Steve Mitchell

‘When the Sea Flooded Britain:
A Catastrophic Late Holocene Isostatic Interlude along the Eastern Seaboard of England and Scotland’

Article from Chronology & Catastrophism REVIEW 2005
(Production: Val Pearce)
© Society for Interdisciplinary Studies and author.

NOTES

Any errors found post-publication of the original article will have been noted in a subsequent issue of Chronology & Catastrophism REVIEW and as far as possible such errors (and any other errors found) will have been corrected in this PDF edition.

Original formatting style and layout has been retained.

Page numbers are those in the original article
When the Sea Flooded Britain:  
A Catastrophic Late Holocene Isostatic Interlude along the Eastern Seaboard of England and Scotland  
by Steve Mitchell

This article is a preliminary assessment of the nature and extent of the evidence for relative sea-level changes in the period from around AD 400 until AD 1700. It will seek to show that much of the eastern and southern coast of Britain was under the sea by up to 30 metres or more in the late Roman/early medieval period. This resulted in a landscape that was dramatically different from that today, which has profound implications for our understanding of British early medieval history [1].

Introduction

Some years ago I set out to explore the origins of Christian architecture. This has taken me to the Near and Middle East, most parts of central and southern Europe and the remoter parts of Insular Britain. Whilst in the Shetland Isles and the Outer Hebrides, I noticed a distinct type of site. Outwardly, it appeared as an isolated cemetery bounded by a circular wall, situated on a small headland close to a sheltered bay and about 5 metres above the beach. On closer inspection there were the remnants of a small single-cell church within the boundary wall. Traditions have it that these were early Christian sites of uncertain date, often associated with the sea-borne ‘Irish’ missionary phase of conversion [2]. Although very little archaeological work has been done on these sites, those excavations which have taken place do not contradict this hypothesis [3].

I also found this type of site along the western seaboard of mainland Scotland, although with less frequency. Again, on the eastern seaboard, there were sites that generally matched the diagnostic features of those in the west [4]. However, the eastern sites differed in one vital respect. They were all at a much higher altitude off the beach and some were at a significant distance from the present coastline. It was hard to avoid the conclusion that they had been stranded from their original location by a fall in the sea-level (see Figs. 1a and 1b). This led me to investigate recent work by geographers, which I tried to relate to the raised beaches observed along the eastern coast of Scotland, in Caithness and Sutherland.

This remote cemetery on the east coast of Scotland might be one of the oldest Christian sites in Britain. The medieval chapel in the middle of the walled enclosure was destroyed during clan wars in the 17th century. Its great antiquity, according to a leading expert, may be connected with its unusual place-name – navi.

Figure 1a: A twenty metre drop of the land relative to the sea would turn this stranded church site into a low promontory with water wrapping round the back to form a sheltered bay and perhaps even create a small boat-shaped island. This would then be much more like the Shetland model sites. Can this provide the vital dating clue to the raised beach as well as the archaeology?
Professor David Smith and his co-workers have published the results of their environmental surveys in *The Holocene* (see ‘Research by Smith *et al*’ on p. 22), tracing the fluctuations of salt-water and fresh-water movements along the Wick River valley of Caithness. Diatoms indigenous to salt-water determine the inland extent of seaward regimes and, by careful sampling and dating the layers of deposition, a calibrated chronology was assembled. I reasoned that this chronology could be used to date the stranding of the church sites, thus giving me a ‘not earlier than’ or ‘not later than’ date for their foundation.

Unfortunately there are not enough data from the period in question to build more than a cursory model, but an analysis of the actual landscape does admit some preliminary conclusions. The sea had fallen relative to the land by some 30 metres sometime in the medieval period. However, it was not the sea itself that had fallen – eustatic sea-levels have changed little in the last 2,000 years [5]. It was the land that had risen in what the geographers describe in their shorthand as ‘bounce’, or post-glacial isostatic rebound or uplift. The recovery was from compression due to the weight of ice depressing the land below it. The mean level of northern Scotland was 15m below present levels at the end of the last Ice Age [6]. As with any ‘bounce’, the levels did not rise up evenly over time. There were upward movements, countered by smaller episodes of subsidence. This makes the chronology much more complex but, at the same time, offers greater potential dating accuracy. Once dates can be obtained from secure strata for these turning points, then there is much more scope to determine reasonably accurate upper and lower boundary dates for the church-building activity.

The reason why the east coast of Scotland differs from the west (including the Hebrides and Shetlands) is that the geology to the east of the Moyne Thrust is less rigid. The western half is composed of older and harder rocks of the Torridon series whilst the eastern half is younger and ‘softer’ (Fig. 2). At this point it is perhaps worth recounting the development of the Holocene coastal features.

**The Holocene Coastline**

The Holocene coastline of eastern Scotland is mainly distinguished by a series of raised beaches (see Fig. 3a). The highest and earliest dates from the earlier Holocene (between 7000 and 5000 BC) and is associated with the Mesolithic (archaeological) or the Flandrian (geographical) period. This phenomenon has long been familiar to geographers as the ‘100 foot’ beach; that is, the top of the original beach is stranded at around 30m OD. Prior to this, the sea had risen quite steeply following the glacial melt. The Mesolithic/Flandrian divide is clearly characterised by a marked change in climate, as well as the submersion of the land-bridge between the British Isles and continental Europe.

The sequence starts at present sea-level, where there is a modern beach and ‘clifflet’ about 3 to 5m OD that might
The deposition of ice was thickest in the Loch Rannoch area, leading to a compression of rocks of up to an average of 15m. The development of the Holocene and the rapid retreat of the ice-sheet are easily traced in a series of raised beaches. Only the highest of these beaches has been dated. The lowest beach does not appear to have been colonised until at least the late medieval period and most of the coastline communities were not founded until the early 19th century. Towns such as Ullapool, Wick, Thurso, Golspie, Brora and Helmsdale all started on top of Cliff 1 (see Figs. 3a and 3b) and did not migrate below 10m OD until the late 19th century.

Fig. 2: The effects and after-effects of glaciation in Scotland. The deposition of ice was thickest in the Loch Rannoch area, leading to a compression of rocks of up to an average of 15m. The development of the Holocene and the rapid retreat of the ice-sheet are easily traced in a series of raised beaches. Only the highest of these beaches has been dated. The lowest beach does not appear to have been colonised until at least the late medieval period and most of the coastline communities were not founded until the early 19th century. Towns such as Ullapool, Wick, Thurso, Golspie, Brora and Helmsdale all started on top of Cliff 1 (see Figs. 3a and 3b) and did not migrate below 10m OD until the late 19th century.
only be a few hundred years old, at most, and is still growing. Immediately above this is the youngest of the ancient ‘beach and cliffs’ in the sequence. It looks very fresh, with little or no surface erosion, evidenced by a ‘sharp’ profile and virtually no slump at the base of the cliff (see Fig. 3b). The top stands between 15m to 25m OD. There are some moraine deposits at this level.

The next beach is much narrower and its cliff is much shorter, perhaps no more than 10m high on average. On top of this cliff is the 100 foot (30m OD) beach that rises gently to meet the side of the mountains that formed the earliest of the original cliffs. We can see that this is where the sea stopped because the mountain streams fall steeply to meet the ancient beach at this point.

The oldest and highest beach is lined with moraine deposits that complicate the sequence and make the surface landscape difficult to read. Their age is uncertain but cannot be older than the formation of the ‘beach and cliffs’ in which they sit and might be the result of much later, i.e. post-Mesolithic/Flandrian, ‘sea-push’ type deposition [7]. It is on this level that the church sites occur. This could mean that the churches were originally built on top of cliff number two and that if we apply the general model for church foundations in the highlands and islands, then the sea-level must have been at least 25-30m OD higher than present. This would place them somewhere in the early medieval period, but certainly no earlier than AD 400, the threshold date of the first Christian mission in Scotland [8].

This has interesting implications, if found to be true. Firstly, the last and youngest two cliffs in the sequence are much more recent than previously thought possible and, secondly, the basic structure of the Clynakirkton site is older than had been concluded from the available archaeological evidence [9]. This was a tantalising prospect and I started to wonder if there was any corroborating evidence from elsewhere, for surely, I argued, this is not a totally isolated incident.

**Research by Smith et al**

Professor D. E. Smith, Director of the Centre for Quaternary Science at Coventry University (now at the School of Geography and the Environment, Oxford University) has conducted most of the post-glacial research along the eastern coast of Scotland [10]. Along with Dr S. Dawson, he has demonstrated the relative sea-level changes in the lower Wick River valley, in which there was a major flooding due to glacial melt, peaking at around 5500 BC. As the world’s ocean eustatic levels rose at this time, any isostatic uplift accompanying the release of the weight of the glacier over land would have been masked. This was followed by a small but rapid retreat, bottoming out around 4000 BC and then followed by a much smaller and slower rise in sea-level, culminating at around 1500 BC. It was during this later phase that we have unambiguous isostatic uplift because, although there were still eustatic changes occurring, the ‘bounce’ was far greater in amplitude. Following this, the sea-level retreat was more rapid, dropping back to near its previous low level. This bottomed out at around 100 BC. Sea-level then rose quite rapidly to AD 1000 and much less rapidly after that until by 1950 it was possibly near its peak, which was marginally higher than the previous one. From 100 BC the changes were almost entirely isostatic
The ‘beach and cliff 1’ is on the left (see Fig. 3a) looking north towards Helmsdale and Navidale. The cliff has a clean sharp profile indicating its extreme youthfulness. This may be in part due to it having been exposed to wave action for a relatively short period during a retreat of the sea after c. AD 1200. The present beach is already forming a fledgling ‘clifflet’ of no more than 5m high that might have started as late as two to three hundred years ago.

In nature. This is illustrated in Fig. 4. It is these last two half cycles that are of immediate interest.

The first thing I noted about this graph is that it provides an analogue for the raised beaches I have been studying. The curves relate negatively in altitude to the examples on the ground, but with one small but very important difference. The graph does not show the formation of the last and youngest of the ancient cliffs in the sequence. To do this it would have to show an earlier culmination or peak, together with a downturn with a bottoming out sometime in the second millennium AD. The graph itself is broad-brush and deals adequately with time-spans of several thousand years and sea-level changes analogous to several tens of metres, so perhaps it is not fine-tuned enough to pick up late and more subtle changes. In fact, there are conflicting data between AD 500 and AD 1000 and the last calibrated dated sample is no younger than 1100 years BP. This means that the up-slope of the last curve has the largest element of sampling error and the final part of the curve from AD 1000 to AD 1950 is an extrapolation. This is acknowledged in the text of the paper by Dawson and Smith. Although no evidence of marine transgression was discovered, they concluded that this may well be because of local conditions and point to alternative findings in the Dornoch Firth area which clearly show a marine transgression starting around AD 1200.

In their summary, Dawson and Smith stated that ‘it seems likely that the two late-Holocene marine transgressions in the lower Wick River valley … reflect widespread, or secular, relative sea-level changes of a regional dimension….other areas generally reflect a number of marine transgressions after the mid-Holocene rise. Thus Tooley and more recently Zong and Tooley (1996) identify a number of transgressions along the Lancashire coast, whilst Plater and Shennan claim to have identified late marine transgressions in Northumberland … it is argued here that there is sufficient corroborative information from elsewhere to support regional late-Holocene fluctuations in sea surface levels …’ and conclude that the particular value of the report ‘… is in the record of late-Holocene relative sea-level changes and … in time the identification of similar sites in Scotland …’.

Elsewhere, place-name evidence has been recently published to show that Loch Maree could have been ‘stranded’ sometime not later than the 17th century AD. The present lake surface lies just below 10m OD [11]. A glance at OS maps covering the west coast of Scotland reveals several other lochs ‘stranded’ at the same level, some of which provide similar place-name parallels. As with the raised beach along the Applecross section of the west coast, the isostatic altitudes are not as pronounced. This is in marked contrast to Loch Brora. Today, this is a fresh-water loch with a lake surface at around 30m OD. Its shore consists of a fine sandy beach backed by sand-dunes of no more than 5m above the surface of the lake. This has not been formed by downhill river action but by the action of the sea within the sheltered confines of the surrounding hills. The tidal range indicated by the dune margins and the former sites of medieval churches (kils) along the margin suggest that the sea-level reached a maximum around 33 to 34m OD.

The dates of the kils are not known (but they are generally supposed to date from the 7th century onwards [12]), nor is the date of the stranding, other than it was probably sometime before the 17th century, judging by the date for the start of development of Brora as a town [13]. Following the Shetland model, the kils must have been founded
Relative sea-level changes in the Wick River Valley (from Dawson and Smith)

This graph shows the rapid and huge rise of pre-Flandrian sea-levels. The post-Flandrian movements are relatively modest. The right hand part of the curve may have been over-smoothed. The pecked lines (error limits) shows that there could have been a much steeper rise and fall from AD 500 onwards.

Reproduced by kind permission of Dr S. Dawson and Prof D. E. Smith.

Dawson and Smith’s model inverted

The graph above has been de-calibrated, inverted and re-orientated to match that of the geomorphic schema below. The arrows mark the cyclical turning points of relative sea-level. The pecked lines mimic the profile of the actual raised beaches shown in profile schematically below.

Raised beach geomorphic schema to show sequence of formation

The numbers relate to those in Figure 3a. The bold arrows relate to those in the graph above. This graph is not calibrated and only scaled vertically (height in metres OD). As an analogue of the Dawson and Smith model there is good logical agreement, with the last two arrows on the right reflecting the difference – here the ‘bounce’ is at the same date but more pronounced. The final part of the present cycle is in two phases with a pause or very slow retreat starting around AD 1200.

Figure 4: Isostatic changes along the coast of Caithness & Sutherland
from the sea. Each small kil could have served a broch or cluster of brochs although it is by no means certain that they were contemporaneous. Brochs, ubiquitous in most of the Northern Highlands and the Islands, are thought to be round-tower defensive dwellings dating from the Iron Age through to the middle of the first millennium AD, and seemed to have gone out of use by the time of the Viking invasion, although most were built between 100 BC and AD 100 [14]. The

Sea level c. 7,000 yrs BP

Following the pre-Flandrian flood the sea freezes over pushing beach material on top of beach 3 to form moraines. (The numbers in circles refers to the ‘beach and cliff’ sequence in Figure 3a)

Sea level c. 2,000 yrs BP

In the next 5,000 years the land rises and the sea retreats close to present levels. The moraines are stranded between 20+ and 30+m OD and cliff 2 is formed.

Sea level c. 1,500 yrs BP

A sudden land subsidence in the late Roman/early medieval period opens up the Clynekirkton channel to navigation and re-floods Strath Brora. From around AD 1000 the land starts to rise again and as the sea retreats it forms ‘beach’ 2. After a pause around AD 1200 the rise continues and ‘beach and cliff’ 1 is formed.

Sea level today

What we see now. The stranded remains of the church site at around 40m OD; fresh water Loch Brora, a former sea loch stranded at 30m+ OD; moraine material stranded on ‘beach’ 2. The modern ‘clifflet’ represents a recent isostatic spurt.

Fig. 5: A model for the sequence of raised beach formation at Brora, Sutherland, to explain the existence of stranded man-made and natural features.
best we can say is that Brora was a sea-loch from before the 7th century and became stranded as a fresh-water loch sometime before the 17th century. This fits the general picture suggested by the Loch Maree evidence and the English evidence set out below. A reconstruction of the complete late Holocene sequence at Clynekirkton, near Brora, Sutherland, is illustrated in Fig. 5.

The Coastline in the Late Roman Period

The sea was slowly receding during the last millennium of the prehistoric period and carried on receding until the end of the Roman period in Britain [15]. If there was a marked reversal of this trend then we should be able to detect both aspects of this movement but this has proved very difficult to spot on the ground. There could be several reasons for this. Firstly, isostacy is a more difficult concept to visualise as it is almost counter-intuitive: this means that it can be easily overlooked unless you are prepared for it. Secondly, it could be the result of local circumstances – some natural (erosion and silting) and some man-made (damming and draining). Thirdly, the sea-level is back close to the late Roman levels which means that interpretation of any surviving site could fool the investigator into thinking that nothing had happened during the intervening period. Not all sites would have been destroyed by wave action; indeed they may well have been preserved by marine depositions of mud, sand and shingle. The anaerobic environment of the wetlands in general is conducive to the survival of organic remains. Some would be exposed later and some would remain buried and this may have happened more than once during the intervening period. Archaeological evidence such as this would, therefore, mostly lie south of the present Scottish border as the Roman and Anglo-Saxon influence did not extend this far north [16]. I shall present examples, working from north to south round the present coast of England, as far as Romney in Kent. Some of the evidence is anecdotal but I have tried to rally as much scientific corroborating as possible. However, this is not an exhaustive study and is only intended as a snapshot, showing the possibilities for further, more detailed, local studies and the need for more synthesis to form a wider picture. In this I have had to rely on Rackham’s History of the Countryside [17] and Dark’s The Environment of Britain in the First Millennium AD for an overview.

Rackham

Oliver Rackham’s work was published in 1986 and has not yet been superseded. A more recent review of current research is that by Petra Dark [18], which brings Rackham up to date without challenging his general conclusions. She clearly identifies the central problem that I am trying to tackle. She concludes in her summary of sea-level and coastline change:

‘It is likely that little of Britain’s existing coastline is identical to that of any stage of the first millennium AD, but identification of past coastlines is problematic. The processes of uplift, erosion, silting and reclamation have varied around the coast to such an extent that no general reconstruction is possible. Most research has concentrated on trends in vertical sea level rather than on reconstructing coastal topography, and detailed maps of former coastlines are currently available only from the East Anglian Fens. Despite the limitations of the existing data, they at least alert us to the dynamic nature of the coastal zone and urge caution in interpreting the archaeological record of settlement in relation to current topography’ [19]. (My emphasis).

Although Rackham covers Britain and Ireland, his main evidence is drawn from woods and woodlands in an English context, and that mainly from the Midlands. It has obvious limitations as a result. His coverage of Scotland, Wales and Ireland is brief.

Rackham’s method is to combine the written record with scientific analysis of pollen deposits, archaeological evidence, fauna and flora survivals and extinctions, aerial photography, testimony and tradition. He analyses this evidence within classifications such as: woodland; fields; hedges; trees; highways; heathland; moorland; grassland; ponds; marshes, fens, rivers and sea. The last section, on wetlands, is pertinent. Dark uses the same general methodology but with increased emphasis on environmental science and archaeology.

We can start with some of Rackham’s definitions of wetlands and these are the ones I shall use throughout. Salt marsh is coastal wetland that is covered by the high tide. High tides can also cause the fresh water of rivers to back up and spill over, as happens in the Norfolk Broads. This intermediate zone is dominated by brackish water and its own distinct ecology [20] but is not distinguished in common parlance or terminology, except for marsh indicating a mixed regime [21]. It is in this intermediate zone that the ancient salt industry is found. Further inland, as the freshwater starts to dominate, then this is where the neutral or calcareous peaty area known as fen starts. The common term bog is sometimes used technically to define areas where acid peat is found. This does not apply to the flooded landscape under examination and the term is avoided [22].

The Fens (as opposed to fen) is the name given to the wetland area ranging from the lowlands of Lincolnshire in the north to Cambridge in the south. It is not the only wetland of a similar nature – there are the Yorkshire marshes, from Hull and Doncaster to nearly as far north as Scarborough; the Somerset Levels; the Norfolk Broads; Romney Marsh; the Essex marshes; and so on in many smaller areas around the coast [23] – and generally as delineated in Fig. 6 (see next page).

The Fens have been successively drained in three main phases [24]. The first was by the Romans, then by the Anglo-Saxons and the medieval monks and the last and third phase started by Vermuyden in the 17th century. Each was a different economic response to the changing environment. The Romans found that the sea-level was falling and were able to fully utilise their hydraulic skills in driving the sea further back. In the late Roman period the sea started to rise only to recede again in late Anglo-Saxon times so there was an emphasis on defences and the exploitation of a fenland economy [25]. From AD 1200 [26] (or AD 1250 [27]) the sea began to rise again and that trend is continuing – the Thames estuary is sinking at around 300 mm each century whilst Scotland is gently rising. This at first sight seems contradictory. It is not easy to see that the English coast is sinking – after all the tidal head of the Thames has moved...
steadily down the valley until it is some 25m OD or more below its medieval level (see The Thames Valley below) so it would appear that the sea is receding rather than rising. This is an entirely erroneous picture. It is the Thames Barrier that tells the real story of relative sea-level – a mistake here at a really high Spring tide and much of London will be under several metres of sea. London has been on the brink of crisis for much of the last century. Nevertheless, this level seems to be still well below the levels in the 14th century.

None of this is controversial. My findings differ only in degree from the generally accepted picture. The paradigm is one of relatively small and sluggish changes in the sea-levels over the whole period in question, whereas I suggest that the late Roman/early Anglo-Saxon marine transgression was higher and quicker than previously thought and that, as a consequence, it disrupted the whole fabric of society. The Roman civil engineering effort that built Carr Dyke and canalised the rivers flowing to the Wash disappeared under an unstoppable flood of sea-water just at the point when the economic might of the Empire deserted Britannia for good. It never recovered. However there were others who could and did exploit this flood disaster. The ‘Irish’ Christian missionaries were one such group [28] and, a little later, the sea-borne immigrants from northern Europe were another [29], as, later still, were the Viking raiders [30]. England no longer had an infrastructure based on the Roman road but a much more flexible one based on the small sea-going boat. It is this thesis that I wish to explore more fully.

A Preliminary Model of Seawater Incursions

In order to test for evidence of flooding in the historic period, I examined several coastal areas of England at random and decided that, on the basis of the Scottish raised beach altitudes, I should search within two distinct horizons – below the 30m OD contour and the 15m OD contour. I would not expect to find any evidence of sea incursion above 30m – most of the middle/late Iron Age (I have ignored the early Iron Age and previous periods for the sake of simplicity) should lay below this height. There should be some evidence
of sea incursion below 30m especially along the major river valleys; most late Roman settlements would be found there as well as early settlements of the post-Roman period. Most sea incursions would lie below 15m OD and would show up as former or present fen and marsh areas and would be marked by earlier Roman settlement as well as later medieval activity and more recent maritime features. The areas investigated are indicated in the section headings below and in Fig. 6, [p. 27].

Yorkshire

The Vale of Pickering during the Iron Age may well have been flooded inland as it lies below the 20m contour. There is an interesting similarity with the Lincolnshire Carr Dyke (see Lincolnshire below) in as much as the area of the estuary is now known as The Carrs and is flanked by drainage channels known to be of Roman origin [31]. These may have been a method of flood control and land reclamation associated with the fens in particular. The place name Car(r) is defined as either a marsh or fen: wet boggy ground; meadowland reclaimed from bog or marsh or a marshy copse, especially of alders; boggy ground overgrown with shrubs [32]. In this context, we are probably seeing land reclaimed from marsh or fen. It might also be a borrowing from the Scottish Lowland place-name, Curse, a derivation of an Old Norse word for ‘low lying land by a river’ [33].

Virtually all of the early Anglo-Saxon church foundations lie on the Yorkshire Wolds or Moors above the 15m contour, as do early cemeteries. Most Domesday (AD 1086) settlements also lie above the 15m contour. Virtually all of the monastic sites are post-Conquest and lie below the 15m contour (see Monasteries below). This same also holds true for Northumbria, the ancient kingdom now identified as modern Northumberland, Tyne and Wear and County Durham.

The Humber Wetlands Project [34] initiated several excavations of which two are of special interest, inasmuch they demonstrate the extremes of Roman hydraulic work. An extensive Roman settlement was discovered at Trent Falls, the area where the Rivers Uose, Trent and Don meet the Humber. It is very low-lying although it occupies a slightly raised island below 5m OD. This has yet to be dated but must be the result of a general fall of sea-level as well as extensive local drainage works. South of this is another Roman engineering triumph. Scaftworth lies just below the 10m contour on the South Yorkshire – Nottinghamshire border. The Roman road consisted of a series of wooden rafts that floated on the peat fen; again this has not been dated [35].

Lincolnshire

Attempts to identify the ancient coastline of Roman and early medieval Lincolnshire have been made by Bennet and others [36]. However, the situation is complicated by extensive coastal defence work and fresh-water drainage schemes along the fen edge in both Roman and medieval times. As a consequence, it is not always clear where salt-water ended and fresh-water began. For instance, peat deposit analysis may not have been charted down to the oldest regime of the sea’s inland incursions or may have decalcified or have been stripped away. A much more telling diagnosis is offered by the distribution of salterns, the Roman salt-pan boilers, which lined the salt marshes at the point where they were regularly scoured by fresh water. They show two distinct scatters. The earliest is further inland from the later scatter and marks two events – the gentle fall of the sea-level mentioned above and the construction of an enormous drainage channel on the fen edge known as Carr Dyke (see Fig. 7a, p. 29). This has not been dated but probably originated between the 2nd and 4th centuries. In the post-Roman period the coastline appears to have moved eastwards so that by the 13th century it is close to the modern seaboard. What is not particularly evident is whether there was a sudden rise in sea-levels between these two dates. Today, Carr Dyke is at about 3m above OD but its levee rises another 1.5m. The channel is large enough to drain off moderate flooding above this level.

If we look at the age of settlement patterns, then all of the earliest villages (as defined by an entry in the Domesday Book in AD 1086) occupy altitudes no lower than this although their location might be dictated by other criteria such as spring lines rather than tidal surges. As we move forward in time, the settlements that come after Domesday occupy the areas that had once been fens or marshes [37].

This is also true of the large monastic houses, some reputedly founded in the 7th and 8th centuries (see Monasteries below). As with Yorkshire, all early church foundations lie above the 15m contour, as do early cemeteries.

A more significant picture emerges when one examines the strategic location of surviving Roman towns. They all occupy positions between 15m and 20m OD [38], which would place them at the navigable head of the tidal channel at the first inland place of transhipment. This includes towns such as Lincoln, Sleaford and Bourne; a little further south (but not in Lincolnshire), Oundle and Stamford; and further south still, Cambridge (see Gyrwas below). It is highly probable that they were all sea-ports at some point (see The Nene Valley, see p. 31). Stamford, for instance, was the source of widely distributed eponymous glazed ceramic wares dated from the 9th to the 12th centuries. This would make logistical sense if the pottery were being shipped by boat along the tidal rivers rather than overland.

The Trent Valley

The Trent is perhaps the most dynamic of all the English river systems and consequently the most difficult to tame and manage. Excavations at Hemmington, on the borders of Leicestershire and Nottinghamshire, have shown that the river was bridged at this point in medieval times but the river was constantly changing its course, requiring much rebuilding [39]. This was almost certainly not the first crossing point and, because it was bridged then, we can infer that the first fording point was much further inland. Hemmington is about 25m OD. There is some archaeological evidence to suggest that the tideway reached this far inland [40]. Therefore, it is perhaps no coincidence that the raiding army of the Vikings over-wintered at Repton in AD 873-4 [41]. The river at Repton stands at around 30m above OD, so the Vikings might have taken advantage of higher winter tides to have reached this far inland. Repton was also a base for the Mercian kings from the 5th century onwards and, if it were the head of the Trent tideway, then this would have lent it strategic importance. From here, the Mercian overlords
This massive double bank and ditch is over 30 metres from bank top to bank top and is more than 4.5 metres deep. It ran for more than 90 km between Lincoln and Cambridge. Early theories that it was a contour canal are incorrect – it is a fresh water drain running along the fen edge protecting the landward side from salt water incursions. This is one of the very few surviving dry sections near Helpringham, Lincolnshire. The bottom of the ditch is just at or above modern sea level. The channel is now dry because drainage has lowered the water table to more than the depth of the ditch.

Yet another Carr Dyke – this one is near Car Colston, Nottinghamshire. It is much smaller than its Lincolnshire cousin and is the same size as the one in the Vale of Pickering, Yorkshire being a mere 11m across and 2m deep. This one is a canalised stream – a tributary of the River Devon which in turn joins the Trent about 17 kilometres north of here. The southern end of this channel is close to 30m OD and the northern end close to 20m OD.

could access most of their kingdom by boat quite rapidly, on swift-running tides [42].

The exploitation of the Trent tideway at Repton as a strategic site of the Mercian kings is clearly a possibility if the sea-level rose by, say, 30m or more. This would give a ‘not earlier than’ date of AD 600 based on Mercian king-lists but the conditions could already have been in existence before this time [43]. In fact, the Mercian ascendancy may have been largely due to the incursion of the tideway facilitating such rapid means of communication. The Mercian kingdom reached its zenith in the 8th century and then withered under the Viking onslaught. It is interesting to note that the superior Viking boat technology allowed them to traffic further inland with specially-adapted craft [44]. If the effects of a rapid sea incursion were starting to ameliorate by the late 8th century, then this could give them the window of opportunity. They could reach those parts that the Mercians could no longer reach.
In the valley of the Devon, a tributary of the Trent, there is yet another Carr Dyke. It is similar in size and dimensions to its cousin in the Carrs of Yorkshire and, like the giant Carr Dyke of Lincolnshire, it also serves to define the drainage area, namely draining the edge of the valley. As the southern end and highest point of the drainage channel (near the eponymous village of Car Colston), it lies at around 30m OD so we must wonder if the valley it was draining could have been brackish sometime in the Roman period (see Fig. 7b on previous page).

The Broads

Sometime during the medieval period, extensive peat cutting was taking place in north Norfolk. The volumes were enormous – 900 million cubic feet - and left several thousand hectares of shallow depressions across the landscape. Analysis of 2000 bore holes shows that this enormous quantity of peat was mined in a three hundred year period ending in December 1287. At this date, these declivities were suddenly filled by a surge of seawater [45].

This is of peculiar interest because it has been shown that the sea-level at this juncture was nearly 4m OD lower than at present, possibly as a result of the land surface bowing upward towards the middle of the north-south axis of East Anglia [46]. Sometime after this, some of the salt-water lakes became fresh-water lakes connected by rivers which are now known as the Norfolk Broads. The process by which this occurred is unclear. Today, the water surface of the Broads is mostly just around OD, so that some of the Broads are affected by high tides and are, as a consequence, brackish.

However, a tidal surge, possibly in excess of 6m deep, appears to have swept inland in the year AD 1287. This depth was probably greater than the 1953 surge and may have been aggravated by, or caused by, fairly rapid isostatic subsidence sometime after AD 1200, if we accept the Dornoch Firth data, or slightly later if we accept the Thames River levels data (see The Thames Valley below).

Monasteries – Islands in the Fens

Most of the medieval monasteries date from the 12th century onwards, sponsored by the new Norman land-owning aristocracy. They were able to exploit the fenlands in ways beyond the scope of smaller local communities. Their economic wealth derived from rent rolls of tenant farms on land granted to them, as well as mineral rights and direct patronage. This gave them critical mass to undertake extensive civil engineering projects such as flood-control schemes. New drainage channels were cut and existing (mostly Roman) channels restored. We can see the remains of flood-dykes commissioned by the monks in many parts of the low-lying countryside. The value of the reclaimed land rose considerably, leading to greater wealth.

We do know of instances where the flood-control failed, drowning the hinterland. This indicates that the sea-level was still within the tidal range that could reach a long way inland. We also know that there was a successive breakdown of the flood-controls, once the monasteries had been dissolved in mid-16th century. The Bedford Levels and fens of Cambridgeshire and south Lincolnshire were not fully reclaimed until the 17th century by Vermuyden [47]. The overall picture is one of a gradually retreating sea, right up to the present day. Today the sea-dykes at Blakeney, in north Norfolk, are about 6m high. However, they are still well below the foot of the 14th/15th century dry docks at the foot of the cliff at the adjacent Blakeney Priory and these are well above the 1953 flood level – which points to the conclusion that the sea-level in Norfolk must have fallen many metres over the last five or six hundred years.

But what happened in the centuries before the Norman Conquest? What evidence is there from the very early monastic foundations that the sea-level was considerably higher than in the 12th century? Looking at the East Anglian and Midland fens there are several documented monasteries to consider. Working from north to south, these are: Crowlands, Thorney, Peterborough, Ramsey and Ely [48]. All except Peterborough lie on islands in what was a fen. Peterborough lies on a low promontory, as defined by the 15m contour, and an island as defined by the 20m contour. Ramsey and Peterborough lie to the west of the Roman Carr Dyke, Ramsey on a low island just 5m above OD and Peterborough just above the 10m contour. The other three lie to the east of Carr Dyke at similar altitudes on small islands (the ey element means ‘island in the fen’), with the exception of Ely (Eel-ey = ‘island of eels’), which lies above 25m. Of all the foundations, this is possibly the earliest, having been recorded by Bede as originating in AD 673 [49]. However, there is no physical evidence other than the surviving fabric of Ely Cathedral, which dates to no earlier than the late 11th century [50]. Crowlands claims to have been founded in the reign of King Aethelbald (reigned 716-57) of the Mercians, but there is no archaeological evidence for this. We know nothing even approaching certainty about it until well into the 10th century [51]. The same goes for Thorney and Ramsey.

This leaves the problem of Peterborough. The present Cathedral lies below the 15m contour but above the 10m one. The archaeological evidence is unclear but an earlier structure lies below the ground level of the present nave. It is possibly 10th century – a survival from the fire and rebuild of AD 1116 [52]. Nothing of the monastic buildings remain, having been sacked successively by the Danes in AD 870, rebuilt in c.965 and then razed again by Hereward in 1070. According to the popular ballads, Hereward conducted his guerrilla campaign from the safety of the adjacent wetland and maze of waterways [53]. The earliest sources tentatively point to a 9th century foundation. But what of the very first Benedictine monastery, supposedly founded around AD 656? A charter names this as Medeshamstede (Medeshamstedi) but, because the charter is corrupt [54], the story may have been invented by the monks of Peterborough sometime in the late 12th century. They may well have based it on the brief reference in Bede, which merely records that Sexwulf was the first Abbot of Medeshamstede, in the country of the Gyrwas (see Gyrwas below). There is no other known connection between Medeshamstede and Peterborough (or anywhere else) that can be considered reliable. Unfortunately the early provenance for Thorney and Ramsey is also based on this spurious charter.

Therefore the best estimate for all of these ‘early’ foundations, with the exception, perhaps, of Ely is the late 9th or early 10th century. If this is the case then, for one
reason or another, the sea-level had moved below 5m OD by this date, perhaps through reclamation.

The Gyrwas – a Seaside in the Heart of England?

Bede mentions the Gyrwas [55] but only that it was the home of Medeshamstede, the ibly-mistaken forerunner of Peterborough monastery and cathedral, and that he calls it a province, divided between north and south and ruled by princes [56]. The general location for this province or sub-kingdom is thought to be south of the present Wash, in the area drained by the rivers Ouse, Nene and Welland. Peterborough and March were probably near its southern extreme and bounded by King’s Lynn and Spalding to the north. It takes in most of the fens of East Anglia and perhaps part of the Holland district of Lincolnshire but definitely excludes Ely, which Bede informs us was under the control of Peterborough. The present river system is of modern origin. In the 5th century, this whole area was criss-crossed by Roman navigation and drainage channels of a wholly different pattern, many of which survive and are in use today [57].

No previous attempt has been made on the etymology but I put forward the following suggestion based on the work of Eilert Ekwall. The second element of the name is surely diagnostic. It is the same as the modern Wash, from Old English ‘(ge)waesc’, meaning wash, the washing of the waves on the shore, surging movements of the sea or other water. Connected to this is Old English ‘waesse’, meaning wet, as in wet place, swamp. Ekwall goes on to define the Wash or Washes as ‘fordable portions of the estuary between Lincolnshire and Norfolk. It is used in the sense of a sand-bank or tract of land alternately covered and exposed by the sea, or a portion of an estuary admitting of being fordable or crossed on foot at low tide’ [58]. If this interpretation is correct, then we can construe that the Gyrwas was similar to the modern day Wash.

The Nene Valley

From the above, we know that part of the Nene valley was probably in the mysterious ‘province’ of the Gyrwas and that it could have been on the edge of an area of marshes and tidal creeks. There must also have been some habitable land, either on small gravel or sand islands, or on the upland margin – the fen edge. Bede dates the Gyrwas to the 7th century [59]. So what of the archaeological evidence to support this?

The River Nene flows past the modern city of Peterborough and it is along its banks that the remains of the Roman centre of Durobrivae (in the Parish of Water Newton) is to be found. Close by are a complex of Roman settlements in the adjacent parishes of Castor and the Orton. These seem to have been replaced by settlements that spread inland westwards along the Nene valley in late antiquity [60].

The pattern of settlements is dense and the excavations to date are not easy to interpret. The earlier settlements all lie in the lower part of the valley and do not seem to have survived beyond the 5th century. They are characterised by extensive palaeo-Christian activity, with a possible hiatus in this activity sometime after the 5th century, when a baptismal site near Rushden was abandoned for reasons that remain obscure [61]. If this was because of flooding, then there may have been continuity further up the valley at sites such as Irchester, which lies above 45m OD close to the Nene, about 8 km beyond the 30m contour. It is possible that this too was tidal, for the river bottom is still below 30m OD at this point. This tends to support the idea that the Roman settlements had shifted upstream as the tidal head moved inland, sometime after the 5th century. Certainly, several feet of clay of unknown date were deposited immediately on top of the 4th century Roman period remains at Fengate. The excavator interpreted this as widespread sea-flooding, following the close of the Roman period [62]. Fengate lies less than a mile east of Carr Dyke, near where the modern Nene enters Peterborough. If this were tidal, then Northampton could have been the head of the tide-way, in a manner similar to Reading on the Thames (see The Thames Valley below) and Repton on the Trent. As with Repton, this may have had a bearing on Northampton’s rise to importance as a Royal centre from the 8th century onwards.

There is some evidence of Roman river-frontages (wharfages) at Durobrivae and upstream from there, without certainty as to whether they were riverine or estuarine [63]. However, they were most likely to have been for sea-going trade, especially since we know that there was a tidal passage from the Wash to Peterborough right up to modern times [64].

Sutton Hoo

The early 7th century boat-burials at Sutton Hoo are perhaps the most famous discoveries of the early medieval period in recent times. The site is thought to be the royal necropolis of the Wuffingas, an East Anglian tribe related to the Merovingians, judging by the style of the lavish grave-goods of their boat-burials [65]. The Merovingians held sway in what is now northern France and Belgium, which is only a day’s sail away. Today the Hoo is some 17 kilometres inland and lies above the 30m contour, nearly two kilometres from the banks of the River Deben. If one traces the 25m contour then it is easy to visualise the Hoo as the first promontory or island on the north-shore, overlooking the ancient port of Ipswich.

Ekwall gives the meaning of Hoo as a spur of land [66]. However, all of the place-name survivals listed by him occupy coastal or former estuarial positions. It would appear, therefore, that the descriptive term might apply specifically to spurs of land by the sea.

The early date established for these boat-tumuli suggests that any marine incursion was well advanced by the middle of the first millennium AD [67].

The Thames Valley

In the 13th/14th century, bulk commodities bound for Oxford came up the Thames as far as Henley by boat and were then transshipped by road [68]. The boats arrived on the flood-tide from London. Henley was then the nearest transhipment point for Oxford. There is no reason to suppose that the tideway stopped there. Today, the difference in altitude between Henley and Teddington, the modern tidal limit, is somewhere about 15m OD [69]. There is tentative evidence that the tidal limit might have been as far inland as Reading, which might have been the first fording point, as
The river-level dropped continuously between the 1st and 2nd centuries. This would mean that the wide valley west of London would have consisted of salt marshes criss-crossed by tidal creeks - a far cry from the modern landscape.

The Roman town of Londinium was a busy port from the 1st century. Extensive excavation over recent years has revealed the development of the river-frontage showing that the river-level dropped continuously between the 1st and 2nd centuries [70]. The wharfs can be seen successively moving out and down from their original positions ‘in an ultimately vain attempt to maintain sufficient depth of water for the docking of cargo vessels’ [71]. These Roman wharfs at Swan Lane, Seal House, New Fresh Wharf and Billingsgate Lorry Park, on the north bank of the Thames between All Hallows and Billingsgate Dock (from hereon collectively called the ‘Londinium’ wharfs – see Fig. 8, p. 34), fell out of use sometime in the 4th century. The youngest is several metres below the oldest and 15 to 20m out into the channel.

Lying immediately over the ‘Londinium’ wharfs are a series of medieval wharfs (from hereon collectively called the ‘Swan Lane’ wharfs – see Fig. 8, [p. 34]). The first in the sequence, dated to the early-mid 11th century, starts on the same level as the earliest of the ‘Londinium’ wharfs dated to the 1st century. The next two in the sequence, although almost exactly mirroring the ‘Londinium’ series, were built further out into the channel and at a lower altitude. However, the last of the ‘Swan Lane’ wharfs was built back up to the level of the first, evidencing a sudden rise in sea-level of several metres. The tidal amplitude is not thought to be the cause of this change. It has been measured between the 11th and 12th centuries and found to give a range of 3.4m (+1.9m OD to -1.5m OD). Similar studies were done for other medieval river-front structures dating from the 12th to 14th centuries but, although they show that tides were slightly higher (possibly the result of excessive silting of the channel), the most significant feature was that the high-water level was quite constant throughout this later period [72].

The reason for these various changes is not clear but is not inconsistent with my interpretation that the sea-level had risen sharply in the early medieval period and then fell back to Roman levels at a later stage of the medieval period. A point to note is that there is absolutely no evidence of anything between the end of the functioning of the ‘Londinium’ wharfs and the start of the medieval ‘Swan Lane’ series – a gap of over six hundred years. During that in-between period, the earliest recorded settlements in the vicinity of modern London are clearly Anglo-Saxon. Lundenwic (the wic of Lunden) is further upstream from the ‘Londinium’ wharfs (nearer modern Westminster) and further inland (at a higher altitude) [73]. As the sea-level fell, the new Alfredian town of Lundenburg flourished in the early 10th century. The royal ‘port’ was founded and settlement started amongst the Roman ruins that had, until then, been submerged.

At some point in the Middle Ages, the port started to silt up, probably as a result of fish weirs and milling activity further upstream. Millers used temporary dams across the river to equalise water-flow for their commercial purposes. This had the effect of restricting fresh-water scouring of the channel. In turn, the tidal head would have been pushed downstream - at which point more mills would be established, driving the headwaters further east. We have some tentative evidence that the tidal head reached up as far as Reading sometime before the 12th century. However, with the foundation of the large Abbey there in the mid 12th century, and the consequent widespread exploitation of the Thames and Kennet rivers, the process described above could have had the consequence that, by the late 16th and 17th centuries, the river through London itself was so sluggish that the smell was extremely unpleasant. By the time of the 19th century Victorian expansion it was a serious health hazard.

The upper Thames was effectively controlled by the millers, so it was not until the early 20th century that proper weirs and pound locks were constructed and navigation started to regain its rightful place under the protection of a Statutory Body [74]. However, although this process may have hastened the downhill movement of the tidal head, it could not have created the significant gradient between the upper and lower parts of the river.

What happened in the period between AD 400 to AD 1000? Unfortunately there is very little archaeological evidence to help us answer this question and what little there is presents a truly conflicting picture. We know that the Roman town of Londinium was abandoned and was not fully reoccupied until the early 10th century, with the establishment of the Alfredian port at Queenshite [75]. There was Anglo-Saxon activity elsewhere in the vicinity from immediate post-Roman times and, furthermore, the building of St Paul’s in AD 609 acknowledged the significance of the old Roman city in the mind of Pope Gregory, who tried to establish London as his archdiocese for southern England [76]. However, the practical difficulties were such that Augustine was forced to choose Canterbury instead. Offa struck trading treaties with Charlemagne, based on access to the ‘port’ of Lundenwic, as it was now known [77], although we do not know exactly where this might have been, or even if it had a discrete location [78].

The picture that is emerging is one of sea-borne trade, conducted on the beaches along the numerous inlets and estuaries. Care had to be taken to avoid the hard Roman remains that would have posed an underwater hazard. The centre of riparian activity shifted up and down the north foreshore, probably as a result of Viking raids [79]. It was not until the recapture of ‘London’ by Alfred in c.886 that the first controlled port was established. This was at what later became known as Queenshite. There was no quayside, just a hard ramp simulating a beach. Indeed ‘hithe’ simply means ‘landing place’- the term ‘wharf’ was not current until the 12th/13th centuries [80].

If one looks at this problem of lack of evidence afresh, then one might expect some evidence to survive. A small boat carrying goods arrives at a prearranged point on the tidal surge. It stays to trade for as long as it takes for the tide to turn, or until the next ebb tide, and then departs leaving….nothing? Beach trading was the accepted means of regional, national and international trade. Such sites are known from the Viking period up and down the country, usually in a coastal location buried under sand dunes, high above the present tide line. The evidence is in the
archaeological record [81]. But what about sites on the major river estuaries – estuaries and valleys flooded by sinking of the land surface?

Until recently, there was no evidence at all. Then a large site at Lake End, Dorney, near Windsor, was excavated in advance of the Maidenhead Flood Alleviation Scheme. The village of Dorney lies close to the northern edge of the Thames Valley. The site had previously been excavated, as it was known to be Roman, but further excavations in 1996 revealed a unique type of site dating from the 8th century. ‘One hundred and thirty large pits were spread over an area of 500m by 200m, but there was no trace of any contemporary building or ditch’. The report goes on to describe an incredible range of broken goods, mostly of high status, and food processing and debris. The authors are careful not to draw any finite conclusion but a detailed analysis of the pit contents and their locus suggests that the ‘dynamics of modern open-air gatherings of people seem to offer the best scenario by which to explain this peculiar body of evidence ... small parts of other “gathering” sites may have already been revealed but not recognised as such. Only time will tell whether Lake End is unique or whether we have the first of a new type of Anglo-Saxon temporary occupation site’ [82].

My hypothesis suggests that this is also a ‘beach market’ at the tidal head of an inlet, about one tide’s sailing distance from Lundenwic. If correct, then we should expect to find more examples, both upstream and downstream from major Dark Age entrepots such as Hamwic (Southampton), northwic (Norwich), Ipswich and the like. Indeed one could profitably start by searching the south bank of the Thames, opposite to the Lake End site.

The chronology, together with evidence of relative sea-levels for the Thames Valley, as discussed above, is modelled and shown graphically in Fig. 8.

Kent

When Augustine first landed in England in AD 597, he is said to have landed at Ebbsfleet on the Isle of Thanet. The island was separated from the mainland by a stretch of sea and salt marsh, known as the Wantsum Channel. This has since disappeared, leaving a surface which, on average, is about 3m above OD.

Bede, writing in AD 731 but possibly quoting sources from over a hundred years earlier, describes it thus:

‘To the east of Kent lies the large island of Thanet, which by English reckoning is six hundred hides [90,000 acres or 36,422 hectares] in extent; it is separated from the mainland by a waterway about three furlongs broad [1 furlong = 201 metres or 220 yards] called the Wantsum, which joins the sea at either end and is fordable only in two places’ [83].

The Wantsum was a channel in Roman times, providing access to Canterbury [84]. We know that the channel still existed in the 6th/7th centuries, but was greatly reduced in width and depth, and had probably become fresh-water fen by the 12th/13th centuries, because we can still trace the outline of monastic drains and banks that flank the modern coastline. These drains cannot have been built earlier than the 12th century nor later than the 16th century. Both ends of the Wantsum channel were eventually blocked by a build-up of sand and shingle. This process had started at the southern end in Roman times, and was the first to close, but the northern entrance remained open until the 19th century [85].

This complex scenario is repeated at Richborough, a few miles along the coast. Richborough was the ancient gateway port founded by the Romans in the 3rd century. It was an island in the marshes, just off a low promontory, and was connected by a raised causeway. The causeway, which was built in the 3rd century, was later covered by alluvial clay but it is not known whether this was due to a marine transgression [86]. Boats of people arrived by sea from the continent at the quay just below the cliff, which was just less than 20m above them [87]. Today, it is believed that the quay would not lie more than about 5m above mean sea-level, although it has not yet been found. Recent environmental test bores by English Heritage have shown that the sea was still level with the present base of the cliff (at around 3m OD) in the 13th century [88]. At about these levels, it was also possible for William the Conqueror to make a beach landing at the ruins of the former Roman shore-fort at Pevensey in East Sussex. Recent estimates of sea-level in AD 1066, the date of the Battle of Hastings, suggest that the sea stretched well inland at around 5 to 10m OD at high-tide [89].

Romney Marsh

Cunliffe [90], and later Brooks [91], have comprehensively analysed the historical origins and development of Romney Marsh in Kent. Again, this is a highly complex area but, in conclusion, Brooks states that the:

‘...survey of the extant historical evidence for Romney Marsh in the early Middle Ages must raise as many questions about the current understanding of the geomorphological development as it answers...the calcareous marshland [salt marsh] may have been inundated, at least at high tide, by the late ninth century: it was not to be reclaimed until the later Middle Ages, whilst the decalcified [fen] area contained a tidal channel at least by the eleventh century. We therefore need to question how far the geological evidence can accommodate these contrasts and apparent contradictions. For the future, the need is clear. Historians, geologists and archaeologists must work in collaboration if the problems of the Marsh’s evolution are to be solved’ [92] (my parentheses and highlighting in bold).

Amen! I have tried to show that such anomalies have occurred elsewhere, and provided a possible explanation, but Brooks’ message is still timely and apposite.

Conclusions

There is ample evidence for changes of sea-levels. However, determining their amplitude, and dating them, is more problematic. Sometime after the end of the Roman period, the fall in sea-level gradually stopped and reversed into a relatively rapid rise of at least 15m and possibly as much as 30m or more in some places. This was caused by a fall in the level of the land rather than by a rise in the sea-
level. The timing of this isostatic subsidence is uncertain and might be at slightly different times in different places. The evidence tentatively points to it starting in the late Roman times. Dorney Wood has the archaeologists puzzled because it defies normal explanations. However, it can easily be explained as a beach-market served by the eb and flow of the tide. Strategically it is located halfway between Reading and Queenshithie, or a single trip on an alternate tide from each of these places. The medieval wharfs at Swan Lane lie over their Roman counterparts, which appears to corroborate the evidence from elsewhere of isostatic regression.

Notes and references

1. I use the shorthand term ‘sea-level’ to mean ‘sea-level relative to land’. All land altitudes are measured by reference to sea level so again when I use the term OD (Ordnance Datum) I am again using the shorthand for ‘above Ordnance Datum’ which is set from the steps in Newlyn harbour. When dealing with history, both the sea-level (eustatic change) and the land-level (isostatic change) move independently of each other, sometimes going up and down together and sometimes in opposite directions. The fact that land goes up (isostatic uplift) and down (isostatic subsidence) can be confusing and is often completely ignored by historians and archaeologists, to their detriment.

2. A good introduction (unfortunately now out of print) to the Christian conversion of Scotland is Charles Thomas, Britain and Ireland in Early Christian Times, AD 400-800. Thames and Hudson, 1971. A more recent work, Malcolm Todd, Immigrants & Invaders: The Movement of Peoples in the Ancient World, Tempus, 2001, is useful for understanding all post-Roman transmigrations to and from Britain up to the 6th century.

3. There is an excellent series of introductory books published by Historic Scotland but they are all regionally-based or topic-led, so do not give an overview. The most useful and still the most authoritative texts are Charles Thomas’s The Early Christian Archaeology of Northern Britain, Oxford University Press, 1971 and Christianity in Roman Britain to AD 500, Batsford, 1981. Individual reports are few, with Peter Hill, Whitthorn & St Ninian: The Excavation of a Monastic Town 1984-91, Sutton Publishing, 1997, leading the field.

4. Steve Mitchell, ‘The Stranded Kil Sites at Brora and...
Kildonnan, Sutherland: Evidence for an Isostatic Interlude’, (in preparation). Over 20 diagnostic features have been identified from preliminary site surveys and desk-top reviews in Scotland (Highlands & Islands), the Shetland Isles and Ireland by the author and also from the preliminary site surveys of the Shetlands undertaken by GUARD (Glasgow University Archaeological Research Department). Physical features include a site next to a sheltered bay or natural harbour, within 50m from the beach and no higher than 15m above sea-level. Man-made features include the sites being a day’s sail apart from each other, with each having an enclosure wall and a one- or two-celled structure on an E-W alignment within the enclosure. Other factors include oral traditions, place-name survivals and being a spot where Pictish artefacts are found.

5. On average, a range of about 2 metres. Source: British Geological Survey (BGS).


7. No evidence is available for such a cold snap in this geographical area, although very cold dry episodes have been recorded elsewhere, but significant global temperature reversals happened at the Bronze Age boundary at 4300 years BP – see Moe Mandelkehr in C&CR 1999:1. For a description and classification of the Holocene chronozones, see John Wymer, Mesolithic Britain, Shire Archaeology, 1991, pp 9ff. A recent analysis of the moraine deposits by the present author reveals that the tallest and steepest part is closest to the sea and consists of large smooth boulders. Further inland, the boulders diminish in size to smooth pebbles mixed with sand. Furthest inland, at the western end of Loch Brora there is a fine sandy shore edged with consolidated sand dunes. This strongly suggests that moraine was formed by sea-ice of some sort and then sculpted by wave action. The moraine seems to be localised to the area of the Brora ‘estuary’. It has been identified as a moraine from aerial photographs (personal communication from Steve Pearson, BGS).

8. C. Thomas, Christianity in Roman Britain to AD 500, op. cit.. He gives the date for the Ninian phase as no earlier than the last quarter of the 4th century.

9. The recent work at Clynekrton by members of the Clyne Heritage Society have pushed the date of the church fabric back, perhaps as early as the 14th century (unpublished, personal communication). A recent reading of Originales Parochiales Scotiae has revealed the previously unacknowledged fact that there was a parish church in Clyne from, perhaps, as early as AD 1145.


11. Chris Lowe, Torridon, the Nature of the Place, Lowe, 2000, p. 127. I am also indebted to this work for the general introduction to the bedrock and surface geology, as well as the geomorphology and ecology of the Highlands.


16. It is not that there is no evidence in Scotland but that it is not so widely or deeply researched as elsewhere. In fact, there is much more Roman activity in Scotland than generally thought (see Lawrence Keppie, Scotland’s Roman Remains, John Donald, 1998). If Anglo-Saxon evidence is scarce, then Pictish artefacts are even scarcer, with only place-names and Class I & II sculpted stones as safe documentary sources. The archaeology of brochs, duns and burnt mounds are not well-understood and there has been no systematic attempt to investigate, analyse and classify early Christian monuments – see note 3.

17. O. Rackham, op. cit.


21. The term ‘skirtland’ is used by Robert Evans in his article, ‘The Early Courses of the River Nene’, Durobrivae, Vol. 7, without making it clear what is meant by the term and may refer to the limits of a former? brackish-water zone. Interestingly, Evans cites evidence of 40 cm of marsh-clay overlaying a Roman saltern dated to AD 50-200. The saltern is about 14 km due west of modern Peterborough.


23. Ibid.

24. Ibid.

25. Ibid.

26. BGS (see note 5).

27. O. Rackham, op. cit. p. 376.

28. C. Thomas, op. cit. [2].


31. Source: article by Charles Clover in The Telegraph newspaper, November 26, 2002, p. 10. An aerial photo together with interpretative captions supplied by English Heritage, is shown of part of the Vale of Pickering near Malton. A double linear feature running along the southern edge of the Tye River valley at between 20 to 30m OD is
described as a ‘Roman drain (flood defence from Fen to the north)’. The scale shows it to be approximately the same width as the smaller Carr Dyke in Lincolnshire. The place name, if any, for this feature is not known.


34. A review of all the Wetland Projects can be found in *Current Archaeology*, 172, 2001 (www.archaeology.co.uk). In this issue, there is also a useful review and bibliography of current publications on this topic (John Colles, pp. 157ff).


36. Much interdisciplinary work has been done by local geographers, archaeologists and historians in Lincolnshire. An excellent round-up of the latest research is available in S. and N. Bennett (ed.), *An Historical Atlas of Lincolnshire*, Phillimore, 2001.


38. A. E. Brown (ed.), *Roman Small Towns in Eastern England and Beyond*, Oxbow Monograph 52, 1995. Despite discussing all aspects of spatial distribution, there is no mention of relative altitude or the possibility of sea-level changes in their development.


40. *Ibid*. A considerable number of eel-trap wicker baskets set in weirs have been recovered, but it is not known whether they were for fresh or brackish water use. The earliest of these dates from the 7th century. The first bridge was not built until AD 1096.


42. A quick calculation suggests that you could sail effortlessly between Repton and Lincoln in three full days. The journey overland is about 85 km (50 miles) as the crow flies across difficult river valleys. To cross at the nearest fording points would require massive detours, possibly doubling the distance.

43. M. Swanton, *op. cit.*, pp. 24, 42, gives Pybb as founding the dynasty prior to AD 632.


46. *Ibid*.

47. The great inland lake of Whittlesea Mere did not totally disappear until well into the 19th century.


53. He razed the monastery but spared the church; this was accidentally destroyed by fire in 1116 (F. M. Stenton, *op. cit.*, p. 597). The earliest part of the present superstructure is late 12th century (N. Pevsner & P. Metcalf, *op. cit.*).


55. *Ibid*, *op. cit.*, IV 6, p. 216.

56. Shown in Bede, *op. cit.*, III 20, p. 176; IV 19, p. 236. The Tribal Hidage written in the 10th century assigns 600 hides (between 60 to 180 acres per hide) to each of the two parts of the region, with each containing 600 households, so it is not large. The source also mentions six other tribes, probably to the immediate south, and some of the names are thought to be associated with places in Huntingdonshire (F. M. Stenton, *op. cit.*, p. 292).

57. O. Rackham, *op. cit.*, p. 385. See also R. Evans, *op. cit.*


60. The complex history of this area of the lower Nene valley is dealt with in *Durobrivae: A Review of Nene Valley Archaeology*, which is published annually. Occasional summaries also appear, such as D. F. Mackreth, ‘Durobrivae, Chesterton, Cambridgeshire’, in A. E. Brown, *op. cit.* Recent general and specialist publications are listed in *Current Archaeology* (see note 34).


63. D. F. Mackreth, *op. cit.*

64. It is surprising just how far inland sea-borne trade could reach – see aspects of this development, from the Romans through to the arrival of the train, in Susan Oosthuizen’s *Cambridgeshire From the Air*, Sutton Publishing, 1996.

65. Ten of the fifteen visible mounds have been investigated but only Mound 1 has been fully excavated (and recently re-excavated by Prof. Martin Carver). There are many publications about the site (including Carver’s *Sutton Hoo: Burial Ground of Kings?*, British Museum Press, 1998) and its finds have been lavishly and widely illustrated.


67. Some of the mounds (see note 65) could be earlier than Mound 1 and in any case the burials (if that is what they are) would stretch back over time, perhaps into the 6th century.


71. Ibid.

72. Ibid.

73. Source: Museum of London permanent exhibition; also John Clark, *Saxon and Norman London*, Museum of London, 1989. An interesting reconstruction of the landscape of Thorney Island is offered in *Current Archaeology* 162, pp. 218ff. This shows the present site of Westminster Cathedral and the Houses of Parliament as they were at the foundation date of the cathedral in c. AD 959. Evidence suggests that this was indeed an island that was bridged in the late Saxon period. Adjacent hithes were created on the mainland side which flooded by a metre or more at high-tide, allowing for the beaching and unloading between tides. There then followed ‘a period of crisis…when river levels rose sharply and new quays had to be built…tree-ring dated to 1179-80…’.

74. The Thames Conservancy, now a division of the Environment Agency. Also, whilst pointing to extreme paucity of (and conflicting) data, *The Holocene Evolution of the London Thames*, MoLAS Monograph 5, 2000, summarises thus: ‘…that there was a significant downstream migration of the tidal head in the Roman period (AD 43-410, or 1907-1540 cal BP) … This appears to have reversed in the later Roman/Early Saxon period (1650-1300 cal BP) … By the C14 … the tidal influence was much stronger than it had been throughout the historic period and this trend has continued with river levels rising to the present day’ (p. 110).


76. Ibid.

77. Ibid.


79. Ibid. Also, for an overview see George Lambrick, ‘The Development of Late Prehistoric and Roman Farming on the Thames Gravels’, in M. Fulford and E. Nichols (eds.), *Developing Landscapes of Lowland Britain: Archaeology of the British Gravels: a Review*, Society of Antiquaries, London, 1992, pp. 78 ff. The review only takes in the upper Thames valley but notes that at Farmoor, near Oxford, a Middle Iron Age (350-50 BC) site in the flood plain is buried below a metre of alluvium towards the end of the period. This strongly suggests that the river had backed up for a substantial period sometime after this date. Farmoor is above 50m OD.


81. Martin Carver, Bulletins of the Tarbat Discovery Programme, Tarbat Peninsular and Tarbat Church, Portmahomack. (www.york.ac.uk/depts/arch/sites/tarbat)

82. *Current Archaeology*, 178, March 2002, pp. 427ff (see note 34). Helena Hamerow’s attempted overview, ‘Settlement on the Gravels in the Anglo-Saxon Period, in M. Fulford and E. Nichols, *op. cit.* [79] is inconclusive and was written before the Dorney excavation. Anglo-Saxon ‘gathering sites’ is now the hot topic amongst Anglo-Saxonists.


85. Ibid. Note that Bede, *op. cit.*, p. 75, describes a channel of just over half a kilometre wide, whereas the narrowest point of the Roman channel is estimated to be around 2 km.

86. Ibid. Note, however, that the situation here is very similar to the Fenland examples cited above, which are interpreted as sea inundation.

87. This is the current model of Roman Richborough promoted by English Heritage.


92. Ibid.

All photographs and diagrams by the author unless otherwise stated.