthophagus* and *Aphodius* which are both ‘dung beetles’ (Timpany *et al.* 2020). On the insect fauna present at Pett Level, David Smith notes that many are quite rare or now extinct in the British Isles and therefore further illustrates the important biodiversity records that these sites hold (Timpany *et al.* 2020). There is little signal in the pollen work done to date of any major disturbances that could be associated with the presence of communities; however, this is mitigated to some degree by the probable very local signal of the pollen assemblage and should not negate against populations ever being present. Microscopic charcoal was observed through the pollen assemblage (Figure 3b) and offers some suggestion that people may have been around in the wider landscape.

CONCLUSIONS

This paper has set out to show the importance of studying submerged forests and intertidal peats and demonstrates their ecological value in understanding the range of former woodlands in the UK through two case study examples of Benbecula, Western Isles, and Pett Level, Sussex. The floristic and faunal diversity of these sites is increasing our knowledge of the biodiversity records and at both sites the first insect studies from these regions have been undertaken from (past) native woodland. The investigation of these sites is challenging not just in the fieldwork element but also in understanding often complex stratigraphic relationships. The work presented here has a direct link to Martin as without the guidance and knowledge he passed on during my PhD studies I doubt this work would ever have been undertaken, and personally I hope some of the above captures Martin’s own enthusiasm to these important and evocative sites.

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Chapter 6

Neolithic and Bronze Age landing places in Britain, Ireland and Scandinavia

Richard Bradley¹

ABSTRACT

Martin's research has placed an important emphasis on ancient uses of the coast and has taken advantage of the exceptional preservation of archaeological evidence in the intertidal zone. This contribution considers one feature of the ancient shoreline in three areas which experienced isostatic uplift. It reviews the evidence for prehistoric landing places, comparing these sites with what is known about similar locations in the medieval period. In Britain and Ireland the evidence includes enclosed estuaries associated with exceptional collections of artefacts, and in south Scandinavia it extends to comparable locations associated with panels of rock art showing Bronze Age boats.

Keywords: *coastlines, estuaries, production sites, rock art*

INTRODUCTION

The sea has always been present in Martin's research, even where the original coastline is lost. A Neolithic pit at Bishopstone contained a deposit of seashells, and his project at Brean Down investigated an important settlement on what was sometimes an island. His work in the Severn Estuary brought him even nearer to the water's edge. Here his excavations took place at low tide and found part of a Bronze Age boat.

Maritime archaeologists have many concerns (Catsanbis *et al.* 2011). They study ancient watercraft, particularly shipwrecks, and investigate cargoes, currents and navigation. Much of their research takes place underwater, but at times it includes the intertidal zone and activities associated with the sea (Bailey *et al.* 2020). Among them are boat building, fishing, and grazing livestock, and the surviving evidence extends to special structures, wooden trackways, the paths followed by animals, and human footprints. Coastal products would have had a wider significance in the past. Cobbles suitable for making maceheads and axes could be collected on the beach, and salt was extracted there. Scientific analysis suggests that people, livestock and artefacts must have been transported by water, but in lowland Britain there remains a problem. Evidence survives from the coastal margin, but the original shoreline is no longer preserved. The situation is quite different in northern Britain and the north of Ireland; the same applies to Scandinavia. The distinctive evidence from all these regions is considered here.

COASTAL CHANGES

The explanation for that contrast is simple, but the details are complex. They concern the changes that happened during the early postglacial period. Melting ice released a large amount of water and sea levels increased. At the same time the retreat of the icecaps meant that some areas no longer supported the weight of glaciers. As a result certain regions rose (isostatic uplift), while others were submerged. The process was most severe during the Mesolithic period, but in the south of Britain and Ireland the Neolithic and Bronze Age coastline has been lost. Further to the north, the ancient shore is preserved on what is now dry land (Figure 1). The same is true in Scandinavia (Figure 2). The extent to which these changes happened must be assessed on a local basis. A further factor is important in the British Isles. As the water withdrew it exposed sediments which could be reworked by rivers, winds and tides. Dunes and bars developed as a result of these processes, but again they have to be considered one case at a time. Even when the ancient coastline survives, its archaeology is difficult to investigate.

The result is paradoxical. Where sea levels have risen in relation to the land, important projects are taking place. They are conducted underwater or in the intertidal zone. Much is known about life on the coastal margin, but the shore itself has been lost. Where its remains can be identified above water this kind of research is rarely possible because the findspots are buried beneath high dunes or have been planted with trees. More troubling is the

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Figure 1. The distribution of earlier prehistoric landing places in Britain and Ireland in relation to the area of isostatic uplift. After Bradley *et al.* (2016), with the addition of three sites suggested by submarine contours and concentrations of artefacts in the hinterland (drawing: A. Watson).

reluctance of prehistorians to consider the large collections of artefacts already documented on dry land beside the sea. That applies mainly to Neolithic and Early Bronze Age Britain. The later Bronze Age and Iron Age present fewer problems.

LANDING PLACES

The ‘landing place’ is an important concept in the archaeology of the first millennium AD. The clearest definition is by Kristin Ilves (2011). Such sites were at the water’s edge where people arrived by sea or embarked on maritime journeys. Landing places were protected from winds and waves and were associated with rivers, estuaries and deltas. They could also be sheltered by offshore islands. Ilves’ analysis is based on sites in Scandinavia dating from the first millennium AD. Others are considered in a study of the same period along the Channel and the North Sea coasts. They were commonly associated with beaches or dunes used in trade, perhaps on a seasonal basis (Loveluck & Thys 2006). Again they were connected with estuaries, inlets and the mouths of rivers and creeks.

The same features are highlighted by Seán McGrail in a study that combines his analysis of ancient boats with his own experience as a mariner. His account introduces some further elements (McGrail 1987: 267–273). Landing sites were often in places with soft sediments where watercraft could be beached at low tide and floated as the water rose. Their positions might be indicated by natural landmarks so that they were easy to identify from a distance, and they were sometimes in the lee of promontories or headlands. They could be protected by archipelagos and offshore rock formations. Others developed beside an isthmus where watercraft could be carried overland to avoid a dangerous journey.

Figure 2. The maximum extent of isostatic uplift in Fennoscandia in relation to sections of the shoreline with concentrations of carved ships. Information from Nimura (2016) (drawing: A. Watson).

In these accounts the landing sites could double as beach markets and were among the places where artefacts were made or exchanged. That is why Ilves called a paper ‘Is there an archaeological potential for a sociology of landing sites?’ (Ilves 2011). Although these places formed part of the ancient seascape, they also played a role in meetings between different groups of people.

EVIDENCE FROM NORTHERN BRITAIN AND IRELAND

In 2016, together with a number of colleagues, I published an account of ‘maritime havens in earlier prehistoric Britain’ (Bradley *et al.* 2016). The term had the same connotations as the ‘landing places’ studied by historical archaeologists, and this point was made in the article. In fact some of the same sites were used in the pre-Roman and early medieval periods. Even the activities undertaken there had points in common.

The impetus for this study did not come from maritime archaeology. Instead it was suggested by a series of unusual assemblages of Neolithic and Early Bronze Age date recovered from dunes and similar deposits during the nineteenth and early twentieth centuries. All these sites were by the sea, and with only one exception – Hengistbury Head – their distribution was restricted to the area of isostatic uplift. These collections attracted attention because they were so different from the evidence recorded by field walking. In an article published in 2004 David Clarke drew attention to their extraordinary character. There were exceptional numbers of finds from the Culbin Sands, the Luce Sands and Littleferry Links, and they included a remarkable quantity of arrowheads (Clarke 2004). Pottery was represented and there was some evidence of Early Bronze Age burials and metalwork. But structures of any kind were virtually absent. A year after our first study appeared I reviewed similar evidence from sites in Ireland, in particular the Dundrum Sands (Figure 3) and Portstewart Strand (Bradley 2017).

Figure 3. The sheltered harbour protected by the Dundrum Sands, Northern Ireland. The finds of prehistoric artefacts come from the vegetated spit to the right of the harbour entrance (photo: R. Bradley).

Many of the finds disappeared into private collections, but studies of those that remained from Culbin, Littleferry and the Luce Sands emphasised Clarke's observations. They also showed that some of the artefacts were incomplete and must have been made where they were found. It was clear that the original findspots clustered on sand or gravel bars by the mouths of enclosed estuaries. These observations raised several questions. Were so many items discovered there because they were easy for collectors to recognise when the dunes shifted in strong winds? Were they any more than a sample of a wider distribution of material? And if their locations on coastal bars were significant, did they take this form in the prehistoric period? The question was important as so little material came from undisturbed contexts.

There were two ways of dealing with these problems. The original study presented the results of field walking on cultivated land beside the Culbin Sands. It soon became clear that the most fertile soils in the surrounding area contained a low density of surface finds and that they had little in common with the enormous collection recovered from the dunes (Bradley *et al.* 2016). Its unusual character became even more apparent. After that account appeared, the exercise was repeated around Littleferry Links (Bradley *et al.* 2017). Again the project confirmed the exceptional character of the collections formed a century or more ago.

A second approach drew on the research of Fraser Sturt who was able to reconstruct the shorelines associated with these sites based on changing sea levels. His work demonstrated that the artefacts were deposited on spits, islands or bars at the entrances of shallow harbours (Bradley *et al.* 2016). His approach has suggested other sites where the topography was similar, but their features are submerged today. It applies to Merthyr Mawr and Newborough Warren in Wales which are associated with Neolithic and Bronze Age artefacts. In Ireland, a good candidate is Dalkey Island. Sturt's analysis is confirmed by the few intact deposits which include pits, hearths, shell middens and cremation burials. They are recorded at Luce Bay, Culbin and Dundrum. In these cases the sediments cannot have been disturbed since they include well preserved concentrations of extremely friable ceramics. Elsewhere lithic artefacts may have moved in the sand, but their condition indicates that they were not

transported over long distances. In some cases the dunes themselves were later in date and covered the prehistoric deposits.

The results of this research showed that the collections from coastal sites shared a special character (Bradley *et al.* 2016). The quantity and quality of artefacts were exceptional, and so was the evidence of imported items and raw materials. For example, the numerous finds from the Luce Sands include Langdale axes and Arran pitchstone. Another feature is the evidence that objects were made in these places, sometimes by heating pebbles from the beach. They included arrowheads at Culbin, Littleferry and Luce Bay. In addition there was evidence for the production of metalwork and faience beads at Culbin and for pottery production on the Luce Sands. Another characteristic of these sites soon became apparent. Although they occupied similar positions and were employed in similar ways, they had quite different histories. To take the four largest collections, the Luce Sands and Littleferry were important during the first half of the Neolithic period, while Hengistbury Head, the only site investigated in southern England, played a major role in the Late Neolithic. Culbin was particularly significant during the Beaker phase (Bradley *et al.* 2017).

Taken together, these observations suggested that a series of enclosed estuaries were associated with specialised activities during earlier prehistory. They offered shelter from harsh conditions at sea and were where artefacts were introduced from other areas. They were also where objects were made. All the sites provided access to a wider hinterland in which monuments of the same date were built, but there were no substantial structures by the coast. The only exceptions are a few small cairns associated with Early Bronze Age burials. In some cases they mark the final phase of prehistoric activity. The same localities were utilised during the first millennium AD.

The point of departure for these studies was the anomalous character of the assemblages found on those sites and the ways in which they contrasted with finds from the surrounding areas. The project investigated a problem in terrestrial archaeology. It is worth revisiting these findings from a specifically maritime perspective. Can these places be described as ‘landing sites’? Do they conform to the definitions proposed by historical archaeologists?

The information shows a remarkable consistency. The prehistoric sites seem to share similar characteristics to early medieval landing places, and the pattern extends to others mapped in Figure 1 which provide less information. McGrail’s review also emphasised the association between portages and landing places on either side of an isthmus. Luce Bay provides an obvious candidate as it is in the lee of the Mull of Galloway. A short overland route would have led to the west coast of Scotland. This interpretation was first proposed seventy years ago (Scott 1951: 31–32).

It is obvious that there are Neolithic and Bronze Age sites where the concerns of maritime archaeology can be addressed on dry ground. Their presence provides some clues to a pattern of seaborne contacts that extended around these islands and connected their inhabitants to communities in Continental Europe. They played a part in the movement of people and resources between distant areas. The list of identifiable locations is almost certainly an underestimate. Even in the areas affected by isostatic uplift prehistoric landing sites are only identifiable through the activities of collectors a long time ago. Because so many dune systems are affected by strong winds, few of the findspots are accessible today. The sediments have been stabilised by planting vegetation.

Similar sites must have been present in parts of Britain and Ireland where the original coastline is submerged. The best clue to their existence is provided by occasional discoveries of plank-built boats or parts of boats. Their dates extend from the Early Bronze Age onwards. It remains an open question how such finds were related to the landing sites considered here, and activity in those places was significantly reduced from about the same time.

EVIDENCE FROM SOUTH SCANDINAVIA

These finds of seagoing vessels were contemporary with the earliest images of watercraft in the rock art of south Scandinavia. That is fortunate as the first remains of plank-built boats in this region date from the pre-Roman Iron Age.

The drawings of ships took many forms between 1700 and 500 BC (Ling 2014: 59–105). The vessels were of very different sizes. Some were shown with their crews – at times improbably large ones – while others were completely empty. They were represented in groups or individually. There was an important distinction between boats suited to inland waters and larger craft that could undertake long journeys.

Images of watercraft are not found on every panel, even by the coast. On the other hand, few have been recorded far from the sea, major rivers, and the two large inland lakes in Sweden (Figure 4; Nimura 2016: fig. 4.2). The association with water is the one consistent feature and is clearly documented by studies of the changing coastline in Scandinavia (Ling 2013, 2014). This is particularly striking since the interior of the country included numerous panels of rock art in which boats were not represented. In most areas the drawings of vessels were limited to the edge of the settled landscape.

Figure 4. A drawing of a Bronze Age boat at Bolstad site 18.1 on the edge of Lake Vänern, Sweden. It is close to the mouth of the River Dalsbergsä (photo: R. Bradley).

INTERPRETATIONS

The connection between drawings of ships and the coast helps to arrange them in order. Studies of shoreline displacement have played an important part because particular rocks first became available for embellishment as the land rose and the water retreated. Certain surfaces would not have been available before a particular time. Johan Ling has shown that this method of dating the images provides similar results to studies of decorated artefacts (Ling 2013, 2014).

These panels also feature in interpretations of seaborne trade. That is hardly surprising as recent work has established that Scandinavia depended on imported metals throughout the Bronze Age. The argument draws on depictions of exotic artefacts in the panels by the coast. People may have engaged in long distance expeditions, and access to foreign objects and materials may have become an important source of power. It is a popular interpretation (Ling *et al.* 2018), but it is not clear how these pictures were related to more arcane images on the same sites.

DRAWINGS OF VESSELS IN THEIR LOCAL SETTINGS

Again it is possible to discuss the siting of these pictures in relation to the landscape and seascape. Comparisons with the archaeology of the first millennium AD can be useful here. The main carvings of Bronze Age ships follow the Baltic and Atlantic coasts and their locations share features with Late Iron Age sites in the same areas. To the east, one of the greatest concentrations of petroglyphs was around the shores of Lake Mälaren (Ling 2014). Although the land continued to rise after the production of rock art ceased, it is no accident that three of the most important centres in Sweden should be found in the same region: Helgö, Birka and Sigtuna (Callmer 1994). These places engaged in craft production and long distance trade. Like the petroglyphs, they were in sheltered positions a considerable distance from perilous waters of the Baltic.

A similar approach can be taken to sites along the Atlantic. An influential paper by Dagfynn Skre considers the Norwegian coast during the first millennium AD. He explains how the country acquired its name:

England means ‘the land of the Angles’ ... but the Old Norse name of Norway, *Nordvegr*, is composed differently. The prefix simply means ‘north’, while the suffix means ‘way’. This ‘way’ is no doubt the

sailing route along the coast of western Scandinavia, running for more than 1000 km ... The route is, for the most part, sheltered by thousands of islands, islets and reefs. Although the open sea outside can be rough, and the wind terrifying, it is safe to sail along the sheltered route. The name of this route was *Nordvegr*, the Northern way. (Skre 2014: 35).

The earliest royal manors in the west Scandinavian kingdom were situated along this route, and similar considerations influenced the siting of rock art on the Atlantic coasts of Sweden and Norway. Studies of shoreline displacement show that most of the drawings of ships were beside estuaries, channels and creeks some distance from open water. That is particularly striking as Bronze Age cairns were built on offshore islands which would have been exposed to bad weather – it is obvious that less hospitable environments were being used at the same time. Along both the Atlantic and the Baltic shores of Scandinavia the sites with most drawings of ships were protected by an archipelago and occupied sheltered positions (Nimura 2016: 71–99). It is obvious that their siting was influenced by practical considerations. It is no accident that certain of these locations provided access to the interior of the country where more cairns are found.

Few Scandinavian petroglyphs are associated with large collections of artefacts, and production sites are seldom found on the shoreline, although the main sites with evidence of metal working were in regions with sheltered harbours and panels of rock art. It seems possible that the complex panels were used on special occasions and that the simpler designs were more closely integrated with the pattern of settlement (Ling 2013: 228). How do these patterns compare with the results of work in Britain and Ireland?

COMPARISONS

In some respects the distribution of these images resembles that of British and Irish sites. In each case they were in places where it would be possible to moor boats and unload their cargoes. They seem to be where non-local objects and materials changed hands, and in Scandinavia some of the drawings of ships were in areas where it would have been easy to travel inland. The most complex panels of rock art could have been offset from the wider pattern of settlement; that was also true of Scottish landing places like those at Littleferry and Culbin. The coast might have been where communities dealt with strangers (Bradley *et al.* 2020). On the other hand, large monuments in the British Isles served a different audience from the landing sites and seem to have been employed in other ways. In some cases these features were deliberately set apart. For example, the palisaded enclosure at Dunragit was on the opposite side of an estuary to activities on the Luce Sands (Bradley *et al.* 2016: fig.7).

The main panels of Scandinavian rock art may occupy similar locations in relation to the coast, but here the panels form regional clusters and may have been directed towards a large number of people. On the west coast of Sweden the most complex groups of ship carvings were spaced at roughly equal intervals, and travel between them might have taken half a day. Around Lake Mälaren towards the east coast, their distributions were more clustered and Johan Ling (2014) argues that these sites were visited by people who came from a much larger area. In that respect the best comparison is with the British and Irish *monuments* rather than the landing places used during the same periods.

The common element was the siting of two archaeological phenomena that have not been compared with one another before. They were in different countries and dated from different periods. Both were by the sea and they can be studied because they are in regions that experienced isostatic uplift. The constraints of weather, tides and perilous shorelines were as strong in one period as another. It is a fortunate accident that in these cases it is possible to extend the concerns of maritime archaeology to what remains above ground.

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Chapter 7

The Sørenga D1A borehole site, Oslo Harbour, Norway: a multi-analytical geoarchaeological and palaeoenvironmental approach

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ABSTRACT

In 2014 a geoarchaeological study was undertaken on two boreholes, reaching ~17.00m below current sea level, from the River Alna and Aker outlets into Oslo harbour at the head of Oslo Fjord, Norway. The study was prompted by development work which would make the area, situated just outside the waterfront of the medieval town of Oslo, inaccessible for many decades to come. The aim was therefore to establish and explore the archaeological potential of the buried sediment stratigraphy. Analysis of the core revealed, contrary to expectation and to sea level curve data, that there was evidence for deep water anaerobic sediments, overlain by shallow water river delta sediments no later than the latest Nordic Iron Age (c. 1000 AD: pre-*Picea*). The latter were increasingly rich in anthropogenic inclusions moving up the sequence, with a topmost sample displaying a subaerial and Dark Earth-like character, with most radiocarbon dates showing an age of c. 1300–1400 AD. The best explanation for these sediment accumulations, types and dates, is an interpretation of Alna River delta front slumping. We suggest this process occurred as a series of contemporary medieval delta sediment accumulations that first slumped sideways gently down-slope, before sliding more steeply downwards, into deep water, with a set of similarly dated sediments becoming a vertical sequence as a result. These medieval sediments in fact recorded probable pro-delta, delta front, channel, levee and marsh facies, which involved both shallow water and subaerial environments. Thus the investigation indicates that sedimentation in the innermost reaches of the Oslo Fjord in the High and Late Middle Ages was massive, with potential effect on harbour conditions. It also shows that the rapidly advancing river delta front offered good conditions for the rapid embedding and subsequent preservation of organic materials in clayey sediments. This would be beneficial even for the preservation of large organic objects like ship hulls which, as a result of slumping events, may be found even at deeper levels than where they originally sunk. Lastly, the study shows how worthwhile and useful off-site coring can be for palaeoenvironmental and archaeological reconstruction where few on-site deposits are preserved, even in the difficult drilling conditions of Oslo Harbour.

Keywords: *delta sediments; Medieval harbour; micromorphology and geoarchaeology; palaeoenvironmental reconstruction*

INTRODUCTION

The infilling and reclamation of the once open water medieval Oslo harbour commenced in the 16th century, and major harbour constructions were still being carried out into the 1960s and 1970s linked to harbour development and modern communications along the west side of the city, and the need to mitigate damage to potential archaeological sites became recognised by Oslo City Council (Falck & Gundersen 2007). For example, presence of ship wrecks and remains of post-medieval docks were suspected (see below). When a major harbour extension was planned for the Sørenga area, both an archaeological survey and coring programme was initiated; historical maps of the harbour were examined from the early 17th century onwards and records of 19 ship remains were listed (Falck & Gundersen 2007), with Oslo an important medieval city and port.

This site, within 250m of the medieval waterfront, was due to be developed for housing (the Sørenga development) and affected by piling, so a decision was made to investigate archaeological potential. It should be noted that two rivers empty into the Sørenga harbour area, from the north the larger Aker River with a catchment of 237.91km² and from the east, the smaller Alna River with a 68.36km² catchment area, with a consequent effect on sedimentation today. The underlying sediments were assessed in advance of development using c. 22 test boreholes.

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Deposits dating to the Viking-medieval age (Borehole 12; AD 970–1030; depth 8.5m), high medieval period (Borehole 50; AD1280–1400; depth 4.8m) and medieval-post medieval times (Borehole 44; AD 1450–1640; depth 7.25m) were recovered. Presence of plant remains and charcoal testified to the palaeoenvironmental potential of the Sørenga sediments (Bukkemoen & Bill 2013). This reconnaissance coring was followed up with deeper coring at the Sørenga D1A location (Bukkemoen 2013).

In September 2014 Johan Linderholm (University of Umeå), Richard Macphail (UCL, London), with Jan Bill and Grethe Bjørkan Bukkemoen (Museum of Cultural History, University of Oslo), examined borehole cores collected from the Oslo Harbour Sørenga D1A borehole site (Bukkemoen 2013) (Figure 1). Twelve cores to a depth of c. 17m below current sea level were assessed for their potential to inform on the past environment of Oslo harbour, using sediment micromorphology, particle size, micro- and macro-fossil analyses, and geochemistry (organic matter, phosphate, magnetic susceptibility (MS), near infrared reflectance spectroscopy (NIR) and XRF measurements). Macro-fossil analyses on the cores provided material for 11 radiocarbon dates.

In addition to previous excavations, two shipwreck sites in Oslo harbour have undergone excavation and paleoenvironmental study by these authors (Engelmark *et al.* 2014; Macphail 2016b; Macphail & Linderholm 2013; see also Macphail & Goldberg 2018: 15–16 and box 1.1, figures 1.1–3).

Figure 1. Oslo harbour and the current outline of the Oslo bay area indicated as white dotted line. Location of Oslo medieval town around the 14th century is north of the Alna river/ river mouth and shaded areas indicate possible sub-aquatic delta/erosional deposits from the Alna and Aker rivers. The coring site is indicated by a black dot. Photos show coring equipment used during the field campaign and core.

METHODS

CORING

The borehole studies were located on the south-west side of medieval Oslo close to the presumed mouth of the Alna River, as indicated by historical documents and maps (Bukkemoen 2013) (Figure 1). Coring was carried out using a hydraulic-driven cylinder which was pushed into the sediments without any rotation. After one core failed, a second borehole location was chosen (Borehole 2), and 23 individual core sections recovered and subjected to laboratory assessment at the Cultural History Museum.

Core log assessment

Before any subsampling took place, each core was visually assessed in terms of general character and grain size (Figure 2). The cores were then scanned at 2–5cm intervals using a Bartington MS meter with a MS2E probe and a NIR spectrometer (JDSU MicroNIR 1700; 1000nm to 1650nm). The preliminary results were then used to select cores and suggest the best locations for combined and exactly correlated subsampling for sediment micromorphology from one half of the core, and bulk sampling every 2–11cm intervals (according to sediment type) from the other half of the core to provide bulk geochemistry and palaeoenvironmental information. Similar combined sampling and correlated investigations had been carried out before, at the Viking Age Gokstad Ship Burial Mound near Sandefjord, Vestfold, Norway (Cannell *et al.* 2020; Macphail *et al.* 2013). At this Sørenga D1A borehole site, standard and adapted techniques were employed, namely: soil and sediment micromorphology (Bullock *et al.* 1985; Nicosia & Stoops 2017; Stoops 2003), magnetic susceptibility, geochemistry and micro- and macro-fossil investigations (Goldberg & Macphail 2006; Linderholm *et al.* 2015; Viklund *et al.* 2013). Seven borehole sediment samples were found to contain sediments disturbed during the coring process, especially Cores 2/10–2/13 and were not subsampled. Intact sediment sequences identified provided material for 17 thin 75mm-long thin sections and 41 bulk samples for geochemistry, and including subsamples for XRF ($n=18$), pollen ($n=10$) and macro-fossils ($n=15$) (Figures 2 and 3).

Figure 2. Core log information, location of micromorphology and ^{14}C -samples (2σ cal AD, terrestrial macrofossils). Samples for pollen (9) and archaeobotany (15) are spread over the sequence. Core scanning using MS2E (189 readings) and NIR (189 measurements; t_1 - t_2 values), positive PC scores are more terrestrial and negative more marine oriented.

RESULTS

DATING

Macrofossils permitted the dating of the sediments to a depth of 12.8m below current sea level (mbsl) (Borehole 2 sample 16) (Table 1). In many cases these were *Picea* needles, although seeds (*Prunus padus*, *Humulus lupulus*) and wood (*Corylus avellana*) were also used. Contrary to expectations for a core reaching in total 16.45mbsl the dates

consistently group in the 1300s AD, with earlier medieval (1020–1160 AD) and possible post-medieval (1430–1630 AD) outliers. Clearly there is not a simple sediment depth-age relationship. It appears that a series of contemporary medieval delta sediment accumulations first slumped sideways gently down-slope before sliding more steeply downwards, into deep water, so that a whole set of similarly dated sediments became a vertical sequence. The lowermost sediments are probably Viking Age and older according to the dated establishment of *Picea* in SE Norway (Bjune *et al.* 2009; Hafsten 1992). Thus, given the slumping model put forward to explain the sequence, age-modelling of the C14 dates seemed inappropriate.

Core/s ample	Depth below current sea level (mbsl)	Material dated	Weight (mg)	Lab code	$\delta^{13}\text{C}$ ‰ VPDB	Radiocarbon date (BP)	Calibrated date (cal AD $\pm 2\sigma$)
2/5	6.50	<i>Picea abies</i> , needle	6.4	Ua-53714	-29.2	550 $\pm$ 28	1310–1440
2/5	6.52	<i>Picea abies</i> , needle	7.7	Ua-53715	-24.8	605 $\pm$ 28	1290–1410
2/6	6.70	<i>Humulus lupulus</i> seed	2.2	Ua-53716	-21.6	556 $\pm$ 29	1300–1430
2/6	6.70	<i>Corylus avellana</i> wood	54.0	Ua-53717	-25.6	396 $\pm$ 27	1430–1630
2/6	6.70	<i>Prunus padus</i> seed	2.5	Ua-53718	-25.0	958 $\pm$ 28	1020–1160
2/9	8.56	<i>Picea abies</i> , needle	3.0	Ua-53719	-28.4	492 $\pm$ 28	1405–1450
2/9	8.67	<i>Picea abies</i> , needle	1.4	Ua-53720	-26.2	561 $\pm$ 27	1310–1430
2/14	11.56	<i>Picea abies</i> , needle	4.1	Ua-53721	-26.2	656 $\pm$ 27	1280–1400
2/14	11.64	<i>Picea abies</i> , needle	3.0	Ua-53722	-27.1	683 $\pm$ 27	1270–1390
2/16	12.73	<i>Picea abies</i> , needle	3.5	Ua-53723	-25.0	667 $\pm$ 28	1270–1400
2/16	12.85	indet. wood, twigs	6.5	Ua-53724	-25.9	576 $\pm$ 27	1300–1420

Table 1. Radiocarbon dating results on the Borehole 2 core samples.

PARTICLE SIZE

Geoarchaeological assessment of the cores and particle size analyses confirmed the presence of medium- and coarse sand-dominated sediments, especially above 11.68mbsl, and mainly silt (71–76%) and clay (19–26%) rich silty clay loams below 11.68m to 16.42mbsl (Table 2). Again, this is consistent with models of delta sediment formation (Reineck & Singh 1986: 335).

Core / sample	Depth in sample (cm)	Coarse sand >600 μm %	Medium sand 200–600 μm %	Fine sand 60–200 μm %	Silt 2–60 μm %	Clay <2 μm %	Texture class
2/2	4–13	8.9	55.4	28.9	4.8	2.0	Medium sand
2/2	35–40	33.9	45.6	14.9	4.1	1.4	Coarse sand
2/14	18–29	0.0	0.1	8.6	71.8	19.5	Silty clay loam
2/16	13–23	0.1	0.5	2.9	76.0	20.5	Silty clay loam
2/17	13–15	0.3	0.8	2.3	71.2	25.5	Silty clay loam
2/20	5–15	0.3	0.8	2.4	70.7	25.8	Silty clay loam

Table 2. Particle size results of selected core sample.

MAGNETIC SUSCEPTIBILITY, GEOCHEMISTRY AND NIR

Initial MS scanning was correlated with laboratory MS analysis of bulk samples (Figure 2) (Linderholm *et al.* 2018) and showed the greatest variations and magnitude (50–121 Si units) above 11.60mbsl, consistent with the presence of brick, tile and other burnt mineral inclusions (see Figure 2). In the lower part (11.60 to >16.00mbsl), there is also magnetic susceptibility enhancement but rather less stratigraphic variation (72–106 Si units). Here, the magnetic susceptibility seems to testify to slow sedimentation of silty clay loam marine alluvium containing very fine burnt material from the Alna River catchment area – and hence its microcharcoal and albeit moderately low, organic matter content (2.6–3.6% LOI). It is suggested that the *in situ* sediments include iron mainly as pyrite (Figure 3), and this is reflected in the generally low MS550 (34–75 $\text{lf}\chi \cdot 10^{-8} \text{ m}^3 \text{ kg}^{-1}$), which is a proxy measurement of iron content.

Figure 3. Geochemistry and loss on ignition results on the core samples. Element variation with depth, P, LOI%, S%, Pb, Sn, and ratios of Ca/Fe and Sr/Ca. For additional information see Figure 2.

Total phosphate (CitPOI) also shows a similar pattern of moderately uniform inputs to the lower deposits (140–160 ppm P), compared to the overlying deposits with higher phosphate (90–212 ppm P) (Linderholm *et al.* 2018). Such findings are mirrored by the XRF log: 720–910 ppm P in the lower deposits and 890–2500 ppm P in the upper deposits (Figure 3). The upper also contain higher levels of lead (25–49 ppm Pb) and tin (Sn) –which may be considered anthropogenic indicators – compared to the lower sediments (21–27 ppm Pb). The increase in bromine (Br) and zinc (Zn) with depth on the other hand, emphasises the more marine nature of the lowermost sediments. Furthermore, the levels of Ca/Fe and Ca/Al reflect changes in marine sedimentation vs terrigenous inputs (Rothwell & Croudace 2015).

Figure 4. Principal component analysis (PCA) on NIR data, first and second component (t1 and t2) with descriptive lithology and core sequence.

After core cleaning, 188 NIR spectra were collected from selected cores. Principal component analysis (PCA) (Figure 4) showed a clear relationship to sediment grain size (t1), with cultural impact demonstrated by high positive score values in the second component (t2). Interpretative categories have been added for the deposits grouped by statistically using those recorded during the first visual assessment e.g., marine clay, humic mudflats, various sands and cultural deposits. These statistical groupings enhance and support the visual assessment of the sediments, and are consistent with the variations evident from the geochemistry, micromorphological and fossil studies (see below). Visual assessment was thus shown to be a useful early step in the overall study of the borehole cores. At first, the observation of PCA groupings with major depth variations seemed totally anomalous, until the dates demonstrated that these sediments were in fact essentially contemporary. This can be exemplified by the clusters formed by samples deriving from cores 2, 4, 6 and 9. Ensuing geochemical, fossil and thin section studies also reinforced the view that these deposits had similarities.

MICRO- AND MACRO-FOSSILS

No identifiable plant fossils were found below 12.85mbsl, which probably indicates relatively deep water sedimentation below this level, and only small amounts of unidentifiable charcoal occur. Upwards, woodland taxa and a dominance of field and meadow plants (e.g. cereals and weeds) provide a strong anthropogenic signal; above 11.56mbsl brackish water *Ruppia maritima* (tassel pondweed) also becomes increasingly abundant, although other aquatic plants are rare. Moreover, the uppermost core samples include an example of *Melilotus albus* (sweet clover), which records the presence of this imported 'harbour plant'; as previously found in contemporary harbour contexts (Engelmark *pers. comm.*). Interestingly, the occurrence of scarce beach-living plants indicate that the sediments in these upper cores were mainly of an unvegetated and poorly stable character. Palynological analysis indicates dominance of woodland and cultural plant pollen, with *Picea* (spruce) pollen being found to 11.72mbsl, indicating the dominance of *Picea* woodland in the medieval period (and supports an interpretation that these layers are Iron Age or more recent). Only the lowermost pollen sample (-14.81m) is without *Picea*, and this is *Pinus*-dominated, which implies a date earlier than the Late Iron Age (Bjune *et al.* 2009; Hafsten 1992) and a markedly different sedimentary regime. This is also consistent with the geochemical analyses and sediment micromorphology (see below).

SEDIMENT MICROMORPHOLOGY

The lowermost micromorphology sample (M23A -16.455 to -16.53m) records low energy silty clay loam sedimentation containing microcharcoal, where anaerobic conditions have produced concentrations of pyrite and gypsum typical of marine sediments (Table 3; Figures 5a, 5b) (Kooistra 1978; Mees & Stoops 2018). As noted above, the sediment has an anthropogenic magnetic susceptibility signal (Figure 2), although seemingly accumulated before the arrival of *Picea*. This is probably a silty clay marine alluvium associated with Alna River pro-delta sediment accumulation (Reineck & Singh 1986: 333–335), and can be compared with the pyrite and gypsum – characterised silty clay loam harbour-fill sediments associated with the late medieval shipwreck at the nearby B13 site to the west (Kooistra 1978; Macphail & Goldberg 2018: 15–21; Macphail & Linderholm 2013; Mees & Stoops 2018). Upwards (M20A1–M20A2; -15.055 to -15.205m), fine weakly humic silty clay loam sedimentation continues, with noted examples of anthropogenic inclusions of rare charcoal, burned mineral (e.g. gravel) and an example of sand-size burned bone occurring, indicating the deposition of occupation material in this Alna River pro-delta location (Figure 5c), where a microlaminated character is typical.

Intercalated pro-delta and coarser delta front sediment accumulation is recorded in samples M17A2 (-13.43 to -13.505m) and M17A1 (-13.43 to -13.505 m), where suggested typical microlaminated deposition occurs; instances of apparent surface drying-out and micro-rilling when some sediments became possibly intertidally exposed, were also observed. Moreover, there is a junction in M17A1, between the silty clay loam and an overlying fine sandy loam with sand-filled burrows present, which logically marks a changing environment from a pro-delta silty clay deposit to a coarser delta front sandy sediment (Table 3, Figure 5). Plant material, including wood fragments, and burned sand occur. Samples M16A1 and M16A2 (-12.655 to -12.805 m) show deposits with an increasingly dominant sandy and gravelly composition of channel and possible sand bar character. Moreover, woody and other anthropogenic components (including bone) occur. This deposition seems to have happened in the 1300s (1270–1400 AD and 1300–1420 AD; Tables 1 and 3), and approximates to a hiatus in the NIR scanning profile and a small but marked rise in magnetic susceptibility values (Figure 2: ~-13.00 m). Another change to the environment seems to be recorded in the sediments 1m above (namely in M14A1–M14A2; 11.635 to 11.785mbsl). Here, a shallow water silty clay loam is present, with U-shaped burrow concentrations, and instances of *in situ* rooting being recorded, consistent with these low energy delta marsh sediments becoming exposed and vegetated on rare occasions (Figure 5d) (Reineck & Singh 1986: 324–327, 331–335). This change in depositional characteristics is again mirrored by the NIR scanning profile, consistent with the lack of small artefacts; magnetic susceptibility is low compared to both the sandy

alluvial sediments below and overlying often coarse alluvium above (e.g. Core 2/6) (Figure 5e). The borehole sequence at this Alna River outflow thus records examples of pro-delta, delta front, channel and marsh sediments, as modelled in Reineck & Singh (1986: 321–338).

Core/ sample	Thin section	Depth below current sea level (mbsl)	Interpretation
2/3			Medieval waterfront-occupied river channel foreshore, with dark earth-like characteristics
2/3	M3A1	4.855 to 4.93m	Medieval waterfront-occupied river channel foreshore: sands dominated by woody remains – wood, hazel nut shells, tree buds. Locally dumped wood processing waste; an urban Norwegian dark earth-like deposit.
2/3	M3A2	4.93 to 5.005m	Medieval waterfront-occupied river channel foreshore: as below, and includes leather fragments.
2/3	M3B1	5.305 to 5.38m	Medieval waterfront-occupied river channel foreshore: here with waterlaid anthropogenic sands, followed by coarse sands and gravels containing (coprolitic/butchered bone?), phosphatic staining and 'soil' formation; alluvial clay inwash (flooding).
2/3	M3B1	5.305 to 5.38m	Medieval waterfront-occupied river channel foreshore: as below with high temperature, furnace heated siliceous sand-embedded slag, and charcoal and possible 'coal' fuel residues, with background middening – burned coprolitic bone – waste; phosphatic 'soil' of occupation/possible industrial origin; a dark earth-like deposit.
2/3	M3B2	5.38 to 5.455m	Medieval waterfront-occupied river channel foreshore: 'anthropogenic sands and gravels', with charcoal, coal(?), coprolitic and burned bone; a dark earth-like deposit.
			Unoccupied delta front, levee and marsh sedimentation (?)
2/5	M5A1	6.255 to 6.33m	Unoccupied delta front, levee and marsh deposition (?): as below, with fine bedded fine silty sand alluvium, often rich in detrital woody plant remains; rooting by monocotyledonous (?) and woody plants indicates marshland environment – hence iron staining – and lack of occupational input.
2/5	M5A2	6.33 to 6.405m	Unoccupied delta front, levee and marsh deposition (?): low energy bedded silts and fine sands, woody detrital organic matter content, with overbank flooding seasonal sedimentation (?); low energy, semi-stagnating water at times (weak iron staining), and hence lack of anthropogenic material input.
			Mainly coarse delta front and channel sedimentation characterised by increased occupation activity (industrial and domestic waste)
2/6	M6A1- M6A2	6.875 to 7.025m	Delta front and channel sedimentation: poorly sorted sands, gravels with thin beds of fine sand, and silty fine sands; high amounts of detrital organic, charred organic matter and woody organic remains, present with upwards, increasingly high concentrations of charcoal, burned bone, burnt stones and e.g. of high temperature fused sands (possible crucible material?). Detrital organic inclusions give the deposits a wide early medieval to post medieval date range.
			Period of unoccupied low energy marsh sedimentation
2/14	M14A1- M14A2	11.635 to 11.785m	Medieval topset deltaic marsh deposits: shallow water silty clay loam, with U-shaped burrow concentrations, <i>in situ</i> roots and iron staining; little anthropogenic input; vegetated with fluctuating water tables and separated from river channel by a presumed levee.
			Sandy clay loam to poorly sorted sands and gravels; pro-delta, delta front and channel deposition
2/16	M16A1	12.655 to 12.73m	Medieval delta front and channel sedimentation affected by Oslo occupation: Poorly sorted fine to coarse sands and gravel, with much biomixing (e.g. crab activity?), large amounts of anthropogenic inclusions and instances of <i>in situ</i> root growth, and poorly sorted sandy clay loam, with gravel; abundant woody and other anthropogenic inclusions including also bone.
2/16	M16A2	12.73 to 12.805m	Medieval interdigitated pro-delta and delta front sedimentation: Mixed bedded sedimentation of silty clay loam and sandy clay loams.
2/17	M17A1	13.355 to 13.43m	Interdigitated pro-delta and delta front sedimentation: Junction between microlaminated intertidal silty clay loams and overlying sandy beach/sand bar sediments (?), with major anthropogenic inputs of woody remains and burned mineral material, and possible coarse burrow mixing (by crabs?).
			Fine silty clay loam pro-delta sedimentation
2/17	M17A2	13.43 to 13.505m	Possible pre- <i>Picea</i> pro-delta sedimentation: delta sediment accumulation and shallowing water with possible tidal flats producing both silty and muddy sedimentation and near surface swash/tides locally fragmenting these pans and reworking them. The presence of clay curls could indicate examples of surface drying.
2/20	M20A1	15.055 to 15.13m	Pre- <i>Picea</i> pro-delta sedimentation: as below, but with layer of coarse sand and fine gravel – some burned; this with charcoal, indicates localised influence of occupation material being deposited in the Alna River delta.
2/20	M20A2	15.13 to 15.205m	Pre- <i>Picea</i> pro-delta sedimentation: fine weakly humic silty clay loam sedimentation; anthropogenic inclusions of rare charcoal, burned mineral and example of sand-size burned bone.
2/23	M23A	16.455 to 16.53m	Pre- <i>Picea</i> pro-delta sedimentation: Microlaminated tidal silty clay loam fine sedimentation, with small amounts of (sometimes horizontally oriented) detrital organic matter, charcoal, and with other slight effects of human activity – hence rare instances of burned sand and gravel. Minor burrowing of sediments occurred at times. Geogenic processes of compaction and anaerobic chemical transformations produced deposition of pyrite and probable pyritised organic residues, and likely related gypsum formations.

Table 3. Micromorphology of the Sørenga core samples.

a: Photomicrograph of M23 (Core 2/23; 18.200–18.275m); very compact diffusely laminated silty clay loam (PSA data: 25% clay, 70% silt), with black pyrite void infills (Py) and channel infill also including a coating of gypsum crystals (Gy). Plane polarised light (PPL); frame width is ~4.62mm.

b: As Figure 4a, under oblique incident light (OIL) pyrite framboids (Py) are brassy coloured.

c: Photomicrograph of M17A1 (Core 2/17, 15.100–15.175m); junction between low energy muddy and microlaminated silty clay loam (PSA data: 25% clay, 70% silt) sediments (mudflat) and overlying more coarse, fine sandy loam (fluvial) deposits. PPL; frame width is ~2.38mm.

d: Photomicrograph of M16A1 (Core 2/16, 14.400–14.475m); root in sediment. Root shows iron-staining, likely associated with oxygen being introduced into this gleyed layer by the root. OIL; frame width is ~2.38mm.

e: Digital flatbed scan of thin section M6A2 (Core 2/6, 8.695–8.770m), illustrating three major units; fine sands and fine bedded sands (FS), layers of silty fine sands (ZFS) and above, anthropogenic sands (AS), with boundary marked by a gravel concentration (Gr). Anthropogenic sands include burned granite (bg), wood remains (w) and much charcoal. (PSA data: Core 2/2 has beds of 30% coarse sand and 45% medium sand; and 30% fine sands and 55% medium sand); frame width is ~50mm.

f: Photomicrograph of M3A1 (Core 2/3, 6.600–6.675m); tree leaf bud. Also present but not illustrated here, are wood fragments, charcoal and unburnt hazel nut shells; frame width is ~4.62mm.

Figure 5. Micromorphology; selected thin sections with descriptions.

As noted above, there is a marked change in sediment character from ~11.60mbsl upwards, as measured by bulk analyses and NIR scanning. Sediment micromorphology evidence of this is found in thin sections M6A1–M6A2 (6.875 to 7.025mbsl), where again delta front and channel sands and gravels predominate alongside instances of fine sands and silty fine sands deposition. Here, however, the ‘anthropogenic’ sands contain relatively high amounts of organic matter (max 8.9% LOI) in the form of fine detrital material, charcoal and woody fragments (Figure 5d). The mixture of probable dumped and detrital material helps explain the small spread of ^{14}C dates at this level, where residual material seems to be present (AD 1020–1160; AD 1300–1430; AD 1430–1630; see Table 1 for additional information). Such deposits are consistent with the dumping of organic debris, for example material associated with wood working in medieval Oslo (Figure 5f), was found only some 300–400m up stream, along the Follobanen Metro route (Buckland *et al.* 2017; Macphail 2016a). There are also fire installation debris-rich layers: charcoal, burnt bone, burnt mineral material and strongly heated fused sands of possible crucible origin indicating local disposal of industrial waste (MS max $183 \text{ l f} \chi 10^{-8} \text{ m}^3 \text{ kg}^{-1}$).

Further examples of suspected unoccupied delta front, levee and marsh sedimentation occur at 6.255 to 6.405mbsl (M5A1–2), where fine bedded fine silty sand deposits, which are often rich in detrital woody plant remains, show evidence of possible overbank deposition and hydromorphic features of stagnating water origin (Duchaufour 1982: 187; Vepraskas *et al.* 2018).

The topmost core samples at 4.855 to 5.455mbsl (M3A1–2 and M3B1–2), which show the greatest anthropogenic signal in terms of macrofossils, pollen, phosphate and lead content, include such a high microartefact content that the deposits can be ascribed to a waterfront and occupied river channel foreshore environment. As detailed in Table 3, wood working remains (wood, bark, tree leaf buds; see Figure 5f), leather, fuel (charcoal and probable coal), middening waste (bone, burnt bone and likely coprolitic bone) occur (Ismail-Meyer 2017; Macphail & Goldberg 2018). These form a dark earth-like deposit, and moreover show phosphate staining typical of medieval occupation (Heimdahl, 2005; Nicosia *et al.* 2017). Excavations at Viking Coppergate, York, UK and along the Oslo Follobanen route found medieval waterlogged urban deposits characterised by wooden structures and waste from wood working and use of other plant materials (Kenward & Hall 1995). It was also interesting to note that clay inwash also affected some levels, testifying to fine alluviation occasionally affecting these coarse anthropogenic deposits (Brammer 1971).

DISCUSSION

According to the sea level curves for the Oslo fjord area, all sediments analysed should be representative of deep water deposition (~4–16mbsl deep) (Sørensen 2006). Instead, only moderately deep, shallow and subaerially influenced sediments were encountered. Seemingly, pro-delta silty clay loam, delta front sands, channel sands and gravels, and sometimes vegetated and burrowed fine levee and marsh sediments, are all found in the 16m of core samples taken from this Alna River mouth location in Oslo Fjord. This anomaly is probably due to slumping down the front of the delta’s depositional surface, slumping being a typical phenomenon of deltas and also a characteristic of fjords (Holtedahl 1975), and here characterised by a moderately uniform medieval date. In general, slumping allows shallow water sediments to be found in deep sea basins (Reineck & Singh 1986: 485). Interestingly, the ~7m thick dated and highly variable sediment sequence is medieval (1300s), indicating rapid deposition of a sediment load derived from the Alna River basin during this period. This suggests the likelihood of marked human disturbance of the river’s catchment during this medieval period. This slumping, perhaps triggered by such rapid delta sedimentation, may also have been contributory to the difficulty in retrieving intact sediment sequences during coring, and the necessity of rejecting so many. A modern analogue to the Sørenga slumping may be found in the large mud slide event in Kråkvik Bay near Alta, northern Norway, that occurred in 2020 and was caught on film, giving some insights as to how the Sørenga sedimentation came about (see internet reference below).

The Alna River sediments record an anthropogenic signal from the earliest, pre-*Picea* deposits (>-14.81mbsl), testifying to a long history of human activity affecting the catchment of the River Alna and its tributaries including upstream habitations and land use in medieval times. The Norwegian National Cultural Heritage Database shows several Iron Age burial mounds in the lower part of the Alna catchment area, especially around Lake Østensjø, where single finds attest settlements back to the Neolithic Period. Several medieval manors were also located around the lake. Further up the river system, settlement and place names are dominated by names ending in *-tvedt* and *-rud*, which are related to clearance, many of them supposedly from the centuries preceding the mid-14th century plague events (Harsson 2010). The medieval sediments, upwards, increasingly record micro-artefacts, macrofossils and pollen evidence of local waste disposal, which is consistent with the chemical and magnetic susceptibility findings, especially above -11.60m. In the uppermost sampled sequence (4.855 to 5.455mbsl), waste was being dumped directly at the waterfront onto the river’s foreshore in medieval Oslo. These deposits form a

dark earth-like sequence, which was intermittently flooded, as in medieval London, Norwich and Perth, UK, for example and material types reflect deposit types found within medieval Oslo itself (Buckland *et al.* 2017; Macphail 2016a).

The fjord and harbour area sediments show changing environmental chemical responses through the core sequence. Worth noticing are clear background levels for several elements at the base of the sediment in comparison to the evident human impact at the top of the sampled core. For example, the uppermost sediments record a mix of Pb and Sn which is probably related to late preindustrial and modern industrial use of (heavy) metals possibly derived from mining activities in the catchment areas of Aker and Alna Rivers where mines were active up until the 1100s AD; speculatively, some heavy metals are also derived from modern ship paints contaminating the upper part of the sediments (Ytreberg *et al.* 2016).

CONCLUSIONS

Contrary to expectations for a core penetrating some 16.45m below sea level at the Sørenga D1A borehole site, Oslo Harbour, there was no simple depth-age relationship and record of deep water fjord sediment accumulation since post-glacial times. Instead, a typical suite of deltaic sediment types consistent with an Alna River outlet was found, with fourteen ¹⁴C dates that group mainly to the 1300s AD (two slightly earlier medieval and one possible post-medieval date). In addition, only the deepest sediments (14.81mbsl) apparently do not include pollen of *Picea*, and thus have a proxy pre-Late Iron Age date (800–1000 AD). The sediments themselves are also seemingly anomalous, in that they include probable pro-delta, delta front, channel, levee and marsh facies, which involve both shallow water and subaerial environments, rather than all being of a deep water fjord character (Figure 2) according to local sea level curves. We have to be cautious however, given that land rise today is only 3.5mm per year, even if it was larger 700 years ago; post-glacial land uplift at Oslo is still likely to have been greater than 200 metres.

Nevertheless, the apparent anomaly is explained by slumping of these shallow water sediments into the deeper water fjord basin; the rapidly accumulated delta deposits were presumably unstable. Slumping disturbance as well as coring issues may account for the fact that only 11 cores out of 24 were deemed intact enough for study.

The multi-analytical approach showed that pre-1000 AD (Late Iron Age) sediments carried a marked anthropogenic signature associated with occupation and exploitation of the Alna River catchment. Disturbance of soils in this hinterland also led to rapid sedimentation and concomitant rapidly changing environments at the mouth of the Alna River, notably during the 1300s AD. This resulted in the formation of a full set of delta sediment facies, when macro- and microfossil, chemical and magnetic susceptibility evidence of urban Oslo life, culminating in the formation of suspected waterfront dark earth-like deposits rich in plant remains, pollen of anthropogenic character and microartefacts. These therefore provide important proxy information for medieval Oslo and usefully supplement *in situ* excavation data from Oslo concerning waste disposal and such activities as woodland resource utilisation.

In terms of future methodological approach, we can now evaluate cores better to ensure that the best samples/sample sequence are chosen out of those collected, by combining visual geoarchaeological assessment and using prospection techniques (e.g. NIR spectroscopy and magnetic susceptibility). At this Sørenga site, even though the stratigraphic integrity is not perfect, it still provides important information on natural and cultural environment of early medieval Oslo, and has already improved our understanding of the numerous sites exposed during later excavations. Further borehole studies will hopefully be more easily managed after this pilot investigation.

To summarise:

- 1) The deep water sediments are characterised by marine clay deposits, gypsum and pyrite etc.; all other characteristics allow it to cluster separated from the other deposits, with a very dominant pine pollen and absence of *Picea* (core samples 23, 20, 17)
- 2) The shallow water sediments reflect fluvial- and wetland environments with heavy metal concentrations similar with the deep water deposits because they remained water saturated. However, clear anthropogenic impact is visible all through this part, exemplified by small artefacts, leather, tile macrofossils of cultural plants (core samples 16, 14, 9)
- 3) The medieval settlement of Oslo is fully reflected in the variety of cultural inputs which record wood working for ships and buildings, craft work (leather) and food preparations (bones including fish bones).

Phosphorus, sulphur, lead and tin increase dramatically as a response to intensified urban activities; again artefacts and cultural plants are more plentiful and diverse (cores 6, 2).

- 4) We would like to suggest the slumping as a series of contemporary medieval delta sediment accumulations that first slumped sideways gently down-slope before sliding more steeply downwards, into deep water, so that a whole set of similarly dated sediments became a vertical sequence.
- 5) Lastly, and very importantly, the massive slumping events attested by the study do have significant consequences for future archaeological management of the Sørenga area and other areas with similar combination of sloping underwater topography and rapid, deltaic sedimentation. Slumping can move sediments with embedded anthropogenic materials horizontally away from their place of formation; the extent of the slumping indicated at Sørenga makes it possible that even entire shipwrecks could be moved as part of such events.

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**PATTERNS IN THE LANDSCAPE:
MOBILITY AND
HUMAN-ENVIRONMENT RELATIONSHIPS**

MARTIN IN THE FIELD

Planning a section at Goldcliff, Gwent (photo: J. King).

Explaining a deep hole to students at Marden, Wiltshire (photo: S. Lambert-Gates).

Getting down close with a hand-lens at Marden, Wiltshire (photos: J. Leary).

Staring into a hole at the base of the Belle Tout shaft Sussex (photo: M. Allen).

Examining a sand exposure, Constantine Bay, Cornwall (photo: T. Walker).

Chapter 8

Hidden landscapes and lost islands – researching Somerset's coastal wetlands

Richard Brunning¹

ABSTRACT

The Somerset Levels and Moors are a low-lying coastal wetland at the edge of the Severn Estuary where the sea has advanced and retreated many times during the Holocene period, providing a parallel to the prehistoric deposits Martin investigated on the Welsh side of the estuary. This chapter provides an overview of recent research into this dynamic landscape, from the inter-tidal mudflats to the prehistory of the extensive peatlands and the 'lost islands' of hard geology within the floodplain. Rescue recording of medieval fishing structures exposed in the inter-tidal zone is contrasted with attempts to preserve and investigate the prehistoric trackways, ritual structures and wetland settlements of the inland moors. Ongoing climate change suggests that many of these sites will disappear in the next few decades but keyhole excavations at sites such as Glastonbury Lake Village have shown what can be achieved on a modest budget. Small scale research projects on the 'islands' have also uncovered a surprising wealth of significant discoveries from an early Mesolithic cemetery to what is possibly the earliest archaeological evidence for monasticism in the UK. Martin has either been directly involved with or has influenced much of the research of this area over the decades and has been a constant source of advice and inspiration.

Keywords: *wetlands; palaeoenvironmental; prehistory; wood*

INTRODUCTION

In the middle of Somerset lie the levels and moors, an extensive coastal floodplain stretching from the Severn Estuary inland as far as Ilchester and Glastonbury, covering about 170,000 acres (70,000ha). They form one of the larger components of the vast Holocene wetland landscape within and around the Severn Estuary that has been the focus for most of work over the last three decades.

Since the late 19th century archaeological investigations have inevitably been drawn to the former area of prehistoric raised bog in the central Brue valley where extensive peat cutting had exposed prehistoric wooden trackways and metalwork (Dymond 1880; Moorland 1922; Stradling 1849, 1854). The nearby discoveries of the waterlogged settlements of Glastonbury and Meare 'lake villages' by Arthur Bulleid retained that focus into the mid-20th century (Bulleid & Gray 1911, 1917, 1948; Gray 1966; Gray & Bulleid 1953). In the 1950s and 1960s Sir Harry Godwin was the first to provide the palaeoenvironmental background to these prehistoric structures (Godwin 1941, 1948, 1955, 1960, 1981) and in the 1970s and 1980s the Somerset Levels Project, under the direction of John Coles and Bryony Orme (later Coles), conducted extensive rescue excavations of the prehistoric trackways in the peat cuttings and reinvestigated the lake villages (Coles & Coles 1986), providing the blueprint for the subsequent investigations of the other major wetland areas in England, funded by English Heritage (Coles & Hall 1997; Hall & Coles 1994; Hodgkinson *et al.* 2000; Van de Noort 2004).

This paper focuses on the work in the Somerset wetlands since the ending of the Somerset Levels and Moors Project. This has included a renewed focus on the archaeology exposed along the coast, assessment of the *in situ* preservation of wetland monuments and enhancement of our knowledge of human activity on the archipelago of 'lost islands' of hard geology within the floodplain. Much of this mirrors work on the Welsh side of the estuary and he has been involved in several of the projects in Somerset.

BETWEEN THE TIDES

The eroding Holocene land surfaces on the inter-tidal area of the Gwent foreshore have been a focus of Martin's activity for the last 30 years. Similar deposits exist on the Somerset side of the estuary, although extensive areas of mud and sand in Bridgwater Bay limit their exposure. No parallels to the prehistoric wooden structures excavated at Goldcliff and Redwick have been found on the Somerset coast, possibly in part because the Somerset inter-tidal

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area has not been favoured by the consistent re-examination of the peat exposures on the Welsh side that was undertaken by the late Derek Upton and is still carried out by Martin at Goldcliff and elsewhere.

Inter-tidal fieldwork in Somerset has instead focused on the numerous stone and wooden fishing structures, initially on Stert Flats in Bridgwater Bay (Bunning 2007a; McDonnell 1994) and subsequently on a more methodical basis through the Rapid Coastal Zone Assessment for the English side of the Severn Estuary (Catchpole *et al.* 2014; Chadwick & Catchpole 2010). Dense concentrations of wooden fish weirs have been recorded in Bridgwater Bay, while further down the coast stone weirs predominate on the rockier shoreline.

A combination of dendrochronology and radiocarbon dating has now enabled the development of the weirs to be better understood. The earliest ones consist of 'V' shapes, formed of lines of vertical posts and horizontal wattles, creating walls that drive fish into a collecting basket, or a ring of stakes and wattlework at the mouth of the V, usually on the ebbing tide. On the Welsh side of the estuary they have been dated from the tenth to fourteenth century (Brown *et al.* 2008, 2010; Godbold & Turner 1994; Nayling 1998, 2000), but on the English side they occur from the seventh to the early thirteenth centuries, with the earliest examples occurring at Woolaston and Aust/Oldbury Flats, and the tradition continuing longest at Stert Flats in Bridgwater Bay (Bunning 2007a; Catchpole *et al.* 2014; Chadwick & Catchpole 2010).

The stone V-shaped weirs on the rockier Somerset coast further west were assumed to be somewhat later, not least because one at Minehead is still in use. Fortunately, the erosion of one arm of a stone weir in Blue Anchor Bay uncovered a series of wooden stakes that were part of its original structure. This allowed radiocarbon dating of a mainly stone weir for the first time, revealing its construction in the early eleventh century AD, suggesting that such stone weirs have been in use for at least a millennium (Catchpole *et al.* 2014).

On both sides of the outer Severn Estuary the large wooden V-shaped weirs appear to have been replaced, at least in part, by long lines of continuous small V-shaped weirs, each of which probably had a basket at its end. On Stert Flats two such structures have been dated from the eleventh to sixteenth centuries, showing the longevity of that form. The large V-shaped weirs made of stone continued in use in places to the present day, possibly because their more resistant construction meant there was no driver to change their form. At their apex they normally have an outlet channel or 'gut', sometimes flanked by lines of stones, where a basket or net would catch the fish. Their morphology varies, with some having multiple outlet channels while others had none, probably functioning as dams to trap fish in shallow water at low tide where they could easily be caught (Chadwick & Catchpole 2010: 8–10).

A later type of fish weir is visible at Brean and Berrow as multiple rows or 'hedges' of stakes up to 1.5m in width, extending for up to 200m parallel to the shoreline (Figure 1). All the examples have either suffered from erosion or are obscured by mud, so their complete form is uncertain. The absence of the larch/spruce and elm that are common species in structures from the eighteenth century onwards suggests that they are earlier than that (Chadwick & Catchpole 2010: 80).

Figure 1. Recording the remains of a 'hedge weir' on Berrow beach in Bridgwater Bay. The green layers in the background are a thin Bronze Age peat deposit.

The long ranks of supports for putt and putcher baskets have been recorded in many areas, the former used to catch a range of fish and eels, while the latter specialised in salmon. They consist of double rows of stakes running parallel to the shore, often with outlying posts and stakes acting as braces and supports, especially with putt ranks where such stakes were used to support and anchor the more complex three part 'kype', 'butt' and 'forewheel' arrays (Jenkins 1974: 45–47; Taylor 1974: 12–13). Putchers are thought to have come into use in the eighteenth or nineteenth centuries with putts having slightly earlier origins but continuing in use until recent times.

Other structures recorded in the intertidal surveys include long linear fishing net hangings in use over the last one and a half centuries, stone conger eel heaps/traps, oyster beds, a small number of wrecks and numerous World War II defensive features, such as anti-glider pole settings and pill boxes. The coastal survey also mapped the full extent of the exposed peat deposits and the location of a palaeochannel that cuts through a peat layer on Berrow beach.

The exposed layers of Holocene peat and clay in the inter-tidal zone are merely the seaward fringes of the vast Somerset floodplain. Space does not permit an overview of the work in the inter-tidal peats in Somerset, let alone further inland, but Wilkinson *et al.* (2021: this volume, Chapter 9) provide an overview of one part of the Holocene deposits in the floodplain. The later history of the wetlands in the Roman, medieval and post-medieval periods is presented by Steve Rippon (2021: this volume, Chapter 1).

WATERLOGGED ARCHAEOLOGY – RESCUE AND RESEARCH

Waterlogged archaeological sites are incredible repositories of archaeological material because of their preservative characteristics. Throughout the UK, and most other countries around the world, such sites and the wider wetlands that contain them are under severe threat from development and destruction by desiccation (Coles & Olivier 2001). The ongoing and future predictions for climate change will hasten this pace of destruction in many areas, not least in Somerset which is expected to suffer from hotter and drier summers and an increasing frequency of severe events such as winter floods and summer droughts (UKCP 2019). This increased storminess, coupled with a rise in sea levels, also presents a threat to inter-tidal archaeology. Several of the wooden fishing structures had noticeably eroded between visits and the exposed peat shelves are gradually being lost as blocks of peat break off and are washed away (Figure 2).

This threat has led to several projects aiming to establish the condition of wetland monuments, assess their chances of ongoing survival and the effectiveness of strategies for their preservation. These investigations have usually involved small excavations, the research potential of which has been maximised wherever possible. Such 'keyhole' excavations are relatively inexpensive but can be very productive. The impact of climate change on wetland sites has been a topic of interest to Martin over recent years and he provided the encouragement for, and oversight of, a Reading PhD study that provided the most detailed monitoring at two of the most important wetland sites in the county, the Sweet Track and Glastonbury Lake Village (Jones 2013).

Figure 2. A sinuous small (1m wide) peat-filled palaeochannel on Berrow beach, exposed by the erosion of the contemporary peat layer on either side. The eroded remains of the peat can be seen in the background covered in green growth. Steep Holm is in the background and Wales is just visible beyond.

A range of prehistoric waterlogged sites known from the work in the Brue valley were an early focus of activity, including assessments of fourteen Neolithic and Bronze Age wooden trackways and platforms at seven sites (Brunner 2013a; Brunner *et al.* 2000). For many of the structures the results were not encouraging. The southern terminal of the Meare Heath and Withy Bed Copse tracks appear to have been entirely lost to desiccation. The remaining stretches of the Abbot's Way, Godwin's and Bell tracks are very desiccated and so close to the surface that they will probably cease to exist in a few decades time. The Tinney's and Chilton tracks and the Saul Platform are in slightly more favourable hydrological situations, but their future is uncertain in the face of the more frequent and severe summer droughts which are predicted with climate change (Brunner 2013a).

The Late Bronze Age ritual pile alignment at Harter's Hill on Queen's Sedgemoor and the site of ritual deposition of a similar date at Greylake are also suffering from desiccation, where peat wastage has exposed the tops of vertical oak piles at both sites (Brunner 1998, 2007b, 2013a). The more deeply buried elements of the sites may survive for a considerable time however, especially at Harter's Hill where the alignment is covered by an increasing depth of peat further away from the dryland.

Similar issues affect the Iron Age Meare Lake Villages. These once waterlogged sites were seen to be drying out when they were excavated by Bulleid and Gray (Bulleid & Gray 1948; Coles 1987; Gray 1966; Gray & Bulleid 1953) and had suffered very badly by the time the Somerset Levels Project studied them (Coles *et al.* 1986; Orme *et al.* 1979, 1981, 1983). Later investigations suggested that the water table was so low in summer that organic materials were unlikely to survive over most of the settlement (Brunner 2013a). A more favourable burial environment was present in the stone and wood causeway between Street and Glastonbury, dated to the mid-Saxon period during the assessment (Brunner 2010, 2013a).

A more promising outlook for continuing waterlogged preservation was encountered in what are probably the two most significant wetland monuments in Somerset, the Neolithic Sweet Track and the Iron Age Glastonbury Lake Village. Of the c. 1.8km length of the Sweet Track, about 370m has been excavated and 550m is preserved *in situ* in Shapwick Heath National Nature Reserve, where it is protected by a high water table maintained by a pumping system (Coles & Coles 1986; Coles & Orme 1984). That system has been shown to be very effective and is likely to ensure the survival of the monument for the foreseeable future (Brunner *et al.* 2000). Where the track runs up to Shapwick Burtle island it doesn't benefit from the pumping system and monitoring has suggested that it may be at risk (Jones 2013). For this reason, a new membrane protection has just been trialled in that area. The membrane proved to be of little help but the naturally high water table in the reserve seems to be sufficient to protect it (Brunner 2021; Brunner *et al.* forthcoming).

Figure 3. Excavation of the Neolithic Sweet Track immediately north of Shapwick Burtle. The track is orientated top to bottom of the image. A flint blade can be seen on the left-hand side of the trackway near the trench edge at the bottom of the image. Another blade was found on the other side of the track. The remains of wood on the same alignment, beside which was a cut pole, was found c. 40cm above the trackway representing activity roughly 500 years later. Scales 1m and 2m.

At Glastonbury Lake Village previous monitoring had suggested that the site was moderately safe from desiccation (Bunning 2013a; Jones 2013). More recent investigations have established the preservation conditions of the waterlogged remains within the settlement and the extent of their survival after the initial excavations (Bunning 2020; Bulleid & Gray 1911, 1917). The assessment of the condition of the monument also presented the opportunity to examine the environmental conditions within the settlement, analyse floors within a roundhouse, determine the size and species of the structural elements of the houses and palisades and obtaining multiple radiocarbon dating samples that allowed a precise chronology for the settlement to be established and identify the sequential rebuilding of house structures over short period of just under a decade (Hill *et al.* 2018; Marshall *et al.* 2020).

LOST ISLANDS

Roughly 150 ‘islands’ of hard geology rise above the peat and clay deposits of the Somerset floodplain, forming a natural focus for human activity over the last 10,000 years and acting as major determinants of prehistoric routeways, as Martin explored in a recent publication (Bell 2020). Many are now contained within a single small field and only rise a few metres above the surrounding wetlands, while at the other end of the scale Wedmore, the largest island, is c. 4 miles (7.5km) north to south and reaches 230 feet (70m). The four high ‘peaks’ of Brent Knoll, Burrow Mump, Nyland Hill and Brean Down form prominent features of the landscape. Many of the villages on the islands retain the ‘-ey’ and ‘-zoy’ endings to their names which are derived from the Anglo-Saxon word for island.

This archipelago has seen relatively little archaeological investigation, so the opportunity was taken to conduct small scale community fieldwork projects, funded by the Somerset County Council, the Levels and Moors Leader+ Action Fund and the Heritage Lottery Fund (Bunning 2019). In addition, there has been a Historic England funded research project examining the wetland/dryland edge in the Mesolithic period (Bell *et al.* 2016).

Figure 4. Map of the Somerset Levels and Moors floodplain (light blue) and the islands of hard geology within it (green). Many of the smaller islands are not shown. Numbered islands mentioned in the text are 1: Greylake; 2: Aller; 3: Muchelney; 4: Burtle; 5: Beckery; 6: Shapwick Burtle; 7: Chedzoy.

The latter was partly inspired by Martin’s work at Goldcliff and his overview of Mesolithic coastal archaeology in western Britain (Bell 2007) and Historic England’s desire to find another site with the preservation levels of the original Star Carr discovery. The initial audit of existing records led to a 40% increase in Mesolithic HER entries. The project also succeeded in establishing the character of the Mesolithic wetlands fringing the islands of Greylake,

Chedzoy and Shapwick Burtle and the wider central Parrett valley and Queen's Sedgemoor (Bell *et al.* 2016; Wilkinson 2021: this volume, Chapter 9). There was clear evidence of activity, probably relating to pastoralism, from pollen and insects at Shapwick and from pollen and non-pollen palynomorphs at Chedzoy, in both cases from c. 3300 cal BC. Test pits at Brickyard Farm on Shapwick Heath produced evidence of stake and postholes associated with charcoal dated to the Mesolithic-Neolithic transition, suggesting that such small islands of dry ground may have been foci for activity at this date. Chedzoy and Shapwick both produced artefacts and biological evidence of the final three centuries of the Mesolithic, augmenting the previous evidence for middle and early Mesolithic activity. The huge, largely untapped, potential of these sites for key stages of the Mesolithic and the transition to the Neolithic was clearly demonstrated.

In addition to fieldwork, some finds from previous investigations were also re-examined, most notably at the small island of Greylake in the Parrett valley where human remains were recovered during quarrying for sand in 1928. The long bones and a skull disappeared amongst local people and two other skulls were destroyed during World War II, but two more skulls eventually found their way to The Admiral Blake Museum in Bridgwater. Radiocarbon dating showed that the individuals had died around 8300 cal BC, suggesting the presence of the only known 'open air' cemetery of the Early Mesolithic in the UK (Bunning 2013b). The individuals were both young adult males, while the early records mention at least one female. The removal of concreted sand from one of the skulls revealed the presence of a phalanx and half a metatarsal in the skull cavity suggesting that excarnation of the remains may have taken place prior to burial. In the 1930s over 4000 flint and chert objects were collected from the site by a local archaeologist. Re-examination of the assemblage has shown that almost all are of Early Mesolithic date suggesting that it was a frequently visited location for hunter-gatherer groups bringing flint and chert from up to 25km away to make a range of blades and tools (Shaw & Scott 2012).

The potential of the smaller islands was demonstrated by investigations at Aller, where geophysical survey of the entire island (of 35ha), followed by evaluation trenching (Bunning 2019: 39–43) and a later excavation in one area (Allen *et al.* 2019), showed the presence of a palimpsest of archaeological features. These included at least five Early to Middle Bronze Age round barrows, an unusual Early Bronze Age mortuary enclosure containing three cremations, two Middle Bronze Age settlement enclosures, a series of Iron Age storage pits and a defensive earthwork, a possible small Early Roman fort, an Early Roman farm enclosure, a later Roman unenclosed settlement, an early 7th century corn drier, an 8th century oval enclosure and evidence for 9th century occupation beside the extant medieval church and manor house. The latter discoveries may help to explain King Alfred's strange choice of Aller for the baptism of the Viking leader Guthrum after the battle of Edington.

Other sites included a Roman ladder settlement at Muchelney, a medieval Priory at Burtle and a test pitting project in the back gardens of East Lyng (Bunning 2019). The latter investigation produced surprising quantities of late Saxon-Norman pottery from the 1m square pits, providing a blueprint for what to expect from other Saxon burghs in the county.

The other notable piece of fieldwork took place at the small island of Beckery, near Glastonbury, which was the site of a chapel owned by Glastonbury Abbey. Investigations by John Morland in the 1880s had uncovered two phases of the stone chapel and an adjacent priest's house (Morland 1889) and excavations by Philip Ratz in 1967–8 recorded a wooden predecessor to the stone chapels and a surrounding cemetery of over 60 individuals. Almost all the graves were adult males, leading to the suggestion that it was the cemetery of a Saxon monastery (Rahtz & Hirst 1974; Ratz & Watts 2003).

The site was re-investigated in 2016 with the primary aim of obtaining scientific dating from the human remains which Rahtz had left *in situ*. The present location of most of the excavated human remains from the 1960s excavations are frustratingly unknown. Fortunately, Rahtz had left *in situ* the graves that partly underlay, or were cut by, the later walls of the stone chapels. Radiocarbon dates could therefore be obtained from seven individuals with Bayesian modelling of the results estimating that burials started in cal AD 350–560 (95% probability) and probably cal AD 440–540 (68% probability). Burials were interred for between 70–240 years (95% probability) and probably 105–195 years (68% probability), ending in cal AD 605–785 (95% probability) probably cal AD 640–710 (68% probability). As the individuals were mainly mature when they died, they could have entered the monastery several decades before the radiocarbon evidence of their deaths. This suggests that the monastery was in existence in the 6th century AD and only came to an end in the mid to late 7th century. It may have begun in the later 5th century and possibly even at the end of the 4th century, and provides what is probably the earliest direct archaeological evidence for the monastic tradition in the British Isles.

A geophysical survey of the site suggested the presence of at least two other stone buildings on the site. One of these was examined by a small trench. Although the walls had been completely robbed down to the base of the

foundations, the internal deposits accumulated to a considerable depth between the late Saxon/early Norman period and the mid-16th century when the stone roof appears to have collapsed, presumably after the dissolution of Glastonbury Abbey estate in 1539. Analysis of these layers using micromorphology, palaeoparasitology and mycology showed that it had been used to house animals and that the species of domesticated animal kept within the building changed over time (Banerjea *et al.* 2020). The fieldwork also discovered evidence of an additional rebuilding phase of the stone chapel and the evidence for Iron Age activity on the site (Brunning 2019).

These small-scale fieldwork projects and investigations, most notably at Greylake, Aller and Beckery, have shown how significant the archaeology of the Lost Islands is, but also what can be achieved with very modest budgets. As over two thirds of the islands have never had any form of archaeological investigation, so much is left to be discovered.

EXPERIMENT AND RECREATION

Two of Martin's many interests have been experimental archaeology and the recreations of archaeological structures, including his involvement in the Experimental Earthwork Project and Butser Ancient Farm. In Somerset samples were taken from a reconstructed Iron Age roundhouse during its gradual collapse at the Peat Moors Centre (since closed) for his wider investigation into what could be learnt from examining the floors of such reconstructions (Banerjea *et al.* 2015; Bell 2014).

Few pure pieces of experimental archaeology have been undertaken in Somerset but in the Avalon Marshes recreations of structures from different periods have produced interesting insights. A 30m re-creation of the Sweet Track was created in a reedbed, similar to its original environment, using materials of the right size, species and method of manufacture as the original trackway (Coles & Brunning 2009). The use of narrow, thin, radially split planks for the walkway allowed a true appreciation of the inherent instability of the structure, and the efficacy of the different methods of stabilising it could be tested. As the roundwood poles that supported the raised walkway, rotted after three years, the reconstruction provided evidence for the trackway duration that could be combined with the dendrochronological dates of the original structure (Hillam *et al.* 1990). The trackway built in 3806 BC therefore probably underwent wholesale repair in 3803 BC or 3802 BC, had some replacement planks added in 3800 BC and must have gone out of use by 3798 BC (Coles & Brunning 2009).

Re-creations have also been made of the Iron Age dugout canoes from Shapwick Heath and Glastonbury Lake Village, three roundhouses from the latter site, the mid-Saxon longhall from Cheddar and the dining room of a Roman villa with hypocaust flooring, based on generic evidence from a number of sites in Somerset (Brunning 2016, 2017). These have all provided valuable experience of such construction projects, demonstrating what is simple or difficult, suggesting why things were done the way that we find in the archaeological record and raising new questions. They have also proved to be a valuable way for the general public to appreciate the material culture of the past at first hand.

CONCLUSION

Over recent decades the work in Somerset in the inter-tidal zone, the investigation and preservation of wetland monuments, the archaeology of islands in the floodplain and archaeological experimentation and recreation have all overlapped with some of Martin's many interests. He has been involved in several of the projects, advised in others and his work elsewhere has always been a constant source of inspiration.

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BREAN DOWN, SOMERSET

Martin has led many major excavations, but perhaps the largest was that at Brean Down in Somerset. Between 1983 and 1987 he conducted a major excavation on the southern slopes of this headland. Mike Walker writes in his *Appreciation*: 'This is probably the best-preserved Bronze Age settlement sequence in southern Britain.'

Brean Down excavations; left: Bronze Age houses; right: Bronze Age burials (photos: M. Bell).

Martin (centre) with his 1985 Brean Down team (photo: M. Allen).

Martin (far right) and the 1986 Brean Down team. Jennifer is in the centre, holding her new-born daughter Sarah, with Eleanor looking up at her Mother adoringly (photo: M. Bell – using a self-timer!).

Chapter 9

The Early–Middle Holocene of the River Parrett, Somerset: geoarchaeological investigations 2006–2011

Keith Wilkinson¹, John Athersuch², Rob Batchelor³ and Nigel Cameron⁴

ABSTRACT

The late Quaternary stratigraphy of the southern part of the Somerset Levels (Sedgemoor) was until recently much less well understood than that of its northern neighbour (the Brue valley). However, that situation has changed in the last two decades largely as a by-product of (a) improvements to flood defences, (b) infrastructure development, (c) proactive studies commissioned by Somerset County Council, and (d) the Historic England-funded Mesolithic of wetland/dryland edge in the Somerset Levels (MWDESL) project. A series of geoarchaeological borehole studies has been carried out as a result (as mitigation for sub-surface disturbance in the case of a and b), revealing the complexity of the Early–Middle Holocene sequence. These data demonstrate that the present predominantly flat topography of King's Sedgemoor is a product of recent basin infilling and that there were many undulations comprised of bedrock bluffs, surficial fans of Late Pleistocene solifluction and projecting 'islands' of Middle/Late Pleistocene marine sediment (the Burtle Formation). Indeed, the earliest Holocene deposits are lacustrine beds found in hollows in the Burrowbridge area and which date to c. 8500 cal BP. While pollen from these deposits indicates an environment of fen carr woodland, ostracods and Mollusca suggest alternating fresh and brackish water lagoonal conditions. Alluvial and intertidal deposits overlie the Triassic bedrock, Pleistocene superficial deposits and the lacustrine beds over much of King's Sedgemoor. These former initially comprise estuarine muds forming in channel and mud flat environments during the 7300–5000 cal BP interval, and are in turn covered by intertidal sediments and peat. The latter forms an extensive outcrop, but is more discontinuous in its distribution than the Brue valley equivalent. Further, unlike the Brue valley peats, those on King's Sedgemoor are buried beneath several metres of later prehistoric and historic estuarine and floodplain minerogenic deposits, have not been subject to the same commercial exploitation, and hence their archaeological content is poorly understood. Nevertheless, where Early–Middle Holocene sediments onlap bedrock and superficial geology 'islands' and can be investigated by conventional archaeological means, Mesolithic and Neolithic archaeological sites have been found, suggesting that King's Sedgemoor was exploited in these periods in a similar way to the Brue valley.

Keywords: *Mesolithic; Sedgemoor; borehole survey; geoarchaeology*

INTRODUCTION

In terms of its archaeological investigation of its prehistoric stratigraphy, Sedgemoor (the area of the Somerset Levels south of the Polden Hills), has until relatively played second fiddle to the Brue valley (the area north of that range) (Figure 1). In large part that state of affairs is a product of the wide expanse of thick peats in the Brue valley, the exploitation of those peats by industrial concerns and consequent focus of archaeological endeavour by the Somerset Levels Project (SLP) and its successors on that area (e.g. Coles & Coles 2006). As is well known, the Brue valley peats contain well preserved trackways, as well as other structural and artefactual remains of Neolithic and Bronze Age date, while 'islands' of bedrock and pre-Holocene superficial geology are marked by dense concentrations of Mesolithic lithic artefacts (e.g. Coles & Coles 1986; Wilkinson & Bond 2001). On Sedgemoor, on the other hand, peat outcrops are discontinuous, of variable thickness and often buried beneath several metres of minerogenic intertidal and alluvial sediment. They have not been as intensively exploited for industrial and horticultural use as a result. Indeed, of the *Archaeology of the Somerset Levels* volumes published by SLP between 1975 and 1989, only the last two included detailed accounts of Sedgemoor sites. However, the archaeological and

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palaeoenvironmental importance of Sedgemoor has latterly been recognised and is, for example, evidenced in publication, e.g. six articles published in *Archaeology of the Severn Estuary* on Sedgemoor's prehistory from 1990–2013 compared to five on the prehistory of the Brue valley in the same period. In large part this change in emphasis is as a result of a decline in the peat extraction industry (meaning less 'rescue' archaeology in the Brue valley), but also increased infrastructure development south of the Polden Hills. Further, the Historic England-funded Mesolithic of wetland/dryland edge in the Somerset Levels (MWDESL) project led by Martin Bell in 2012–2015, enabled further exploration of Early–Middle Holocene stratigraphy revealed by previous outline investigations. This paper considers one aspect of infrastructure improvement, namely bank strengthening carried out by the Environment Agency of the River Parrett, and the Mesolithic and Neolithic (Early to Middle Holocene) strata that were revealed during geoarchaeological borehole surveys conducted in 2006–2007 and 2011. In addition, strata from similar borehole studies commissioned by Somerset County Council to examine infilled palaeochannels of tributaries of the Parrett in the Burrowbridge area are discussed (Table 1).

Project name	Year	Commissioned by	Number of boreholes	Depth drilled (m)
Bank strengthening between Monk's Leaze Clyse and Northmoor Green	2006	Environment Agency	14	4–8
Bank strengthening between Thatcher's Arms and Moor House	2007	Black & Veatch Ltd	4	8–20+
Southlake Moor: bank assessment and palaeochannel investigation	2008	Somerset County Council	10	5–12
Saltmoor: palaeochannel investigation	2010	Somerset County Council	6	5–11
Bank strengthening west of Burrowbridge	2011	Environment Agency	2	6

Table 1. Stratigraphic investigations of the middle Parrett valley that have encountered Mesolithic strata.

SEDGEMOOR AND THE RIVER PARRETT

Sedgemoor is an approximately 200km² area of low lying (+6 to +3m OD) land between the Polden Hills (+81m OD) to the north and the Blackdown Hills (+85m OD) to the south. It is divided into two parts, King's Sedgemoor to the north which is drained by the River Cary and West Sedgemoor to the south, in which the River Parrett is the main axial drainage (Figure 1). However, although separated by a series of surface bedrock outcrops (Mercia Mudstone Group) at High Ham, Othery, Middlezoy and Westonzoyland, deposits from the two rivers coalesce between these islands and also to the west of the last, to form a single drainage system (the River Sowey which links the Parrett and Cary through the High Ham–Othery 'gap', is an artificial construct). According to British Geological Survey (2021a) mapping, the Parrett and Cary valleys are filled by Holocene 'Alluvium' and 'Peat' (*sensu* British Geological Survey 2021b and collectively of the Somerset Levels Formation, *sensu* Campbell *et al.* 1999) to between +5m (in the west) and +10m OD (in the east). However, while mapped as such, the alluvium and peat are in practice the products of fluvial (in channel, natural levee, overbank and floodplain margin) and intertidal (channel, mudflat and saltmarsh) deposition during the Holocene. The former is likely to have been more important in the west and the latter in the east, while variations in the rate of relative sea level rise during the Holocene will also have led to changing patterns of accretion (Brunner 2013a; Hill *et al.* 2007). These superficial deposits rest on Triassic Mercia Mudstone Group bedrock at the valley margins and along the High Ham to Westonzoyland spine, but they also onlap outcrops of Middle/Late Pleistocene marine sediments (Burtle Formation) between Middlezoy and Westonzoyland, and around Chedzoy. The latter form further 'islands', extend to +11m OD and in the case of Greylake Burtle, was used for burial in the Mesolithic, and occupation in both the Mesolithic and Neolithic (Brunner 2013b; Brunner & Firth 2011).

An 8km stretch of the middle Parrett valley between Langport in the east and Thatchers Arms in the west was examined in the borehole surveys reported here (Table 1; Figure 1). The Parrett is affected by tidal processes for the much of this stretch (as downstream), but lock gates at Oath presently prevent saline water penetrating further west.

METHODOLOGY

The methods employed on the four projects were broadly similar. Borehole locations in the case of the bank strengthening works were predetermined and were positions most likely to be affected by construction, while in the case of the palaeochannel investigations, borehole transects were set out perpendicular to the channel axes as determined by LiDaR imagery. In both cases borehole positions were planned in the office using the ArcGIS software

and the relevant coordinates transferred to a GPS for site survey. A Leica GS20 dGPS (horizontal accuracy $\pm 0.300\text{m}$ following post-processing) was used to survey in the boreholes for the two bank strengthening projects, a Leica Zeno dGPS ($\pm 1.500\text{m}$ accuracy) for Saltmoor and a Leica System 1200 RTK GPS ($\pm 0.015\text{m}$ accuracy) for Southlake Moor. Elevation data was acquired using the Leica System 1200 GPS for the Southlake Moor site and by reference to LiDaR data for the other sites.

Figure 1. Location of (a) and (b) of the Somerset Levels in southern and south-western Britain, and (c) boreholes drilled by ARCA in the Parrett valley.

Except in the case of two geotechnical boreholes at Thatcher's Arms and Moor House (see Table 1), boreholes were drilled using Eijelkamp percussion drilling equipment comprising an Atlas Cobra petrol-powered hammer, a 53mm diameter by 1m long core-sampler and 75–50mm diameter by 1m gouge augers and 1m extension rods. Continuous core samples were taken from the ground surface to the depths outlined in Table 1 in the case of the projects associated with bank strengthening works. These cores were then transported to the laboratory for further study. At Southlake Moor and Saltmoor, gouge augers were used to sample the stratigraphy of the majority of the boreholes and the exposed strata described on site and then discarded. Once the profile of the palaeochannels had been determined two further boreholes were drilled on each site using the same core sampler as above. In the laboratory the plastic tubes containing the cores were sliced in two longitudinally using a bench mounted stone saw, and the strata revealed were then carefully hand-cleaned and described using standard geological criteria

(Jones *et al.* 1999; Munsell Color 2000; Tucker 1982). The stratigraphy exposed in the gouge augers was described in the field according to the same criteria.

At Thatcher's Arms and Moorland House single boreholes were drilled by the geotechnical contractor Fugro Ltd using a Dando (shell and auger) rig. Gouge auger heads were used and the stratigraphy described on site by a geotechnical engineer. Samples of key deposits were collected both from the auger head and also by using a U4/100 core sampler. On completion of the drilling the Fugro geotechnical engineer provided ARCA with the borehole logs and a single peat sample from the Moorland House site (16.75-17.20m below ground level [BGL]).

Figure 2. Drilling a borehole at Withey Drove in 2007 using the Eijkelkamp percussion drilling equipment.

Bulk peat sub-samples of 10mm thickness were opportunistically collected from organic strata found in the cores for the purpose of ^{14}C dating from all four sites (a sub-sample of the 16.75-17.20m BGL sample from Moorland House was also dated), while operculae of the freshwater gastropod, *Bithynia tentaculata*, were also collected for dating purposes from Saltmoor. A total of 17 such samples were submitted to Beta Analytic Inc (Florida, USA), Scottish Universities Environmental Research Centre (SUERC, East Kilbride, Scotland) and the Waikato Radiocarbon Laboratory (Waikato, New Zealand) for AMS ^{14}C measurement.

Sub-samples of 10mm thickness were also collected for biostratigraphic assessment (Southlake Moor) and analysis (Saltmoor). Six sub-samples from Saltmoor were analysed and twenty-one sub-samples (Southlake Moor) assessed for their fossil pollen content. Pollen was extracted and studied at the University of Reading using standard density separation methods (Moore *et al.* 1991), and pollen grains and spores identified using the University of Reading pollen type collection and the keys of Moore *et al.* (1991) and Reille (1992). Pollen analysis consisted of counting the grains and spores until a total of 300 total land pollen was reached while assessment consisted of scanning the prepared slides, and recording the concentration and preservation of pollen grains and spores, and the principal taxa on four transects (10% of the slide).

Five sub-samples were examined from the Saltmoor site to recover microfaunal remains including Ostracoda, Foraminifera and Charophytes. The extraction process involved: (1) measuring the sample volume by water displacement, (2) processing the sample by wet sieving through a 125 μm mesh size, and (3) drying the samples; (4) dry-sieving of the samples through a nest of different size fractions. Semi-quantitative estimates of specimens of ostracods and charophytes from the fraction >250 μm were made with using modern reference material and publications (e.g. Athersuch *et al.* 1989; Meisch 2000; Murray 1979).

The preparation of 20 diatom samples from Southlake Moor followed standard techniques (Battarbee *et al.* 2001). Two coverslips were made from each sample and fixed in Naphrax for diatom microscopy. A large area of the coverslips on each slide was scanned at magnifications of x400 and x1000 under phase contrast illumination. The concentration and state of preservation of diatoms, and the principal diatom taxa, were recorded.

RESULTS

The relevant borehole litho- and chronostratigraphies are presented in Figure 3, from which it should be noted that the Thatcher's Arms and Moorland House geotechnical boreholes (TA BH1, MH BH1) were the only records that extend to the Mercia Mudstone Group bedrock. Indeed, only three percussion boreholes penetrated the entire thickness of the Somerset Levels Formation to reach Pleistocene Head and fluvial gravels. The infilling Holocene stratigraphy of the Parrett valley is therefore of >10m thickness throughout except in the immediate lee of the steeply shelving bedrock outcrops. The geotechnical boreholes indicate that fluvial gravels overlies Mercia Mudstone Group bedrock at 19m BGL (-12.5m OD) (Moorland House) and that Head lies above Mercia Mudstone Group at 10m BGL (-2m OD) at Thatcher's Arms (Figure 3). Pleistocene fluvial gravels were also encountered at 12m BGL (-8.7m OD) in the northern part of Southlake Moor (SM BH2 and SM BH10), while Head formed an apron around the Barrow Mump bedrock island in the southern part of the same site at 7m BGL (-3.8m OD) (SM BH5). On the Saltmoor site, Early Holocene gyttja (lacustrine) deposits outcropped at 10.7m BGL (-7.2m OD) (Salt BH1-2, Salt BH6) but the latter could not be penetrated and therefore their thickness and the nature of underlying strata are uncertain.

Figure 3. Composite cross section and stratigraphy from selected boreholes in the Parrett valley.

LACUSTRINE STRATA

The earliest Holocene deposits recognisable in the Parrett boreholes are lacustrine deposits and which have been found in two locations: Saltmoor (Salt BH1 and Salt BH6) and at Moorland House (Figure 1). The strata are dated by AMS ^{14}C to before 8640–8400 cal BP at Moorland House and at least 8430–8210 cal BP on Saltmoor (Table 1: Beta-229912 and SUERC-36630), but despite the similar age, the character of the lacustrine strata on the two sites is different. It is therefore likely that the deposits might have formed (a) in separate lakes (geographically and/or chronologically separated), (b) in different parts of the same lake, or (c) the properties of a single lake had changed over time. The Moorland House deposits were described by geotechnical engineers and therefore, while load bearing and basic morphological properties are known, more precise details that might infer mode of formation, are not. Nevertheless, the basal part of the sequence seems to be comprised of laminated muds and thin peats. A single bulk sample from these deposits at 16.75–17.20m BGL (-9.25 to -9.70m OD) contains the gastropod species *Bithynia tentaculata* and *Valvata piscinalis*, suggesting the presence of a moderate-sized or large water body containing slow moving or still water (Kerney 1999), but further biostratigraphic study was not possible.

Laboratory number	Site	Borehole	Depth (m BGL)	Material	Radiocarbon age	$\delta^{13}\text{C}$ (‰)	Calibrated date (cal BP) (2 σ)*
Wk-20275	War Moor	PAR BH7	6.54–6.55	Peat	2830±50 BP	-28.8	3140–3120 (0.5%) 3110–3090 (0.4%) 3080–2840 (89.6%) 2830–2780 (4.9%)
Wk-20276	War Moor	PAR BH7	8.78–8.80	Peat	5823±65 BP	-28.2	6790–6480 (94.6%) 6470–6450 (0.8%)
Beta-229912	Moorland House	MH BH1	16.75–17.20	Peat	7740±60 BP	-29.1	8640–8400
Beta-229913	Moorland House	MH BH2	6.30–6.31	Peat	4520±50 BP	-26.0	5320–5030 (92.3%) 5010–4970 (3.2%)
Beta-229915	Thatchers Arms	TA BH2	6.36–6.37	Peat	3310±40 BP	-27.0	3680–3670 (0.9%) 3640–3450 (94.5%)
Wk-25624	Southlake Moor	SM BH6	1.89–1.90	Peat	2528±33 BP	-28.5	2750–2670 (29.3%) 2660–2610 (17.6%) 2600–2490 (48.6%)
Wk-25626	Southlake Moor	SM BH2	12.81–12.82	Peat	6336±33 BP	-27.2	7330–7160
Wk-25627	Southlake Moor	SM BH11	0.94–0.95	Peat	2850±36 BP	-28.2	3080–2850
Wk-25628	Southlake Moor	SM BH11	2.18–2.19	Peat	4975±33 BP	-28.2	5860–5820 (6.4%) 5760–5590 (89.0%)
Wk-30634	Saltmoor	Salt BH5	3.87–3.88	Peat	4368±25 BP	-28.2	5040–5010 (5.6%) 4980–4850 (89.9%)
Wk-30635	Saltmoor	Salt BH5	1.74–1.75	Peat	3097±26 BP	-26.1	3380–3230
SUERC-36630	Saltmoor	Salt BH6	10.81–10.83	Shell+	7560±40 BP	-8.9	8430–8310 (90.2%) 8260–8210 (5.3%)
SUERC-37119	Burrowbridge	BUR BH1	4.70–4.71	Peat	3055±30 BP	-29.6	3360–3170

Table 2. Results of AMS ^{14}C dating of samples from the middle Parrett valley. * calibration using the IntCal20 curve (Reimer et al. 2020) and OxCal v 4.4 (Bronk Ramsay 2009). + operculum of *Bithynia tentaculata*.

The Saltmoor lacustrine deposits are gyttja-like, i.e. highly compressed organic detritus laminated with mineral sediment, while as with the basal strata at Moorland House, frequent mollusc shells were noted in the sediment. The small sample window of the sampled Saltmoor borehole (Salt BH6) precluded detailed quantitative study of macrofossils but, an analysis was carried out of pollen, diatoms, charophytes, foraminifera and ostracods.

The pollen assemblage (Figure 4) does not vary to any great extent between samples, which are all characterised by high values of tree (60%) and shrub (35%) pollen. *Alnus* (40%) and *Corylus* type (35%) dominate, with lesser quantities of *Quercus* (15%), *Ulmus* (5%), *Fraxinus*, *Betula* (both <5%) and sporadic occurrences of *Pinus*, *Tilia*, *Calluna vulgaris*, *Hedera*, *Salix* and *Frangula alnus* (all <2%). Herbaceous pollen is limited (<5%) and includes Poaceae, Cyperaceae, Asteraceae, *Chenopodium* type and Apiaceae. It is notable that aquatic and spore taxa are limited to sporadic occurrences of *Sparganium* type, *Dryopteris* type and *Polypodium vulgare* (all <1%). These data indicate that alder (*Alnus*) dominated the wetland and together with willow (*Salix*), probably formed fen carr woodland. The ground flora consisted of herbs, including grasses (Poaceae) and sedges (Cyperaceae), and ferns (e.g. buckler fern [*Dryopteris* type]). Oak (*Quercus*), elm (*Ulmus*), ash (*Fraxinus*), birch (*Betula*), hazel (*Corylus*) and ivy (*Hedera*) may also have grown within the alder fen carr, but together with small-leaved lime (*Tilia*) more likely formed a mature woodland community on dry land at the edge of the wetland, the island and/or on the surrounding hills.

Two distinct environmental settings can be recognised during formation of the gyttja on the basis of their invertebrate fauna and non-pollen microflora, despite the absence of macroscopic lithological change. In the lowest part of the stratum ostracods are extremely rare and represented by individual juvenile specimens of *Loxoconcha elliptica*, *Cyprideis torosa* (smooth), *Heterocypris salina* and *Candona* spp. However, operculae of the gastropod genus *Bithynia* are found in large numbers, as are oospores and gyrogonites of charophytes (algae), the latter including including rare specimens of *Nitellopsis obtusa*. Charophytes are indicators of clear, slow moving or standing fresh to slightly brackish water preferring calcium-rich waters, but the occurrence of *Nitellopsis obtusa* suggests the presence of fresh water in this instance.

Figure 4. Pollen diagram for Saltmoor borehole Salt BH6.

The number of ostracods increases higher in the gyttja and the fauna comprises *Cyprideis torosa* (smooth variety), *Heterocypris salina*, *Loxoconcha elliptica*, *Candona* spp (including rare specimens attributable to *C. angulata*), *Cytherura gibba* and rare specimens of *Semicytherura ?cornuta*. Charophyte oospores, representing at least two different unidentified species, are at their most abundant in this interval, but *Bithynia* is absent, while the foraminifer *Haynesina germanica* is also present. These data indicate connection to the coast, penetration of tidal waters inland and the formation of a brackish lagoon at Saltmoor. *Cyprideis torosa* is tolerant of a wide range of brackish environments, while *Candona angulata*, with which it is often associated, prefers slightly saline waters. *Loxoconcha elliptica* and *Cytherura gibba* are exclusively brackish water species confined to estuaries and lagoons. The foraminifera *Haynesina germanica* is indicative of brackish water environments, common in estuarine, lagoonal or supratidal environments. The presence of charophytes is consistent with mildly brackish conditions, while the presence of gypsum crystals might indicate evaporative conditions.

The aquatic environment probably returned to a freshwater state in the very top of the gyttja. Only a single specimen of the ostracod *Loxoconcha elliptica* is noted in the uppermost sample, but *Bithynia operculata* are present in profusion, while apices of *Bithynia* and *Valvata piscinalis*, and fragments of the bivalve genus *Pisidium*, are included in the assemblage. Rare charophyte gyrogonites and oospores including those of *Nitellopsis obtusa* are also present. The quantity of freshwater gastropods, together with the charophytes, in particular *Nitellopsis obtusa*, indicates clear, slow-moving or standing fresh, calcium-rich waters during the final phase of gyttja formation.

INTERTIDAL AND ALLUVIAL STRATA

The lacustrine deposits described above from Moorland House and Saltmoor are succeeded by a suite of minerogenic deposits (clays, silts and fine sands) and peats of alluvial and intertidal genesis. These same strata also form the base of the Holocene sequence at Southlake Moor and the lowest part of the sampled sequence in boreholes to the east of Burrowbridge.

The earliest intertidal/alluvial stratigraphy for which there is good evidence for depositional environment is from channel fills on Southlake Moor. These strata outcrop from -9.5 to -3m OD (SM BH2 and SM BH10) and comprise grey laminated silts and fine sands, with occasional thin peat beds. An AMS ^{14}C date on one of the latter produced an age of 7330–7160 cal BP (Table 2, Wk-25626), while marine planktonic diatoms such as *Cymatosira belgica*, *Paralia sulcata*, *Campylosira cymbelliformis*, *Podosira stelligera*, *Actinopteryx undulatus* and *Rhaphoneis* spp. were recovered from a sample at -9.07m OD in the same borehole (SM BH2). The sample also contained benthic mesohalobous diatoms such as *Nitzschia navicularis*, *Diploneis didyma* and *Diploneis aestuari*, while these and the dominance of the marine forms indicate a connection with the Bristol Channel and therefore that the channel was within the tidal

frame. Similar laminated deposits were noted above the lacustrine sequence in the Saltmoor boreholes, while it is probable (as noted above, only geotechnical descriptions were available for the lowest Holocene stratigraphy) that they also outcrop at Moorland House. Boreholes from the eastern part of the Parrett study area did not penetrate to sufficient depth to encounter the laminated sediments (if indeed they are present at this location).

The laminated beds are occasionally overlain by macroscopically homogeneous minerogenic silt/clays and frequently by peat. Although the latter does not occur in every borehole, a peat bed outcrops across much of the Parrett valley at -1 to +2m OD. Several radiocarbon dates were obtained on the base of the peat which produced ages ranging from 6790–6450 cal BP (Table 2, Wk-20276) at War Moor to 5040–4850 cal BP at Saltmoor (Table 2, Wk-30634), albeit that the latter was on the base of a thin peat overlying a palaeochannel. An assessment of 11 sub-samples from the peat on Southlake Moor (SM BH6) suggests that it formed in a carr environment dominated by alder, with an understorey of grasses, sedges, mixed herbs and aquatics. Oak, birch and hazel may also have grown within this environment, but are more likely to have formed mixed deciduous woodland on the surrounding hills. However, although diatom preservation is poor and while the assemblage is dominated by oligohalobous indifferent diatoms such as *Aulacoseira italica*, *Cocconeis placentula*, *Epithemia adnata* and *Synedra ulna*, halophilous diatoms such as *Rhoicosphaenia curvata* and the rheophilous diatom *Melosira varians* are also present. Indeed, the marine planktonic diatom *Paralia sulcata* is present, suggesting that saline waters from the Bristol Channel reached as far east as Southlake Moor during peat accretion. AMS ^{14}C dating from the top of the peat at War Moor, Thatchers Arms, Southlake Moor (SM BH6 and SM BH11), Saltmoor (Salt BH5) and Burrowbridge produced results in the 3680–2490 cal BP range (Table 2), i.e. the Early Bronze to Middle Iron Age. Minerogenic sedimentation of silts and clays succeeded peat development, which although diatom assessment at Southlake Moor demonstrates very poor frustule preservation, was probably as a result of an increased influx of brackish water. Indeed, the increasing younger ages for cessation of peat accretion on a west to east basis is an argument for relative sea level (RSL) rise being the cause of silt/clay deposition.

DISCUSSION AND CONCLUSIONS

The various borehole studies carried out in the Parrett valley between 2006 and 2011 have demonstrated that Early Holocene depositional environments were much more dynamic than those of later periods. Dynamism undoubtedly reflects the rapid rate of RSL rise in the Early Holocene, but is also a factor of the varied topography left by periglacial processes (e.g. solifluction and braided channel development) during the Late Pleistocene. Nevertheless, there is no evidence in any borehole for the presence of deposits dating from the first two millennia of the Holocene and it is therefore likely that such strata have been eroded by later processes or reside deep in basins that have yet to be sampled. This absence is unfortunate given that many, perhaps even the majority of the Mesolithic lithic scatters on the Burtle Formation and bedrock islands are of Early Mesolithic type, i.e. pre-dating 8500 cal BP (Wilkinson & Bond 2001), while the Mesolithic burials on Greylake Burtle have been AMS ^{14}C dated to 10,480–10,200 cal BP (9118 $\pm$ 37 BP, Wk-30930; 9134 $\pm$ 37 BP, Wk-30931) (Brunner & Firth 2011) and also pre-date the earliest Holocene strata yet found on Sedgemoor. As a result, there is little palaeoenvironmental context for the earliest Holocene occupation of the area.

The earliest Holocene strata in the boreholes are lacustrine beds of c. 8650–8200 cal BP age at Saltmoor and Moorland House. The biostratigraphic evidence suggests that at Saltmoor these calcium-rich lake waters formed in hollows in the Pleistocene topography and initially in an entirely freshwater environment, demonstrating that the River Parrett, although draining into the Bristol Channel, was not affected by tidal processes. Although this evidence of connection might have been short-lived (the biostratigraphic evidence indicate a return to freshwater environments at the top of the relevant stratum), it is notable that the evidence is at -7.50 to -7.18m OD, this at a time when RSL was c. -8 to -9m OD (Haslett *et al.* 1998; Heyworth & Kidson 1982) and therefore consistent with present tidal ranges (a spring tide range of +6.13 to -4.78m OD at Hinkley Point today [National Tidal and Sea Level Facility 2021]). During this period the environment of Sedgemoor would have been highly dynamic and comprised lakes which were at times connected and other times disconnected to the Bristol Channel, surrounded by alder-willow carr vegetation, but with a species-rich oak–elm woodland on the surrounding interfluvies.

After 8430–8210 cal BP, connections with the coast became firmly established, and lithological and diatom evidence demonstrates that saline waters extended up the channel system as far as Southlake Moor. Deposition of laminated sands and muds in these tidal conditions thereafter deposited the majority (9–12m of deposits) of the Holocene sequence in the Saltmoor, Southlake and Moorland House areas. The Parrett (and indeed the Carey) valley would have been estuarine at this time, and inundated twice a day by the ingress of tidal waters to at least as far east as Saltmoor, but probably beyond (boreholes to the east did not penetrate beneath the overlying peat). Mesolithic people are likely to have foraged in this environment, but are very unlikely to have inhabited the valley, and rather

the Late Mesolithic lithic scatters on the bedrock and Burtle islands are more likely to reflect the location of camps. The rapid intertidal sedimentation ceased earliest in the east at War Moor (6790–6450 cal BP), later at Southlake Moor (5860–5590 cal BP), and still later at Saltmoor (4040–4850 cal BP) presumably as depositional rates had outstripped RSL rise. This change coincides with the Neolithic and saw marsh develop across large parts of the Parrett valley and thereafter remain until as late as the 2750–2490 cal BP, the Middle Iron Age, at War Moor. Indeed the Neolithic–Iron Age peat in the Parrett valley is both the lithostratigraphic equivalent of the better known stratum in the Brue valley that contains the well-known Neolithic and Bronze Age trackways, but also analogous to peat strata of the same age in other estuaries in southern Britain (e.g. the Thames). Although the biostratigraphy has only been assessed at Southlake Moor, and microfossil preservation is poor, it is clear that the peat formed in alder carr and that there was similar mixed deciduous woodland on the surrounding ‘uplands’ (presumably the Polden and Blackdown Hills, and possibly the Burtle and bedrock islands). Nevertheless, the carr must have been tolerant of at least some salinity given diatom evidence for halophilous and even marine taxa in the peats from Southlake Moor. Indeed, lithostratigraphic evidence suggests that the peat did not have uniform coverage and was crossed by channels carrying saline water on Southlake Moor and probably Saltmoor. As with the Brue valley and the Thames, later prehistoric trackways might also be expected in Sedgemoor, perhaps linking the bedrock and Burtle islands with the surrounding hills.

This paper has presented a very outline picture of changing environments in the Parrett valley during the first part of the Holocene. The majority of the work has been carried out as mitigation for the insertion of flood defence or reflooding works, neither of which is likely to damage strata at depth and which did not require the excavation of trenches or test pits as a result. The limited data that have been acquired in the reported boreholes highlight our present lack of knowledge of depositional environments and human activity in Sedgemoor during the first seven millennia of the Holocene. Nevertheless, there are a number of important implications of the borehole work, key of which is that the Holocene basin fills of the middle Parrett valley range up to almost 18m in thickness, and are typically greater than 12m. Furthermore, given that the top of the peat unit at +2.5 to +0.8m OD (c. 6–2m BGL) has been dated to the 3680–2490 cal BP interval, 12–16m of deposits infilling the middle Parrett valley are of Middle Iron Age–Mesolithic date. These deposits are, however, overwhelmingly found at >4m BGL, significantly below the water table and cannot therefore be investigated by conventional archaeological means

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Chapter 10

Drylands and wetlands; soils, sediments and snails

Michael J. Allen¹

with a contribution by Rob Scaife²

ABSTRACT

This short paper provides vignettes of geoarchaeological fieldwork and research on, or near, the South Downs in East Sussex. It shows the research gain that can be obtained by tenacious field work, close and careful observation, and interactive field testing. It demonstrates the ability to conduct good academic fieldwork research with both small budgets and untrained, but keen and highly motivated, volunteers. This interim statement of three projects highlights some of the, as yet unrealised, geoarchaeological potential of uncompleted small-scale fieldwork on dry chalk, and of small-scale and highly localised wetlands and foreshore 'land'scapes, on or adjacent to those drier Downlands.

Key words: *chalkland geoarchaeology; palaeoenvironment; colluvium; waterlogged*

INTRODUCTION

This paper echoes some of the themes addressed in a paper for *Eastbourne: aspects of archaeology, history and heritage* (Allen 2014). But here I look at two aspects of the chalk downland upon which Martin started his archaeological career, in which I was able to participate as a 14 year-old schoolboy as a digger, then surveying sites for him and being one of the field team in his PhD fieldwork. That research theme (dry valleys, colluvium and palaeoenvironmental proxies) (Bell 1983) and the use of molluscan analysis were both aspects that formed a major plank in my own archaeological career.

The chalk downlands of southern England have long been studied and in part they are redolent in major archaeological monuments that we see in the Avebury, Stonehenge, Cranborne Chase and Dorchester (Maiden Castle, Maumbury Rings, Mount Pleasant etc.) areas. But other areas, perhaps less rich in obvious major physical monuments, have been blessed with equally important archaeologists; Sussex and the South Downs in particular have benefited from a long tradition of archaeological research, and in essence spawned both Martin's and my own careers.

Anyone wishing to undertake land-use and environmental research of the downland will often end up examining soils, sediments and snails. Pollen may be a much better palaeoenvironmental proxy, but its survival is rare or negligible in the chalkland soils and in archaeological features on the chalk. Although there are, however, exceptions, some of which we will explore here, the majority of the data is via the poorer palaeoenvironmental proxy of land snails. Soil science has been a key part of downland research, but the study of soil micromorphology was largely neglected or surprisingly sparingly deployed until relatively recently (see French in French *et al.* 2007: Cranborne Chase; French *et al.* 2012: Stonehenge landscape) and current work in the Avebury area. Some key studies were undertaken on the South Downs by Richard Macphail at Chalton, Hampshire/West Sussex (Macphail in Bell 1981a, 1983) and the Bourne Valley, Eastbourne and Ashcombe Bottom, Lewes, for me (Macphail in Allen 1994, 2005, 2007).

The two sets of points this paper therefore addresses are: a) the existence of and value of localised wetlands which exist and if searched for can provide important palaeoenvironmental information to complement the excellent, but biased data sets obtained via snails and soils alone; and b) the representative nature of sediment reservoirs and their contained palaeoenvironmental proxies and the scale and resolution of their interpretation. Both points allude to the lack of completeness of our extensive palaeoenvironmental record for the chalk. Sites in the

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Eastbourne general environs in the Seven Sisters dry valleys, Belle Tout, and at Shinewater on Willingdon Levels, and sites in the Ouse Valley north of Lewes at Barcombe and The Wilderness are briefly discussed (Figure 1).

Figure 1. Location of the key sites discussed in the text (graphic: J. Foster).

DRYLANDS

Dry valley colluvium was the topic of Martin's post graduate PhD research with fieldwork in 1977–1979 (Bell 1981a). It was also a study I took to heart excavating a dry valley in Old Town, Eastbourne, as a schoolboy in 1980, the results of which formed the basis of my undergraduate dissertation (Allen 1983), and the excavation published somewhat tardily in 2007 (Allen 2007) (Figure 1). Dry valley colluvium provides sediment reservoirs that enable sequences of land-use history to be determined via the study of the sediments themselves and their contained land snails. Sequences are dated via the distributions of artefacts, rather than the occurrence of finds assemblages from any 'layer' (e.g. Allen 1982; Allen 1988, 1991; Bell 1981b, 1983). Such environmental histories are constructed that reference the local area, and have been used as representative proxies for the surrounding landscape, or whole regions. It is this representative nature of the valley environmental sequences which I briefly explore here.

SEVEN SISTERS DRY VALLEY PROJECT

An investigation of several dry valleys was conducted as part of a large National Trust Seven Sisters Archaeology Project (Allen 2016a), a community archaeology and research project to investigate and record the archaeology which is under threat from coastal erosion. One of the wider aims was to train and provide an opportunity for National Trust volunteers to engage in archaeology and scientific archaeological investigation. The geoarchaeology programme included:

- i) walkover survey;
- ii) selected augering of five valleys and the Birling Gap western footslope;
- iii) three hand-excavated test pits (the dry valley excavation) and auger profiles;
- iv) foreshore survey (which included the Belle Tout shaft excavation, see below).

Fieldwork was conducted with a total of 14 untrained volunteers, many without any archaeological experience or knowledge, and I was assisted in part by one professional archaeologist and one experienced amateur archaeologist. In 2015 four of the dry valleys were rapidly examined and 23 auger points recorded: Flathill Bottom (10 auger points); Rough Bottom (6 auger points); Limekiln Bottom (2 auger points); Gap Bottom (5 auger points); and the western slope of Birling Gap (8 auger points). Augering was not conducted in the three valleys of Short Bottom (far western valley where access and distance were considerations), Michel Dean (far eastern valley where again access and distance were considerations) and Flagstaff Bottom. Colluvium was recorded in the Birling Gap footslope and all four valleys and up to 2.4m of hillwash (Limekiln Bottom) was recorded over periglacial solifluction/gelifluction deposits (Combe Deposit) (Allen 2015, 2016a).

Three were selected for simple single hand test pit excavation and sampling and augmented by an auger profile across the valley. Methods followed Bell (1983) and Allen (1988) and in each valley a test pit of 1.2m² was hand excavated, with all artefacts being two-dimensionally recorded on the main drawn section to record their distribution, and thus providing a chronology for the sediment sequence. All spoil was recovered in 0.1m spits and sieved to >10mm to ensure artefact recovery. In addition, an auger transect and valley profile was surveyed for each valley. The field work was conducted in August and October 2015 with 2 days for each dry valley investigation. It resulted in 107 auger holes, three test pit excavations with artefact locations recorded, the recovery of over 350 finds, and a total of 31 samples taken from mollusc columns in the test pits (Table 1).

Valley location	Depth of Holocene colluvium (m)	Number of finds	Date range	Number of snail samples
Rough Bottom	0.74	21	Mid- to Late Bronze Age – Romano-British	6
Limekiln Bottom	1.03	165	Mid-Bronze Age – Romano-British	11
Gap Bottom	0.88	169	Mid-Bronze Age – Anglo-Saxon	14

Table 1. General information from the three dry valley test pits. Note: the depth of Holocene colluvium does not equate to the depth of the test pit as all were excavated into the top of periglacial Coombe deposits. Find numbers are those recorded precisely or by 10cm spit.

This paper is not the place to provide the detailed results, and the land snails, although processed, have only been assessed (Allen 2016a) as there was no funding available for the analytical phase. Nevertheless, some interesting differences between the valleys can be clearly, but perhaps tentatively, noted.

Although the initial test augering indicated that Limekiln Bottom might have appreciably deeper colluvial deposits than the other valleys, the test pit and further augering revealed just over 1m. In places the Late Glacial/periglacial deposit was a 'dirty' calcareous deposit which was probably mistaken for colluvium in the initial auger survey. That being said the three valleys all contained modest depths of hillwash (0.64–1.03m). The character of the hillwash was, however, subtly and appreciably different in each valley. On the face of it all seemed to be largely Middle Bronze to Roman in date. However, there was a hint that the Rough Bottom colluvium might be slightly later (Mid-Late Bronze Age) and that Gap Bottom may have continued into the Saxon period. In general, each had very similar colluvial sediment histories commencing in the Bronze Age and ceasing at the end of the Romano-British or Saxon period when more stable conditions ensued and grazed downland turf was established. This differs from other deposits such as in Kiln Combe (Bell 1983) where, only 2.5km as the crow flies and on the other side of the Birling Gap, over 2.75m of colluvium was present containing Beaker pottery layers and Beaker ard marks (at c. 1.80m) and colluviation continued through both the medieval and post medieval periods. However, at Seven Sisters perhaps the most significant, although at this stage still tentative, observation is regarding the preliminary land-use histories. Although the 31 mollusc assemblages have only been assessed, the general land-use can be suggested and differences in these preliminary interpretations is seen in, and between, each valley history (Figure 2). It tentatively suggests a sequence of long grass → pasture → arable at Rough Bottom, but arable → long grass → pasture at Limekiln Bottom, and long grass → pasture → arable at Gap Bottom. If correct it confirms open and farmed conditions in all three valleys during the later prehistoric to Roman periods, but it does hint at individual land-use histories for each valley. Again if correct this could be considered to be varying land-use practices within a large farmed downscape, or perhaps different regimes practised by different owners, different communities or farmers, or even different families (Allen in press).

Figure 2. Tentative initial land-use history and chronology of each dry valley based on the finds, sediments and preliminary mollusc assessment.

WETLANDS

One of the main palaeoenvironmental data sets that the chalklands lack is that of wetlands, and the preservation of long stratified pollen sequences, which seem so redolent in many other areas, and of the preservation of waterlogged remains. Admittedly the long alluvial sequences in the main Sussex main rivers (Arun, Adur, Ouse and Cuckmere) contain many metres of alluvium (Allen 2016b), from which long stratified pollen sequences were obtained (Ouse), but these were undertaken over 50 years ago and published in the early 1970s (Thorley 1971, republished and amplified in 1981; and see Robinson & Williams 1983). Some other significant pollen work was also obtained from the chalklands at the foot of Caburn (near Lewes) by Waller (Waller & Hamilton 1988, 2000), and the exemplary work of Rob Scaife in the Upper Ouse and in the Cuckmere at Stream Farm, Chiddingfold (Figure 1) (Scaife & Burrin 1983, 1985, 1992). These provide very rare instances associated with the South Downs and south-eastern England as a whole (however see also Kerney *et al.* 1980; Preece & Bridgland 1998: Holywell Combe, Kent). Closer to home, and more recent, are the fascinating and important discoveries of waterlogged Bronze Age occupation and activity at Shinewater, Willingdon Levels, near Eastbourne (Figure 1) (Greatorex 1995, 2003). Although some significant environmental analysis was published (Jennings *et al.* 2003), this was in a book on *Alluvial Archaeology in Europe* and divorced from the archaeology (Greatorex 2003) which was unfortunately never explored or published fully (at no fault of the excavator), having fallen through the developer-funding net! The pollen data provides information about the site situated in the wetlands of the Willingdon Levels at the boundary between the Chalk and eastern Weald, and of exploitation of these rarely studied and limited southern wetlands.

These wetlands can provide an important clue to the vegetational history of the chalklands, a landscape which has otherwise been studied by land snails from archaeological features (e.g. Thomas 1982) or colluvial sequences (e.g. Kerney *et al.* 1964, 1980; Preece & Bridgland 1998), which only provide an indication of vegetation structure (Allen 2017; Evans 1972). So where can we find important wetlands which better reference archaeological sites and human activities, other than these huge alluvial sequences which have a large landscape perspective? Small localised peats, and waterlogged microcosms do exist ... but we need detailed ground knowledge, geoarchaeological investigation and they need seeking out. Some are, in retrospect obvious, but others are more tenacious to identify. I briefly explore two examples here.

BELLE TOUT SHAFT (Figure 1)

Looking eastwards along the chalk cliffs with the Seven Sisters behind us are the cliffs of Belle Tout and Beachy Head which contain the important sites of Belle Tout, the studies of Bullock Down (Drewett 1982) and behind them to the north even one of Martin’s own key pieces of PhD research at Kiln Combe (Bell 1982, 1983). Mapped within the Belle Tout Beaker enclosure in 1909 was a hollow (Bradley 1970; Toms 1912) which Richard Bradley described as a ‘modern chalk pit’, in the publication of his 1968 and 1969 excavations of the enclosures (Bradley 1970: figure 1). Shortly after the publication of his excavations, a cliff fall early in 1971 exposed a c. 45m (c. 150ft) vertical chalk-cut shaft (Figure 3a), which Bradley admitted was the hollow he had incorrectly ascribed to a ‘modern chalk pit’.

The shaft was recorded as having a diameter of about 1.7m and tapered about 9m above the foot of the cliff. A series of foot holes and two types of tool marks were recorded, possibly a metal pick and a metal blade (Bradley 1974: 156). A Middle Bronze Age body sherd was found about 20m down the shaft (Bedwin 1982). The base of the shaft was excavated in part by the late Arthur Sayers (a local amateur archaeologist who had also dug at Belle Tout with Bradley) in 1975, when it was virtually at the base of the cliff and had become exposed (Figure 3b). The exposed shaft-base was recorded to be about 1m in diameter (Stevens 1979: 260), and about 0.5m deep (but he did not reach the base) and he reported the finds of waterlogged deposits (Sayers *pers. comm.*; L. Stevens *pers. comm.*), and of waterlogged wood.

Figure 3. (a) Belle Tout shaft; (b) excavation of the shaft base in 1975; (c) excavation of the shaft base in 2016 with, left to right, Edrys Lupprian, Martin Bell, Mike Allen and Lawrence Stevens (photos: a: D. Freke; b: L. Stevens; c: R. Williams).

By the summer of 1980 a further cliff fall had removed most of the shaft fill (Bedwin 1982), and by 1982 it was not locatable and the shaft and its fill were lost (Allen *pers. obs.*), but its base was relocated on the foreshore in February 2016 as a result of a search I instigated with the Southdowns Research Group, CITiZAN volunteers, National Trust volunteers and National Trust wardens, as part of the National Trust community programme in the Seven Sisters Country Park.

The significance of relocating the shaft base was the possibility of finding a small microcosm of waterlogged deposits and rare environmental evidence to reference the Downs to the north which contain the important monument of Belle Tout, and the Bullock Down landscape studied by Drewett. Such survival had been demonstrated by the recovery of important waterlogged finds in the Wilfsford Shaft in the chalklands of the Stonehenge area. That was excavated by Paul Ashbee and Edwina Proudfoot in 1960–2, for which the environmental post-excavation work was led by Martin Bell (Ashbee *et al.* 1989). This shaft produced amazing waterlogged preservation, absent from most chalkland sites, and included oak and alder bucket bases, alder bucket staves, fragments of rope and an environmental record including waterlogged plant remains, insects, bryophytes, pollen and a land snail sequence through the shaft infill. This project (of which I was lucky to be one of Martin's research assistants for the post-excavation) was to inspire the search and excavation of the Belle Tout shaft base.

The base of the Belle Tout shaft was eventually found by the volunteers on 17 February 2016 about 15m from the cliff line. Detailed plans were made to excavate, record and recover the important waterlogged remains, including extensive health and safety briefing to very limited and selected band of volunteer archaeologists from the South Downs Research Group. One professional archaeologist contacted me and asked permission to join the team; and so Martin became a part of the field team! The shaft base was exposed, excavated, but was only 0.20m deep! It had been totally scoured by the tide (Figure 3c) and contained only beach pebbles; all the sediment seen by Sayers in 1975 had been scoured and lost. We were too late! Nevertheless it was fully recorded, planned (by Martin), photographed and all was not lost (Allen 2016c).

The archaeologists had failed this important resource. Amateur, professional, field and curatorial archaeologists, had known of its existence from 1971, and only an amateur archaeologist working alone had ever explored the important waterlogged remains. However, all was not entirely lost for three reasons. Several metal stains, potentially cupric, were present on the chalk base of the shaft and were sampled. Three samples were analysed by

Chris Carey of Brighton University including pXRF to provide an overview of the geochemical composition, and Inductively Coupled Plasma Mass Spectrometry to analyse their geochemical composition. By comparing the results with other archaeological datasets Carey concluded that they were ‘from a copper based alloy, of probable Bronze Age date’ (Carey 2019). This concurred with our second strand of information. In 1980 I was given some jars of the waterlogged remains recovered by Arthur Sayers. Some had been lost in the interim, and some of the waterlogged wood become dried and desiccated. Nevertheless these were identified by Dana Challinor, and four fragments were selected and dated (Table 2). These give a clear Late Bronze Age date for deposits possibly 0.5m to 1m above the base of the shaft, and clearly end any supposition of it being medieval or Roman, and compares well with those from the Wilford Shaft (Ashbee *et al.* 1989) (Table 2).

Object	Material	Lab. number	Radiocarbon date (BP)	$\delta^{13}\text{C}$ ‰	Calibrated date (cal BC)
Wilsford Shaft					
Bone, 2.3m	Horse calcaneum	OxA-1210	2450±60	-	760–410
Bone, 2.6m	Human left femur	OxA-1211	2320±80	-	760–190
Bone, 2.6m	Human left femur	OxA-1212	2360±60	-	760–230
Bone 2.7–2.9m	Horse cuboid/tibia	OxA-1213	2480±60	-	780–410
Bone, 8.9m	Cattle skull	OxA-1214	3130±70	-	1610–1210
Bone, 13.2m	Sheep/goat skull	OxA-1215	3130±60	-	1520–1230
Wood, 28.3m	Bucket	OxA-1216	3160±60	-	1610–1260
Wood, 28.5m	Bucket	OxA-1217	3150±60	-	1600–1260
Bone, 28.5m	Cattle horncore	OxA-1299	3200±80	-	1670–1270
Wood, 30.3m	Bucket	OxA-1089	4640±70	-	3640–3110
Belle Tout shaft					
Charcoal twig C1	<i>Corylus</i> r/w	SUERC-73736	2708±33	-27.6	920–800
Twig C6	<i>Populus/Salix</i> r/w	SUERC-71927	2770±29	-28.2	900–830
Twig 9	<i>Crateagus</i> r/w	SUERC-71925	2794±29	-27.0	1020–840
Twig 10	<i>Corylus</i> r/w	SUERC-71926	2888±29	-27.0	1190–970

Table 2. Radiocarbon results from Wilsford Shaft (after Ashbee *et al.* 1989: table 3) compared with Belle Tout shaft waterlogged wood 0.5 to 1m above the base of the shaft.

Our third line of environmental evidence was from land snails. Two samples were recovered from the shaft fill in the early 1980s by the coastguard and an undergraduate student analysed them as part of a dissertation (Hill 1984). Another five samples were collected in the early 1980s by being lowered over the edge on a rope tied to the tow-bar of a vehicle above. The results (Table 3; Figure 4) indicate open downland conditions, probably pasture (Allen 1997), and are similar to the assemblage from Wilsford Shaft (Bell 1989). However the Belle Tout area today survives as rare chalk heath (cf. Burnham 1983; Burnham & Green 1983; Perrin 1956). More detailed ongoing analysis comparing modern mollusc faunas from the chalk heath might allow further interpretative comment, and seem to confirm the radiocarbon results in ruling out a medieval or post-medieval date due to the absence of introduced Helicids which are a post-prehistoric introduction to the British Isles.

Sample	MJA 1	MJA 2	Hill 2	MJA 3	MJA 4	Hill 1	MJA 5
Depth (m)	c. 6	c. 7	c. 8	c. 10	c. 15	c. 20	c. 25
Weight (g)	1000*	1000*		1000*	2000*		2000*
<i>Pomatias elegans</i> (Müller)	+	+	-	-	-	-	1
<i>Carychium tridentatum</i> (Risso)	23	1	-	-	-	-	-
<i>Cochlicopa lubrica</i> (Müller)	1	-	-	-	-	-	-
<i>Cochlicopa lubricella</i> (Porro)	-	-	-	2	-	-	-
<i>Cochlicopa</i> spp.	-	-	-	-	-	-	-
<i>Vertigo pygmaea</i> (Draparnaud)	12	7	2	4	6	4	1
<i>Vertigo</i> spp.	-	-	-	-	-	-	+
<i>Abida secale</i> (Draparnaud)	-	+	+	1	+	+	-
<i>Pupilla muscorum</i> (Linnaeus)	77	56	48	122	384	294	12
<i>Vallonia costata</i> (Müller)	17	22	5	18	37	42	6
<i>Vallonia excentrica</i> Sterki	41	34	22	42	51	130	9
<i>Punctum pygmaeum</i> (Draparnaud)	2	-	-	-	1	-	1
<i>Discus rotundatus</i> (Müller)	-	-	-	-	-	-	+
<i>Vitrea contracta</i> (Westerlund)	-	1	3	-	1	-	-
<i>Aegopinella nitidula</i> (Draparnaud)	1	2	1	-	1	-	-
<i>Clausilia bidentata</i> (Ström)	-	-	-	1	-	-	-
<i>Helicella itala</i> (Linnaeus)	8	4	1	2	2	4	-
<i>Trochulus hispidus</i> (Linnaeus)	27	31	49	46	87	165	+
Taxa	10	9	9	9	9	7	6
TOTAL SHELLS	209	158	131	238	570	649	30

Table 3. Belle Tout shaft; land mollusc data. * Note: weight of sample is of soils less than 5.6mm in thickness.

Figure 4. Mollusc histogram of relative abundance from the Belle Tout shaft.

The excavation of the shaft base in 2016 was undoubtedly disappointing, with no *in situ* fills or waterlogged deposits remaining. Despite its widely known presence among the archaeological community, informal discussions in the mid-1980s with English Heritage and plans to excavate it with local archaeologist Lawrence Stevens (who first published the presence of the shaft in the cliff face (Stevens 1979)), nothing was ever progressed by the archaeological community. These sites are fragile and in danger and opportunities should be seized. Nevertheless, there is still information to be gained and post-excavation analysis is well-advanced, and important lessons have been learned.

THE WILDERNESS, BARCOMBE (NEAR LEWES)

As a part of the Barcombe Roman villa excavations directed by David Rudling (2000–2012) on terrace gravels on the edge of the Ouse valley 2.5km north the chalk Downs at Lewes (Figure 1), a geoarchaeological and hydrology study of the environs was conducted in 2009–2010 and funded by the Margary Fund of the Sussex Archaeological Society to try and place the Roman villa and bathhouse into their landscape setting. Fieldwork was undertaken over a couple of seasons, often assisted by volunteers, at least one of which became a professional archaeologist. The fieldwork involved a moderate auger and test pit survey over the landscape. It included augering across a small hedged muddy ditch which now separates the Roman villa from the bath house, to find that this was once a much larger watercourse, perhaps infilled with over 2.6m of alluvium and colluvium that could almost have accommodated shallow boats or rafts! (Allen 2010). Also found was a cobbled edge suggesting a hard. Elsewhere the course of a Roman road was confirmed, and deep valley-side colluvium and alluvium recorded indicating the modification and burial of parts of the Roman landscape. However, amongst a tangled mess of trees and undergrowth, in what was a former small tributary of the river Ouse, and appropriately known at The Wilderness, were some very unexpected finds.

A preliminary investigation was undertaken in the wooded former tributary valley of the Ouse, off the terrace and in the Ouse floodplain, which at Sharpsbridge, 6km north (upstream), was known to contain 11m or so of floodplain alluvium (Scaife & Burin 1983). The steep-sided broad-flat bottomed valley at The Wilderness runs across the floodplain and, although now lightly wooded, was in the past an important former tributary of the Ouse giving access to the Roman bathhouse and villa by shallow-draughted boats or barges. Preliminary augering in 2009

indicated the presence of alluvium over rare important waterlogged peats in the former channel, lying over more than 3.5m of bluish grey minerogenic alluvium (not bottomed). In 2010 a small 1.2m x 1.2m key-hole test pit was excavated to examine and sample the upper alluvium and peat. The sequence is summarised as follows:-

0–0.20m	Dark greyish brown humic peaty pelo-alluvial soil
0.20–0.25m	Mottled gleyed grey silty clay alluvium (?medieval/post-medieval)
0.25–0.65/0.70m	Stone-free fine-grained grey silty clay alluvium (?Iron Age to post-medieval)
(0.65–0.70m)	Slightly humic silty clay with some flints (including, artefacts)
0.70–1.09m	Humic silty peat with many wood fragments becoming drier and woodier at base
1.09–1.19m	River-stained flint gravel in a dark yellowish brown sandy silt and waterlogged hazelnuts
1.19–1.65m+	Bluish-grey minerogenic silt and sandy silt (and augered to nearly 4m).

Under 0.7m of minerogenic alluvium was a 0.4m thick peat deposit with hazelnuts, twigs and preserved leaves. Perhaps most astonishing was the discovery, in the small test pit, of a large waterlogged oak stake over 0.50m long and more than 0.20m in diameter (Figure 5a) and clearly cut into a point (Figures 5b, 5c) (Allen 2011). It was c. 586mm long with a maximum diameter of 218mm, and a worked point that extended for c. 28mm. There are a number of clear adze facets on the point, made with a metal, rather than a flint tool. The facets vary and are c. 48mm, 34mm, 31mm, 39mm, 26mm and 24mm at their widest. They are flat to slightly dished facets with no adze steps. Photographs were submitted to Masie Taylor who reported by email that 'It looks classic Middle Bronze Age/Late Bronze Age and oak.' Indeed a radiocarbon date (funded by grants from the University of Sussex Archaeological Society, the Sussex University Sally Christian Bequest and Allen Environmental Archaeology) gave a result of 3340±40 BP (NZA-36948) which calibrates to 1680–1530 cal BC and confirmed the rare survival in Sussex of another Middle Bronze Age waterlogged site. We assume it formed part of a trackway or platform over a shallow peat-filled channel, and now buried under nearly 1m of Roman and medieval alluvium.

Figure 5. The oak stake from The Wilderness, Barcombe. (a) John Kane volunteer with the stake on discovery; (b) and (c): the stake (photos: M. Allen; drawing: J. Oldham).

Preliminary pollen assessment, by Rob Scaife

Pollen assessment of one spot sample was undertaken to establish if sub-fossil pollen and spores were present (Scaife 2009). Well-preserved and abundant pollen was extracted and preliminary pollen count made. Standard techniques were used for pollen extraction (Moore & Webb 1978; Moore *et al.* 1992) on samples of 2ml volume and a total pollen count of 421 grains and 53 spores was made (Table 4).

Pollen was well preserved and abundant. Trees and shrubs were important but also with a substantial representation of herbs. The on-site, depositional, habitat was clearly alder dominated flood plain alder carr

woodland with a typical understorey of sedges and other fen/marsh taxa. The flora of the adjacent dryland/interfluves was partially wooded with oak and hazel with some lime. The latter may, however, have been more important than the small percentages imply as this tree is frequently underrepresented in pollen spectra due to entomophily and by not producing as much pollen as other tree taxa. Dominance of grasses with some ribwort plantain suggests grassland, possibly pasture. However, cereal pollen is also present and portrays arable cultivation in the nearby region. The on-site vegetation was a flood-plain alder carr and the environment was partially cleared of woodland, with areas of open pasture and probably arable land. The surrounding interfluves had some woodland remaining, comprising oak and hazel with some lime.

Species	Count	%	Herbs	Count	%	Species	Count	%
Trees & Shrubs			<i>Anemone</i> type	1	+	Fen/Marsh		
<i>Betula</i> (birch)	1	+	<i>Ranunculus</i> type	1	+	<i>Typha angustifolia</i> type	1	+
<i>Ulmus</i> (elm)	3	2	Trifolium type	1	+	Cyperaceae	12	3
<i>Quercus</i> (oak)	35	18	<i>Lathyrus</i> type	1	+			
<i>Tilia</i> (lime)	2	1	<i>Dianthus</i> type	1	+	Spores		
<i>Alnus glutinosa</i> (alder)	205	50	<i>Persicaria maculosa</i> type	1	+	<i>Dryopteris</i> type	20	4
<i>Corylus avellana</i> type (hazel)	40	20	<i>Plantago lanceolata</i>	5	3	<i>Pteridium aquilinum</i>	30	7
<i>Salix</i> (willow)	1	+	<i>Cirsium</i> type	1	0	<i>Polypodium vulgare</i>	3	1
			Lactucoideae	3	2			
			Poaceae	97	38			
			Cereal type	9	5			

Table 4. Pollen data from *The Wilderness*, Barcombe.

Bronze Age Wilderness

The limited fieldwork has clearly indicated the presence of a waterlogged Bronze Age archaeological site. Unfortunately funds were not forthcoming to cover the full pollen analysis, nor to undertake further work. Nevertheless, the presence of small localised survivals with a very rich potential is indicated.

CONCLUDING COMMENTS

In this short paper I have touched on a few themes and ideas, many of which require further work and investigation, but which have been generated from downland geoarchaeology and fieldwork. It demonstrates the presence of small highly localised (unpredicted) wetlands with pollen records that reference the chalk, normally devoid of this data, and which reference the Weald that is clearly poorly represented in archaeological investigations of its prehistory and prehistoric environment (e.g. see Allen 2016b). The work of Simon Jennings in particular on the sites of Shinewater on the Willingdon Levels the coast and of older pollen analyses at *The Wilderness* in the Ouse Valley exemplifies this, and demonstrate Bronze Age wetland activity in the low Weald. Ironically all these fieldwork exercises were conducted with volunteers, and all reflect, I hope, the interests of Martin, and in writing this paper I not only acknowledge my gratitude of debt to him, but also hope that it has inspired me to pursue the final funding required to complete these pieces of research.

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Despite being a tribute to Martin Bell, this paper is dedicated to the memory of Lawrence Stevens (1939–2020) who invited me to direct the dry valley excavations of the Bourne Valley in 1980, and with whom in the 1980s and 1990s we planned to (re-)excavate and was the inspiration behind the search and excavation in 2016 of the Belle Tout shaft base.

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FIELDWORK IN THE KENNET VALLEY

Test pitting and boreholes in the Kennet Valley involved not only professional archaeologists but members of the local community. Presentations and press releases to the media helped to inform the public of what was happening in their neighbourhood

Late Upper Palaeolithic and Mesolithic Archaeology and Environment in West Berkshire:
A Best Practice Guide for Developers and Extractors

Historic England
University of Reading
wessex archaeology
West Berkshire Council

(photos: C. Barnett, J. Last, S. Orr and Wessex Archaeology).

Chapter 11

The Kennet Valley Predictive Mapping Project: contributions to development control, heritage management and nature conservation

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ABSTRACT

The Kennet Valley, southern England, shows an unusually high concentration of Terminal Upper Palaeolithic and Mesolithic sites. The close association of archaeological sites with deep contemporary waterlogged sequences enables the artefactual record to be placed within a wider landscape context, using a range of geoarchaeological and environmental archaeological techniques. Threats to this nationally important and finite resource are prevalent, with the valley subject to significant development and aggregate extraction pressure. Funding was provided by English Heritage (now Historic England) to develop a proactive geoarchaeological approach to predicting, identifying, mapping and protecting prehistoric assets and landscapes through the Kennet Valley Mapping Project, with the outcomes incorporated into the local and national planning process. A predictive model was developed to map and locate deposits of raised potential to preserve artefacts and palaeoenvironmental remains. This model was tested through fieldwork on key sites including Thatcham Reedbeds, Wawcott and Victoria Park, Newbury. This paper provides an overview of the contributions to the project, and the wider body of Kennet Valley research led by Martin over many years which has influenced the local and regional planning process, including HER enhancement, improved development control, outreach and nature conservation.

Keywords: *development control, geoarchaeology and predictive mapping, Upper Palaeolithic-Mesolithic archaeology, nature conservation*

INTRODUCTION

BACKGROUND

The National Heritage Protection Plan (NHPP) 2011–2015 provided a framework for heritage protection built around priorities resulting from widespread consultation. Under the heading ‘Assessment of Character and Significance’, a range of themes emerged as insufficiently understood, threatened by change and of high significance, with actions to be focussed on tangible protection measures. One was Pleistocene and Early Holocene archaeology, for which improved assessment of significance was needed in order to address site protection and management challenges, with our understanding over-reliant on a few iconic sites, such as Star Carr, North Yorkshire.

The first of two associated NHPP calls for proposals focussed on the wetland/dryland edge, where evidence of occupation occurs close to wet-preserved deposits with palaeoenvironmental remains related to contemporary environment and economy. Projects were sought for areas with known potential for Late Upper Palaeolithic-Mesolithic occupation and palaeoenvironmental remains that were under development pressure or equivalent risk. The Middle Kennet Valley fit the bill admirably and the Kennet Valley Mapping Project (‘Tracing their Steps’: Predictive Mapping of Upper Palaeolithic and Mesolithic Archaeology) was formulated (Barnett *et al.* 2019). Other projects funded included one in the Somerset Levels led by Martin (Bell *et al.* 2016), aspects of which are discussed in the paper by Keith Wilkinson *et al.* (2021: this volume, Chapter 9).

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The second call aimed to improve poor representation of early prehistoric archaeology in Historic Environment Records (HERs), which risked Palaeolithic and Mesolithic sites being inadequately considered within the planning process. The resulting projects took different approaches to enhancement, with some, including this project, incorporating ‘predictive’ models (Cattermole 2018).

The project team comprised the University of Reading, Wessex Archaeology, English Heritage (now Historic England) and West Berkshire Council, drawing collaborative strength from academic, commercial and curatorial heritage spheres. A multi-faceted approach to predicting early prehistoric land-surfaces and remains was developed, with fieldwork and analysis from 2013 to 2018. The main findings were reported in Barnett *et al.* (2019), with an intention to expand on aspects of the project subsequently. Were this paper not prepared as a surprise for Martin, he would have been an author and he will be central to the preparation of others. Here we focus on contributions the project and wider Kennet Valley research led by Martin over many years have made to planning processes, HER enhancement, environmental management and to outreach and engagement.

THE KENNET VALLEY

The study area comprises 30km of the Kennet Valley floodplain and low Beenham Grange Terrace between Avington and Ufton Bridge, West Berkshire (Figure 1). The River Kennet is designated as a Site of Special Scientific Interest (SSSI) with the floodplain of high nature conservation and archaeological value, set against ongoing high development and aggregate extraction pressure.

Figure 1. The study area, with Upper Palaeolithic and Mesolithic sites depicted, recorded in the West Berkshire HER; key sites considered in the project are named.

The area contains one of the greatest concentrations of hunter-gatherer sites dating to the Late Upper Palaeolithic, including Long Blade sites Avington IV and Crown Acres, and the Mesolithic, including Thatcham, Wawcott, Faraday Road (Barton & Froom 1986; Ellis *et al.* 2003; Ford 1992; Froom 1963a, 1963b, 1963c, 1965, 1970, 1972a, 1972b, 1976, 2012; Froom & Cook 2005; Froom *et al.* 1993; Healy *et al.* 1992; Reynier 2011; Wessex Archaeology & Jacobi 2014; Wymer 1977) known in Britain. Several are associated with well-preserved waterlogged sequences, comprising 2-4m thick Late Glacial and Early Holocene floodplain deposits, providing a detailed palaeolandscape record for 9700-7550 cal BC (Barnett 2009). Extensive fieldwalking and lithic distribution studies by the Kennet Valley Fieldwalking Survey (Ford 1992; Lobb & Rose 1996), Stephen Allen and in particular Roy Froom, have enhanced understanding of settlement and activity patterns, despite localised removal of deposits by peat cutting, quarrying and development.

The Thatcham sites (Healy *et al.* 1992; Wymer 1958, 1959, 1960, 1962, 1963a, 1963b, 1963c) are of such concentration and longevity that they might be argued to represent semi-sedentary or at least oft-repeated settlement at the water's edge, whereas sites such as Ufton Bridge seemingly represent transitory kill and butchery sites, together forming a network of activity areas and sites. While a rich archive exists for several sites, others lacked investigation using modern geoarchaeological techniques and/or scientific dating. Consequently, new targeted investigations were undertaken at Wawcott, Thatcham and Ufton, and small-scale excavation of a new site at Victoria Park.

PROJECT AIMS AND METHODS

Exceptional potential for recovery of palaeoenvironmental sequences, close association with known artefactual remains and existence of detailed analyses made the Middle Kennet Valley an ideal testing-ground for mapping, predictive and prospective methods.

The aims were to:

1. develop a predictive modelling framework through comprehensive research and the application of appropriate technology, in order to better inform awareness of the finite and significant early prehistoric archaeology of this region;
2. assist the local authority in identifying appropriate mitigation measures in response to development proposals;
3. create systems that can be applied to similar archaeological landscapes throughout the UK.

Archaeological, sedimentary, palaeoenvironmental and geochronological datasets were drawn into the project GIS, allowing spatial relationships to be assessed. The sedimentary record was used to create a ground model, identifying distribution and thickness of lithological and stratigraphic facies, including those potentially archaeologically rich.

The ground model was enhanced through chronological modelling, using existing and newly acquired scientific dates, and a predictive model generated of where further chronologically related deposits might lie. New geophysical and borehole surveys, with radiocarbon dating of key stratigraphic events, were used to fill data gaps identified. Detailed case-study sites were used to explore how geoarchaeological techniques (geophysical, geoarchaeological, palaeoenvironmental and trenching) can be used solely and in combination to identify, investigate and interpret areas of high potential, and inform both research and development-led site investigation.

KEY FINDINGS AND ACHIEVEMENTS

MODELLING AND METHODOLOGY

Predictive modelling considers the likelihood of locating archaeological remains in an area, based on a sample of known sites and/or on fundamental notions concerning human behaviour (Kohler & Parker 1986: 400). Predictive models have limitations, including possible over-simplification of correlations between behaviour and environmental characteristics, resulting in a reductionist approach to archaeological interpretation (Wheatley 2004), but can support archaeological prospection and development of good sampling designs (Kamermans *et al.* 2004).

Geoarchaeological data, including the PhD theses of Chisham (2004), Collins (1994), Holyoak (1980) and Cheetham (1975), supplemented BGS and other geotechnical datasets to develop the ground model. The spatial distribution of data was uneven, greater in floodplain areas where aggregate prospection or extraction has occurred. The 3296 data points were re-interpreted into lithological units nested within a stratigraphic framework of mapped Quaternary

and geological formations, the stratigraphic units of greatest interest being the Woolhampton Gravel Formation (Devensian) and Midgham Member (Late Devensian and Holocene).

Figure 2. Kennet Valley deposit model: (A) data source distribution for ground model; (B) topography of study area, with modelled Late Glacial/Early Holocene drainage and distribution of peat, tufa and marl deposits; (C) predicted areas of high potential for Upper Palaeolithic and Mesolithic material.

The Woolhampton Gravel Formation surface topography represents the late glacial/early Holocene Kennet Valley floodplain, showing highs and lows, including Early Holocene palaeochannels. Mapping of the Midgham Member, coupled with chronological modelling, indicates the broad layout of the floodplain sequence, areas of raised palaeoenvironmental potential and where archaeologically rich deposits might be preserved. This data, with hydrological and topographic modelling of the ground model and spatial analysis of the HER data, enabled creation of an inductive predictive model of high archaeological potential areas (Figure 2). The model identified areas where insufficient information exists, requiring additional data points, and was tested and refined by targeted field investigations and dating. With an increased interest in archaeological sensitivity mapping and similar approaches across the sector in response to the Planning for the Future White Paper (HMG 2020) such tools are of considerable current relevance.

GEOARCHAEOLOGICAL, GEOPHYSICAL AND PALAEOENVIRONMENTAL CONTRIBUTIONS

The geoarchaeological context of the archaeological record is best realised at an individual site scale. At Ufton Bridge, findings from numerous student training exercises (198 boreholes taken 1999-2013) were augmented with geophysical survey (Mansfield 2007), excavation and post-excavation analysis (Barnett *et al.* 2019; Chisham 2004). New surveys enabled characterisation of deposits of key archaeological importance. Combined with the ground model, their inter-relationship with other deposits across the valley floor and low terrace could be recognised, providing an enhanced and testable understanding of the geoarchaeological resource and a solid base from which to advance into prediction.

Figure 3. Thatcham reedbeds, south of railway GPR and ERF (Wessex Archaeology) transects.

Ground Penetrating Radar (GPR) transects conducted at Thatcham (Figure 3), Wawcott and Victoria Park by the English Heritage Geophysics Team, with Henry Webber, one of Martin’s PhD students, enabled interpretation of recent made ground and services, buried channels and other geomorphological units, despite differing site conditions. Comparison with Electrical Resistance Tomography (ERT) profiles proved useful given variation in lateral resolution with depth between the techniques. Set against the sedimentary record, it was apparent that ERT could identify the top of gravel deposits synonymous with the first Mesolithic activity at Thatcham and Wawcott, with GPR providing high-resolution information about horizons and deposit interfaces. Small-scale stratigraphic changes in thinner sequences, (e.g. Victoria Park), were less well differentiated. Mansfield (2007) too highlighted the value of a comparative approach, employing a range of geophysical methods to draw out different aspects of the buried landscape for Ufton Bridge. The implications for development control are that a combination of systems and techniques tailored to different types of site provides more reliable results and helps identify earlier prehistoric sites with their lack of visible remains.

The occurrence of specific Terminal Late Glacial and Early Holocene strata (Barnett *et al.* 2019: 212-220) was a better guide than broad landscape characteristics in considering potential for presence, preservation and association with environmental remains. The sedimentary model showed distinct spatial patterning to some deposits, helping to further define areas of potential, and the occurrence of these layers at any given site should be assumed to indicate high potential for associated palaeoenvironmental and artefactual remains for development control purposes.

The modelling was underpinned by detailed analytical work. This included work for PhD and MSc theses, several supervised by Martin. Barnett reconstructed Mesolithic landscape evolution and environmental manipulation for Woolhampton, Thatcham and Ufton (Barnett 2009; Chisham 2004), while Fern (2004), Collins (1994), Holyoak (1980) and Cheetham (1975) explored the fluvial, sedimentary, botanical and faunal context of the Kennet Valley. Analytical work by Higbee and Baker, Walker, and Banerjea lent rich detail and contextualised the newly investigated Mesolithic site at Victoria Park (Barnett, Bell & Grant 2019). At Ufton Bridge, geochemical, plant macrofossil, molluscan and charcoal analyses, micromorphology and animal bone analysis (Banerjea & Scales, in Barnett *et al.* 2019; Chisham 2004) complemented geoarchaeological work and elucidated deposition and landscape of archaeologically significant deposits.

Without that detail and critical examination, our work would have been diminished and broad brush. The multi-proxy data approach is felt to be crucial in guiding planning and policy in a robust and meaningful way. The ‘Tracing Their Steps’ report (Barnett *et al.* 2019) presents that data, ensuring the model remains testable and its use in the local planning process transparent.

ARCHAEOLOGY AND CHRONOLOGY

Model-testing exploratory work (ERT, GPR, coring surveys) and revisiting of archived remains from construction of the Newbury A339 flyover and boating lake (Sheridan in 1963–4; see also Froom 2012: 124), led us to hand-excavate a small trial trench in Victoria Park, Newbury. Rigorous sampling, GPS locating of all finds and wet sieving of spoil to 2mm maximised results, allowing exhaustive environmental and microdebitage recovery. Analysis of molluscs, sediments, animal bone, worked bone and flint from occupation horizons (Walker, Banerjea, Bell, Barnett, Higbee, Foster, Harding, in Barnett *et al.* 2019) and dating (Marshall *et al.* 2015) demonstrated two phases of Mesolithic activity (Figure 4) in a repeatedly flooded landscape, represented by distinct strata correlated to other local sites, exploitation of numerous taxa including beaver, and a distinctive blade industry, with the whole reduction sequence represented.

Figure 4. Schematic diagram summarising the two periods of dated activity at Victoria Park, Newbury. Horizontal bars represent the probability that activity was taking place in a particular 100-year period (light shading less probable, darker shading more probable). Derived from rerunning the model described in Barnett *et al.* (2019: figure 98) using IntCal20 (Reimer *et al.* 2020).

The results of test pitting over a lithic concentration (Allen & Allen 1997) then excavation at Ufton Bridge were brought to publication via this project. Dating, lithic and animal bone analysis (Allen, Scales in Barnett *et al.* 2019) indicated two phases of short-term knapping, butchery and processing, including of roe deer. Further excavation is warranted at this site, funding for which Martin is keenly pursuing.

A series of terrace-edge sites were investigated at Thatcham by Wymer (1958, 1959, 1960, 1962, 1963) and Healy *et al.* (1992), while dating and multi-proxy analysis (Barnett 2009; Chisham 2004; Holyoak 1980) elucidated the landscape and demonstrated chronological and activity (clearance, burning) associations with specific strata. Our project subsequently contextualised finds and features by tying those sequences to Wymer's Site II, using ERT, GPR survey, coring and dating (Barnett *et al.* 2019; Marshall *et al.* 2015).

In addition to the relatively small number but highly significant Late Upper Palaeolithic sites locally (Chamberhouse Farm, Crown Acres, Avington IV, Wawcott XIII), 110 Mesolithic sites have been identified in the middle Kennet Valley study area to date, both Early and Late Mesolithic, dominated by lithic scatters. Approximately 30 have been excavated around Wawcott thanks to the exemplary research undertaken by Roy Froom (Froom 1963a, 1963b, 1963, 1965, 1970, 1972a, 1972b, 1976, 2012; Froom & Cook 2005; Froom *et al.* 1993). Froom's engagement with the Kennet project and generosity with his data and knowledge were of great benefit to our work. The potential for associated palaeochannels and complex deep strata on his sites was confirmed by ERT, GPR and coring at Wawcott XXX 2013 (also Fern 2004: Wawcott XXXI, Wawcott XII, Long Blade site, Wawcott XIII), placing the sites in a broader stratigraphic context and sedimentary model.

The findings from these targeted interventions highlight the exceptional potential of the Middle Kennet Valley, with further significant sites expected to be found on and adjacent to the floodplain. The project provides evidence for enhanced mechanisms of protection on archaeological and palaeoenvironmental grounds, establishing a robust basis for requiring appropriate investigation and mitigation ahead of development and extraction. The outcomes for Victoria Park demonstrate an enhanced ability to predict location of new sites using the sedimentary model coupled with multi-system geophysical and geoarchaeological surveys.

Chronological modelling has enabled more precise chronologies for the individual sites, both archaeological and palaeoenvironmental, and allowed us to begin to characterise the timings and tempo of human activity in the Kennet valley. We do not perceive the environment as a passive backdrop to human activity, but as the locus for continual engagement in the world, as people attend to one another and as they go about their varied tasks. Outputs from our chronological models are the first step to writing a more nuanced narrative of the Mesolithic timescape of the Kennet valley.

NATURE CONSERVATION AND HABITAT MANAGEMENT

Martin drew out the contributions geoarchaeological approaches can make to nature conservation agendas in Bell *et al.* (2006). Indeed, investigation of Late Glacial and Early Holocene archaeology inevitably has a strong ecological emphasis. Much of our understanding of the period stems from palaeoenvironmental analyses that demonstrate floral and faunal responses to rapid climate change, recovery and adaptation, landscape dynamism and human intervention, also the flux in taxa and dominance over time. There is, therefore, merit in incorporating palaeoecological data in planning for present and future habitat management, including planning for climate change.

Designation of Thatcham Reedbeds as a SSSI has enabled preservation of floodplain sequences associated with Early Mesolithic sites, despite extensive past quarrying at the site, with the site kept wet and relatively undisturbed for nature conservation purposes. Today, traditional methods and management activities include coppicing, rotational reed and fen cuts and water level management are undertaken by the Wildlife Trust (BBOWT), mimicking past prehistoric plant management behaviours and encouragement of raised water levels by beavers in the early Holocene (Worsley 2009). A Statement of Significance prepared by Barnett on behalf of English Heritage under Project 6240 Exceptional Waterlogged Heritage (Heathcote & Campbell 2013) recognises the exceptional importance of the wetlands of Thatcham and environs.

The need to identify and characterise areas of the valley floor where key sediments remain, preserved by a variety of mechanisms, including deep burial, protection due to nature conservation value (SSSIs, SACs, LNRs) and constraints on development or intrusive works imposed by the development control system, was central to our project. Considering how they may most effectively be investigated or preserved long term serves both archaeological and nature conservation interests.

Dissemination and education in the context of environmental agendas and nature conservation is useful, with an integrated approach taken to heritage (Bell 2004). Close collaboration with agencies such as Natural England and BBOWT during surveys, inclusion of findings in the Thatcham Reedbeds Management Plan and production of a combined archaeological-palaeoecological interpretation board for the Nature Discovery Centre have promoted cross-working in tackling these themes.

ENGAGEMENT, COMMUNITY INTEREST AND OUTREACH

While there is substantial appetite for engagement with archaeological science among the West Berkshire community, external funding priorities at the time of application meant outreach initiatives could not be financially supported. Informal outreach included encouraging volunteers to take part in sample processing at Victoria Park, holding an open day and explaining the project to interested passers-by at our various fieldwork exercises. Engagement with the parish council led to press releases and involvement of the Newbury Weekly News, while the West Berkshire Council team members of our team supported the open day, presented the project to the public and ensured publicity for walks and talks given at West Berkshire Museum and Thatcham Reedbeds (see page 112). The presence of Phil Harding, a well-known TV archaeologist as the Wessex Archaeology project officer was an additional draw at Victoria Park, with interest and excitement generated.

Have we made enough of this work? Probably not. Now the findings are published there is potential for outreach and communication to be expanded, to include initiatives such as heritage trails, museum displays, reconstructive phone apps, QR code points with links to a project website to bring the findings to life and give longevity to their relevance and accessibility. Funding would be needed for set-up and long term maintenance but is something we are collectively keen to explore.

DEVELOPMENT CONTROL

Predictive models provide an evidence base upon which planning control at strategic and site-specific levels can be developed and implemented. Where the likelihood of early prehistoric remains is indicated, a defined geoarchaeological approach can be provided to direct site investigations to confirm potential, contextualise discoveries made and enable mitigation strategies to be developed from an early stage. Development-led work will also provide ongoing ‘ground-truthing’ of the predictive model, permitting West Berkshire Council’s archaeological team to refine the model over time.

The importance of a phased geoarchaeology-led approach is demonstrated by the identification of new prehistoric sites in this lowland environment, with best practice comprising use of appropriate combinations of geophysical surveys, coring and targeted test pitting. The sites investigated can now be used as case studies to inform developers, their archaeological consultants and contractors of how and why these approaches should be implemented, strengthening the position of local curators. These themes were drawn out in one of the project deliverables, a West Berkshire Council leaflet aimed at aggregate developers, bringing the message to this key audience. Having a visual mapped representation of broad archaeological and palaeoenvironmental potential disseminated via the West Berkshire HER is also helpful in explaining the prehistoric importance and sensitivity of the Kennet Valley.

NATIONAL CURATORIAL CONTEXT

The project has demonstrated the potential of developing landscape approaches to early prehistoric archaeology that can be integrated into the protection mechanisms offered by the National Planning Policy Framework (NPPF). The importance of deposit modelling at different scales has been highlighted in recent guidance (Historic England 2020), and the Middle Kennet Valley can be added to the examples gathered for that exercise (Carey *et al.* 2018). If, as seems possible, a new planning system is developed where land could be pre-allocated for development, understanding archaeological potential at an early stage of the plan-making and site allocation process will become increasingly critical. HERs must contain reliable evidence for early prehistory, and there remains scope to build on the Kennet Valley work to determine what models are suitable for different areas (Cattermole 2018).

Most open-air Palaeolithic and Mesolithic sites remain ineligible for designation through scheduling (Historic England 2018) so it is important to recognise when sites and deposits could be considered nationally important, which in principle offers equivalent protection within the NPPF. To this end, Historic England commissioned pilot projects as part of a ‘national importance programme’, including a spin-off from this project which aimed to use the predictive model to develop methodologies for identifying and defining nationally important Mesolithic sites.

The work highlighted the particular significance of wetland areas, and how previously investigated sites of known significance can be used with the model to define wider areas of interest (Wessex Archaeology 2015).

Nevertheless, significant issues remain with both the way early prehistoric lithic and palaeoenvironmental sites are treated within the planning process, and their wider recognition and profile. We advocate a focus on sedimentary and topographic contexts for the Mesolithic in making appropriate decisions regarding protection and management; nowhere demonstrates that better than the significant yet vulnerable remains in the busy landscape of West Berkshire.

Dissemination of results of projects such as this to professional and public audiences is important; at a time of climate emergency there is growing interest in understanding past human responses to changing environments and the Late Glacial to early Holocene is therefore a key focus. The contemporary relevance of evidence for Upper Palaeolithic and Mesolithic communities living in areas that are once again prone to seasonal flooding and rapid environmental change is evident.

REFLECTIONS AND NEXT STEPS

Multi-disciplinary approaches have advanced and tested the way we use existing systems and methodologies. Besides enhanced outreach and dissemination, next steps include long term data curation and enhancement, the model should not stagnate but be a live working tool into which new information is fed to remain relevant and useful. The West Berkshire Council Archaeological Service wish to put the GIS model into a more accessible public place and produce a heritage sub-set of their multi-discipline online map including layers from this project. Testing the predictive model further through development control mechanisms and seeking new sites for research-led excavation is favoured, also revisiting Ufton Bridge and Victoria Park. Such investigations should have a public element, enabling our enthusiastic fellow community members to be involved and share in ownership of the local heritage resource.

The project provides a set of tools and informed guidance to strengthen the development control process, ensuring that appropriate mitigation is understood, and that vulnerable Late Upper Palaeolithic and Mesolithic sites are handled in the best way possible in the face of development, dewatering and aggregate extraction. The approach developed is widely applicable to low-lying and wetland areas where early prehistoric remains might occur. The project furthers our understanding, management and curation of the exceptional Upper Palaeolithic and Mesolithic resource of the Kennet Valley and other tributaries of the River Thames so attractive to humans at the end of the Ice Age and Early Holocene. A wider ambition is to encourage further investigation and contextualisation of sites of similar potential in the Colne Valley such as Three Ways Wharf and Denham (Corcoran & Howell 2002; Grant *et al.* 2014; Grant 2019; Halsey 2006; Lewis 1991; Lewis & Rackham 2011; Lewis, Wiltshire & Macphail 1992; Wessex Archaeology 2005; Wymer 1977) and Lea Valley (e.g. Barnett, Grant & Bates 2013; Chambers, *et al.* 1996; Corcoran *et al.* 2011; Powell 2012).

This project demonstrates well a passion for collaborative working, with relationships built between the University, professional practice, curators and local archaeologists formalised in the partnership that delivered the project. We hope this work might encourage and inform future opportunities for cross-sector working.

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Chapter 12

The lumpy outdoors: moving through landscapes and weather-worlds

Jim Leary¹

ABSTRACT

Taking the lead from Martin's *'Making one's way in the world'* (2020), this chapter will focus on the sensuous feeling of moving through landscapes and weather-worlds and explore how the environment, the seasons and the weather afford different mobilities, constrain behaviour and lead to distinct ways of perceiving. By moving in the world, we are in constant contact with it, touching its contours and feeling its shape; so much so that there is no separation between us and it. But landscapes are not blank slates on which people can move wherever they please, and mobility does not exist in an abstract world. They require different modes of movement depending on their nature; they afford distinct protection and dangers, provide dissimilar ways of perceiving the land, and create separate kinaesthetic experiences. The views from a mountain as you climb it give you a different perception of the environment to that provided by, say, walking through woodland, which is again unlike paddling along a watercourse. Indeed, travel by water provides quite separate experiences and perceptions to moving on land. This type of movement has its own patterns and rhythms; ebbs and flows influenced by the water itself, providing the people moving on it with a distinct identity. Landscape and traffic, landform and travelling, interact, and there is a correspondence between terrain and different, idiosyncratic ways of moving.

Furthermore, these movements do not happen with a neutral sky above and around them – it is sometimes scorching and sometimes freezing, there is fog and mist and rain and storms. And these affect the way one moves, so that mobility is closely linked to weather and the seasons. Events happen under scudding skies. You can't escape weather – it is everywhere always, and it brings variance to routes and paths. Flooded roads or snowed-in mountain passes make a very considerable difference to people's mobility. Weather is transformative, shifting the light and temperature. It changes every surface altering the texture, absorbing and reflecting light in distinctive ways. Landscapes, weather and seasonal changes have run through all human existence, influencing and changing it. They lie at the very heart of human lives. The land and the weather shape the walk; they determine the gait and the pace, whether to step carefully or stride confidently, whether to crawl or climb, as we make our way through a lumpy, textured weather-world.

Keywords: *movement; walking; landscape; weather*

WALKING AWAY

Movement and mobility are frequently discussed in archaeology, and are often central to ideas explaining large-scale cultural change, such as migration or trade. However, archaeology is not good at drawing out the gritty detail of these movements, tending instead to homogenise them so that they become abstract and disembodied (Aldred 2021; Leary 2014; Leary forthcoming). People are portrayed as moving across the landscape like the zombies, known as 'Walkers', in the television series *The Walking Dead* – that is to say, like herds of mobile but mindless bodies. Mobility in archaeology remains frustratingly rational and abstracted from the actual experience of movement. This is true of any period, but particularly so when discussing prehistory where movement is seen as an involuntary reaction, just like those disembodied 'Walkers'. This is about as far removed from the reality of moving around as one can get (Ingold 2004, 2010, 2011).

Martin Bell's *Making one's way in the world* (2020) provides the first recent, detailed, study of the origins of paths and routeways. It draws out how movement along these paths by people and animals impacted the landscape, and how this movement through the landscape also impacted on people; on their perception and understanding of their world. The land influenced travellers and in turn was shaped by them. This is the theme I will draw out further in this chapter – that mobility, past or present, is interwoven with its physical surroundings. Reacting against overly

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human-less concepts of moving in the past, I want to highlight the human sensory experience of moving in our three-dimensional, lumpy, bumpy, weathered world.

MOVING THROUGH LANDSCAPES

The terrain, the surface of the land, the vegetation and the atmosphere around us impacts the way we move, and we move through it in different ways depending on our direct experience of its nature. The body is in constant contact with the environment, moving and adjusting its form to avoid pot-holes, or mud, or cowpats, stepping over logs, leaping streams or disentangling limbs from the grasping reaches of brambles. The ground, far from flat and even, is textured and full of objects and debris that can trip you up (Edensor 2000). There are valleys and coombes where the sides both embrace and blinker you, while their orientation directs your movement, and since the Bronze Age there have been hedges and field boundaries that need careful negotiation. In areas of exposed rock and heaps of clutter, the geology determines the way to walk, hopping from one surface to another, leaping to avoid crevices and fissures and sliding stones. Elsewhere there is the vastness of the flat moor, heath and plain, which provides broad open movements and allows views across long distances. It is easy to lose one's way in landscapes like these, although paths and signs can help provide direction. Waymarkers and signposts send a message to the traveller, while alignments of round barrows, cairns and other monuments, as well as petroglyphs, will have pointed the way in prehistory (Bell 2020) (Figure 1). Similarly, the network of 'trods' across the North York Moors, will have kept people on track in wide open spaces. These presumed medieval routeways, made of flagstones around half a metre wide, were used to move commodities across the moors, either from markets or the big producers, such as monasteries, or by panniermen to carry fish inland, while smaller trods linked to mills, churches and farms (Evans 2008). These navigational aids indicated the best routes and the direction of travel to significant or ceremonial places. As Martin Bell has also pointed out, modified plant communities along routeways will have helped provide not just sustenance on the go, but prompts as to the correct way (Bell 2020). We can see this even now along old and still well-used paths – lines of favoured food plants, such as blackberries and sloes, the presence of which are testament to generations of animal and human path-users eating and then spitting, tossing or defecating the seeds and stones to one side. These traces create readable routes.

Figure 1. A waymarker on the Whitby Road, North York Moors (photo: J. Leary).

Elsewhere there is the soft springiness of sphagnum moss, or acidic bog and alkaline fen; carr and marshland where feet sink into watery peat as if it were a saturated sponge and pathless wanderings are not easily possible. There are swaying reedbeds with dense mats of vegetation that can be walked on, but you have to be certain of your footing. Here there can be swarms of obnoxious, biting flies requiring a meandering movement to get around them. To enable movement in these landscapes people have constructed wooden trackways from at least the Neolithic. The best known, and one of the earliest, is the Sweet Track in the Somerset Levels, which dates to 3807/6 BC, although it replaced an underlying earlier version dated 3838 BC, and which was maintained for a number of years after construction (Coles & Coles 1986). The technique of using raised timber trackways continued, with variations, through the Bronze and Iron Ages.

To travel across saltings, mudflats and coastal marshes one needs to learn to walk without sinking. One also needs to know the land intimately; shifting mudflats make the topography ever-changing and dangerous to cross on foot. Tide times are essential knowledge here too, as routes become quickly blocked by high-tide water or low-tide mud. Once again, in these amphibious landscapes the topography directs the feet, and the unwary become inundated. The Mesolithic footprint tracks Martin Bell has recorded, and continues to record, in the Severn Estuary highlights exactly this point (Barr 2021: this volume, Chapter 2; Bell 2007). Through careful excavation and analysis, we can see trails of humans and animals from which we can garner a certain amount of data on their movements, from the direction of them, to stride length and pace, to foot size. But it doesn't take a huge leap of the imagination to look at these footprints and feel bare feet sinking into soft, wet mud and the sensation of it squeezing up through the toes, or the alarming feeling of one foot sliding out from underneath you (as recorded in one of the footprint tracks). Then there are mountains. Climbing is a different type of mobility altogether. It forces an estrangement from society and can provide a sense of raw freedom, particularly on reaching the summit and seeing and feeling the emotion of the panorama. Even the texture of the air changes as you move from the drier whirling winds of the lowlands to the moisture-laden atmosphere of uplands. But it requires harder work than most movements, more effort, and contains greater dangers that focus the mind with each careful step. Climbing uses the hands as well as the feet, requiring one to physically touch the environment; to feel their way up the mountain. In this sense it is more tactile and requires greater kinaesthetic awareness than other forms of movement, uniting body and environment more intimately. As the climber moves up the rock face, the rock cuts into hands, wears down fingernails and bruises knees; inscribing itself onto the climber, just as the climber is inscribing him or herself onto it. Done often enough and over time the movement becomes second nature and the climber's body is slowly cultivated into a 'climber's body' (Lewis 2000). The skeleton is plastic and mouldable and mobility scores itself into the body (Davies *et al.* 2014). We can see just this sort of evidence for habitual climbing (albeit in trees) in the Pleistocene hominin skeletal record (Georgiou *et al.* 2020).

The presence of death is never far away on a climb and to fall might be to die: the mobile rendered permanently immobile. A slip that at ground level would leave nothing more than a graze can be fatal on a mountainside. Survival is dependent on the climber's skill and experience; movements here need to be scalpel-sharp. In the mountain air, the faculties tend to sharpen too, and fear has a transcendental effect that can transport one to a different state of being.

Mountain climbing is by nature exclusive – accessible to a more limited group of people: the adventurous, the risk-takers, the able-bodied, and the fit. Climbers also need to be appropriately attired; 'Ötzi' the Neolithic Tyrolean Iceman, for example, was very warmly dressed in three layers of clothing when he was found on a ridge in the Alps: sheep leather leggings and loincloth, a soft chamois leather jacket and a cape made of grass and bast fibre. His hat was bearskin, and his shoes, which were insulated with grass, had bearskin soles and cattle leather uppers (Dickson *et al.* 2003; Püntener & Moss 2010). His clothes, which were all kept in good condition, were sophisticated and entirely apposite for the environment he was eventually killed in over 5,000 years ago. As was a 2300-year-old Scythian woman's leather boot, preserved in the Pazyryk region of the Altai Mountains in Siberia, which had pyrite crystals embedded into its sole to provide grip on the frozen ground (Rudenko 1970).

In contrast to the wide-open vistas of mountains, the views in woodlands and forests can be limited to what is directly in front of you, and movement, by necessity, is along pathways and clearings (Bell 2020; Noble 2017) (Figure 2). They provide another environment that requires different ways of moving, and are distinctively sensuous environments that smell of damp leaves and earth and have striking colours and textures and sounds that give an other-worldliness feel to them. To move through and live in wildwood is to be in close contact with animals and other beings; they are messy entanglements of people, the wood and all the multitudinous lives within it – trees, plants, fungi, animals, as well as spirits and others – all engaging with and attempting to make sense of one another, creating a web of living 'thoughts' in and around the forest (Kohn 2013). They are also jam-packed full of meaning – whether spiritual, ancestral, or loaded with myths and cautionary folktales.

Figure 2. A medieval hollow way through a woodland, Cropton, North Yorkshire (photo: J. Leary).

MOVING THROUGH WATER

Moving across land for any sort of distance will always eventually come up against a body of water, and while much discussion of past mobility centres on terrestrial landscapes, movement on water offers a different experience of travel. Rivers and lakes do not sit apart from the landscape but are components of it – dominating ones even (Edgeworth 2011). They also run through our minds as much as they do the landscape, providing a sense of place as well as a source of memories that help shape our world. Rivers attract people to them, as well as attracting other animals and birds for watering and more, so that the riverbanks become gathering points. Water is sensorial: it shines serenely like mercury, it bubbles and tumbles over rock, and roars whitely as it crashes down waterfalls. There's something fearful and mysterious about bodies of water too, perhaps something to do with power and force or its unseen depths; the sharp, primal terror of the deep, dark water. In early Christian literature rivers and other bodies of water were portrayed as holding great danger, and it has been argued that journeying on water could be an 'ordeal of faith' (Widell 2017). Rivers and lakes are certainly dangerous places and the location of countless drownings. They were often used in the past to dispose of the dead too, and so are death-receiving as well as life-giving. Rivers are also part of sacred geographies (Bradley 2016).

Rivers create boundaries that need to be crossed, but they also represent routeways, playing a vital role in producing mobility and movement as people travelled on them, not just alongside them. In wet and watery landscapes, waterways become the highways. This form of movement enabled people, animals and materials to travel along rivers, estuaries, coasts and across the seaways around Britain, and encouraged the dissemination of ideas. It also provided a means for a national network of long-distance contacts, the extent of which, particularly in prehistory, has undoubtedly been under-estimated. People attune themselves to the flow of the river; its force providing an axis of movement – an upstream or downstream that makes it easier moving in one direction than the other, and buildings, towns and cities, orientate to this flow (Edgeworth 2011). This generates its own rhythms as well as identities and communities and provides a different experience to moving on land. Water travel unfolds

in different temporal ways so that time is experienced differently. Travel by water can take many forms and each would have provided a different experience and perception of the environment. Canoeists are caught up in, and need an understanding of, the different rhythms and movements of the water bodies they move through. To sail is to enter a different realm of everydayness. But travel by water did not just require knowledge of the water, itself highly variable, but of nautical astronomy too – to navigate large bodies of water one needed an intimate understanding of the heavenly bodies (Leary 2014).

The ports and terminals that boats start and finish at are gathering places. Boats themselves are also gathering places and travelling by boat and being in physically closer proximity to people can lead to more intense sociality than other forms of movement. It affords travellers the opportunity to meet new people, greet old friends, catch-up, and pass on information and news. It allows people to talk about places they've come from and ask about the place they're heading. On boats people eat and drink together and, depending on the size and duration of the journey, might sleep next to one another. This leads to an entirely different experience of travel, which includes the smell of each other's bodies and the sound of snores and other bodily functions. Boats are hubs of social activity (Van de Noort 2011; Vannini 2012).

Water travel also brings places closer together; it affords greater connection, which in turn leads to opportunities for further mobility as ties are made. It also speeds up mobility and the sensory perception of it, creating a compression effect where the landscape moves ever quicker so that one engages with the world around differently. New and different mobilities lead to changes in relationships and perceptions of the world. Further, social inequalities are brought about using a boat, as opposed to feet, as a form of travel – new mobilities can create elites. Not everyone can pay the ferryman.

MOVING THROUGH SEASONS AND WEATHER-WORLDS

One more aspect, little considered, is that these movements do not happen with a neutral sky above and around them – it is sometimes scorching and sometimes freezing, there is fog and mist, and rain and storms (Ingold 2007, 2010). And these affect the way one moves, so that mobility is closely linked to weather and the seasons. Events happen under scudding skies. You can't escape weather – it is everywhere always, and it brings variance to routes and paths. Flooded roads or snowed-in mountain passes made a very considerable difference to people's mobility. Weather is transformative, shifting the light and temperature. It changes every surface altering the texture, absorbing and reflecting light in distinctive ways.

Hardly anyone ever talks about seasons or weather in archaeology (although see Pillatt 2012 for a notable exception), particularly in prehistory – it's as if everything happens in one homogenous, weatherless day. We rarely even acknowledge days and nights, or the way that as the sun moves round the shadows change. By ignoring that weather happened in the past we deny any sort of difference. The likely reason is that, like mobility, weather is difficult to pick up in archaeology. It is difficult to see from the archaeological record people squinting and shading their eyes from the sun, or snuffling irritatingly; we cannot trace numb hands, chapped fingers, and watering eyes. But we know it must have happened. This is not the same as climate, which can be, and frequently is, recorded within archaeology (Ingold & Kurttila 2000; Leary 2015; see also Bell & Walker 2005). Weather is more instantaneous – a mountain blast or a sea breeze.

Wild weather can throw the world into the unfamiliar, so that it is not easily navigable. Violent wind is unnerving – terrorising even. Fierce squalls batter and pound, whipping up birds and trees. Roofs are blown away and trees topple, while on sea, ships can be dashed and lives drowned. This is the punishing weather-world. Not all of it is bad though – a storm can also wash ashore tidewrack treasures, revealing secrets from the deep, or unearth discoveries on the coast. It's not only wild weather that transforms the landscape; rain can subtly change the texture of the land. Weather produces other wonders in the sky too: clouds and rainbows, thunder claps and lightning forks, which add to other mobile marvels, such as murmurations of starlings at dusk, and the breath-taking magnitude of the stars in the night sky.

The weather is inseparable from the way one moves through it, from the sense of lived experience and daily routine; places, paths and people 'weather' and become 'weathered'. Identities and practices, technologies and memories are all shaped by the atmosphere (Harris 2015; Hulme 2017). Weather, and the way it is constructed and imagined by people, shapes the way people move through a landscape. And, like the landscape, it carries layers of meaning, whether that is divine (bad weather is often seen as a punishment from God) or made up of personal memories and moods (perhaps brought on by Seasonal Affective Disorder). People understand the weather differently.

Furthermore, it is embodied – it is seen, heard, and felt; it soaks the skin, stings the eyes, bedraggles the hair, and floods the lungs. We are bodily immersed in weather.

People are also bound to the rhythm of the changing seasons; days extend and shorten, and light grows and fades in strength, and mobilities change and elasticate with them. Spring is a time of rebirth and fertility when the world re-greens and the air is hot and wet. Travelling conditions improve in spring and people can head out on the road again (Figure 3). It's a time for ditch-digging and fencing, logging, ploughing, sowing, and weeding, and, in the medieval period, for court and nobility hunting, hawking, and jousting. March, named after Mars, the Roman god of war, was when military campaigns traditionally began.

Figure 3. A frosted path across a river valley, North Yorkshire (photo: J. Leary).

The summer is the time to scythe and rake, to make hay and build ricks, woolgather in the fields, and a time for long, fair-weather travel when days are longer and paths dryer. Sun lifts the spirits and allows the body to produce health-improving vitamin D during long dog day afternoons. The world moved through in spring and summer is denser, more fulsome and tangly; it is the best time to travel, even if undergrowth can sometimes reclaim woodland paths.

In autumn fallen leaves hide paths. A time of thick, sticky mud, and heavy rainfalls that catch you off guard and drive you to shelter, while fog makes the world shrink to what is immediately in front of you. It is also a time of roars and bellows from stags, a harvest of apples and the pleasure of blackberrying and picking sloes. Thick mud makes it difficult to move, and routes, particularly rural ones, can become impassable through the autumn and winter months. Rain swells rivers and floods fields, and causes people to squelch home, filthy-footed, or stay inside altogether.

Thick snow can disorientate, hiding paths normally trod (Figure 4). Although it can expose them too – trails in the snow that makes tracking animals easier. It can also make the world seem silent, muffling sounds and stilling the air. Light changes when snow lies about reflecting sunlight and moonlight. People slow, and rivers stop their flow,

becoming silent and beautiful. The otherworldliness of snow is exciting, especially for children who can barely contain themselves to get out of the house and see the world afresh (see Schofield 2009). A winter world can be a magical world; a winter wonderland. Children make slides out of paths, and when rivers and lakes freeze over skates can be put on and a new type of mobility starts – one that without practice can look clumsy. Bone skates from medieval and post-medieval London and York testify to the fun people must have had skating (Gardela 2012; MacGregor 1976), or, more accurately, sliding, over a frozen Thames or Ouse. The appeal is perhaps in its transience, for it doesn't last long, and we are soon back to spring.

Figure 4. A trackway in snow and fog, showing both human and vehicle tracks, North Yorkshire (photo: J. Leary).

There are religious festivals associated with the seasons, and for farming communities in particular, the seasons are of existential importance. A number of Neolithic monuments across Britain and Ireland were built to align with celestial events and solar and lunar alignments at certain times of the year. The most famous being Stonehenge, which is aligned with both the summer and winter solstice, but also Newgrange in Ireland and Maeshowe in the Orkneys, as well as the stone circles of Castlerigg and Long Meg and Her Daughters in Cumbria. In both prehistoric and historic times, seasonal movements between uplands and lowlands or wetlands and drylands formed part of annual cycles.

COMING HOME

If this all seems sentimental, then it is only because the modern world has made it seem so, with its comfortable, protective clothing, flat and even paths, and new ways of moving, from cars and trains to planes (although see Graves-Brown & Schofield (2020) for how these new mobilities create new ways of perceiving). Landscapes, weather, and seasonal changes have run through all human existence, influencing and changing it. They have always been woven into our rhythms as much as day and night, from the winds and tides, growth and harvest, to the migratory patterns of birds and animals. They lie at the very heart of human lives. Feeling, understanding, reacting to, and reflecting on the landscape, the weather and the changing seasons, with all its joys and dangers, forms an indivisible part of what it is to be human, and to move humanly in this world.

One last point worth mentioning is that landscapes are always social and cultural, political and contested, and these aspects also impact on routes taken. Landscapes are places of memory, which may bring people to them, even becoming sites of veneration, or force them to avoid it, occupied by ghosts and spirits or bad memories. Landscapes are full of significance. They are also disputed and struggled over; they witness warfare and disease, and see removals, evictions and clearances, excluding and sometimes erasing people (Bender & Winer 2001; Smith & Gavin-Schwartz 2008). They are dynamic and volatile and are cultural constructions, and people always have some relationship to the landscape they move through.

Landscapes require different modes of movement depending on their nature; they afford distinct protection and dangers, provide dissimilar ways of perceiving the land, and create separate kinaesthetic experiences. Landscapes are not blank slates on which people can move wherever they please, and mobility does not exist in an abstract world. The land and the weather shape the walk; they determine the gait and the pace, whether to step carefully or stride confidently, whether to crawl or climb. Landscape and traffic, landform and travelling, interact, and there is a correspondence between terrain and different, idiosyncratic ways of moving. The wrinkled hide of the landscape – with all its folds and creases, tangles and twists – has a habit of imposing itself upon the moving body.

Archaeology has not always included these considerations in its narratives, but we have to find a way of drawing in the actuality of moving in the world – the rosy cheeks and aching legs, the mud and the wind and the rain – if we want any shot at understanding moving in the past. This is something that Martin Bell's carefully considered research, combined with an interest in, and appreciation of, the messy human-ness of life, has shown is, in the right circumstances, achievable and possible.

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EXCAVATIONS AT MARDEN, WILTSHIRE

The University of Reading Field School was held at the Neolithic henge at Marden in Wiltshire for three years, 2015 to 2017. Martin was an integral part of the team, investigating the environmental aspects of the area, mainly with a coring exercise across the Avon valley, but also in the excavation of three trial pits. He played an active part in the instruction of students during these excavations.

Teaching students in the ditch in the southern part of Marden henge (photo: T. Walker).

Those who know Martin will readily agree that he likes to get stuck into his work and is never happier than when in a hole. Here he is in one of the pits dug at Marden, this one in 2015, placing monolith tins to obtain environmental samples. Those watching saw him slowly sinking further and further down into the soft clay, despite standing on a board. Eventually, however, he completed his tasks and emerged from the pit. That was not the end of the problem, though. His borrowed wellington boots had become so full of clay that he was unable to remove them, and after 10 minutes of struggling with the aid of a human puller, resort had to be made to a pair of scissors and he was literally 'cut out of his wellies.'

Slowly disappearing into a deep hole (photo: T. Walker).

**ARCHAEOLOGY IN OUR CHANGING WORLD:
HERITAGE RESOURCE MANAGEMENT,
NATURE CONSERVATION AND REWILDING**

MARTIN'S DRESS

Martin's attire is variable, from the very formal to the very informal, and clearly adapted to the situation and weather at the time.

Degree ceremony, University of Reading (photo: S. Lambert-Gates).

Crowned by a First Nations hat on Vancouver Island, Canada (photo: D. Croes).

At Stonehenge (photo: J. Foster).

Hunting for footprint at Goldcliff (photo: S. Lambert-Gates).

Surveying the scene at Woolacombe Bay, July 2002, in preparation in for his Southern regional review of geoarchaeology: windblown deposits (photo: T. Walker).

Chapter 13

Translating geoarchaeology into geo-itineraries

Rowena Banerjea¹

ABSTRACT

Martin Bell's research into routeways of the past (Bell 2020) provided a stimulus for this paper, which explores ways to translate the important role that geoarchaeology plays in understanding past landscapes into heritage and tourist trails in relation to frontier landscapes in the Middle Ages with reference to 'castlescapes' (Banerjea *et al.* 2019). In effect, the creation of tourist trails and geo-educational itineraries can utilise patterns of movement made by historic agents for current and future movement.

UNESCO Global Geoparks and National Parks provide an ideal setting to use geoarchaeology to synergise the presentation of cultural and natural heritage in their past landscapes. This is done to some extent in Italy, with researchers looking for new ways to link and present cultural and geoscientific data (Brandolini *et al.* 2019; Giodarno *et al.* 2016). Giodarno *et al.* (2016) examine the 'Franks Trail', a route crossing 60 km the Susa Valley territory that follows the path blazed by Charlemagne in A. D. 773 which is located within the 'Cottian Alps Geopark'. They reconsider the 'Franks Trail' as a geo-itinerary due to the presence along the path of many interesting sites both from the geological and the cultural point of view; the geo-itinerary itself is developed to improve tourism and scientific knowledge and in this example showcases the formation of landforms and their fragility at the geosites and cultural sites along its route. This paper proposes to enhance heritage routeways, such as the 'Franks Trail' and hiking trails in castle landscapes (Pluskowski *et al.* 2019), by using geoarchaeological and other environmental data to educate visitors as to not only how castle life and the landscape looked at the time, but also how scientific data are collected and analysed to reach conclusions. The 'castlescape' is an abstract concept, not a physical dimension, and in essence is the cultural landscape associated with the biography of the castle, the boundaries of which can be fluid. The paper explores how these data can be presented effectively in trails through the 'castlescape', drawing on ideas from enotourism (wine tourism), where soil profiles are regularly presented (Schneider 2013), the focus on peat in whisky tourism, and visualisations such as augmented reality (Unger & Kvetina 2017).

Keywords: *geoarchaeology; landscape archaeology; science communication; heritage management*

INTRODUCTION

Cultural routes and trails are increasingly commonplace tourism products (MacLeod 2017) and important aspects of tourism in Geoparks, National Parks, the Council of Europe's Cultural Routes programme and regional branding such as *Le Pays Cathare* (or Cathar Country) in France, the Lucchesia 'District of Taste' in Italy, and the Wild Atlantic Way in Ireland (Bedini 2004; Giodarno *et al.* 2016; Hanrahan *et al.* 2017; Pluskowski *et al.* 2019). However, trails are multi-faceted constructs that would benefit from more scholarly attention to their socio-cultural significance for tourism, education and wider society, and further research on their rationales, development and management (MacLeod 2017). This paper proposes to enhance heritage routeways by using geoarchaeological and other environmental data not only to explain how daily life and the landscape looked at the time, but also how scientific data are collected and analysed to reach conclusions, in order to avoid a 'static and sanitised version of culture' (MacLeod 2017), which could be the end-product of a linear trail that simply linked cultural points of interest. It examines the important role that geoarchaeology plays in understanding past landscapes and daily life within and around a fortification, and how this information is translated into heritage and tourist trails relating to frontier landscapes in the Middle Ages with reference to 'castlescapes' (Banerjea *et al.* 2019).

Martin Bell writes that 'Human agents had a significant effect on geomorphic agents – making patterns of movement entrenched in a way influencing future patterns of movement, land-use and the perspective from which perceptions are formed' (Bell 2020: 249). In effect, the creation of tourist trails and geo-educational itineraries can utilise patterns of movement made by historic agents for current and future movement. The bodily engagement of movement is central to the way we structure space and understand our identity and place in the world (Bell 2020;

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Bell & Leary 2020; Nuninger *et al.* 2020). Landscapes, routeways and tourist trails can be strongly linked to identity and embedded within a range of social, political and cultural aspects of movement along them (Bell & Leary 2020; Bender & Winer 2001; Hanrahan *et al.* 2017; Holley-Kline & Papzian 2020; MacLeod 2017; Santos 2002), and 'castlescapes' can be equally evocative and contested, and conflicts of the Middle Ages can still resonate in present day politics and recent conflicts (Banerjea *et al.* 2019; Harrison 2013; Link 2015; Pluskowski 2012; Vandekerckhove 2020: xi). Equally, tourist trails can be experienced simply for the pleasure of walking and engagement with the contemporary landscape (Menzel 2017).

ON-SITE AND OFF-SITE GEOARCHAEOLOGICAL HERITAGE AND NATURE-CULTURE ENTANGLEMENTS

The articulation of what constitutes 'natural' and 'cultural' and the identification of these processes in the archaeological record are vital for the establishment of common factors of communication through the display of palaeoenvironmental remains to broadcast their meaning and scientific value to a wider audience (Schiffer 1987; Shanks & Tilley 1992). Nature-culture entanglements concerning land-use history, cultural history, human experience, political territory, and current environmental issues (Bartolini 2020; Butzer 2008; Katić *et al.* 2017; Latour 1993) can be integrated and translated into geo-educational itineraries for visitors within the 'castlescape' and, where feasible, heritage trails could retrace routeways of the past. Geoarchaeological and palaeoenvironmental research add colour not only to stories about contested pasts within the soil history (Banerjea *et al.* 2019), but also to other aspects of cultural identity such as food and wine tourism (Metro-Roland & Soica 2019), where soils play a fundamental role in past, present and future production (e.g. Bevan & Connolly 2011; Brown *et al.* 2021; Goodman-Elgar 2008; Lal 2009; Lang & Stump 2017; Stanichi 2012; Stump 2010; Turner *et al.* 2021). Menzel (2017) reports that the hikers or tourists resist the dominant heritage agenda inscribed in the tourist guides of the Cathar Trail, favouring scenic views of the contemporary landscape over immersion in the medieval history of castles of the Cathar Country, with hikers articulating ideas reflecting their experience of natural (vegetation and climate) rather than built heritage that they did not have time to visit. Arguably, GPS-activated digital presentation of geoarchaeological data can add chronological depth to their experience of natural heritage to show the landscape beyond what Menzel describes as an experience of 'contemporary chronological time, where the passing of time was carefully measured and the distance to be covered during this time was charted by their maps' (Menzel 2017: 113–114), and combine it with built heritage.

During the Covid-19 pandemic of 2020 and 2021, an increase in walking and recreational use of outdoor spaces has stimulated discussion on sustainable environmental recovery post-pandemic and the mental and physical health benefits of walking. For example, the 'Walk 1000 Miles in 2021' (Country Walking Magazine 2021) is supported by organisations such as the Ordnance Survey and Forestry England. This challenge in particular promotes a range of different types of walking activities to meet the 1000 mile target. Activities such as geo-educational itineraries around heritage sites could be integrated into such future endeavours and georoutes (eg. Geoparque Comerca de Molina-Alto Tajo 2021). The culture and value of walking is well established (as outlined in Bell 2020). However, it is timely for reinvigorating heritage landscapes in National Parks, UNESCO Global Geoparks and trails to provide a more holistic understanding of archaeological sites in their landscapes, not only bringing to life how the landscape and, in this case castle life, looked at the time, but also integrating the scientific process into visuals and information to demonstrate how conclusions were reached.

The timeliness of this topic is enhanced further by the support for an 'International Geodiversity Day', the proposal for which will be submitted to the 41st session of the UNESCO General Conference that will held in November 2021. This day marks a celebration of all aspects of geodiversity (the earth's minerals, rocks, fossils, soils, sediments, landforms, topography, geological and morphogenetic processes, and hydrological features such as rivers and lakes) and coordinates educational, awareness raising, and public and policy engagement activities (Brilha *et al.* 2021). Hiking trails that showcase the geoheritage are common-place features in UNESCO Global Geoparks and National Parks with considerable thought put into the production of information for visitors to meet the UNESCO requirements for education, geoconservation and local development (Carcavilla 2007; Girault 2019; Ruban 2016). The objective of the administrative protection of a UNESCO Global Geopark is to include the ethnographies of particular heritage and/or tourism sites and activities linking both natural and cultural values (Di Giovine 2009). In the province of Guadalajara, Spain, where the Molina and Alto-Tajo UNESCO Global Geopark is located, García-Quintana *et al.* (2004) stated that greater attention has been paid to the biological and human history than to the geological history, with the social and historical development of a territory reflected in the quantity and range of its anthropogenic elements (Roman roads, bridges and medieval castles, railroads and highways, airports, etc.). Following the designation of the Molina and Alto-Tajo UNESCO Global Geopark in 2015, the geological history of the territory is now disseminated (Saiz *et al.* 2015). However, the cultural and geoheritage within the Geopark still require further integration in a landscape archaeological context (Banerjea *et al.* 2019) where the castle is

incorporated into current georoutes and activities (Fernández-Martínez *et al.* 2014; Geoparque Comerca de Molina-Alto Tajo 2021).

Research in Italy has taken important steps to integrate cultural heritage, geoscience, and landscape archaeology in tourist trails (Brandolini *et al.* 2019; Giordano *et al.* 2016); the geomorphological focus to the interpretation of heritage sites provides foundations that can be built on to integrate on-site with off-site geoarchaeological data for translation into the visitor experience (Banerjea *et al.* 2019).

SCIENCE COMMUNICATION IN PUBLIC ARCHAEOLOGY

In 2009, Karl Butzer reflected on 35 years of the *Journal of Archaeological Science* as an explicitly interdisciplinary medium, linking archaeology with the natural sciences, and one that emphasizes methodological innovation (Butzer 2009). He notes that during this period the journal steadily grew from 400 to 3200 print pages per annum, and from a small to a large, double-column format and the impact factor increased until it became the leading archaeological journal overall. This growth in archaeological science research is not only represented in the expansion of *Journal of Archaeological Science* and the addition of *Journal of Archaeological Science: Reports* in 2015, but also sees this research published in other journals such as *Archaeological and Anthropological Sciences*, *Archaeometry*, *Environmental Archaeology*, *Geoarchaeology*, *Heritage Science*, *Open Quaternary* and *Quaternary International*. Despite this vast and growing body of archaeological science research, the translation of the collection and range of scientific data from archaeological sites, the preparation processes of samples, and the explanation of results in general remains superficially explained to visitors to a heritage site or museum, if at all.

A study by Copley (2010), targeted 100 randomly selected curators of archaeology in museums in the UK (or other professionals in smaller museums) with a short questionnaire (62 returned) which posed eight questions to understand the respondents' backgrounds and attitudes to science in a museum setting, the current coverage of science in their museum, what they would like from future coverage, and any further comments. The study hypothesised that the majority of curators of archaeology exhibits do not possess scientific backgrounds and this was shown to be true; however, it was noted that many current archaeology degrees do have scientific components. Despite this, the respondents did not think that 'science' or 'scientific enquiry' was difficult to understand. On presenting science in archaeology museums, they considered that the translation of science into accessible language is important and that it would be useful to have guidelines to integrate science into archaeology displays. It is of note that 'geoarchaeology' did not feature in the comprehensive list of sixteen scientific topics (Copley 2010: 391) that were put to the respondents to describe how they were incorporated into museum displays. The topic 'stratigraphy and the excavation process' was reported to be the joint top ranked topic most likely to be currently incorporated into archaeology museum displays, which could provide geoarchaeologists with a foundation to build on to include more of their research in exhibitions. 'Palaeoecology' was also absent from the list of topics, but it can be assumed that techniques such as palynology were considered part of 'archaeobotany', which was included, whilst others such as entomology and molluscan analysis were overlooked. Despite these omissions on the questionnaire, the respondents reported that 'environmental reconstructions' are the most likely to be granted space with a dedicated panel (Copley 2010: 392), as can be seen at the Ceide Fields Interpretative Centre, County Mayo, Ireland, a heritage centre situated on the 'Wild Atlantic Way' tourist trail.

Currently, there is an anecdotally perceived trend of presentation of archaeological science results focussed on research relating to human and faunal remains and material culture, which are arguably the most captivating sources of scientific evidence (Conforti *et al.* 2013); however, this requires testing through further Europe-wide, semi-quantitative research, developing that conducted by Copley (2010). Copley's study reports that 55% of respondents (comprising curators of archaeology) wanted to include more human osteology and palaeopathology in their displays, which might be a contributing factor to this anecdotal observation. A study in the UK by Dawson (2018) found that participation in science communication and visits to museums operated as a form of 'cultural capital' (Bourdieu 1984; Ruban 2016) for dominant groups in society, and these were seen as Eurocentric. Engagement with science by marginalised social groups is more likely to be through digital media rather than a museum visit (Dawson 2018). Some respondents to Copley's questionnaire replied to say that they thought that archaeological science was too complex for permanent exhibitions and, therefore, it was more suited to temporary exhibitions and supporting web-based material to enhance visitor experience (Copley 2010). Museums may not be best suited for learning complex scientific facts and details (Copley 2010: 385) and citizen science projects (e.g. Brown *et al.* 2004; Milek 2018) and experimental archaeology centres (Bell 2009) may be more effective for engaging non-specialists with scientific research practices and processes, particularly now the range of portable instruments available to geoarchaeological practice has increased (Milek 2018).

PRESENTING THE ‘CASTLESCAPE’

Hingham (2010) observes that castles are prime resources for the heritage and tourism sectors, and how they are preserved and presented to the public at the heart of this issue. A recent special issue in the journal *Landscapes* entitled ‘Forgotten Castle Landscapes: Connecting Monuments and Landscapes through Heritage and Research’ (Pluskowski *et al.* 2019), focussed on the lack of connection between castles, landscapes and heritage and how these aspects can be more comprehensively presented and understood. Collectively, the papers in the special issue present many case studies for integrating palaeoenvironmental data with survey and museum engagement to bring castle landscapes to life for a wider audience. These range from embedded, active museum engagement with a range of research strands, such as geo-radar survey (Runge 2019), to castles at risk from climate change (Kerr 2019), the challenges of presenting castle landscapes to the public (Bizri *et al.* 2019), the challenges of conducting landscape research on urban fortifications (Borderie *et al.* 2019), and the application of geoarchaeology to examine on-site and off-site activities associated with castles and cultural and natural heritage (Banerjea *et al.* 2019).

Ways to interpret and present geoarchaeology to heritage site visitors are explored here in relation to castles and their landscapes, ‘castlescapes’. Geoarchaeology in its essence is cross-disciplinary. Soils and sediments are the backbone of the archaeological record (Goldberg 2008) and their analysis is pivotal in providing a micro-contextual and micro-stratigraphic understanding for the interpretation of a range of other proxies such as archaeobotanical remains (Banerjea *et al.* 2020a), the depositional and post-depositional processes that form and alter the archaeological record (e.g. Banerjea *et al.* 2015; 2020b), in underpinning palaeoecological studies of landuse around archaeological sites (e.g. Brown *et al.* 2015; Brown *et al.* 2021; French 2003) and in understanding site geomorphology (e.g. Marini *et al.* 2019) and resource exploitation (e.g. Hayward 2019). In effect, geoarchaeology links and provides cohesion for all these aspects of the ‘castlescape’, linking its construction materials and the activities taking place at the monument which are illuminated through the buried archaeology, with agricultural activities, vegetation change, and the sourcing of materials (Banerjea *et al.* 2019).

Banerjea *et al.* (2019) argue that the ‘castlescape’ of Molina de Aragón, Spain, situated within the Molina and Alto Tajo UNESCO Global Geopark, provides an ideal administrative and educational setting to create models for ‘geo-educational itineraries’ (Brandolini *et al.* 2019), which can be used by castle museums and visitor centres outside of a Geopark context. Brandolini *et al.* (2019) propose four ‘geo-educational itineraries’ for the Central Po Plain, Italy, (Protohistory, Roman, Medieval and post-medieval) that link archaeo-historical sites, human-induced landscape transformation, and the main environmental and historical phases of the study area with geomorphosites to promote future geotourism projects of the area; the trails can be travelled on foot, by bike or car. This concept is explored in relation to the diachronic biography of the ‘castlescape’ of Molina de Aragón, with the intention of focussing on how geoarchaeological data are integrated into the visitor experience, from using it, in conjunction with GIS to identify ancient route-systems that can form part of the narrative and trail, to the integral role that museums and digital technology play.

Wilkinson *et al.* (2010) use three scales of analysis in the region of Tell Brak in northern Syria to identify hollow ways and date them with a ceramic typological chronology. They identify macroscopic features in the landscape using satellite imagery, then conduct field investigation and soil micromorphology, coupled with the ceramic chronology, to reconstruct the abrasion and infilling processes of the hollow way, its wetting and drying cycles and surface and basal palaeosols. The focus of their study was on the Early Bronze Age features and hollow ways around Tell Brak; however, a second set of narrower tracks were identified using satellite imagery which appear closely associated with a 14ha settlement of the early Islamic period (c. AD 700–900) that grew around an earlier Castellum at the north-eastern corner of the site. The dating of such trackways poses similar dating challenges to those of agricultural features such as constructed terraces and lynchets, which require multi-method solutions to establish their chronology (Bell *et al.* 2020; Brown *et al.* 2021; Turner *et al.* 2021; Vervust *et al.* 2020). Identifying and using ancient trackways in the landscape, where feasible, can embed visitors within the historic landscape and act as a conduit to show how it has been transformed. However, this is not without issue as tensions can arise between ‘new’ versus ‘old’ paths (Bartolini *et al.* 2020) and the framing or imposition of signage (DeSilvey *et al.* 2020).

The importance of connecting museums with heritage trails and wider archaeological landscapes cannot be underestimated, particularly their role in fostering a digital narrative for which the widespread use of the internet has created new opportunities (Runge 2019; Swensen & Nomeikaite 2019). Three aspects of Copley’s study (2010) are relevant here: 1) the comment that archaeological science is too complex for permanent exhibitions and therefore, it is more suited to temporary exhibitions and supporting web-based material to enhance visitor experience; 2) that ‘environmental reconstructions’ are the most likely to be granted museum space with a dedicated panel; and 3) that ‘stratigraphy and the excavation process’ was reported to be the joint top ranked topic most likely to be currently

incorporated into archaeology museum displays. New opportunities in digital media enable these issues to be capitalised on and used to present and interpret geoarchaeological research in a way that departs from applying digital technologies simply as a supplement to existing practices, on to more integrative approaches of communication, interaction and exchange that exceed the physical boundaries of a museum (Swensen & Nomeikaite 2019).

Lodwick (2019) discusses digital archaeobotany which has, so far, focused on static websites and databases, with a growing number of blogs, and highlights the role of archaeobotanical data in creating visualisations reconstructing daily life on a settlement. The Stonehenge website also uses palaeoenvironmental data in this way to show reconstructions of the landscape with two lines mentioning that pollen, charcoal and molluscan evidence was used for this (English Heritage 2021a); the information about activities that took place is more comprehensive in showing how different scientific analyses can inform interpretation (English Heritage 2021b). The Stonehenge website contains interactive, clickable figures, whereby a smaller box shows additional information and further windows of detail. Reconstructions play an important and popular role in this mental journey from artefact to historical image, but they can reduce visitors or viewers to passive consumers rather than interactive participants (Colomer 2002).

A map of the ‘castlescape’ can be hosted on a museum website, whereby these additional windows of detail can be used not only to present information about the castle life and its landscape (in a way that the Stonehenge website is used), but also to show evidence-based, scientific processes such as sampling in action during the excavation process, laboratory preparations, and photomicrographs of interesting features to contribute to the ‘public understanding of research’ (see Copley 2010 for discussion of this issue). This information about scientific process can also be integrated into heritage trails around the ‘castlescape’, which at Molina de Aragón not only includes the castle and nearby towers and mill, but also associated agricultural terraces, irrigation systems, mining and quarrying areas. In November 2018, UNESCO added the dry-stone walling associated with terraces in Croatia, Spain and Greece to its list of Intangible Cultural Heritage (Turner *et al.* 2021), which provides an opportunity, particularly in a geopark context to showcase soil profiles and associated scientific analyses associated with these features (Figures 1 and 2). Ways in which to present soil profiles can be sought from wine tourism, where soils play an important role in wine production and are regularly showcased (Schneider 2013); similarly the importance of peat in whiskey production and tourism, and Conway (2010) shows a model for a soil trail through the landscape to highlight its role in geodiversity.

Figure 1. Excavation (a) and sampling for soil micromorphology (b) on the terrace adjacent to the castle of Molina de Aragón. The dry stone walling of the terrace (c) is shown, together with a comparative profile from Agicampe, Andalusia, Spain (d), showing a rebuilt terrace wall (see Porras *et al.* 2021).

Figure 2. Irrigated field system in Molina de Aragón, which is thought to be a Christian extension of an Islamic system and it is still in use today (a); it is located to the left of and across the river from the Museum (b). The field system was excavated (c), recorded (d) and sampled (e) in 2016.

The available range of digital media is growing. On a journey through the ‘castlescape’ QR codes on information boards provide multiple opportunities for visitors to find out further information such as from augmented reality and 3D visualisations (Runge 2019; Unger & Kvetina 2017). Visualisations showing past landscapes, particularly while walking in the landscape, can be used to show visitors the strategies used to deal with challenges brought by climatic factors, and processes such as urbanisation. Within the monument itself, digital media presented through QR codes or GPS activation can bring to life ‘blank canvasses’, which are areas with no standing remains, but that have buried archaeology. Photogrammetry models that show sample collection in action (e.g. Aspöck & Banerjea 2016) make a valuable contribution to presenting the scientific research process, which can then be followed by short explanations of results and photomicrographs such as those on analysis of sediments from Cártama, Malaga, Spain, that were keenly shared on social media by the local excavator and association of friends of the museum (Figure 3). These elements of the scientific process can not only be accessed through QR codes on information boards, but also through apps for a heritage site such as that which is being developed for the ‘Landscapes of (Re)Conquest’ project for use at Molina de Aragón (Halfman 2021).

Figure 3. The dissemination via Facebook of videos of soil micromorphological analysis of samples collected from below the castle at Cártama, Andalusia, Spain. (a) The original post on the ‘Landscapes of (Re)Conquest’ Facebook group (called ‘Ecologies of Crusading’); (b) the sharing of the post by the local site director; (c) the sharing of the post by the site director to the page of the ‘Friends of Cártama Museum’ (translation).

CONCLUSION

Martin’s pioneering research on routeways of the past provided a perspective through which to develop ideas about communicating geoarchaeological data through heritage trails. It allows us to consider how the creation of tourist trails and geo-educational itineraries can utilise patterns of movement made by historic agents for current and future movement, and how landscapes, routeways and tourist trails can be strongly linked to identity and embedded within a range of social, political and cultural aspects of movement along them, which is particularly relevant for some European castle landscapes. Nature-culture entanglements concerning land-use history, cultural history, human experience, political territory, and current environmental issues can be integrated and translated into geo-educational itineraries for visitors within the ‘castlescape’, not only to highlight the cultural aspects of the heritage site, but also as a way of showing visitors the adapting and coping strategies to challenges brought by climate, and the scale of change through processes such as urbanisation. Advances in digital technologies enable researchers to collaborate with museums to provide layers of detail to their research and results that can be accessed by visitors in a future-proof way with museums playing a pivotal role in hosting the narrative.

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Chapter 14

30 years of discovery, conservation and management of cultural heritage in England's wetlands

Jen Heathcote¹

ABSTRACT

Historic England, and its precursor English Heritage, has a long tradition of supporting research into the discovery, understanding and management of archaeological sites in wetland landscapes, spanning uplands, lowlands, and coastal environments. In this paper I will explore how the emphasis of that research has changed over time, from the early extensive surveys and assessments of archaeology in the main lowland wetland areas of England, through to detailed understanding of particular places under threat and processes that pose risk to the long-term preservation of archaeological and paleoenvironmental remains in wetlands. Such processes encompass environmental risks, including climate change, and those created – intentionally or otherwise – by changing land management practices. Emphasis has shifted from management regimes that focus on individual sites towards those that include a detailed understanding of their broader hydrological context and landscape setting. Throughout the paper, I will reflect on the way Martin's research has complemented, influenced and contributed to the evolving research agenda for England's wetlands.

Keywords: *wetlands; heritage management; archaeology*

INTRODUCTION

Wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

(Ramsar Convention Secretariat 1971).

Wetlands comprise fragile, biodiverse environments such as mires, ponds, rivers and their floodplains and estuaries. Their deposits can be organic (e.g. peat) or minerogenic (e.g. alluvium), and they are seasonally or permanently waterlogged. This water saturation, and the accompanying episodic or permanent exclusion of oxygen, creates a sub-surface environment that supports the preservation of organic materials and biological remains, and provides a wealth of information on material culture and evidence for past environments that is lacking from dryland sites in temperate regions; this is why they are so highly prized by both archaeologists and Quaternary scientists.

Wetland habitats are widely distributed across England. There are a variety of habitat types, including extensive areas such as the Fenlands and Broadlands in the east, the Somerset and Humberhead Levels, and the wetlands of the north-west. The national wetland resource comprises c. 740,000ha alluviated lowlands; 550,000ha of land above the 10m OD contour in river valleys; 210,000ha lowland peatlands; c. 150,000ha upland peatlands; and more than 300 small wetlands (defined as less than 10ha) such as mires, kettle holes and ponds (Van de Noort *et al.* 2002). They also include the intertidal zone of estuaries and coasts.

HERITAGE SIGNIFICANCE AND VALUE

A wide range of remains, both prehistoric and historic, are significant for wetland and waterlogged archaeology, including all surviving physical remnants of past humans and their activity, as well as landscaped, planted or managed vegetation. Features occur at a variety of scales, from palaeochannels to specific crossing points on river reaches, to extensive tracts of upland and lowland peatlands, the latter having considerable heritage value due to their associated archaeological remains (artefacts, features, bog bodies) as well as the peat matrix itself which is an archive of information on past environments (Heathcote 2012). Their value and significance in terms of both

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natural and cultural heritage creates opportunities and challenges for management (Olivier 2004). Nowhere is this more evident than in peatlands, where restoration schemes designed to create wetter conditions can be detrimental to archaeological remains if not handled with sensitivity to mitigate damage to the latter. Place-based partnerships have emerged to address this locally, but a national steer has been missing until the publication of the recent partnership guidance by Historic England and Natural England (Hazell 2021).

CHALLENGES PAST, PRESENT AND FUTURE

Identifying threats to wetlands in freshwater and coastal environments has been the subject of several research programmes over the past two decades (Atkins 2013; Fulford *et al.* 1997; Van de Noort *et al.* 2002). Drainage, water abstraction, conversion to arable agriculture, peat wastage, peat erosion (uplands), peat extraction and development were identified as the key threats (Van de Noort *et al.* 2002), though domestic peat extraction for horticulture should diminish with the planned phasing out of extraction for horticulture by 2030 (DEFRA 2011). Additional threats include:

- natural processes and changing environmental conditions;
- changes in resource management, exploitation and land-use (e.g. de-watering at quarries may create a sphere of influence on groundwater over a much wider area than the quarry footprint alone);
- habitat loss and the creation of new habitats in compensation;
- accelerated upland peat erosion from increased recreational pressure (walkers and recreational vehicles) and risks (fire);
- renewable energy solutions; biomass crops (with high water demands) may affect wetland hydrology of wetlands; windfarms and their associated infrastructure (e.g. access roads) can cause erosion on upland peat sites; microhydroelectric power generation can require reconfiguration of the fabric of both historic mills and their associated watercourse infrastructure (Heathcote 2012).

With respect to climate change, both direct and indirect impacts are relevant. Direct impacts of climate change are expected to include: regional and local changes to groundwater availability and quality for groundwater-fed wetlands (Acreman *et al.* 2009); increased erosion in river valleys due to altered river channel behaviour; increased frequency and magnitude of pluvial, fluvial and groundwater flooding; changes to vegetation composition and thus landscape character; and peat desiccation and erosion particularly impacting later Holocene (medieval and later) portions of sequences. A key indirect and significant impact is the action undertaken to adapt to, or mitigate for, predicted climate change or habitat loss. Such activities include remodelling floodplains and reactivating palaeochannels for flood risk management purposes; creating compensatory habitat to mitigate that lost through infrastructure development; and rewetting upland peatlands. Other factors include increased competition for available groundwater, especially in East Anglia and south-east England; and increased visitor numbers and length of tourist season, particularly for upland peatlands (Historic England 2015).

1983 – 2002 WETLAND DISCOVERY: SITES AND SURVEYS

ENGLISH HERITAGE AND WETLANDS

ENGLISH HERITAGE WETLAND SURVEYS

Between 1983 and 2004, English Heritage invested a total of £7M commissioning surveys of the main wetland areas of England – the Somerset Levels, Fenlands, North West Wetlands and Humberhead Levels – covering 887,000ha of lowland peatlands and alluviated lowlands (Van de Noort *et al.* 2002). This large-scale, systematic survey programme identified the archaeology of these major wetland areas, reported in 45 monographs and underpinned the development of the English Heritage Wetland Strategy (Olivier 2004).

Towards the end of this period, English Heritage also commissioned a desk-based condition assessment of wetland monuments in peatlands (upland & lowland) and alluviated lowlands (Van de Noort *et al.* 2002). Its purpose was to create a benchmark against which changing levels of risk could be judged, particularly with respect to threats from hydrological change, peat extraction, and land-use (forestry, urban and industrial expansion). The report estimated that over 10,000 wetlands sites had been lost or damaged over the past 50 years and concluded that whilst the most visible threat was from peat extraction, this accounted for only 0.5% of the losses, and the greatest impact resulted from drainage for agricultural purposes.

ENGLISH HERITAGE STRATEGY FOR WETLANDS

Development of the English Heritage Strategy for Wetlands (Olivier & Van de Noort 2004) was informed by the extensive wetland survey programme of the previous three decades. This high-level conservation management strategy supported the development of specific policies and actions against four main principles – Management, Outreach, Policy, and Research – and advocated partnership working with national and international bodies to implement them. Practical mechanisms to aid management decisions were promoted through guidance and best practice advice. This included reference to the importance of controlling hydrology to enable preservation *in situ* by protecting the whole wetland context in which the site was situated, rather than trying to deal with ‘monument islands’, and it promoted the importance of providing cross-compliant benefits for archaeology, nature, recreation, access and owners. A key response was the creation of an inventory of the most important monuments, with proposals for site-specific management strategies (Van de Noort *et al.* 2004).

Outreach focussed on raising awareness of the cultural heritage attributes and values of wetlands to public audiences, as well making the results of the English Heritage wetland surveys more accessible to all stakeholders; public, professionals, landowners and managers.

The Strategy also called for policy and advocacy actions to alert local, national and international agencies to issues such as the need to understand the impact of development on the hydrology of wetland landscapes; the importance of assessing the archaeological potential of deep stratigraphy; and providing tools to improve support to local authorities in addressing wetland archaeology within the planning process. A key response was a pilot GIS project which modelled the spatial extent and archaeological potential of different wetland types based on the relationship of soil properties with the known archaeological resource (Van de Noort *et al.* 2002).

Finally, a research agenda was presented, focussing on the need to better understand direct and indirect threats to upland peatlands and deeply buried lowland sites; develop wetland-specific prospection techniques; and refine understanding of the requirements for *in situ* preservation. Several of these topics would go on to be addressed under the National Heritage Protection Programme (NHPP) between 2011 and 2015.

ENGLAND’S COASTAL HERITAGE

Alongside this work in freshwater wetlands, systematic survey of the coastal and intertidal zones and their associated wetlands began in the 1980’s with threats from erosion, sea-level change and development (e.g. the Second Severn Crossing), and recognition of the archaeological potential of submerged prehistoric landscapes (e.g. Isles of Scilly), prompting work in several regions (Tyson *et al.* 1997: 99–100). During the 1990s, the national Rapid Coastal Zone Assessment Survey (RCZA) programme was initiated by Historic England (then English Heritage) and undertaken by archaeological groups around the country. *England’s coastal heritage*, published in 1997, synthesised information on the coastal archaeology of England and proposed themes and places for further survey and investigation, also identifying the need for policy development to help local groups undertake opportunistic surveys and subsequent monitoring programmes (Fulford *et al.* 1997).

Martin’s own chapter in that report focussed on synthesising information on coastal wetlands through the lens of environmental archaeology (Bell 1997). In it, he highlighted the long history of reference to submerged forests as examples of past landscapes, as mentioned in medieval and antiquarian texts, and showed how these features, together with the distribution of intertidal and submerged peat around the UK, demonstrated extensive Holocene coastal change particularly in the Fenlands; Somerset Levels; and in major estuaries such as the Humber, Thames and Severn.

MARTIN AND WETLANDS

COASTAL WETLANDS

Estuaries, with clearly defined environmental changes, which can be precisely dated by dendrochronology, are key contexts in which to investigate the relationship between environmental change and past human communities.

Bell & Neumann (1997: 96)

In 1983, Martin started working in the Severn Estuary at Brean Down, a project largely funded by the newly created Historic Buildings and Monuments Commission, also then known as English Heritage. A key component of the project was understanding the archaeology of the eroding cliff face and its relationship with the wider

contemporary landscape of the Somerset Levels and Severn Estuary. This required integrating data from an extensive geoarchaeological survey and scientific dating programme to establish a well-dated paleoenvironmental history (Bell 1990) tied into the estuary-wide regional stratigraphic framework developed by Professor John Allen and colleagues (e.g. Allen & Rae 1987). Over the next decade and a half, Martin developed a detailed understanding of local depositional sequences at specific places along the shoreline and wetlands of the Severn Estuary, highlighting the importance of geoarchaeological approaches to understanding local detail and linking that back to widespread regional processes and landscape change.

At this time, he also provided mollusc, soil and sediment analysis for sites in and across southern and south-west England for the English Heritage Ancient Monuments Laboratory, a number of these situated in the coastal wetlands of Devon and Somerset, including intertidal exposures at Westward Hol (Balaam *et al.* 1987), where several discrete areas of prehistoric activity were examined and recorded following finds by local people. The importance of local knowledge, and the benefits of building long-term research partnerships with local people able to respond quickly to monitoring opportunities in these dynamic environments is exemplified by his working relationship with Derek Upton. Derek's intimate knowledge of the archaeology of the mudflats and peat exposures of the intertidal foreshore in the Welsh Severn Estuary Levels was refined through repeated visits over 15 years, providing a wealth of information to both inform and supplement the detailed, site-specific work at Goldcliff and beyond (Bell & Neumann 1997; Bell *et al.* 2000).

2002 – 2015 WETLAND RESEARCH AND CONSERVATION

ENGLISH HERITAGE AND WETLANDS

In the early part of this period, implementing the Strategy for Wetlands and working through its recommendations was undertaken with an emphasis on the importance of building relationships with the nature conservation sector. A key response to one of the recommendations from the outreach element of the Strategy was to become full partners in the Wetland Vision, a partnership project comprising English Heritage, The Environment Agency, Natural England, The Royal Society for the Protection of Birds, and The Wildlife Trusts. The partnership sought to promote the interdisciplinary value of wetlands and provide a vision for healthy and functional wetland landscapes 50 years hence, together with the development of tools to help achieve that goal (Wetland Vision 2009). Maps were developed to show where future wetlands had the greatest potential to benefit biodiversity and the historic environment, and others showed where we should be looking for a range of other socio-economic benefits; these were to be the main areas to focus wetland creation and restoration. Whilst the project has ended, the website is archived and accessible, and the products still in use and of value.

AGGREGATES LEVY SUSTAINABILITY FUND

Between 2002–2007, several other recommendations – especially those relating to hydrological behaviour, and the modelling, survey, excavation, regional synthesis and research into prospection techniques applicable to river valleys dramatically expanded – benefitted from the extensive research made possible by the introduction of DEFRA's Aggregates Levy Sustainability Fund (ALSF). The core objective of the programme was to reduce the impact of aggregate extraction – terrestrial and marine – on the historic environment, and it was distributed by a range of organisations including English Heritage. During this period, over £23.75M was invested in 250 projects involving archaeology and the historic environment (Flatman *et al.* 2008).

ENGLISH HERITAGE STRATEGY FOR WATER AND WETLAND HERITAGE (2012)

The focus on working with the nature conservation and environmental management sectors was driven in large part by the need to respond to emerging initiatives associated with a) the UK National Ecosystem Assessment and its follow-on work (2011, 2014); and b) the Catchment Based Approach to water quality management (DEFRA 2013). In addition, changes to European and domestic legislation, including the Flood and Water Management Act 2010 created new opportunities and challenges for protecting the historic environment and reflected a fundamental conceptual shift about how water would be managed in future. These factors resulted in an updated remit for wetland research, and a revised strategy for freshwater wetlands (Heathcote 2012). Key topics included: integrating evidence from wetland work with dryland sites to better understand period/regional archaeological issues; improving understanding of the condition and character of specific sites, their vulnerability and whether/when preservation is viable, sustainable and appropriate; promoting wider use of geoarchaeological approaches to identify the archaeological sensitivity of wetland and waterlogged sites; promoting the value of evidence from

palaeoecology to inform habitat management; and understanding likely impacts of climate change and environmental management practices on the cultural heritage of wetlands.

NATIONAL HERITAGE PROTECTION PLAN

The National Heritage Protection Plan provided a framework for heritage protection between 2011 and 2015. It was built around priorities set by sector and public consultation and was introduced as ‘... the business plan for the historic environment’ (Historic England 2012). It was intended to promote joint working by clearly identifying priority issues for research and action. Several areas aligned strongly with the topics were identified in the new wetland strategy, enabling significant resource to be directed to address them through developing research projects, literature reviews, technical advice and best practice guidance. Focal points for concerted effort were:

- **Identification of wetland/waterlogged sites** – a programme of work to address knowledge gaps in specific areas, particularly the distribution of waterlogged urban archaeology (e.g. Derham 2013; Hurst *et al.* 2014; Wilkinson *et al.* 2013) and the resource potential and significance of small wetlands (Farrell & Hazell 2016); improving access to data on key wetland heritage assets; publishing a list of high quality and/or vulnerable sites for targeted investigation (Heathcote & Campbell 2013); establishing the condition and research potential of material remains at specific sites; identifying the potential for site-specific, *in situ* preservation of archaeological and palaeoenvironmental remains.
- **Major environmental threats** – Flood Risk Impact Assessment for English Heritage Estate (Pearson 2013); understand the timing and planning context of EU Water Framework Directive actions in partnership with the Environment Agency and local authorities; understanding direct and indirect impacts on wetlands and waterlogged archaeology; understanding the hydrological context and dynamics at key sites, including Star Carr and Flag Fen.
- **Attritional environmental threats** – producing guidance on monitoring burial conditions, identifying critical conditions and determining responses; guidance on monitoring and interpretation of hydrological behaviour (Historic England 2016).

MARTIN AND WETLANDS

PRESERVATION *IN-SITU*

In 2007 Martin, in partnership with English Heritage, was awarded an AHRC/EPSRC Science and Heritage Collaborative Research Studentship to investigate the *in situ* preservation of wetland archaeology in Somerset. The project built on prior monitoring of the Neolithic Sweet Track (Brunning *et al.* 2000) and on the findings of the Monuments at Risk in Somerset’s Peatlands (MARISP) project which carried out monitoring (13 sites) and keyhole excavation (21 sites) in the Somerset Levels, including at Glastonbury Lake Village (Brunning 2013). The project was designed to assess the burial conditions and preservation potential of two of the most important prehistoric sites – Glastonbury Lake Village and Sweet Track – and examine a third, Chedzoy – where evidence for Mesolithic activity and Neolithic trackways had been found. The doctoral research, undertaken by Louise Jones, collected monthly monitoring of several variables – rainfall, water levels, soil moisture, soil chemistry and included localised hourly monitoring of redox potential in the site core – to assess the burial conditions and effect on the organic remains. Key questions posed related to whether Glastonbury Lake Village could be characterised more fully by extrapolating data and whether the data collected could inform management decisions (Jones & Bell 2013). The results showed a complex and varied hydrological regime across the site, with water-tables both perched and at depth. Locally, and episodically, water levels fell below the top of the archaeological deposits, suggesting the site was at risk of desiccation. Consequently, the authors concluded that hydrological monitoring of the site should continue, and keyhole excavation to examine the current preservation status of the remains was advised (Jones & Bell 2013: 123).

MESOLITHIC SOMERSET LEVELS

The NHPP provided funding for Martin to investigate the relatively under-researched evidence for Mesolithic activity in the Somerset Levels, and develop a framework and guidelines for assessing the significance of buried Early Holocene sites at the wetland margins (Bell *et al.* 2016). Borehole surveys, geophysics and test pits were used to look for evidence of Mesolithic and Early Neolithic activity, and located two stratified Late Mesolithic sites with palaeoenvironmental and palaeoeconomic potential. Borehole synthesis from four geoarchaeological projects provided data to reconstruct the contemporary landscape (see Wilkinson *et al.* 2021: this volume, Chapter 9). In

addition, the partnership project – which involved the Universities of Reading and Winchester, Somerset County Council Heritage Service and The Natural History Museum – undertook an audit and update of HER data for the Mesolithic in Somerset, resulting in a 40% increase in entries (Bell *et al.* 2016: 14).

2015 – 2021 CONTEXTUALISING WETLANDS AND MANAGING CHANGE

HISTORIC ENGLAND AND WETLANDS

April 1st, 2015 marked the division of English Heritage into two new bodies, Historic England and English Heritage Trust. Historic England became the common name for the Historic Buildings and Monuments Commission for England, the public body that protects the historic environment. English Heritage Trust, tasked with caring for and presenting the National Heritage Collection of more than 400 state-owned historic sites and monuments across England, became a charity.

Coincidentally, 2015 also marked a shift of approach, from viewing wetlands as a specific thematic area of research, to one which places the archaeology of wetlands within the broader context of contemporary archaeological evidence from other habitat and landform categories, an approach advocated by Bell (2020: 133).

MODELLING POTENTIAL

Many sites are unexpected discoveries and whilst it will never be possible to accurately predict the location of individual sites and important palaeoenvironmental sequences, there are methods of assessing landscapes that can be used to flag areas of higher archaeological potential by modelling the sub-surface deposits in terms of their depth, character & chronology. Promoting this approach and developing guidance to help people put it into practice was identified as priority in both the revised wetland strategy and NHPP (Heathcote 2012; Historic England 2012). Then, the call was to use the approach to model wetland and waterlogged potential and provide guidance for geoarchaeological deposit modelling in peatland and alluviated contexts, although, clearly, such an approach does not need to be specific to wetlands. The shift away from segmenting wetland work allowed a broader approach to be taken and projects were developed to a): agree best-practice with experts and clients; b): create a collection of real-world case studies to show the range of models that might be useful together with details of their construction (Barnett *et al.* 2021: this volume, Chapter 11; Carey *et al.* 2018); and c): guidance for how to do it (Historic England 2020).

MARTIN AND WETLANDS

Emphasising that wetland information should not stand in isolation, Martin's recent research has explored new aspects to demonstrate how it should be considered in relation to dryland archaeology (Bell 2020: Chapter 6). He acknowledged that the relationship between wetland and dryland activity was rarely achieved due to the typical lack of complementary evidence (Bell 2020: 133). However, using the topic of trackways and communication networks, he highlighted cases where the orientation of trackways across wetlands had been used to infer the location of activity on dry ground, e.g. at Shapwick in the Somerset Levels and in the Cambridgeshire fens at Flag Fen/Fengate.

WETLAND MATTERS

Wetlands are valued for the habitats they support, the material culture and evidence of human activity they may contain, and the cultural heritage that shapes their landscape character. They are places that allow us to see details of ancient lives at a relatable scale – footprints, tools and toolmarks, textiles and textures – thus animating the past. Wetlands are places that let us see environmental change over a wide range of timescales (daily, seasonal, decadal, millennial) and reveal human responses to those changes locally and regionally. And they are places where we begin to understand the intimate, iterative relationship between environment and people; people shape land, and land shapes people (Bell 2020: 162). Martin's research has always captured this.

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Chapter 15

Wildwood, wood-pasture and rewilded woods: palaeoecological perspectives from ancient woodland

Petra Dark¹

ABSTRACT

In recent years approaches to landscape conservation and restoration have been heavily influenced by the concept of ‘rewilding’ – in which management of previously intensively farmed land is relaxed and modified or totally suspended, allowing a return to a more ‘natural’ state. A key feature of the approach in lowland temperate contexts is regeneration of woodland, and debate has focussed especially on the nature of this secondary woodland and its management. A major influence has been the work of Frans Vera, emphasising the role of wild herbivores in creating and maintaining an open woodland structure. There has been considerable debate over the extent to which the original natural woodland of Europe, prior to the advent of farming, may have had such a structure, informed especially by analysis of pollen and beetle remains, but aspects that have received less attention are what palaeoecology can tell us about the processes and outcomes of woodland regeneration when it followed land abandonment in the past, and how grazing by domesticates may have influenced the long-term development of the species composition of woods. This paper uses pollen sequences from woods in lowland southern England to illustrate their varied origins and histories, and the extent to which their current vegetation reflects their past. Key factors that emerge are the variability of trajectories in woodland development, and the extent to which human activity has influenced these, even in what might be considered primary woodland. The implications of the results for approaches to rewilding in the twenty-first century landscape are considered.

Key words: *rewilding; pollen analysis; woodland regeneration; medieval Royal Forest*

INTRODUCTION

In recent years approaches to landscape conservation and restoration have been heavily influenced by the concept of ‘rewilding’ – in which management of previously intensively farmed land is relaxed and modified, or totally suspended, allowing a return to a more ‘natural’ state (e.g. Tree 2018). The means and motivations involved vary widely – including both passive and active/interventionist approaches (see O’Connor 2021: this volume, Chapter 16) – but a key feature in lowland temperate contexts is colonisation by scrub then woodland. Much debate has focussed on the nature of this secondary woodland and its management, influenced greatly by the work of Frans Vera (2000) who emphasised the role of large herbivores in creating and maintaining an open woodland structure. According to Vera, ‘the original vegetation in the lowlands of Europe is a park-like landscape ...’ (Vera 2000: 376) and ‘wood-pasture should be seen as the closest modern analogy of this landscape’ (Vera 2000: 370).

In formulating his hypothesis, Vera drew on evidence for woodland structure from pollen analysis, arguing that pollen sequences under-estimate the degree of landscape openness due to the relatively high pollen productivity of trees growing in open conditions compared to those in woodland, the filtering effect of ‘mantle’ vegetation, and reduced grass pollen productivity when grazed (Vera 2000: 93–94). Subsequent debate over the character of the original natural vegetation of Europe (see overview in Hodder *et al.* 2005) has been able to draw on a larger body of literature concerning pollen dispersal and deposition, from a wider range of site types (e.g. Mitchell 2005), and, crucially, has included other environmental proxies, notably beetle remains (Whitehouse & Smith 2010). Today, the consensus, among palaeoecologists at least, is that the evidence does not support the interpretation of the Early-Mid Holocene landscape of lowland western Europe generally as park-like, and it seems that extensive grassland was usually only a feature of this region from the Neolithic and later. This is not to say that the Mesolithic landscape was clothed with vast unbroken tracts of forest – rather it had a mosaic-like character with woodland interspersed with more open areas reflecting the influences of topography, soils, cycles of woodland

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regeneration/succession, concentrations of herbivores and human activity, the latter perhaps especially in ‘edge’ environments such as around lakes, rivers and the coast.

Two aspects of Holocene vegetational history directly relevant to rewilding, but that have received far less attention than the woodland openness debate, are what palaeoecology can tell us about the processes and outcomes of woodland regeneration when it followed land abandonment in the past, and how woodland responded to different levels of disturbance (including grazing) short of actual clearance, i.e. the impacts on species composition rather than structure. In the context of the present landscape the outcomes of rewilding former agricultural land can be expected to be heavily dependent on a number of variables, including previous land use, soil conditions, nature of surrounding vegetation and thus seed sources, presence of wild and domestic herbivores, etc. These variables will all most likely have differed considerably in the past, and thus the vegetation that develops could not be expected to resemble the original ‘natural’ state of the site. Pollen analysis offers the opportunity to assess the relationship between the original vegetation on a site and that which developed following abandonment of cleared land, on timescales of centuries and millennia, offering an important long-term perspective which can complement necessarily shorter-term ecological monitoring (e.g. Harmer *et al.* 2001).

This paper uses pollen sequences from wooded sites in lowland southern England – with a particular focus on the near-complete Holocene pollen sequence from Sidlings Copse, Oxfordshire – to examine the origin of the woodland on the site today and the extent to which its current composition reflects its long-term history. All are within the area where lime (predominantly *Tilia cordata*) was widespread in the later Mesolithic period (Greig 1982). As both native species of lime (*T. cordata* and *T. platyphyllos*) are especially susceptible to grazing (Pigott 2020), pollen data from this region provides a useful barometer of the possible long-term effects of large herbivores, as well as other disturbance factors, on woodland history, and a contrast to the focus on oak (*Quercus* spp.) and hazel (*Corylus avellana*) which characterises the Vera debate.

POLLEN ANALYSIS, WOODLAND ORIGINS AND WOODLAND REGENERATION IN THE ENGLISH LOWLAND LANDSCAPE

Pollen analysis from many sites across Britain shows a general picture of extensive woodland cover in the Mesolithic period – the composition of which varied regionally (Bennett 1989) – followed by progressive clearance beginning at various dates from the Neolithic through to the Roman period and after (Dark 2000: figures 3.3a-b). Pollen sequences that could be interpreted as indicating continuous tree cover following the early Holocene development of woodland are few indeed. More commonly, pollen data provide evidence of changing proportions of woodland in response to variations in local land use, climate change, or a combination of these. The pattern at individual sites varies greatly, but there are some periods when land abandonment was more common than others, notably towards the end of the Bronze Age (Dark 2006) and in the aftermath of the Roman period (Bell & Dark 1998; Dark 1996, 2000: chapter 5). While woodland that regenerated during these episodes may have persisted to the present day, frequently this secondary woodland was later itself subject to clearance as pressure on land use increased.

This long-term variation in woodland cover is especially clear in the long pollen sequence from Sidlings Copse, Oxfordshire – a site conventionally described as ‘ancient woodland’, both in terms of historical evidence for its existence prior to 1600, and its extensive list of ‘ancient woodland indicator’ plants, but which pollen analysis shows to have a long history of clearance and regeneration (Day 1991, 1993). The site is instructive in relation to several aspects of debates around rewilding, including the character of the pre-clearance woodland (for which, highly unusually, both pollen and molluscan data are available due to the tufaceous nature of much of the Early-Mid Holocene part of the sequence), the nature of the woodland that regenerated in response to changing local land use, and the palynological ‘signature’ of a medieval Royal Forest.

SIDLINGS COPSE AND THE ROYAL FOREST OF SHOTOVER AND STOWOOD: REWILDING IN THE MEDIEVAL LANDSCAPE?

Sidlings (also known as Sydlings) Copse is today a small (3ha) wood dominated by ash (*Fraxinus excelsior*), field maple (*Acer campestre*), hazel and oak on the slope of a minor valley 4km north-east of Oxford. The wood mainly overlies Corallian limestone and sands and is rich in ‘ancient woodland indicator’ species, including wood anemone (*Anemone nemorosa*) (Figure 1) and dog’s mercury (*Mercurialis perennis*). Sidlings Copse, and the adjacent Wick Copse, are the remains of a larger block of woodland, depicted on a seventeenth-century map, that lay within the Royal Forest of Shotover and Stowood, first mentioned in Domesday Book (Day 1990). The woodland within the Stowood portion of the Forest, of which Sidlings Copse was part, was divided into nine coppice compartments (‘copses’),

bounded by earthworks intended to keep animals out of recently coppiced areas to avoid damage to the regrowth. The pollen sequence from a small wetland in the valley bottom towards the eastern end of Sidlings Copse demonstrates that this medieval woodland was not related to the original primary woodland on the site and that in fact there had been several episodes of major woodland disturbance/clearance prior to the medieval period.

Figure 1. Wood anemone (*Anemone nemorosa*), an ‘ancient woodland indicator’ present at Sidlings Copse today. Its pollen was recorded only in the medieval and later part of the sequence, when the woodland was managed as coppice with standards.

Figure 2 shows pollen percentage data for selected taxa from the site (for full data see Day 1991), from which three main wooded episodes can be identified – primary woodland that developed in the Early-Mid Holocene, secondary woodland that formed after major disturbance (probably involving grazing and cultivation) in the Late Neolithic and Bronze Age, and what might be termed tertiary woodland that regenerated following clearance of the secondary woodland towards the end of the Roman period. The character of each of these woodland episodes differed considerably.

PRIMARY WOODLAND

The first half of the Holocene saw the successive arrival of arboreal taxa – birch (*Betula*), pine (*Pinus sylvestris*), hazel, elm (*Ulmus*) and oak – culminating in woodland dominated by lime on well drained soils by the end of the Mesolithic period. Beech (*Fagus sylvatica*) arrived locally at about the same time as lime (c. 8000 cal BP), but never became established as a significant woodland component. Pollen of herbaceous taxa most likely to have been growing on well-drained soils was very sparse – Poaceae (grasses) never exceeded 5% of the pollen sum (% total pollen and spores excluding aquatics) between c. 10,500 and 4500 cal BP – suggesting a closed woodland canopy away from the immediate site of deposition. Pollen of *Bidens* type was abundant in some samples from the tufa, but undoubtedly over-represented due to its resistance to corrosion, and probably attributable to the wetland plant hemp agrimony (*Eupatorium cannabinum*), the seeds of which were common in the corresponding deposits. The pollen evidence therefore suggests closed canopy woodland on well-drained soils around the site, with more open conditions on the waterlogged area.

The molluscan sequence shows the early Holocene replacement/decline of species of open ground, notably *Vertigo angustior*, by those indicating shade, such as *Carychium tridentatum*, corresponding with the development of hazel-rich woodland at around 10,500 cal BP (Preece & Day 1994). The seemingly rapid expansion of lime at c. 8000 cal BP was accompanied in the molluscan assemblages by the first appearance of *Oxychilus cellarius*. The presence of *Oxychilus* suggests a possible reduction in shading, which might seem at odds with the increase of lime (and alder), but it may be that the trigger to the expansion of these trees was the creation of minor openings in the existing woodland due to later Mesolithic human activity – microscopic charcoal particles are consistently present in the corresponding part of the sequence (Day 1991).

Figure 2. Summary pollen percentage diagram from Sidlings Copse showing woodland phases. Selected taxa only are shown, excluding wetland herbs and ferns. The sum for calculations is percentage of total pollen and spores, excluding those of obligate aquatics. The suggested chronology is based on a series of radiocarbon dates (for details see Day 1991; Preece & Day 1994).

More unequivocal evidence for canopy disturbance comes some two millennia later with the classic Neolithic elm decline, here accompanied by a marked decline of lime and increase of hazel, with declines of several shade-demanding mollusc taxa and major increases of *Leiostyla anglica* and *Oxychilus cellarius*. This seems to represent a period of disruption of the canopy rather than woodland clearance – perhaps due to grazing and/or harvesting of leaf fodder, which may in turn have encouraged the spread of a disease of elm similar to Dutch elm disease (now generally accepted to explain the overall character and especially rapidity of the elm decline in Europe (Parker *et al.* 2002)). This disruption was followed, later in the Neolithic, by a return to the *status quo* in terms of woodland composition.

Elm underwent a second and final decline at the end of the Neolithic period, accompanied by a sharp drop in hazel and a slower and final decline of lime. During this phase pollen of ash and field maple (both trees that are strongly under-represented in the pollen record, but significant components of the woodland at Sidlings Copse today) is consistently present, suggesting, along with the rising curve for pollen of grasses and first consistent presence of ribwort plantain (*Plantago lanceolata*), that the woodland had a relatively open character. Lime disappeared locally in the Early Bronze Age, accompanied by declines of all other arboreal taxa to such low levels that it seems that primary woodland must have disappeared from the site, perhaps leaving scattered oaks and patches of hazel. At this point local arable farming is indicated by the first records of cereal pollen, followed by the development of extensive areas of bracken (*Pteridium aquilinum*) nearby.

PREHISTORIC SECONDARY WOODLAND

After around 800 years of open conditions, secondary woodland began to form in the Late Bronze Age/early Iron Age, comprising oak and hazel and apparently at the expense of bracken. A ready seed source for these trees would have been available as the pollen record indicates persistence of both in the area, as noted above. This secondary

woodland differed greatly from any of the phases of primary woodland – lime and elm were almost completely absent – and was far less extensive. It also seems to have been more open in character, in view of the abundant pollen of herbs and spores of bracken, and may have been managed – perhaps by coppicing. Dog’s mercury was present – its first appearance in the sequence corresponding with the final decline of lime. It is interesting that lime was able to recover from the disturbance at the time of the Neolithic elm decline, but not that of the Bronze Age, suggesting the loss of trees by prolonged heavy grazing and/or felling. It is also possible that climate change created conditions unfavourable to recolonisation by lime, the Late Bronze Age/Early Iron Age coinciding with a period of climatic deterioration that may have triggered changes in land use at some sites (Dark 2006).

This secondary woodland itself underwent further clearance in the Late Roman period, to the extent that by the end of that period there can have been little or no woodland left on well-drained soils at the site. Conditions then remained open – with pollen evidence for local cereal cultivation – for around seven hundred years, until approximately the eleventh century, at which point woodland regeneration began again.

MEDIEVAL TERTIARY WOODLAND

Renewed woodland regeneration from around the eleventh century again involved especially oak and hazel. The abundance of oak, and herbaceous pollen types, both probably reflect management by the coppice with standards system, and perhaps also the practice of pannage (in which pigs were released into woods in late summer/autumn to feed on the acorns), which textual sources indicate operated in the Forest during the medieval period (Day 1990).

The origin of today’s woodland in around the eleventh century is especially notable, as it corresponds with the period when the area obtained its Royal Forest designation. Medieval Royal Forests were places of deer and not necessarily trees (Rackham 1990: 165), although many did contain woodland. It seems that grazing and cultivation at and around the present Sidlings Copse declined or ceased, allowing woodland to return. In a sense, then, the imposition of Forest Law led to what might today be considered rewilding, although the resulting woodland came to have a much more open structure than the primary woodland of the Mesolithic due to coppicing, as well as an entirely different composition. Cartographic sources indicate that the full extent of this woodland was considerably greater than today, Sidlings and Wick copses, and Stow Wood further north, being all that remains of a block of nine copses which were cleared following the removal of Forest Law in 1660. The nature of the current woodland represents the combined effects of regeneration under a new land-use regime that limited or prohibited local farming, with seed arriving predominantly from local hedgerows, with later (discontinuous) management of the woods in a coppice with standards system in which animals were excluded for at least part of the cycle.

OTHER WOODLAND HISTORIES

There are few other woods from lowland England with pollen sequences which can be compared with that from Sidlings Copse, but Epping Forest and the New Forest have both been the subject of detailed pollen-analytical investigation and both benefit from the availability of textual sources for the medieval and later periods, providing evidence of their management. Whereas Shotover and Stowood was a compartmented Forest, with the coppices protected from grazing animals for at least part of the cycle, Epping and the New Forest were mainly uncompartmented wood-pasture, animals being allowed to mingle with the trees which were cut at around head height (pollards) so that the regrowth was out of reach.

EPPING FOREST, ESSEX

Epping Forest today is a substantial (over 2400ha) expanse of woodland and grassland, the woods being dominated by beech and birch (*Betula pendula*) on freely draining sandy soils and oak (*Quercus robur*) and hornbeam (*Carpinus betulus*) on those overlying London Clay. The original pollen sequence from Lodge Road bog (Baker *et al.* 1976) (Figure 3) suggested that the site had been dominated by lime (with oak and hazel) woodland into the Roman period and beyond, but more recent pollen analysis and radiocarbon dating by accelerator mass spectrometry (Dark 2017: fig. 2.3; Grant & Dark 2006) indicates that the decline of lime was actually earlier, beginning in the first half of the Roman period. This was accompanied by a decline of oak and major increase of birch and then expansion of beech and, to a lesser extent holly (*Ilex aquifolium*) (Figure 4), clearly reflecting disturbance but apparently not significant clearance – the proportion of herbs, including grasses, remained low (Poaceae reached only c. 10% of a pollen sum equivalent to that used at Sidlings Copse at this stage). The most likely explanation is grazing of domestic stock – perhaps in a form of wood-pasture. The proportion of grass pollen approximately doubled in the medieval part of the sequence, in the context of the fully developed wood-pasture system. Hornbeam became more prominent at this time, while oak and hazel declined, resulting in a woodland composition similar to that of today, although with less birch.

Figure 3. Lodge Road Bog B, Epping Forest. Note ancient pollard beeches in the background.

The last couple of centuries have seen a major increase of birch in the Forest, apparent not only in the Lodge Road pollen sequence but also in a shorter sequence from the artificial late nineteenth-century Baldwin’s Pond towards the eastern edge of the Forest (Boreham & Moxey 1997). Boreham and Moxey note how fluctuating grazing intensity (by cattle, deer and rabbits) in the nineteenth and twentieth centuries led to variations in the quantity of scrub and birch woodland, a major phase of regeneration following the population crash of rabbits in response to myxomatosis in the 1950s. Recent decades have seen further changes reflecting differing management regimes and their effects on shading and soil conditions (Rackham 2006: 415–427), currently including grazing by longhorn cattle.

The Epping Forest pollen sequences therefore demonstrate that while woodland now on the site is arguably primary (assuming that there was no major clearance before the start of the Lodge Road sequence, probably in the later Neolithic period), it has undergone significant changes in composition and structure over the last two millennia. The medieval wood-pasture was quite different in composition from the woodland of prehistory, not only in terms of the virtual or complete absence of lime, but also the lesser abundance of oak and hazel – in direct contrast to the what might be expected from the Vera hypothesis. By the medieval period, it seems, the woodland had been managed for centuries, and had a far more open structure than that of prehistory. The character of the Forest today is largely a reflection of abandonment of that management – especially pollarding – in the late nineteenth century.

Figure 4. Comparison of changes in the predominant tree taxa over time in pollen sequences from Sidlings Copse (Stowood Forest), the New Forest and Epping Forest. For the New Forest, information from the separate pollen sequences from Church Moor and Barrow Moor has been combined, as the former contains a substantial hiatus and the latter covers only the second half of the Holocene. Based on data from Day (1991), Grant & Edwards (2008) and Grant & Dark (2006).

THE NEW FOREST, HAMPSHIRE

Like Epping, the New Forest contains extensive areas of beech woodland, accompanied by oak (*Quercus robur*), and has also been grazed for centuries at least, continuing to the present day (Newton *et al.* 2013). Here, however, beech did not become a significant component of the woodland until the medieval period or later, its expansion occurring at different dates in different parts of the Forest (Grant 2005; Grant & Edwards 2008). Pollen sequences from Church Moor and Barrow Moor in Mark Ash Wood (Grant *et al.* 2009) show that there was originally oak-hazel-lime woodland on well-drained soils, lime declining in the Bronze Age accompanied by an increase of holly and bracken, again probably attributable to grazing (Figure 4). Later survival of at least localised areas of lime in the Forest is suggested by the place-name Lyndhurst ('lime-grove') (Rackham 2003: 241), and the presence of lime pollen into the post-medieval period in the pollen sequence from nearby Gritnam Wood (Grant & Edwards 2008).

As well as a different species composition, the original Mesolithic woodland clearly had a more closed character than the medieval wood-pasture, grasses generally comprising less than 10% of the pollen sum (% TLP excluding *Alnus*, Ericaceae, Cyperaceae, aquatics and spores) compared to 15–20% in the medieval period. Once more, the character of the New Forest woods in the medieval period bore no relation to their original composition and structure, and further change has occurred in recent centuries in response to changing management practices (Rackham 1990: 173–174).

DISCUSSION

Comparison of the histories of woodland in these three Forests, the vegetation of which may have been similar in the Mesolithic period, demonstrates the extent to which human activity, probably especially through the medium of livestock, created differing trajectories of woodland development. A key factor appears to be the susceptibility of lime to grazing. As Donald Pigott, in his recent definitive account of *Tilia platyphyllos*, states: 'both native species of *Tilia* are very vulnerable to both types of damage [browsing and barking] from deer, sheep, and cattle and their seedlings and saplings almost eliminated' (Pigott 2020: 2654). In terms of the Vera hypothesis, if wild herbivores had been sufficiently numerous to create and maintain a park-like Mesolithic landscape, it seems that lime could not long have survived as a significant component of it.

While lime was an important, and often dominant, component of the later Mesolithic woodland of much of lowland England, pollen sequences record its decline at different dates in different areas later (Grant *et al.* 2011). Of course, some areas of lime woodland survive in lowland England today, including in parts of East Anglia and the Wye Valley. The reason for their current restricted distribution is puzzling and, as Oliver Rackham (2003: 253) notes, 'must depend mainly on historical events whose effects are irreversible'. There are no long pollen sequences available from an extant limewood, but a preliminary pollen sequence covering the medieval period and later has been obtained from the edge of Shrawley Wood, a lime (*T. cordata*) wood on the banks of the River Severn in Worcestershire. This suggests an abundance of lime in the medieval period, declining in more recent times. The very low levels of lime pollen in the near-surface samples seem to reflect its limited dispersal (Richer 2017), the assemblages instead being dominated by pollen deposition from vegetation on the site of sediment accumulation and beyond the woodland edge.

For lowland England at least, human activity has clearly been a driving force in development of the variety of woodland types present today, their composition depending on the nature of disturbance combined with factors such as soil type, topography, seed sources etc. Exploitation of the woods' resources triggered changes in species composition, including increases of grazing-resistant taxa, such as holly, or those which arrived relatively late following the climatic warming of the early Holocene, and which would otherwise have remained minor canopy components due to competition, such as beech. Where woodland was removed but then later able to return, oak and hazel were especially significant, probably accompanied by the palynologically under-represented ash. This pattern is apparent not only in both regeneration phases in the Sidlings Copse sequence, discussed above, but also in more limited 'snap-shot' data from pollen analysis of the fills of archaeological features in woodland in Pamber Forest (Hampshire) and Hatfield Forest (Essex). In Pamber, pollen from Iron Age ditches in two of the coppice compartments of the later Forest indicate that it was at least partly open and probably farmed in the Middle Iron Age, followed later in the Iron Age by regeneration of oak and hazel (Dark a, b in prep.). Archaeological evidence for post-Iron Age disturbance, probably including ploughing, indicates that part of the present woodland of oak and hazel may be of even more recent origin (Barnett & Fulford in prep.). Similarly, pollen analysis of a ditch fill from the Portingbury Hills earthwork enclosure in Hatfield Forest suggests at least locally open conditions, including cereal cultivation and grazing, in the Late Iron Age, followed by regeneration of hazel and oak (Young *et al.* 2018). Birch and hornbeam are recorded only at very low levels in the pollen assemblages, yet both are

prominent features of Hatfield today. The timing of the hornbeam increase remains uncertain, but Rackham (1989: 222–224) suggests that the rise of birch is a recent phenomenon resulting from twentieth-century management.

Beyond this region, pollen sequences from other woods in Britain and more widely in western Europe demonstrate further the extent to which, even on sites with a long history of tree cover, the nature of the woodland as we see it today owes its character to a combination of the period of time over which the site has been wooded and recent and ongoing management practices (e.g. Bradshaw *et al.* 2015; Brown 2010; Edwards 1986; Mitchell 1988; Shaw & Whyte 2013).

In terms of rewilding, it is apparent that attempts to recreate a perceived ‘original’ wooded state face the problem that woodland is highly dynamic on timescales of millennia, centuries and even decades, as well as regionally variable. At any particular location, woodland 8000 years ago will have been very different from that 4000 or 2000 years ago, even if the site remained wooded. Furthermore, the types of disturbance operating in those woods, and contributing to their composition and structure, will also have varied over time in ways which could not necessarily now be recreated. For example, despite Rackham’s memorable, and in most modern contexts doubtless true, observation that, apart from pine, native English woods ‘burn like wet asbestos’ (Rackham 2006: 56), there is growing evidence that fire may have played a role in the dynamics of deciduous woodland in the first half of the Holocene (Tsakiridou *et al.* 2020). As noted above at Sidlings Copse, and in pollen sequences from the New Forest (Grant *et al.* 2009) and more widely (e.g. Chambers & Elliott 1989), there seems to be an association between the expansion of alder and local fire, while evidence from the submerged forests of the Severn Estuary suggests later Mesolithic burning of hazel and possibly oak (Bell 2007a, 2007b; Dark 2007). In some, perhaps most, contexts the source of ignition was probably anthropogenic (Bennett *et al.* 1990), but it may have been a differing (more continental) climatic regime that allowed fire to spread into woodland in a way that would now be highly unusual in a lowland British context.

If the approach to rewilding is to allow woodland to regenerate on previously open ground naturally (by excluding or carefully controlling grazing), the new woodland may well bear no relation to anything that would have originally grown on the site due not only to the lack of variation in age structure but also the many ways in which the current environment differs from that of the past. These include climate (temperature, precipitation and seasonality), soils (erosion, structure, nutrient status), seed sources (loss of woodland, hedgerows and freestanding trees), competition from garden escapes (e.g. rhododendron), herbivory (new insect pests, increased deer numbers and introduced species such as muntjac and grey squirrels), pathogens (including chalara ash dieback (*Hymenoscyphus fraxineus*) and oak mildew (*Erysiphe alphitoides*)) etc. Furthermore, the development of secondary woodland can be expected to take decades at least, as the study of twentieth-century woodland succession on former farmland at Rothamsted Experimental Station, Hertfordshire, shows (Harmer *et al.* 2001), passing through an initial scrub/thicket phase in which diversity of the ground flora may be especially poor.

Planting new woods allows control over canopy species composition, and produces a more ‘woodland-like’ result more rapidly, but decisions have to be made about what to plant. Most projects will not have the luxury of a local pollen sequence to indicate the range of woodland types previously present, although there is now sufficient pollen data across much of western Europe to indicate the range of possibilities. In the face of climate change and new plant pests and pathogens, it may not be appropriate or possible to try to recreate former woodland types, and the focus should perhaps instead be on ‘futureproof’ communities resilient to these challenges, and which help to fulfil specific functions such as flood alleviation, soil stabilization and maintenance of biodiversity. Creation of new woods is likely to be most successful where there are surviving areas of ancient woodland and hedgerows to provide sources of seeds and spores to colonise the site, emphasizing the vital importance of conserving existing refugia of woodland species that can help to ‘naturalise’ rewilded sites and promote connectivity of woodland habitats.

Active rewilding itself can be seen as another form of land management in a landscape already shaped by millennia of human intervention, and one where the specific form of that intervention will fundamentally affect the outcome (Kirby & Baker 2013). Any particular action may have impacts beyond those intended. For example, it is now commonplace to introduce grazing animals – usually cattle – into woods to create or maintain a more open structure. Where woodland contains wetland areas – potentially a source of palaeoenvironmental information as at the sites discussed here – there is a danger that cattle may damage the wetland archive by trampling. Similarly, woodland ponds are sometimes dredged to prevent/reverse the natural hydrosereal succession that would eventually lead to their infilling with sediment and overgrowth by vegetation. Yet this sediment could potentially contain important clues to the long-term history of the site. Management interventions should have specific goals

appropriate to the site and a tailored preferably research-led approach to achieving them, with careful consideration of the potential consequences of that approach beyond the intended outcomes.

CONCLUSIONS

Grazing and anthropogenic disturbance (including use of fire) may have played a key role in shaping the pre-agricultural woodland of lowland temperate Europe, but probably by facilitating establishment of relatively late arriving arboreal taxa in a substantially wooded landscape rather than creating a park-like environment. With the arrival of substantial numbers of domesticates the impact increased, triggering changes in species composition of some woods and complete removal of others.

While ancient woodland is often seen as a relatively stable element of an otherwise changing landscape, pollen evidence indicates that it may owe its composition and sometimes even existence to past human activity. In a lowland British context – where lime was a dominant feature of large areas of woodland for much of the Mesolithic – ancient secondary woodland does not resemble the original woodland cover. Even where tree cover may have persisted continuously since the Mesolithic (as in Epping Forest and the New Forest) the current woodland composition is largely a reflection of relatively recent post-medieval management practices.

The outcome of woodland regeneration in the modern landscape can be expected to differ not only from any of the stages through which primary woodland developed on the site, but also from the character of secondary woodland that would have returned in the pre-modern period. Where planting is used to speed up creation of woodland it allows control of over the initial composition and structure of the canopy and understorey, but the future of the wood on a scale of decades and centuries will largely be determined by its management. As the Sidlings Copse example shows, recreating something akin to the hazel or lime-dominated woodland of the Mesolithic would arguably be more ‘natural’ than the intensively managed coppices of the medieval period, but would almost certainly have lower species diversity. As far as lowland British woodland is concerned, high biodiversity generally means high maintenance.

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EXPERIMENTAL EARTHWORKS AND BUILDINGS

One of Martin's interests had been the Experimental Earthwork project. Although not involved with the initial construction of these banks/ditches, he later assumed the role of being the lead for their continued investigation. The project predicated excavations at increasing intervals – 1, 2, 4, 8, 16, 32 years, etc. – to determine the structural, taphonomic and depositional changes over time. Martin became responsible for 32 year excavations, both for the linear earthworks at Overton Down (Wiltshire) and Wareham (Dorset) and the octagonal earthworks originally made by Peter Reynolds at Wroughton (Wiltshire), Butser and Fishbourne (Hampshire).

The team for the Wroughton excavation, 2015 (photo: M. Bell).

Getting up close before Jennifer and Martin record the section at Fishbourne in 2008 (photos: T. Walker).

The team also conducted excavations of several experimental Iron Age round houses such as the example below, the Moel-y-Gaer house at St Fagans, Cardiff, originally constructed by Peter Reynolds in 1992 and excavated at the end of its life in 2009.

The St Fagans round house during excavation (photo: M.Bell).

Chapter 16

Environmental archaeology and the wilding conundrum

Terry O'Connor¹

ABSTRACT

Landscape and wildlife conservation issues have been brought into sharp focus in England by the need to restructure farming and forestry post-Brexit, concerns over the consequences of climate warming, and enhanced public awareness through the increase in 'celebrity' naturalists. The desirability of 'wilding' extensive areas has been further boosted by the initial success of a few well-publicised projects. There is an active debate between advocates of 'passive wilding', removing all management interventions to allow land and biota to find its own trajectory, and 'interventionist wilding', by which species and landforms are actively restored. Landscape-scale environmental archaeology is well-placed to contribute to the latter approach, and can demonstrate and often moderate shifting baselines. Martin Bell and others have shown how the mid-Holocene saw reduction and fragmentation of primary woodland, slope destabilisation and colluviation, and the disruption of soil maturation. Archaeology shows recent environmental degradation to be a point on a long process of change, meaning that baselines for comparison could be taken arbitrarily anywhere on that long process. Molluscan evidence from northern England shows the former development and prehistoric removal of woodland habitats, even on limestone uplands. The use of prehistoric landscapes by individuals and small groups can be shown engagingly through the recording and analysis of human prints and trails. Finally, environmental archaeology delivered to the wider public can enhance the therapeutic value of today's landscapes by encouraging an understanding of the time-depth of today's 'natural world', the rate and complexity of the changes that are going on in it, and maybe even a sense of wonder.

Keywords: *rewilding; baselines; Neolithic; footprints*

REWILDING AND WILDING

Archaeology as a whole, and environmental archaeology in particular, act within the social context of their times. In the opening decade of this century, a prominent part of that context has been a deepening concern for the state of the British, especially English, countryside. The accelerating loss of uncultivated habitats, the numerical decline and range fragmentation of many plant and animal species, and the general homogenisation of the landscape have been the cause of much alarm and hand-wringing (e.g. see Lovegrove 2007). Although this is by no means a wholly contemporary challenge, the issue has been given a renewed focus by economic changes both within and beyond the UK that necessitate a wholesale reconsideration of how land is utilised and sustained. Public awareness of the issues involved and public engagement with natural history have been strongly promoted by an increasing number of media naturalists and conservationists. This is backed up by developments in sound and video technology that bring remarkable and deeply engaging imagery of the natural world into our homes. An urgent need for practical action has coincided with nature conservation attaining an unprecedented degree of public awareness, thus creating a time of real opportunity.

The response from what might be loosely termed the green community has shifted from familiar and all too oft-ignored calls to stop causing the damage, to more positive proposals for the 'rewilding' of areas of countryside that could be taken out of agricultural or forestry production. The rewilding concept originated in North America, where the intention was to take large areas of land out of production and to relocate most people out of those areas so that 'nature' could have a free hand to re-establish 'the wild' (Soulé & Noss 1998). Such an ambitious plan could only be practicable, if at all, on a continent that has large areas of very low human population density and low agricultural potential. The proposals derived in turn from the US 1964 Wilderness Act, and with the influential writings of philosopher and environmentalist Aldo Leopold. As the rewilding concept made its way to Europe, and especially to Britain, the scale and absolutism of the concept had to be rethought (Brown *et al.* 2011; Monbiot 2015). To rewild Britain on the scale intended by its American originators would involve handing, for example, the whole of Scotland or England north of Sheffield over to reclamation by nature. Much as that might appeal, it is the stuff

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of green fantasies, not reality. For that reason, this paper will use ‘wilding’ rather than ‘rewilding’ in order to maintain a distinction from the original rewilding philosophy.

An important split in the wilding debate is between those who believe that natural processes of colonisation and competition should determine the direction that any wilding project takes and those who advocate informed intervention, for example by seeding old farmland or introducing small populations of keystone species (Carver & Convery 2021). These two approaches are sometimes referred to as passive and active or interventionist wilding respectively. Passive wilding appeals by its purity, handing an area of land and its surviving biota back to nature, which it is assumed will somehow heal or repair the damage. This depends on seed bank and source populations being available to recolonise and may be subject to stochastic, not necessarily desirable, outcomes. An early instance of passive wilding, albeit not intentional nor of a ‘natural’ environment, was the growing-over of bombsites in European towns following the Second World War (Haigh 1980; Salisbury 1943). Large areas of brick and concrete rubble, sometimes with the remnants of adjacent garden areas, were left to await clearance and reconstruction, sometimes for 20 or more years. A few plant species established near-monocultures on bombsites, notably rosebay willowherb (*Chamaenerion angustifolium*) and buddleia (*Buddleia davidii*), both of which further benefitted when hundreds of kilometres of railway line were taken out of use in the 1960s (Carlsson 2017) (Figure 1). Passive wilding is vulnerable to opportunistic colonisation leading to very low equitability in the resulting biota, an observation that might be worth keeping in mind when we investigate abandoned Roman villas and urban locations.

Figure 1. Passive wilding. A former railway track about 60 years after closure (photo: T. O'Connor).

Interventionist wilding avoids the randomness of colonisation by putting in place core populations of what are seen as desirable taxa. To a large extent, this is an extension of conserving species such as hazel dormouse (*Muscardinus avellanarius*) by captive breeding and release in protected habitat patches. Subsequently, decisions have to be made

regarding further intervention, and some would argue for a wilded area, once repopulated, being left alone. However, this approach lost something of its appeal in the winter of 2017–18 when one of Europe's best-known wilding experiments at Oostvaardersplassen, Netherlands, suffered catastrophic and all-too-visible mortality of large grazing animals, their populations having greatly exceeded the winter carrying capacity of the reserve area (Lorimer & Driessen 2014; Theunissen 2019). In a truly 'wild' (or prehistoric) context, herds could have moved away into new areas in search of grazing, spreading their numbers more thinly across the land. In the densely-populated Netherlands there had to be fences, and the interventionist start of the process could not include large enough predators to keep the grazer populations under control.

The best-known wilding project in Britain, at Knepp Castle, Sussex, has run for sufficient years to show that areas of former intensive grazing, in particular, can be wilded surprisingly quickly and that the actively reconstructed biota attracts self-establishing populations of other species that contribute to more species-rich and ecologically complex communities (Tree 2018). Knepp's success in re-establishing, for example, a population of storks has received a great deal of positive media coverage. Less celebrated but in many ways more significant has been the increase in numbers and diversity of insects, contrary to national trends. Knepp's relative success so far has required intervention and the introduction of, for example, a herd of free-living pigs – 'wild boars' seems too loaded a term for them – to act as disruptors of topsoil and turf communities. Active wilding is thus more expensive than the passive approach, not only in providing the starter populations of species but in maintaining the staff to undertake monitoring and intervention.

Between active and passive wilding there is a fundamental difference in philosophy. Advocates of passive wilding are arguing that the biota should choose itself, that the outcome should be decided by the somewhat arbitrary processes of colonisation and competition, and that the outcome might therefore be unexpected. Active wilding requires an *a priori* objective. Any such project must know towards what biotic community and landscape it is directed in order to know which species should or might not be introduced, encouraged or extirpated. And that is where environmental archaeology comes in. Implicit, or sometimes quite explicit, in many wilding projects is an attempt to return to something that previously existed which therefore begs the question 'When?' This is the conundrum of the wilding debate, the problem of shifting baselines, for example the fact that a change in population of a given species over time could be presented as insignificant or truly dramatic depending on the baseline with which it is compared (Papworth *et al.* 2009; Pauly 1995). Because field ecologists prefer to use good-quality data, the tendency is to use relatively recent baselines, periods of time and places for which there are consistent records thought to give acceptable validity. For England, it is common to see current data compared with 'since 1950' or thereabouts. Given the likely consequences of the early 19th century enclosures, of agricultural extensification during the First World War and of intensification in the immediate aftermath of the Second World War, 1950 is not so much a baseline as an arbitrary point on a long and steep trajectory of change. Turn instead to earlier writers such as Gilbert White and the data become patchy and less reliable, albeit providing a longer timeline for comparison. Where could active wilding projects go for their baseline data from which to set their objectives? Given that one of the aims of such projects is often that of repairing the damage caused by agriculture, can archaeology suggest when agriculture began to cause significant lasting landscape change and biotic depletion (Hodder *et al.* 2009)?

NEOLITHIC CLEARANCE: WHERE THE TROUBLE STARTED?

As for many of us, Martin Bell's initiation into environmental archaeology will have included much discussion of Neolithic clearances, the inferred removal of large areas of primary Holocene woodland across mainland Britain as hunting-gathering gave way to agriculture. This inference derived initially from pollen sequences that showed substantial shifts in the ratio of arboreal to non-arboreal pollen coinciding with rises in weeds of cultivation and the first few cereal grains among the abundant Poaceae. In the near-absence of a pollen record for chalk landscapes, attention turned to land Mollusca as indicators of clearance through the work of A. S. Kennard and J. G. Evans, on which Martin's doctoral studies were built (Evans 1972). Whatever the proxy indicators, the inference was much the same: that the mid-Holocene saw widespread clearance and the emergence of arable and pasture habitats. This admittedly simple view came to be critiqued. More detailed studies questioned whether cereals and their cultivation actually played more than a minor role in Neolithic economies (Jones *et al.* 2007). There was, too, something of a tearing-down of old paradigms as the iconoclasts of the Post-Processual movement had centre stage. Our view of the Neolithic in mainland Britain today is far more nuanced and, to be honest, far less certain (e.g. Robinson 2014). Hotly debated but influential work by Frans Vera (2000), for example, has suggested that herds of ungulates such as red deer and aurochs would have kept Early Holocene woodlands at least locally open, creating grazed clearings akin to those seen in modern wood pasture. What is clear, however, is that the introduction of sheep and the close management of cattle led to the spread of grassland (*sensu lato*) habitats that were probably

scarce and localised earlier in the Holocene, and that this trend in landscape change continued through the 3rd to 1st millennia BC (Whitehouse and Smith, 2010). The homogenisation of British landscapes, especially through the lowland zone of England, was well under way by later prehistory.

Landscape changes seen in long sedimentary sequences such as those of chalk dry valleys underline the lasting impact (Bell 1983; Wilkinson 2003). Where palaeosols can be investigated under dry valley colluvium, surviving patches of Neolithic and earlier land surface give molluscan assemblages indicative of a less open landscape. The burial of those palaeosurfaces under colluvium itself signals a major change in the geomorphology, an increased degree of slope instability and erosion associated with molluscan faunas more typical of grassland and disturbed, perhaps arable, habitats. This is, of course, a very sweeping overview and there is much local detail, but the generality of post-Neolithic clearance and slope instability on chalk soils of central and southern England holds up quite well. In the north of England there has been much less systematic study. There is a tendency for chalk colluvium on, for example, the Yorkshire Wolds to be more decalcified than in the south, with consequently poor survival of molluscan faunas (Neal 2006). At the limestone hill of Hardendale Nab, on the borders of Yorkshire and Cumbria, Nigel Thew inferred a mosaic of scrub and grassland from Mollusca associated with a Bronze Age cairn (Williams *et al.* 2004). My own work on Mollusca from two cave sites in north-west Yorkshire confirms a degree of clearance even on this upland limestone landscape.

The Yorkshire Dales is a region of classic glaciokarst scenery where the Carboniferous Limestone bedrock is riddled with phreatic cave and shaft systems of great geological age, part-filled by clays and rubbles that mostly date from the last 18,000 years. Archaeological deposits are usually encountered either near the entrance of ‘walk-in’ caves, where a space not far underground has been used by people in prehistory for burial of the dead or other purposes, or deep in shafts, where material originally nearer to the surface has slumped and fallen deeper into the system over time (Lord & Howard 2013).

Figure 2. Thaw Head Cave and Twistleton Scar (photo: J. Thorp).

Thaw Head cave is located in the limestone cliffs of Twistleton Scars, north-east of the town of Ingleton, and is well-known for its later Neolithic and Bronze Age archaeology (Figure 2). A substantial snail sample came from

a layer associated with Grooved Ware pottery, accumulated just inside the original cave entrance, probably then slumping a little further into the cave as part of a mass-movement of sediment. Norber Cave, near Austwick and just a few miles south-east of Thaw Head, is a complex shaft that has yielded archaeological remains at several levels. The snail sample came from a well-sealed layer at the base of about 4m of deposit within the Upper Shaft and was associated with a number of flint and chert scalene microliths typical of the Late Mesolithic in this region (John Thorp *in litt.* & *pers. comm.*). The deposit sequence probably represents a series of inputs of sediment that originally accumulated in the shallow doline around the shaft entrance. These sediments periodically became destabilised and slumped *en masse* into the shaft below. It is worth noting that the great majority of shells from both samples were in good condition, with little sign of erosion or abrasion, and both samples included numerous juveniles. It is unlikely that differential destruction of shells has significantly affected these two samples.

	Thaw Head	Norber
<i>Acicula fusca</i>	R	-
<i>Carychium</i> sp(p).	O	O
<i>Galba truncatula</i>	R	R
<i>Azeca goodalli</i>	O	-
<i>Cochlicopa</i> sp(p).	C	A
<i>Pyramidella rupestris</i>	O	-
<i>Columella aspera</i>	O	R
<i>Vertigo pusilla</i>	R	R
<i>Vertigo substriata</i>	R	R
<i>Vertigo alpestris</i>	-	R
<i>Leiostryla anglica</i>	R	O
<i>Lauria cylindracea</i>	O	-
<i>Abida secale</i>	C	-
<i>Acanthinula aculeata</i>	O	O
<i>Spermodella lamellata</i>	-	R
<i>Merdigera obscura</i>	R	-

	Thaw Head	Norber
<i>Cochlodina laminata</i>	R	-
<i>Clausilia bidentata</i>	O	C
<i>Clausilia dubia</i>	O	-
<i>Arianta arbustorum</i>	O	R
<i>Cepaea nemoralis</i>	F	R
<i>Trochulus striatus</i>	F	-
<i>Trochulus hispidus</i>	F	R
<i>Punctum pygmaeum</i>	O	R
<i>Discus rotundatus</i>	A	A
<i>Euconulus alderi</i>	O	F
<i>Vitrea contracta</i>	O	C
<i>Vitrea subrimata</i>	O	-
<i>Oxychilus cellarius</i>	C	A
<i>Oxychilus alliarius</i>	F	A
<i>Nesovitrea hammonis</i>	F	F
<i>Aegopinella pura</i>	F	C

Table 1. Molluscs from Thaw Head Cave and Last of the Summer Wine shaft, Norber. Quantification follows: Abundant; Common; Frequent; Occasional; Rare. *Cochlicopa* sp(p). certainly includes typical *C. lubrica* and typical *C. lubricella* in Thaw Head sample, and a range of morphologies but less clear distinction in Norber. *Euconulus* specimens from both sites all show regular spiral striations on the base of the shell, hence their attribution to *E. alderi* rather than *E. fulvus*.

Table 1 lists a semi-quantitative indication of relative abundance. The first point to make is that these are quite diverse samples, especially for Thaw Head. Both caves will have had some rock-rubble habitat: the screes of Twistleton Scars for Thaw Head, and the eroding doline around the top of the shaft at Norber. It is therefore no surprise that species typical of limestone rubble habitats are seen in both samples, but are a more conspicuous element in the sample from Thaw Head. Norber lacks *Azeca goodalli* and *Abida secale*, both uncommon in Yorkshire today and particularly characteristic of open woodland or scrub on limestone rocks, and *Pyramidula rupestris*, which is a specialist rock-rubble species. On the other hand, *Oxychilus* species predominate at Norber. This may reflect the association in this shaft with bones of contemporary animals, perhaps showing that animal corpses were colonised by scavenging zonitids before their incorporation into the shaft sediments, a phenomenon seen in other caves in this region. Compared to modern faunas from the Dales, the presence of ancient woodland indicators such as *Spermodella lamellata*, *Leiostryla anglica* and *Acanthinula aculeata* stands out. So too does the relative scarcity of *Lauria cylindracea* and of helicid snails, which constitute the great majority of mollusc communities in the region today. The prevailing impression is that both caves were in a more wooded landscape, with the earlier sample from Norber particularly indicating the nearby presence of mature woodland with plenty of litter. Crucially, species of open grassland, such as *Pupilla muscorum*, *Vertigo pygmaea* or *Vallonia* species are conspicuously absent.

There is more that could be picked out of the detail, but the key point is evidence that even limestone uplands in northern England seem to have undergone some degree of mid-Holocene clearance. This is matched on adjacent sandstone hills by the presence of tree-root fossils at the base of later Holocene peat. The surviving Neolithic archaeology of the Dales region is sparse and mostly funereal and the topography is steep and irregular, making it at least arguable that this clearance was maintained predominantly by grazing livestock rather than crop cultivation. Today this is a heavily sheep-grazed landscape, and that impact looks to have mid-Holocene origins, much as it does in southern England. This is an important conclusion. Discussion of future landscape management

in the Dales tends to become bogged down in assumptions that open grassland is the ‘natural’ environment, while the palaeoenvironmental record, such as it is, and the persistence of fragmented woodland plant communities in the deep fissures of limestone pavement environments, indicate that this is not the case. The region certainly had browsing and grazing ungulates in the Early Holocene – the bones of red deer and aurochs are a common find in cave sediments (O’Connor & Lord 2013). However, these species had far less grazing impact than the close-cropping sheep and the rabbits that have become common over the last millennium.

What should be the baseline for any wilding project: the herb-rich meadows of 60 years ago or the mosaic scrub and woodland of 60 centuries ago? If government and charities such as the National Trust are to put resources into wilding schemes, there will be a need for specified objectives, a desired outcome. And if the objectives are defined in terms of restoration, of resetting landscapes to an earlier, pre-degradation form, environmental archaeology may find itself caught up in contemporary politics as different factions and interest groups cherry-pick the palaeoenvironmental record in search of support for their *a priori* stance. With great contemporary relevance comes great responsibility!

SETTING FOOT

Another aspect of Martin Bell’s work that is very pertinent here is the mapping of human tracks on their contemporary land surfaces (Bell 2020). The survival of footprints and trails in places such as Formby Point and the Severn foreshore is both remarkable and engaging (Figure 3). Like the potter’s thumb on an ancient potsherd, there is an immediacy about them. Trails that show how people moved through a particular landscape, especially whether certain directions were regularly chosen, bring us as close as we can hope to understanding how past individuals perceived their landscapes. Environmental archaeology can populate prehistoric landscapes with biota and geomorphic processes and discuss how that environment appears to us. Landscape-scale mapping of tracks and trails gives at least some indication of how the stage-set was used by its contemporary actors (Philp 2018; Roberts *et al.* 1996). That record may be quite patchy and limited to places that have a particular sedimentation record, but that makes it all the more deserving of investigation. Ancient human footprints are of more than curiosity value.

Figure 3. Human footprint in a Holocene intertidal land surface, Port Eynon, South Wales (photo: T. O’Connor).

GREEN PLACES FOR THERAPY AND WONDER

One other role of environmental archaeology that I want to mention is its capacity to give a time-depth to our contemporary landscapes. Recently, and rather belatedly, the medical world is waking up to the therapeutic value of regular access to green spaces and places that are not obviously of human construction. The talk is of the importance of ‘access to nature’, though that term is stretched to breaking point by including such wholly non-natural places as large municipal parks and arable farmland (Bell 2005; Korpela *et al.* 2016). The health benefits

seem to derive from moving through landscapes that are largely green and mostly consisting of living organisms such as grass, trees, sheep and birds. What environmental archaeology can do through good public communicators such as Martin Bell is to greatly enhance that therapeutic experience by giving people an understanding of the time-depth and processes of change that are inherent in their 'natural' surroundings. Local history groups are often very good at this on the timescale of a few centuries, giving people a closer engagement with the details of enclosures, watermills, droveways and placenames. Environmental archaeology can be a means of extending that sense of place into millennia. That in turn can open up debates over wilding and desirable outcomes by expanding and enriching the range of possibilities envisioned by the general public, in whose name and at whose expense landscape conservation and restoration is largely undertaken. Good public outreach in environmental archaeology can democratise the wilding debate, and imaginative presentations to local societies and schools are central to that process. It is very regrettable that current priorities in Higher Education in Britain leave its staff with little time and energy to devote to talking to the general public.

Much of the work that Martin Bell has undertaken in his long career has been directed towards showing the place and the role of prehistoric people in their larger contemporary landscapes, whether as prodigious agents of erosion or as solitary pedestrians on a muddy shore. Environmental archaeology's place today should be to show the long view of environmental change, to show that unaltered rural landscapes were not those of Gilbert White but of the earliest Neolithic, if then, and that there is no pre-Lapsarian 'natural environment' to which today's landscapes could be restored. It is certainly a challenge but also a great opportunity to make a constructive contribution to the ongoing wilding debate.

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Chapter 17

Using experimental archaeology at Butser Ancient Farm to interpret the cultural formation processes of ancient metalworking

Chris Speed¹

ABSTRACT

Martin Bell has long been associated with Butser Ancient Farm, a place which provides an ideal setting for long term experimental archaeology investigations. The use of reconstructed structures allows detailed questions to be asked about the formation of activity areas of known inputs in conjunction with records of use. The results can be applied to gain insights into patterns of soil chemistry and micro-artefact distribution on real archaeological sites. Statistical consideration of the chemical results hints that simply looking at chemical concentrations may conflate several formation pathways, making interpretations less robust. As well as showing activity areas, the patterns of soil chemical enhancement also reveal some limits to the precision that can be expected on actual sites. Simple suggestions are made for how sites such as Butser Ancient Farm could be even more useful when interfacing with academic experimental archaeology.

Keywords: *experimental archaeology; formation processes; soil chemistry*

INTRODUCTION

Soil chemical concentrations are routinely used in archaeology to delimit areas of historical metalworking (e.g. Aston 1998). While these samples are good at defining metalworking sites, the interpretation of activity areas within sites is more problematical. This is due both to the practical problem of taking sufficiently closely spaced samples to define the activity areas, and because epi- and post-depositional factors will move the chemical traces, making the areas cumulative palimpsests (Bailey 2007). The changes that occur between the creation of patterns in antiquity and the excavated archaeological record are known as cultural formation processes (CFP), and began to be investigated as part of the 'New Archaeology' in the 1970s (Schiffer 1983; Tani 1995). Experimental archaeology, where controlled, known, inputs are investigated using similar methods to those used on a real archaeological excavation, has potential to help disentangle these complex relationships. This paper will present data, derived from experiments within modern reconstructions at Butser Ancient Farm, Hampshire, UK, that help to interpret archaeological metalworking remains, and thereby to inform the degree of precision which we can realistically expect from this type of investigation on archaeological sites. The paper specifically discusses soil metalworking contamination, but after taking account of elemental chemistry, is likely to be valid for other chemical remains.

Butser Ancient Farm is an educational and experimental area originally started by Peter Reynolds (1979), to investigate Iron Age farming through experimental archaeology. It is an educational outreach and research resource and is one of several sites, such as St Fagan's National Museum of History in Cardiff much promoted and used by Martin Bell. The present site contains an octagonal experimental earthwork, within which are five reconstructed Iron Age roundhouses, and also a reconstructed Roman Villa, Saxon hall and several other craft buildings, with several still evolving. The reconstructions are based on excavated plans, but the building superstructures are conjectural. Physical reconstructions such as these play an important role in contributing to debates about the ways in which ancient buildings functioned, both for academics and lay-people. In particular, experimental study of the reconstructions can be valuable in allowing researchers to understand the formation processes of the archaeological record (Bell, 2009; Mytum and Meek, 2020). The interior experiments described in this paper took place in the Technology hut; a post built, earth floored, timber clad building of modern design (but with similar constructional features to Iron Age roundhouses), built on disused farmland of Upper Chalk geology (Figure 1).

Additional samples were taken from a single use exterior metal smelting area, and the research is discussed in more detail in Speed (2013). Within the Technology hut a group of hearths (typically five), were built around the central roof post as required for experimental metalworking demonstrations. The working area was sampled a total of six

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times (including a pre-work baseline sample) for soil chemistry over a period of four years. The duration of the sampling bridges the information gap between short term single sample experiments, relating to artefact production (e.g. Craddock & Timberlake 2004/5), and long duration studies such as the Experimental Earthwork Project (Bell *et al.* 1996), and thus should be well placed to investigate both initial patterns and epi-depositional changes to chemical patterning, and to optimise sampling strategies, given the archaeologically small targets that the hearths present.

Figure 1. The Technology hut under construction, showing structure and baseline soil sampling grid.

METHODS

Six sets of soil samples were taken over a period of 1200 days on a 0.5m grid set up across Technology hut floor metalworking area, at three different depths; 0–50mm (level A), 50–100mm (level B), and 100–150mm (level C), using a modified 20mm diameter soil gouge auger. This allowed both the temporal, spatial and depth aspects of soil chemical enhancement following metalworking to be investigated. Soil samples were air dried and sieved to sub-2mm for chemical analysis. Main and trace elements were extracted from the samples using pseudo-total *aqua regia* digests (British Standard BS 7755, 1995), and analysed by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), using a Perkin-Elmer 7300DV with cross-flow nebulizer. Butser Ancient Farm experimental metalworking consisted of episodes of lead casting and bronze making in connection with educational demonstrations. Analysis was therefore confined to lead and copper, although the ICP-OES concurrently obtained concentration measurements on around 40 elements. Tin was not measured due to spectral interference problems with the ICP-OES. Background levels of these elements was measured at 1m spacing in surface samples prior to the start of metal working, and were, for copper, 9.5 mg/kg (sd 2.61, n=18), and for lead, 23.9 mg/kg (sd 3.57, n=18), measured at 324nm and 220nm respectively. No spatial pattern in the background lead or copper values was evident on the floor area of the Technology hut prior to the beginning of work. After the start of metalworking, a permanent sampling grid 3x3m square was established within the hut, defined by aluminium tubes driven into the soil to ground level. During subsequent sampling visits, survey pins were inserted into these tubes to define 0.5m x 0.5m squares, giving a total of 36 sampling squares (Figure 2).

Within each square, a random sample was taken on successive visits, positioned using a drilled plywood template, which could be rotated and reflected (to a maximum of 8 positions) to avoid re-sampling locations disturbed by previous samples, while maintaining the same statistical sample distribution (Thompson *et al.* 1993). At each marked location, a sample was taken using a shortened gouge auger hammered 150mm into the hut floor, and the soil sample divided into three 50mm depth segments for analysis (Rowell 1994). There was a small risk of contamination of the lower samples by surface soil, but subsequent analysis showed there was negligible carry-over. Sequential samples were taken 260, 508, 800, 1187 and 1537 days after baseline sampling (day 0), following known metalworking events in the Technology hut.

Figure 2. Hearths within the Technology hut and permanent sampling grid.

Soil chemistry is very variable over short spatial distances, and in order to prevent the effect of single outlying values obscuring larger patterns, the soil chemical samples were considered as a whole statistical population (Sylvester *et al.* 2017). In order to make it more intelligible, the data were presented, using the method of Exploratory Data Analysis, as boxplot divisions of the statistical distribution of the concentration values (Tukey 1977). This is the method used in the Soil Geochemical Atlas of England and Wales (McGrath & Loveland 1992), as it makes no assumptions about the underlying statistical distribution of the data, and allows the position of anomalously high values to be seen and compared easily.

RESULTS

Soil metal contamination related directly to the intensity of metalworking was tested by comparing dates of metalworking events with the concentration and pattern found in soil samples. While there was a general build-up in metal concentration over time, it could not be related precisely to the smelting events that were carried out (Figure 3). It was difficult to directly relate the spatial concentration of increased soil lead and copper to the arrangement of the used furnaces in the Technology hut. Although there was an increased soil metal concentration in the general area of the hearths, this was not true at the finer scale of the individual hearths, which displayed highly variable readings. There were two main reasons for this; firstly epi-depositional processes such as trampling moved the contaminated soil and blurred any signature associated with a particular hearth, secondly that, although dates of smelting were recorded at Butser Ancient farm, no exact record of amount of ore smelted or metal produced was kept. This is essentially because the main business of this and most other ancient reconstructions is education and outreach, rather than experiment, meaning there is no diary or equivalent of a 'lab book' kept in which exact details of work is noted.

Figure 3. Median soil metal enhancement for the total sample area, as a percent of baseline value for each sampled level in the Butser Technology hut against sampling day and depth of sample. Pb (left), Cu (right) baseline values (100%) plotted at 0 days (n=33).

Another observation was that there was little depth expression of the increased soil metal concentration; virtually all the enhancement was confined to the top 50mm slice of the soil, and some limited observations suggested it was virtually all in the friable top 20mm of the soil (Figure 3). This is probably due to the dryness of the soil in the Technology hut; if these had been exterior hearths it is likely that rainfall would have washed unfixed chemical traces further down the soil profile.

The method of analysis, using pseudo-total *aqua regia* digest followed by ICP-OES (a standard method in archaeology), potentially allows conflation of different types of evidence which actually represent different formation pathways. Bulk sampling means anomalous very high soil metal concentrations cannot be distinguished from general soil enhancement within a sample area. It is thus possible that individual particles (such as metal spatter from furnaces, or spilt ore) could be confused with adsorbed soil metal enhancement. This is an important distinction, as the two types of enhancement represent very different formation pathways; in the case of individual high concentration particles this represents chance sampling, perhaps of trampled particles from outside the main activity area, and is represented statistically by outliers. Conversely the general enhanced soil concentration, shown by upper quartile statistical values, may better represent the activity area as a whole.

A worked example will demonstrate this. A 0.1g drop of metal working spatter (concentration 10,000ppm) was sampled within a generally inert soil sample, and incorporated into a 1.5g *aqua regia* digest. A second sample of generally contaminated soil (concentration 1000ppm) was digested as a second *aqua regia* sample. On digestion and analysis by ICP-OES, both these samples give a metal concentration of 667mg/kg. However, the first sample represents a chance sampling of a trampled drop of spatter from several metres from the sample site, whereas the second represents a generally contaminated activity area.

Precise description of contamination from individual metalwork hearths is thus not achievable experimentally in the Technology hut (or in most archaeological excavations) because of bulk sampling methods, post depositional processes, such as subsequent working, trampling and bioturbation. Two types of formation pathway are effectively homogenised by taking bulk soil samples, and so limit detailed questions that can be addressed about experimental (and by extension, archaeological) activity areas. Possible ways to disentangle this problem would be to sieve the bulk into two sample sizes (+/- 1mm?) and analyse these separately. Sample division by sieving would however double the number of samples, which is already near the practical long term work limit. It may be possible to distinguish these two formation pathways in sample populations, which may be represented statistically in one case by values above the boxplot upper quartile ('whiskers'), and secondly by the general geochemical enhancement (sample value/lower quartile) as representing the adsorbed contamination (Sylvester *et al.* 2017). Consideration of the metal concentration in the bulk soil sample alone may thus limit and bias the detailed interpretation of activity areas *within* a site, but may be inevitable with the use of bulk soil samples. By using a measure of soil geochemical enhancement (Sylvester *et al.* 2017), where element concentrations are expressed as the individual sample value divided by the lower quartile ('background'), this problem can be reduced, but not totally avoided.

Sequential sampling over a period of 1500 days did allow the general build-up of metal contamination within the soil of the Technology hut to be quantified. Lead enhancement increased to 500% of the mean baseline value, and copper to nearly 800%, but only in surface samples; levels at 50–100mm depth and 100–150mm depth remained at background levels (Figure 3). The fact that the metal contamination did not penetrate into the lower levels of the soil was probably a function of the soil dryness within the Technology hut. The dryness also meant the top 50mm was very friable, and thus prone to trampling, quickly spreading the soil metal contamination from its original position adjacent to the hearths. Thus even though the original contamination may have been closely confined to the smelting hearth (and thus defined the activity area precisely), the signature was soon diffused over a general activity area. This dryness is likely to be a general effect of interior metalworking facilities and may limit investigators' ability to define, precisely, small scale activity areas on archaeological sites using bulk soil chemistry alone. This trampling was demonstrated experimentally by the use of coloured plastic beads which were placed on the hut floor adjacent to the metalwork hearths, and whose movement was subsequently recorded. To some extent these beads showed movement pathways around the hut, and showed that trampling could extend over the entire floor area, and even outside of doorways. It also demonstrated some 'negative' patterning where the least used areas were where the beads subsequently collected. The experiment at Butser Technology hut was terminated due to an accidental sweeping of the floor to clean up. This was useful in demonstrating that this would be a likely occurrence in archaeological situations, and there too, could remove pre-existing activity traces.

Scuffing of the dry surface layers of the floor imposes its own patterning on the chemical traces (Schiffer 1983), in some cases creating an inverse relationship between high activity levels and low recovered artefact concentration. At the National Museum of Welsh Life, St Fagan's, Cardiff, and at Castell Henllys, Pembrokeshire, the excavations of replica Iron Age huts which had collapsed due to age demonstrated that many artefacts collected on inaccessible areas of the floor, such as beneath furniture and adjacent to walls (Bell 2009; Mytum & Meek 2020), thus the most heavily used areas were deficient in artefacts. The use of small coloured beads as tracers demonstrated a similar effect in the Butser Technology hut, showing soil movement from highly trampled areas around the metalworking hearths to the wall margins and even to the exterior, adjacent to doorways.

EXTERIOR METAL WORKING AREA

In addition to the metal smelting hearths in the Technology hut, an exterior area of 12 shaft smelting pits was built within the octagonal earthwork in June 2014. They were dug in grassland or on the side of a bank, with no other permanent infrastructure (Figure 4). These copper smelting furnaces consisted of shafts, typically 300mm in diameter and 300mm deep, dug to simulate single use smelting sites, and present a contrasting type of experimental situation sampled inside the Technology hut, representing structures that may archaeologically represent 'itinerant smiths'.

Figure 4. Butser Furnace 10 exterior copper smelting hearth. Scale 50mm total.

Sampling of these single-use exterior hearths adjacent to the Technology hut immediately after metal smelting showed that the chemical signature was essentially confined to the hearth itself, with contamination dropping rapidly radially away from the hearth (Figure 4). No subsequent sampling was carried out at the exterior site, so there is no information as to how the copper concentration decreased with time, or how the signature changed in spatial extent due to post depositional effects. These hearths were dug into a grassed area, reducing trampling, and there was no use of the hearths for subsequent smelting. These factors are both likely to have reduced trampling spread. Conversely, elution (the removal of an adsorbed substance by washing) by rainfall is likely to have increased the depth expression of the element concentration, although this would be element and soil specific, depending on initial soil fixation.

Counter-intuitively it may be possible to more precisely delimit short-term, external activity areas if the element sampled for is fixed immediately in the soil, rather than internal working areas where post depositional factors such as trampling may be more important in the subsequent element distribution. The problem with single use hearths such as these at the Butser site is that they are so small that they would be very difficult to detect archaeologically, and would demand very closely spaced sampling which would be impractical on most excavations.

CONCLUSIONS

Controlled, ideally replicated, experiments are needed to disentangle the many facets of archaeological formation processes, and experimental sites are one of the best ways to provide the framework for this. Experimental sites such as Butser Ancient Farm provide replica structures, similar to archaeological analogues; in addition they provide the commitment to continue experiments for extended periods, often combining the experiments with their main mission of education and outreach.

The results of the soil chemical analysis clearly showed a general area of metal enhancement within the experimental hearth area, building over the timescale of use to 500% (Pb) and 800% (Cu) of background values. However the changes were not directly correlated to episodes of metalworking as recorded in work diaries, or to the locations of the particular hearths used for the work. This was because trampling, sweeping and scuffing of the floor surface reduced any pattern almost immediately after formation especially as the chemical enhancement on interior dry floors is initially all confined to the superficial c. 50mm prone to scuffing. This pattern is to a large extent predictable ('negative' artefact patterning), and can be traced by coloured bead tracers. The implications for excavated archaeology are that areas with low artefact numbers (and by extension, low element concentrations) may mean high activity on some parts of archaeological sites. Chemical patterns on archaeological sites should be interpreted with this in mind. There was little depth expression of chemical contamination within the Technology hut. This should probably be regarded as an experimental artefact, and in more realistic situations a depth component of the element pattern would develop upon rain elution (when the metal working hut was abandoned and de-roofed). Exceptions may be in higher pH soils where the pattern may not change with rainfall due to element fixation. The 'room' rather than the 'hearth' may therefore be the practical limit of activity definition on archaeological sites.

Bulk soil samples using acid digests for analysis are likely to conflate different formation pathways. 'Areas of activity' are detectable in building floors, but detailed forensics of activities are probably only rarely possible, given sampling limits and bulk sample formation pathway conflation. Given the likely conflation in interpretations of bulk sample element data, there is a need to rigorously test whether the geochemical enhancement, and statistical whiskers of the sample value distribution do actually represent different archaeological formation pathways. The use of experimental archaeological facilities would be ideal for this type of experiment.

In contrast to the interior hearths where the metal working signature is spread by epi-depositional factors, the exterior, single-use hearths only showed increased element contamination in the immediate area of the hearth, and there was no penumbra of increased concentration. These hearths would be very difficult to find by sampling archaeological sites, as they are only 300mm in diameter, and there is no other infrastructure. Additionally, epi-formation processes may not spread contamination by trampling around single use hearths, especially if the area is stabilized by vegetation growth. Rainwater elution may increase the depth component of the chemical signature, depending on element fixation and soil type. It is likely, therefore that archaeological discovery would need prior suspicion in order to allot sufficient density of sampling to detect these types of hearths. It may be therefore possible to archaeologically underestimate this form of 'itinerant smith' single use metalworking.

Having identified these possible contrasting types of metalworking signature, experimental archaeology reconstructions such as Butser Ancient Farm are ideal places to test hypotheses. Methods to investigate these archaeological problems can be developed at experimental reconstruction sites (indeed it may be the only way) but would need more detailed record keeping such as building diaries (essentially the 'lab book'), which is only done on a small number of experimental archaeology sites such as Lejre (Rasmussen & Grønnow 1999). On many sites this may conflict with use of volunteers and with the primary mission of outreach, income from which allows the sites continued survival.

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BUTSER ANCIENT FARM, HAMPSHIRE

Fergus Milton¹

For several years, Martin Bell and Jennifer Foster brought their archaeology students from the University of Reading along to Butser Ancient Farm to carry out experimental activities.

Visits led by Martin were always informative and entertaining, as the students carried out a wide range of activities and experiments. The casting and testing of experimental Roman plumbata darts under the guidance of Dr David Sim was a popular activity, whilst Jennifer's pit cooking of a salmon encased in clay was both educational and delicious!

Probably the largest activity Martin oversaw was the cutting of trenches across the floor area of a construction of a large Iron Age roundhouse. The house was being deconstructed before building a replacement, so provided the perfect opportunity for the students to practise their trenching. The trench was extended to cut through the bank surrounding the Iron Age enclosure and was the first time in recent years that the earthwork construction had been examined in this way. This work was equally engaging and informative to both the students and the Butser staff.

Excavating the trench cut across the ditch and bank in 2004, with the Iron Age roundhouse in the background. The buried soil at the base of the bank is clearly seen in the right image (photos: M. Bell).

Martin's friendly and affable nature complemented the energy and enthusiasm of the Reading students on their visits. They had clearly always been well prepared by Martin and took full advantage of being in a location where aspiring experimental archaeologists could practice their craft.

To help Butser with our ongoing crop research, Martin also effected an introduction for us to The School of Agriculture at Reading. Through that, we were able to test how effectively modern crop processing equipment dealt with ancient types of cereal grains: not well, was the answer!

On another occasion, a passing remark I made about sourcing some iron ore was picked up by Martin and during fieldwork on the foreshore of the River Severn, he got the students to fill two dustbins with local ore for me. I was surprised and very grateful for the gift, but I imagine the suspension on the University minibus was less enamoured at having to deal with such weight!

Our collaborations with Martin and his students were always thoroughly enjoyable and enriching for us at Butser and we value the experience we had of working with him.

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Chapter 18

Footprints in the mind: a legacy of public engagement through the Living Levels Project

Alison Offord¹

ABSTRACT

It was very easy to write a paper about Professor Martin Bell's contribution to the Living Levels. Martin has left a profound footprint on those he was worked with and supported in the project, aptly echoing those etched into the shifting sands of the Severn Estuary which he has devoted much of his life to studying.

The Living Levels is a cross-organisational partnership set up with the help of Lottery funding to promote and reconnect people to the heritage, wildlife and wild beauty of the Gwent Levels in south-east Wales. At its heart Living Levels is about connections, or more accurately *reconnections*, between people and history, people and environment and just *people*. In landscapes like the Gwent Levels, which sits on a busy transport corridor for South Wales, these connections have been especially heavily eroded by the accelerated rhythms of post-industrial development. A steady accumulation of pressures has led the modern landscape to become degraded, undervalued and at risk from further development in spite of the vast wealth of natural, semi-natural and man-made treasures that this unique landscape harbours – many of which have been discovered by Martin and his colleagues.

The challenge in terms of community engagement for such a 'forgotten landscape' was therefore particularly great, and Living Levels has been very fortunate to benefit from Martin's dedication to public engagement. With everyone he encounters, Martin shares his boyish enthusiasm to uncover the story behind every find from clay pipe to animal bone to fragments of Second World War aircraft (just some of the finds unearthed by Martin's enthusiastic volunteers).

This is a tribute to his close involvement with Living Levels – to his work but also his *ways of working* and in particular his ability to relate to people of all ages and from all walks of life. These qualities make Martin unique – a real peer amongst peers. The paper will set out what the programme is achieving following the many threads Martin has been involved with. It will show the importance of building bridges between academic discoveries and public engagement. To demonstrate the importance of this, the story will be told through the personal reflections of those Martin has inspired through his collaboration with Living Levels.

Keywords: *Living Levels; public engagement*

INTRODUCTION

After a brief summary of the Living Levels (LL) programme, this paper will celebrate Martin's contribution. Through LL Martin has sought to encourage and pass on the essential message that '*archaeology is a subject where anybody can make a really outstanding discovery*' (Bell 2021). The narrative will weave in the voices of those Martin has inspired through LL, flipping between anecdote and theory to mirror the importance of academia to public engagement and *vice versa*. A wider discussion of the Levels, on both sides of the Severn Estuary, and how they have changed over time, can be found in Steven Rippon's paper (2021: this volume, Chapter 1).

Martin's major contribution to LL has been to facilitate understandings of the enormous cultural significance of our landscapes and the fundamental symbiosis between people, wildlife and environment. His legacy is also to draw the public's attention to the relevance of archaeology and to contemporary debates about nature conservation amid ongoing biodiversity losses and the climate emergency.

Through his involvement with LL, Martin argues for an archaeology which is more outward facing, more aligned with nature conservation, and more aligned with community needs including quality of life and wellbeing

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outcomes (Bell 2020b). From such an approach the hope is that a stronger, more holistic understanding and conservation of the Levels will result.

BACKGROUND

The Living Levels partnership² came together out of a desire to reconnect people and communities to their landscape and provide a sustainable future for the Gwent Levels. The partnership has raised £4 million, primarily from the National Lottery Heritage Fund. Beginning in 2018, the programme is divided between 24 interlinked projects in three core themes: conservation, engagement and access.

Between 2016–2018, the partners carried out research to find out what people understood and valued about the Gwent Levels historic landscape. This concluded that despite nodes of good localised knowledge, the Gwent Levels were little known and seldom visited by many from the surrounding area, leading to missed opportunities for a range of socio-economic, cultural and well-being objectives (LLLP 2017).

Compounding this, information on the historic environment of the Levels was largely absent from educational curricula as well as from local collections held in the public domain (LLLP 2017). At the same time more and more of the historic landscape was being lost to new development. Much of the Levels' rich history was thus becoming 'hidden' from the view of communities living nearby the Levels, and the consciousness of the wider public (LLLP 2017).

Studies show that 'sense of place' is made up of locally constituted meanings and values, over and above nationally recognized heritage ones (Harrison 2004; Waterton 2005). It follows that attaching meanings and identities to specific localities is integral to the production of a 'sense of place' (Johnston 1994). The founders of LL shared with Martin a profound and urgent mission: to raise awareness and excitement about what is *on paper* recognised as one of the most outstanding historic landscapes in Wales.

INSPIRING BEGINNINGS

During the two-year Development Phase of Living Levels, Martin's first contact with LL came through his PhD student Kirsten Barr, who did a three-month placement with the team to help connect archaeology and community engagement. Kirsten had been studying the Mesolithic human, animal and bird footprints at Goldcliff and looking at new techniques for recording and interpreting footprint evidence (Barr 2018). Kirsten helped design experimental archaeology activities for LL that have now been delivered to over 300 primary school pupils in the Levels. She also helped design interpretation about the coastal archaeology of the Caldicot Levels, which has been incorporated into route guidance for a coastal walk between Redwick and Newport Wetlands. This was a great start to the project and inspired Living Levels to develop several other successful collaborations with students from the local universities and colleges on other projects.

One of the first LL activities organised with Martin himself was a 'Foreshore Foray' of the Goldcliff footprints, followed by further lectures from him and other leading experts for 98 LL staff and volunteers. Martin would often open his LL activities paying homage to those who had inspired him, including Rick Turner (Bell 2018), but also Derek Upton (Bell 2005) - as LL volunteer Jerry Cross recounts:

Martin explained that it was Derek's work in drawing attention to some of the hidden historical features in the 'Levels' that was responsible for raising the profile of this area and was a contributing factor in the establishment of the 'Living Levels' project, this was enough to get me on side straightaway. It was uplifting to hear from an eminent archaeologist and historian that in order for our historic environment to be preserved then it was necessary for professionals and the interested public to be singing from the same song sheet.

These early events with Martin motivated and inspired those working 'on the front line' of public engagement in the Levels. Further accounts sum up what this meant to people:

² RSPB Cymru (lead partner), Buglife Cymru, Bumblebee Conservation Trust, Cardiff Council, Gwent Archives, Gwent Wildlife Trust, Monmouthshire County Council, Museum of Cardiff, National Trust, Natural Resources Wales, Newport City Council and Sustans.

I have never had history appear in front of my eyes so clearly as when I was side by side with Martin on the mud flats of the Estuary as he explained how he discovered those amazing footprints. He drew pictures in my mind about the people in the past and I was then able to explain it to others through Living Levels.

Kathy Barclay, Gwent Wildlife Trust, Living Levels Learning Project Lead.

Standing there as the tide rapidly started covering them over, I was completely spellbound by the evidence left of these people that once walked in this spot over 4000 years ago. Martin has been instrumental in bringing the Gwent Levels to life for so many and so generous with his time to support Living Levels.

Gemma Bode, Gwent Wildlife Trust, Living Levels Steering Group.

One of those on the Foreshore Foray was Helen Gottschalk, Visitor Experience Manager for the RSPB. She described the visit as ‘*astonishing*’ and ‘*inspirational*’ for her and several volunteers who at the time were working on new interpretation for the Newport Wetlands Visitor Centre. This interpretation was designed to explain the significance of the recreated Wetlands (which resemble the early landscapes of the Severn Estuary) – information that had been entirely missing prior to LL. They delivered a 3m² bronze sculptural landscape relief model of the Levels and a historical timeline explaining key heritage from the Levels – including the Mesolithic footprints. These new resources provide a much-needed historical context to the visitor experiences at the Wetlands, which receive on average 100,000 visitors annually, and are being promoted by LL as a major visitor gateway on the Levels.

Figure 1. Collage of Martin's varied engagement activities: (a) Beaker sherd, 2300–1800 BC; (b) first foreshore foray, Goldcliff, September 2018; (c) Martin's volunteers with finds, Peterstone, April 2019; (d) Family History Day, Tredegar House, September 2019.

MARTIN – STAR ATTRACTION

As word got out about these exciting activities with Martin, I started receiving several ‘animated’ phone calls from local people demanding to meet ‘the Mud Professor’! It was soon evident that Martin was in high demand – we joked that he would soon need to hire an agent!

Martin has (so far) delivered eight public lectures to over 450 people for Living Levels. The universality of his message is illustrated by the age range of his audiences: 8 to 92 years old! His first lecture, 'Archaeological discoveries of the Severn Estuary' was organised alongside Gavin Jones, Living Levels Community Engagement Officer, who reflects on Martin's legacy:

If I could sum up my rich and privileged experience with Martin, it would be the abiding image of a young boy posing for a photograph with our 'Mud Professor' following one of his amazing talks. Gleefully clutching a sizeable burnished brown aurochs bone, the budding young future archaeologist's beaming face was filled with a wide-eyed wonderment for all to see – and that same joyful wonderment was equally etched in the face of the seasoned archaeologist by his side – long may it continue!

I remember fondly having to barter for extra chairs to accommodate the masses who turned out for one of Martin's early lectures in Peterstone. I flinched at the thought of blocked fire escapes but couldn't bear to turn anybody away so we crowded everybody in and I crossed my fingers that worn-looking electrical sockets would hold out! I love this photograph of Martin mid flow at this talk (Figure 2), (in his customary socks and sandals, sadly out of picture!) semi-oblivious to the relative chaos that had preceded the talk and just engrossed in his subject. Notice that his projector is precariously balanced atop a rather unsteady pile of puzzle boxes from the hall games cupboard. The last-minute arrangement was necessary as the projector screen had to be ditched to make way for extra rows of chairs at the front of the hall!

Figure 2. Packed Peterstone village hall.

Such were the idiosyncrasies of delivering in community hubs without technical rehearsal, but the *message* was what people cared about. His early lectures were not delivered from grand venues in city centres but in the villages on the Levels. People, some of whom were not terribly mobile, could walk to them, and this meant an *awful* lot to them.

Catherine Davis, LL volunteer from Marshfield recalls:

The hall was full to the 'brim' with interested locals. The information about our Levels landscape was imparted in a way that was easy to take in for us non-academic lay people. I never tire of listening about his discoveries. It is like being with an old, familiar friend! Professor Bell has inspired and engaged me and many others with his knowledge of the Gwent Levels, and along with the Living Levels Team, to fight for this precious ancient landscape that we are so lucky to have on the doorstep.

Cath has been a key ambassador for LL and is a founding member of 'Friends of the Gwent Levels', a grass-roots campaigning organisation established in 2020 to protect the Levels from damaging development.

NURTURING SKILLS (AND MUD-BASED BEAUTY THERAPY)

Martin was not only keen for people to become more knowledgeable about archaeology but also to actively take part in it themselves. So we hatched a plan for a four-day intertidal archaeology course at Peterstone which Martin delivered alongside wife Jennifer and colleagues from the University of Reading in April 2019 (Bell and the project team 2019). Organisation of the course was to prove protracted and at various stages called for Martin's creativity, negotiating skills, determination and charm to get the event sanctioned! A special mention is reserved for the Wentlooge Wildfowlers, whose kind help enabled us to take a shortcut over a vital patch of saltmarsh, avoiding a treacherous excursion over Peterstone gout! I fondly recall a conversation with the beleaguered RSPB health and safety advisor signing off on the risk assessment, where I stressed a vital point (that Martin also proudly recalls in his oral history recording for LL) *'he has never lost anyone to the Estuary yet!'*

The course was attended by 19 community volunteers. The first day comprised an introduction at the Newport Ship Centre (courtesy of Curator Dr Toby Jones). The second and third days were spent on the foreshore where the intertidal mud would claim more than one welly and several other personal effects inadvertently dropped by volunteers. I smile at the thought that one day in the distant future someone may be writing their own account about a 4000-year-old wellington boot from that day! The fourth day was back at the Ship Centre washing, recording and processing the finds (a report is available on the Living Levels website).

The group uncovered a total of 195 finds, including prehistoric animal bones and teeth, worked wood and clay pipes. Some of the bones showed butchery marks made by flint blades and some had been chewed by dogs. The most rare and remarkable find was a tiny fragment of Early Bronze Age Beaker pottery, dated to around 2300–1800 BC (Figure 1).

Martin Gerrard, finder of the sherd, recalls:

Martin Bell provided my introduction to archaeology, and I thoroughly enjoyed it. He retains a 'boyish enthusiasm' for it, which is addictive. Under his guidance I found a piece of 'beaker' pottery on my first day of retirement. He will remember that, as he referred to it each time he saw me thereafter. They were very excited when I showed them it (when I thought they were going to say it was a 1970s Marks & Spencers!)

LL history volunteer supervisor Rose Hewlett says of Martin, *'Each find is treasured by Martin for the story it can tell.'* This is most certainly true. Martin would ask every audience at the start of his talks for any information they had on fragments of (assumed) Second World War aircraft pulled from the mud – the quest goes on as I write! As for the beaker sherd, the story will forever be immortalised in the public record as Martin recounts it in his oral history recording!

It is evident that the Peterstone course was inspirational for many, as LL volunteer Ceri Meloy testifies:

It was an amazing thought to know that the last person to hold this [Bronze Age reindeer antler] had lived several thousand years ago. Those muddy four days absolutely sparked my interest in archaeology which has gone from strength to strength. Since then, I've done two evening courses at Cardiff University and a week's dig in west Wales, as part of the Strata Florida Trust project.

Martin also readily encouraged the LL volunteers to offer insights based on their own experiences, as LL volunteer Jeremy White explains:

His approach doesn't stick to the archaeological orthodoxy. Whilst there are good and better ways of doing things already, the intertidal zone is a great place for adapting techniques and for new interpretations ... both welcome features of Martin's work. I remember suggesting an interpretation for the stakes sometimes found in the sides of paleochannels that, whilst entirely speculative, might fit well with simple navigation for small boats. The idea could have been met with real evidence for features we already know, like fish traps, but instead it was met with thoughtful consideration.

Many who joined the Peterstone course have also been keen to point out the contribution of Martin's wife Jennifer, whom Martin inspired to write *'The boar with the apples on his tusks'* for Living Levels, a children's book about a prehistoric family from Goldcliff (Figure 3).

Incidentally, the book was printed by LL, translated into Welsh, and sent out to 73 schools on the Levels alongside a new curriculum-linked learning resource which brings together a wide variety of information about the historic and natural environment in the Levels. I couldn't agree more with Martin Gerrard who states, *'the presence of Jennifer on many of his field trips, demonstrates a type of yin and yang – their relationship being complementary to their work.'*

BRINGING AWARENESS TO CONTEMPORARY ISSUES

Martin's activities are bringing an important context to the current picture of sea level rise in the Levels. Another LL project he has worked on is helping people to understand the dynamic forces at work in the Estuary over 8000 years. 'Lost Landscapes' has created a series of animated, digital landscape reconstructions showing how Goldcliff might have looked at six critical time periods throughout history from 8000 years ago, before the formation of the Severn Estuary, to the Great Flood of 1607 (Figure 4). Martin gave invaluable expertise on the topography, flora, fauna and customs of the people during the reconstructed periods in order to build these models in a historically accurate fashion. The reconstructions are featured on the LL website and are also part of interactive displays at five visitor centres around the Levels. 2D stills from the animations have been used on interpretation panels at Goldcliff and other sites across the Levels.

Figure 3. *The boar with the apples on his tusks.*

A LL legacy survey of 102 local people shows climate change and rising sea levels are second (after development) in their ranking of concerns for the future of the Levels, concerns backed up by scientific predictions for the increased frequency of flooding for coastal communities in the coming century (ASC 2016).

The account below, from fellow academic Dr Toby Jones, Curator of the Newport Ship Project, who also worked on the digital reconstructions, attests to Martin's ability to engage the public with these important debates:

Martin is a walking encyclopaedia about the history and significance of this dynamic landscape – he has a way of enthusiastically and clearly explaining the complex geological and environmental changes that have moulded the Severn Levels ... Truly inspiring, his publications are considered standard reference works and will be useful and relevant for many decades to come!

Similar praise is offered by Dr Mark Lewis, Senior Curator at the National Roman Legion Museum at Caerleon, who has worked alongside Martin as an expert advisor on many LL projects:

I have known few professional academics that have given so freely their time to students and to the general public in order to inspire and inform. Sadly, having learned the dangers of intertidal archaeology from Martin, John, Derek, and Nigel Nayling, for whom I block-lifted a medieval woven fish basket (now dried, conserved and displayed at Newport Museum and Art Gallery), I decided that for me, terra firma (the firmer the ground, the lesser the terror) would be my place of work. However, thanks in no small part to Martin, my interest in the archaeology of the Estuary Levels has never diminished, and through his continued work with Living Levels, continues to grow.

Figure 4. Digital reconstructions of Goldcliff.

REWILDING THE LEVELS

Martin's most recent talk for LL has been '*Rewilding: a view from archaeology*'. The mention of 'rewilding' can easily cause hackles to be raised, possibly because of its early promoter, George Monbiot. His book '*Feral*' dreams of ditching many of our 'failing' semi-natural landscapes of Britain in favour of a new-found 'wilderness' abounding with majestic megafauna, for the pleasure of starry-eyed ecotourists. I exaggerate (slightly) to make the point that when Martin suggested 'rewilding' for a talk in the Levels, a community of 400 farmers, I was a tad nervous!

But I needn't have been. His insight was fascinating, bringing fresh perspectives against a backdrop of unrelenting global biodiversity decline (Hayhow *et al.* 2019). Partly due to these failures, the modern conservation movement is under scrutiny from proponents of 'rewilding' for its so-called 'compositional approach' to setting conservation targets, often comprising a single species or vegetation type as a proxy for determining a site's condition

(Haslett *et al.* 2010). Put simply, many of our conservation sites are too small, too isolated and too fragmented to be effective for landscape or ecosystem restoration.

Archaeological evidence (such as Martin's work on prehistoric routeways) helps us understand the agency of people, animals and plants in the construction of landscape and ecological niches (Bell 2020a) and suggests that more functionalist approaches to conservation, that call for bigger, better and more joined up nature reserves (Lawton *et al.* 2010), will have more success in future.

Species reintroductions are also often a component of rewilding, primarily as a means to restore 'niche' ecosystem services such as the damming of rivers by reintroduced beavers for flood alleviation (Law *et al.* 2017). While there is no deliberate 'rewilding' happening in the Levels at present, species which had become locally extinct such as bittern and crane have returned to breed on the Levels in 2018 and 2020 respectively, and water voles are recolonising the reed network following a reintroduction in 2012. The current debates are about scale and the extent to which locations for further reintroductions are properly evaluated. Martin argues that these debates call for better collaboration between archaeology, ecology and heritage in helping to determine effective conservation strategies for the future (Bell 2020 lecture).

On a lighter note and to close this topic, Martin has been helping with a 'metaphorical' rewilding of the Levels' prehistory exhibit at Newport Museum which now houses a spectacular collection of Mesolithic through to Bronze Age finds from the Estuary, including a full aurochs skeleton (a species Martin was keen to point out in the rewilding lecture that is not a candidate for reintroduction!)

HEALTH AND WELLBEING

Martin's final legacy is more universal and overlaps with the wider LL agenda to improve access, recreation and wellbeing opportunities on the Levels for the communities they serve. Some of the communities bordering the Levels are amongst the most deprived in Wales with high incidences of depression and above average suicide rates (Welsh Government 2019). There is strong evidence to suggest we are now facing a global wellbeing crisis – depression is already a leading cause of the overall disease burden worldwide (Global Burden of Diseases Study 2013).

Martin offers one possible remedy:

Walking is increasingly recognised for the contribution it makes to quality of life and health ... It is both a metaphor for, and a route to, self-discovery.

(Bell 2020a: 357).

The Levels are served by an uninterrupted stretch of the Wales Coast Path as well as a good network of local walking trails that LL is working to enhance and promote. Through new engaging interpretation that tells the story of how some of these familiar routes and the surrounding landscapes came into being, Martin is helping provide the tools for people to enrich their understanding, enjoyment and connection to their environment through the simple activity of walking.

CONCLUSIONS

In my introduction I stated the fundamental aim of LL was to reconnect people and communities to their landscape. Martin's legacy in advancing that objective is traceable through the multiple strands of his involvement. His thought-provoking lectures have informed and inspired. His courses have taught people valuable skills for the future. Carefully excavated finds, along with the stories that accompany them, have been added to local public collections. Many hours of his time and expertise have added context and imagination to interpretative and educational resources that are enabling a thoughtful re-imagining of our connection to the amazing landscape and environment of the Levels.

Last but not least, an oral history recounting his experiences over 30 years is a final parting gift. In recording this, he lays down for the public record a lifetime of discovery and gives a welcome nod to the validity of traditional forms of knowledge and the power of storytelling. As LL oral historian Marsha O'Mahony says of Martin '*it is his ability to communicate and share his research outside academia, especially with the communities he works in, that is most striking.*'

From everyone at LL, we wish Martin a very long and happy retirement. It has been an absolute pleasure working with him. For a retirement gift, how about a pair of comfy slippers to replace the socks and sandals?

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LIVING LEVELS TRAINING DAYS

The foreshore is a dangerous place where the tide can come in very quickly (the Severn Estuary has the second highest tidal range in the world), and there are areas of quicksand and open water. It also has high nature conservation importance particularly as a feeding area for both for migratory and resident bird species. For these reasons it is not a safe place for those unfamiliar with conditions. Guided visits, led by Martin, to archaeological sites have been organised from time to time by the Severn Estuary Levels Research Committee and the Living Levels project and hopefully these will continue in the future.

(photos: J. Cross and the Living Levels).

PERSONAL REFLECTIONS

by the authors, arranged in paper order

Those of you who have picked up this book probably already know what a remarkable man Martin is and the phenomenal breadth and relevance of his work. **Mike Walker**, at the start of this volume, admirably expresses the contribution Martin has made to academia and to the countless students and early career staff he has taught and mentored. The contributors to this book were also asked to reflect on their professional, academic and personal connections to Martin in the context of their papers, and these reflections are reproduced below. These show the respect they have for Martin, and may partly explain how and why we selected our contributors.

Steven Rippon

I first met Martin during a break from the Theoretical Archaeology Group conference held at the University of Lampeter in the early 1990s when I had just started my PhD. I was immediately struck by two things: how generous Martin was with his time, and the interest he showed in my research. This is of course typical of Martin, and I have benefitted from his advice and support on many occasions over the subsequent years. I also have many fond memories of Severn Estuary Levels Research Committee meetings when Martin would show us his remarkable discoveries in the intertidal zone of the Gwent Levels. That he and his team could work so meticulously in such a difficult environment filled me with admiration, and inspired me to dabble in intertidal survey myself (most notably with another of the Severn Estuary's great figures, John Allen). But Martin is not just an inspirational teacher and fieldworker: he also has a remarkable publication record and as one of the founding fathers of intertidal research in the Severn Estuary, the profession of archaeology as a whole owes him an enormous amount.

Kirsten Barr

My working relationship with Prof Martin Bell began in 2011, when working on my undergraduate dissertation. I wanted to explore a topic on environmental archaeology and animals so visited Prof. Bell for a chat. He suggested that I may be interested in investigating Bronze Age footprint-tracks preserved in the intertidal sediments in the Welsh Severn Estuary at Goldcliff East. I attended fieldwork that summer to explore the Bronze Age footprint-tracks. Whilst there, Martin was focusing on the Mesolithic footprint-track sites. I got involved with recording these and, just like that, I was hooked. I left the University of Reading to do my Masters degree at UCL, but kept in contact with Martin, publishing a paper together during this time. Martin alerted me of a PhD opportunity and I returned to the University of Reading in 2014 to work primarily on the Mesolithic site I had first encountered back in 2011. Martin supported me throughout my PhD as my supervisor and we are now writing a book together on prehistoric footprint-tracks. Without the encouragement and enthusiasm of Martin it is very unlikely I would have discovered my love of footprints!

Michael Grant and colleagues

Martin Bell is intrinsically linked with Mesolithic coastal sites, with his most famous association being Goldcliff on the Welsh shore of the Severn Estuary. However, he has also had a long history with the site of Westward Ho! on the north Devon coast. Martin has been involved with two excavations of the site, multiple monitoring visits, and supported many undergraduates, postgraduates and researchers working on the site over the last four decades. Our paper provides a summary of the long history of investigation of this site, concentrating on Martin's role and his focus on expanding the range of geoarchaeological methods applied to understand the site.

Thomas Walker

I first met Martin when studying in my retirement for an undergraduate degree in archaeology in Reading. I had long had an interest in molluscs, and so there was an immediate connection of minds. While researching the windblown sands in southern Britain he suggested that the molluscs in a sand profile at Gwithian in Cornwall would be suitable for study, and this led to my dissertation. Having achieved my degree Martin persuaded me to proceed to a PhD and thought that further study at Gwithian would be appropriate, and my paper derives from this work.

I continue to work with Martin on much of his fieldwork, particularly in the Severn Estuary at Goldcliff, studying the human and animal footprints, and more recently the recording of a Mesolithic fish trap – the only one so far discovered on the British mainland.

Scott Timpany

Martin was the Director of Studies for my PhD studies investigating submerged forests as part of a wider NERC funded project into Mesolithic to Neolithic Coastal Environmental Change. These enigmatic former woodlands are often over-looked by archaeologists as they represent the natural rather than the anthropogenic, but Martin has put them at the centre of key archaeological research such as that at Goldcliff East and has always taken a landscape-approach in his work. This multi-disciplinary approach is something I have carried with me ever since and the mantra that you have to put in the hard work even when faced with difficult and challenging conditions, such as working in the intertidal zone, because it pays off. Martin's research and dedication to these areas is simply extraordinary – but look how much we have all learned because of it. Martin started me off on my own journey of working within the intertidal zone, which all began at a PhD interview in Reading in 2001 when I was interviewing for a PhD on Mesolithic burning activity, and just towards the end Martin turned and asked 'What do you know about submerged forests ...?'

Richard Bradley

I first met Martin on a hill close to the sea. It was at Bishopstone where he was investigating a settlement overlooking the Channel and the River Ouse. At the time we were new to archaeology. He was a teenager, and I had finished a period studying law and was excavating on a cliff near Beachy Head. That was fifty years ago, and by the time I was approaching retirement from teaching he was my Head of Department. Throughout his career Martin has maintained his interest in the shoreline of lowland Britain. I have strayed from my original concern with the south coast, but in recent years my research in other regions has made me more aware of the importance of travel by water. My paper reflects that interest and discusses the possibility of extending maritime archaeology to work on dry ground.

John Linderholm and Richard Macphail

Richard Macphail: I met Martin when he was a PhD student at the Institute of Archaeology. We then worked together for English Heritage, and later collaborated at the Experimental Earthworks Project sites of Overton Down and Wareham, in addition to excavations at Brean Down and Goldcliff, Gwent. Martin and Jennifer remain family friends.

Johan Linderholm: I had from my early career followed and admired the work of Martin and in the late 1990s Richard introduced me to Martin at a geoarchaeology workshop at the University of Reading; a meeting that later on resulted in Martin acting as my PhD examiner at Umeå University.

Richard Brunning

I have known Martin since 1991 when he lured me away from Scottish crannogs to be a supervisor with responsibility for wood recording on his excavations at Goldcliff, soon coming to an amicable arrangement to share my time with Nigel Nayling for his fieldwork at nearby Caldicot. The work at Goldcliff was tiring, especially when working 'double tides', but very enjoyable, led to lasting friendships, and was where I met my partner Jan for the first time. Since then, I have done woodworking reports for Martin whenever needed but have also collaborated with him on research projects in Somerset, in my role as archaeologist for the Somerset Levels and Moors (since 1993). As one of the external examiners for my PhD he was kind enough to say that he had never been so amused by a thesis, which I took as a compliment. For many decades we have also worked together on the steering committee of the Severn Estuary Levels Research Committee, which Martin was so influential in making such a success. Everyone who has worked with Martin knows how keen and immensely hard working he is, but also how kind and supportive to those who work for and with him. Martin's unfailing positivity and good humour makes him a joy to work with.

Keith Wilkinson and Rob Batchelor

Keith Wilkinson: I first met Martin in 1988 when – as an undergraduate student at the Institute of Archaeology, UCL – I attended a lecture that he gave on Brean Down. I later worked as a supervisor for Martin at that site in 1989, while I also followed in his footsteps by researching my PhD on a similar subject to Martin's, i.e. studying past land-use as represented in dry valley fills in Sussex (Bell 1983; Wilkinson 2003). I did not then have any formal contact with Martin until 2012 when he invited me to become external examiner for the MSc Geoarchaeology that he had developed at the University of Reading, a role that I continued until 2017 as that course morphed into MSc Environmental Archaeology. During this time also, Martin invited me to take part in his Mesolithic of wetland/dryland edge in the Somerset Levels (MWDESL) project (2012–2015).

Rob Batchelor: I met Martin when he joined the University of Reading in 2008. Since then I have worked with Martin on a number of research projects including the MWDESL (with KW) and more recently, the AHRC funded Vale of Pewsey project. Our paper in this volume is a product of MWDESL and has previously appeared in a very preliminary form in the grey literature report that was the outcome of that project (Bell *et al.* 2016).

Michael Allen

At the age of 13, after having visited Martin's excavation at Bishopstone, and a year later, on 21 March 1974, listened to his talk about the excavation (entitled 'Review and Future Plans') at the local archaeological group (Lewes Archaeological Group), I asked if I could volunteer for the following, and the last, season of excavations at Bishopstone. Luckily, he agreed, as he already knew that I had been digging for over two years. And there started a near 50-year friendship with someone who was to be mentor, guide, field director, employer, and digger. The fact we have shared similar interests is perhaps no coincidence. I helped on his PhD dry valley excavations being the site surveyor for one, and he was an advisor for my own dry valley excavation in 1980. Following my graduation and direction of my second dry valley excavation, he employed me to undertake the land snail analysis from Hambleton Hill with him. I was his assistant director and post-excavation assistant for the Brean Down excavations, and then a post-excavation assistant for his work on the Wilsford Shaft. My subsequent personal research, research interests, employment at Wessex Archaeology for nearly 20 years, and now running my own 'consultancy' (with a new-build bespoke laboratory which he officially opened in 2013), is a tribute to the inspiration and teaching I have received from Martin ... so what I am doing, and have done, in archaeology is largely his 'fault'.

Catherine Barnett, Michael Grant, Jonathan Last and Sarah Orr

Catherine Barnett: Martin shaped, then supervised, my PhD research 20+ years ago. He has been academic mentor and colleague ever since, and his constant encouragement is the foundation for my career in environmental archaeology. My family and I admire his work, share a love of prehistoric landscapes and nature conservation, and are proud to count Martin and Jennifer as friends.

Michael Grant: I was well-aware of Martin through his core textbook as an undergraduate, and joined his MSc Geoarchaeology course in Reading in 2002. I was fortunate to spend time exploring the Kennet with Martin and Catherine and benefitted enormously from his enthusiasm and ability to inspire. The opportunity to work with them again on this project could not be passed, and, as with all Martin has worked upon, opportunities to test and implement new methods were aplenty.

Sarah Orr: My first interaction with Martin involved a skate park, or rather the ancient mollusc he spotted in test pits dug beneath the proposed facility in Victoria Park in Newbury 2011. It was clear that Martin's environmental expertise and academic interest in West Berkshire were valuable for curatorial archaeology, as this project went on to demonstrate.

Jonathan Last: I'm very grateful to Martin for his support for English Heritage (as we were then) research aimed at better understanding and conserving Mesolithic remains, as exemplified by the Kennet Valley Mapping Project, the subject of our paper.

Jim Leary

The first time I properly met Martin Bell was deep inside the enormous Neolithic mound of Silbury Hill; we were within a tunnel into the centre that had been opened up as part of conservation work; a project to which Martin

contributed. Later I became Martin's colleague at the University of Reading where we put together the Vale of Pewsey project and for three years worked at some remarkable Neolithic sites. It was at Reading that we also discovered our mutual love of walking, and an interest in how people moved around in the past, leading to a co-authored paper in the journal *Antiquity* (Bell & Leary 2020). It has been an enormous privilege to work with Martin. A Professor Dumbledore in socks and sandals, he has an intense passion for archaeology, a dry wit, and a piercing intellect, made sharper by his interest in people, both in the present and the past. But what raises him head-and-shoulders above others is his kindness and generosity. Martin shows the way, and the best we can do is to try and follow.

Rowena Banerjea

I first met Martin in 2005 as one of the many students to take the MSc Geoarchaeology Course at Reading. Martin opened my eyes to the potential of palaeoenvironmental research and landscape study. One of my clearest memories is from the Norfolk field trip where Martin introduced me to the wonders of owl pellets and their palaeoenvironmental potential; the study of animal waste in its various forms has continued to be a well-established theme in my research. Over the years, I have had many opportunities to work in the field with him, which range from being covered from head to toe in mud in the Severn Estuary, in all seasons and weather, to drier contexts on experimental archaeology sites. Working in the field with Martin has always been a fantastic scientific experience, but also a lot of fun. During one excursion to Goldcliff, I went to put on my waterproof trousers to return to the foreshore after lunch, only to find a shredded pair waiting for me that could no longer really be described as 'waterproof trousers' (or even trousers) – Martin was wearing mine and had not noticed other than they felt a bit small. Above all, I would like to take this opportunity to thank Martin for all his support for my research and career.

Jen Heathcote

Without Martin's intervention, I would never have considered being an archaeologist. I wanted to be a geographer; a seemingly insurmountable ambition given my lack of studying the subject at A level. On an Open Day in Lampeter, I discussed my predicament with him, who suggested that archaeology wasn't so different really, and why not pop along to his dig that summer to see what it was all about? I turned up with some trepidation at Brean Down and was embraced by the community he had created around the project, and hooked by the process of excavation, returning for several years in various guises. Though I ended up studying elsewhere, fresh from graduation, he gave me my first job, hand-augering in advance of the Second Severn Crossing, where I tested my newly acquired geoarchaeology skills and drew my first deposit models on graph paper. Numerous projects in wet places in and around the Severn Estuary followed, many of which involved Martin directly or by association. I'm very grateful for that brief but profoundly influential conversation with him many years ago, which led to experiences that changed how I view landscape and was the first step in my career.

Petra Dark

It was Martin's 1989 article on post-Roman landscape change (Bell 1989) that first drew my attention to his work, alongside his edited volume on archaeology and woodland ecology (Bell 1982), as both were key themes for my doctoral research. After hearing his paper on the environmental archaeology of historic periods at an English Heritage conference, we discussed the contribution of pollen analysis, and he generously invited me to collaborate on the final version of the paper (Bell & Dark 1998). Shortly afterwards he arrived in the Archaeology Department at Reading, bringing the opportunity to collaborate both in teaching (especially for his highly successful MSc Geoarchaeology programme) and research. One of the most memorable aspects of that research has been investigating the submerged forests of the Severn Estuary, associated with the extraordinary footprint-tracks of Mesolithic animals and people. The present paper is designed to reflect some of our common interests: the structure of the Mesolithic 'wildwood', disturbance factors and woodland regeneration. In writing it, it has been a pleasure to be able to draw on the work of some of our former students, including Michael Grant, Catherine Barnett, Alex Brown and Scott Timpany.

Terry O'Connor

Martin and I met as students at the Institute of Archaeology, London. He already had a good deal of excavation experience, not least at his complex prehistoric site at Bishopstone, and always seemed to be much more than a

single year ahead of me. We shared an interest in snails as proxy evidence. Even though I deviated into vertebrates at postgraduate level, Martin continued to speak to me, a source of reliable good sense and gentle humour. As with many academic friendships, we went our various ways, catching up from time to time, swapping news on our respective families and offspring. From the start, it was clear that Martin would make his name in archaeology, moving our subject forward and encouraging the next generation. Alongside that, he has remained the same thoughtful, generous man that I first knew, with the same kindness, warmth and, if I may say so, dress sense.

Chris Speed

Martin was my first tutor as a part-time archaeology undergraduate at the University of Reading. He later agreed to be my PhD supervisor. I worked for him as a technician, taking a part in many of his geoarchaeology fieldwork projects. These were never less than stimulating, and Martin (and Jennifer) were always generous with supplies of food to keep the workers happy. This was hardly necessary as the projects were always extremely interesting without any other stimulus, although cold days at Goldcliff could get slightly ‘character building’ on occasion. I have enjoyed working and learning from Martin for nearly twenty years. I would wish him a good retirement, but somehow I don’t think that retirement is a likely future for him.

Alison Offord

My introduction to Professor Martin Bell came through his close friend Rick Turner OBE, who masterminded much of the historical engagement programme for Living Levels until his untimely death in 2018. Arriving in the Levels fresh from a project in Pakistan, it is fair to say I quickly needed to get to grips with the grips, ditches, reens, pills, tidal creeks and Estuary mud of the Levels. I couldn’t have asked for better teachers! The Severn Estuary Levels Research Conference was on Rick’s Levels ‘curriculum’ and provided my introduction to Martin. It wasn’t long before I had an invitation to join Martin down at Goldcliff where I was to find my first flint, a joyful moment which remains a source of energy to this day. It is possible to trace many strands of Living Levels back to a memorable experience that started with Martin. Later on, I discovered another connection – a shared interest in rewilding which had been the subject of my MSc dissertation. Here again, Martin’s insight was invaluable. In calling for collaboration between all those who strive for harmony between humankind and the natural world Martin offers hope for the immense challenges that lie ahead.

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MARTIN'S BOOKS

Among his extensive bibliography, Martin has published several books, often with contributions from many of his colleagues. However, he is sole author of the most recent book, *Making one's way in the world*, which been received with excellent critical acclaim.

A small selection of Martin's books is illustrated here.

Martin Bell's bibliography

* book

~ edited book

chapter in book

Book reviews are not included

	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
Book		1	1			1			1					1	1		1
Edited book																	
Chapter in book	1	1	3	2	2			2	4	2	1		2	1	1	1	
Article	1	2	1	1	1	1	3		2	2	1	2		2	3	1	4

	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988
Book									1				2		1		
Edited book					1					1	1	1	1	1	1	1	
Chapter in book	2			1	1	2		2	2	1		1	3	1	3	1	
Article	3	5	3	2	2	2	1	4	4	3	3	5	7	4	1	1	2

	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	Total
Book											1						12
Edited book						2											10
Chapter in book	2	1		1		2	2			2							53
Article	2	4	2		10	11	10		2			3	3	7		1	134

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Television programmes

In addition to conventional publications, Martin has also contributed to several television programmes on aspects of his research, because in this way the research reached a far wider and more varied audience. The main examples are:

Programme	Presenter	Channel	Date
Countryfile: Goldcliff	Matt Baker Ellie Harrison	BBC1	March 2020
History of Ancient Britain: Goldcliff	Neil Oliver	BBC	February 2011
Coasts: Goldcliff	Nicholas Crane	BBC 1/Open University	2005
Meet the Ancestors: Goldcliff	Julian Richards	BBC 2	2004
Time Team: Goldcliff	Tony Robinson	Channel 4	2004
Landscape Mysteries: Figure in the Chalk: Wilmington Long Man	Aubrey Manning	BBC/Open University	2003

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compiled by Jennifer Foster

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Environment, Archaeology and Landscape is a collection of papers dedicated to Martin Bell on his retirement as Professor of Archaeological Science at the University of Reading. Three themes outline how wetland and inland environments can be related and investigated using multi-method approaches. 'People and the Sea: Coastal and Intertidal Archaeology' explores the challenges faced by humans in these zones – particularly relevant to the current global sea level rise. 'Patterns in the Landscape: Mobility and Human-environment Relationships' includes some more inland examples and examines how past environments, both in Britain and Europe, can be investigated and brought to public attention. The papers in 'Archaeology in our Changing World: Heritage Resource Management, Nature Conservation and Rewilding' look at current challenges and debates in landscape management, experimental and community archaeology. A key theme is how archaeology can contribute time depth to an understanding of biodiversity and environmental sustainability. This volume will be of value to all those interested in environmental archaeology and its relevance to the modern world.

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