

Offa's Dyke Journal



Volume 3

Edited by Howard Williams and Liam Delaney

Aims and Scope

Offa's Dyke Journal is a peer-reviewed venue for the publication of high-quality research on the archaeology, history and heritage of frontiers and borderlands focusing on the Anglo-Welsh border. The editors invite submissions that explore dimensions of Offa's Dyke, Wat's Dyke and the 'short dykes' of western Britain, including their life-histories and landscape contexts. *ODJ* will also consider comparative studies on the material culture and monumentality of frontiers and borderlands from elsewhere in Britain, Europe and beyond. We accept:

1. Notes and Reviews of up to 3,000 words
2. Interim reports on fieldwork of up to 5,000 words
3. Original discussions, syntheses and analyses of up to 10,000 words

ODJ is published by JAS Arqueología, and is supported by the University of Chester and the Offa's Dyke Association. The journal is open access, free to authors and readers: <http://revistas.jasarqueologia.es/index.php/odjournal/>. Print copies of the journal are available for purchase from Archaeopress with a discount available for members of the Offa's Dyke Association: <https://www.archaeopress.com/>

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University of
Chester

Utilising Lidar Survey to Locate and Evaluate Offa's Dyke

Liam Delaney

The enigmatic and gigantic Offa's Dyke has long been understood as a demonstration of the power of the Mercian state in the long eighth century. Despite this, rarely have previous studies involved anything more than the visual observations of the earthwork. Moreover, ground-level perspectives cannot possibly contextualise its total breadth and character. The shortcomings in the resulting quality of data on the Dyke has led to uncertainties and debate over its route, extent, and placement in the landscape. With the application of lidar and other digital technologies, my ongoing doctoral research is providing a fresh understanding of the nature and original extent of Offa's Dyke's route by the creation of an accurate and empirical dataset. This digital dataset for Offa's Dyke is identifying hitherto unknown sections of the monument. Furthermore, it is providing the foundation for new investigations of the nature of the frontier in the eighth century by creating the basis for new investigations into the placement and landscape context of the monument. This article presents interim results on the investigation of the Herefordshire section of Offa's Dyke, a stretch that has been among the most problematic and poorly understood from all sections of the earthwork. This study thus provides fresh perspectives utilising digital heritage tools and data sources to examine and re-evaluate evidence of the nature and extent of the monument and the wider Mercian frontier.

Keywords: GIS, Herefordshire, Lidar, Landscape Archaeology, Offa's Dyke

Introduction

The route of Offa's Dyke survives running roughly north–south following the topographical border between Britain's western highlands and eastern lowlands through the modern administrative areas of Flintshire, Wrexham, Shropshire, Powys, Herefordshire, and Gloucestershire. Nevertheless, combinations of natural and deliberate destruction alongside dense woodland results in limited visibility hindering detailed terrestrial survey. Ambiguity persists over the presence or absence of the earthwork, the antiquity and significance of 'gaps' in the route (Fox 1955: 170; Noble 1983: 44), or indeed where the monument really was a continuous construction (Ray and Bapty 2016: 285–288). In the far north, there is ongoing debate regarding how and to what extent Offa's Dyke continued through Flintshire towards the Dee Estuary and the Irish Sea (Ray 2020, 2021).

These issues are pertinent in Herefordshire where there are only smaller segments of linear earthworks surviving separately between Rushock Hill and the River Wye (Figure 1) (Fox 1955: 174–182; Ray and Bapty 2016: 285–288). These disparate lengths – along with no recorded presence in the Herefordshire Plain and South Herefordshire – coupled with the revaluation of the Whitford Dyke (Hill and Worthington 2003: 156; Jones *et al.* 2013) were the basis of a theory declaring that Rushock Hill was the southern terminus

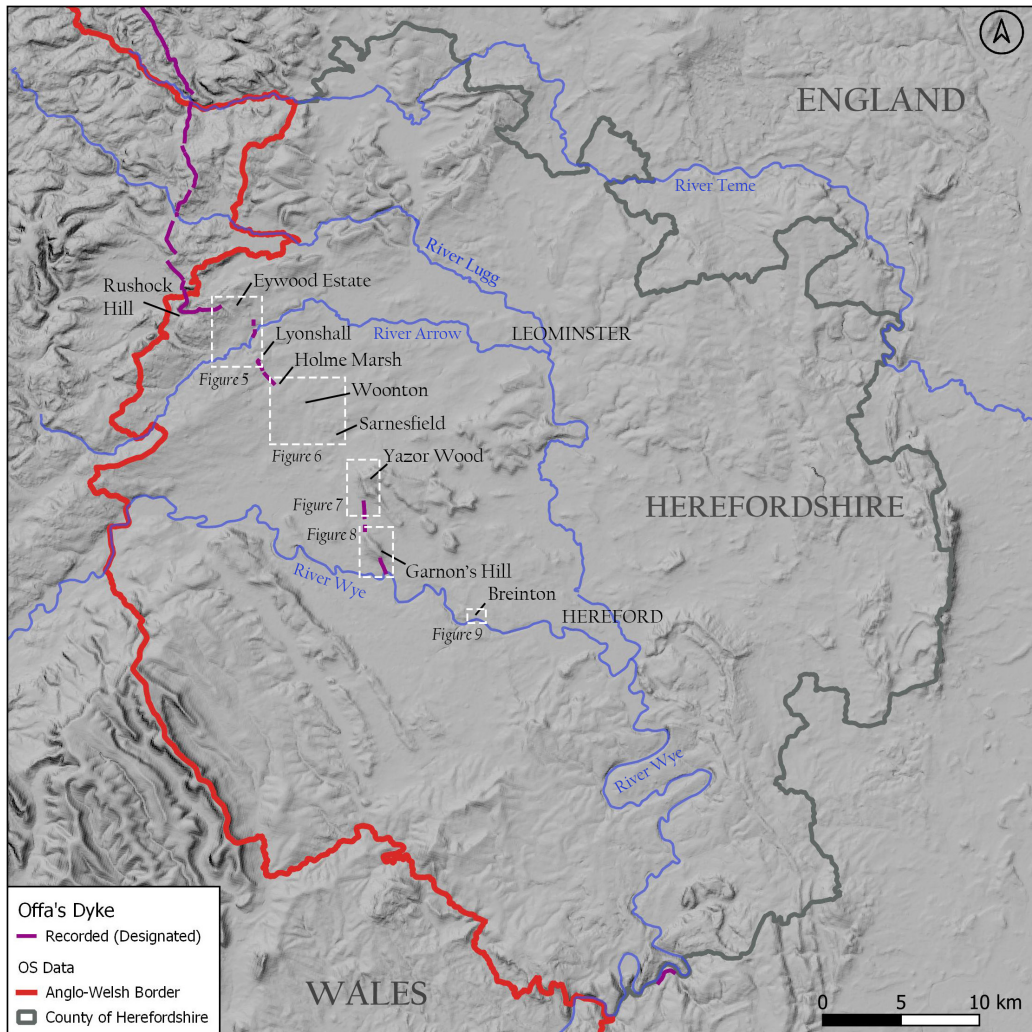


Figure 1: Plan of Offa's Dyke in Herefordshire with locations along the route mentioned in this paper. Illustrated is the recorded existence of Offa's Dyke in the current available data, prior to the lidar survey outlined in this paper (Base Map: Hillshade)

of Offa's Dyke and thus stretches of linear earthwork further south were unrelated (Hill and Worthington 2003: 107). Although extensive field observations tackling that model indicated a continuity of build practices across extant segments over the entire route (Ray and Bapty 2016: 164–213, 335–336), debate over the nature of the gaps in the route linger (Belford 2017: 75–77). In summary, there is still no exact consensus for the route, or in places the existence of, Offa's Dyke in Herefordshire. Given this situation, it remains difficult to conclusively study a monument without knowing its likely full extent, this Herefordshire stretch is a crucial zone demanding further investigation.

The ramifications of this study extend beyond academic questions regarding early medieval linear earthworks: they pertain to modern practical heritage issues over the

conservation and management of Britain's longest earthwork. Sections which are not formally recognised as part of Offa's Dyke are among those at greatest threat from accidental or deliberate damage. Moreover, the COVID-19 pandemic has demonstrated that Offa's Dyke still has a significant place in the popular consciousness and political discourses of modern Britain. The differing legislation and guidelines between Wales and England led to Offa's Dyke being mistakenly and rhetorically presented as the physical manifestation of the Anglo-Welsh border (Smith 2020; Williams 2020: 12). One of the issues that stems from this common misunderstanding is the considerable ambiguity over the exact route and placement of the monument in which the modern border, the Offa's Dyke Path National Trail, and stretches where the monument survives as an earthwork are frequently conflated and confused (Fox 1955; Hill and Worthington 2003: 47–50; Ray and Bapty 2016: 29–54; Ray 2020). Such public misconceptions thus match, and are arguably fostered by, the ongoing academic uncertainties regarding the precise extent and character of Offa's Dyke.

Set against this popular awareness but widespread confusion, this research attempts to better understand the route, placement, and form of Offa's Dyke in its entirety, contextualising the monument in relation to the landscape. Using digital modelling to better understand the monument's route and placement, it may be possible to garner insights into what dictated decisions over its construction and use. To this end, I focus on exploring Offa's Dyke in Herefordshire through lidar survey (Figure 1).

Methodology

Utilising lidar data in archaeological survey has proved to be an effective tool to add detail to surveys. Such data reveals aspects of the landscape that have evaded traditional terrestrial or measured survey. By controlling the light source aspects, the landscape can be seen in shadows cast along the lidar models, revealing earthworks and other features which are not always visible on the ground.

The significant advantage of utilising lidar is the ability to strip away dense vegetation cover (Bennett *et al.* 2013: 197–206), this aspect reveals even heavily degraded features, including those with next to no surface expression. The effectiveness of lidar survey has already been proven before on Offa's Dyke, where previously unrecorded segments of the Dyke were identified through Wyeseal Wood, and north-east of St Briavels (Hoyle 2008: 77, 96, 120). In my own ongoing research, the Camlad floodplain between Shropshire and Wales is a great example of a preserved length without apparent surface expression now revealed by lidar (Figure 2; Ray 2021). Meanwhile, the identification of Offa's Dyke through Leighton Woods, Powys, is an instance of this method's application to better discern the monument's route through dense woodland (Figure 3).

In the UK, lidar data is accessible through the Environment Agency who are in the process of making available 1m resolution lidar for the whole of England and Wales

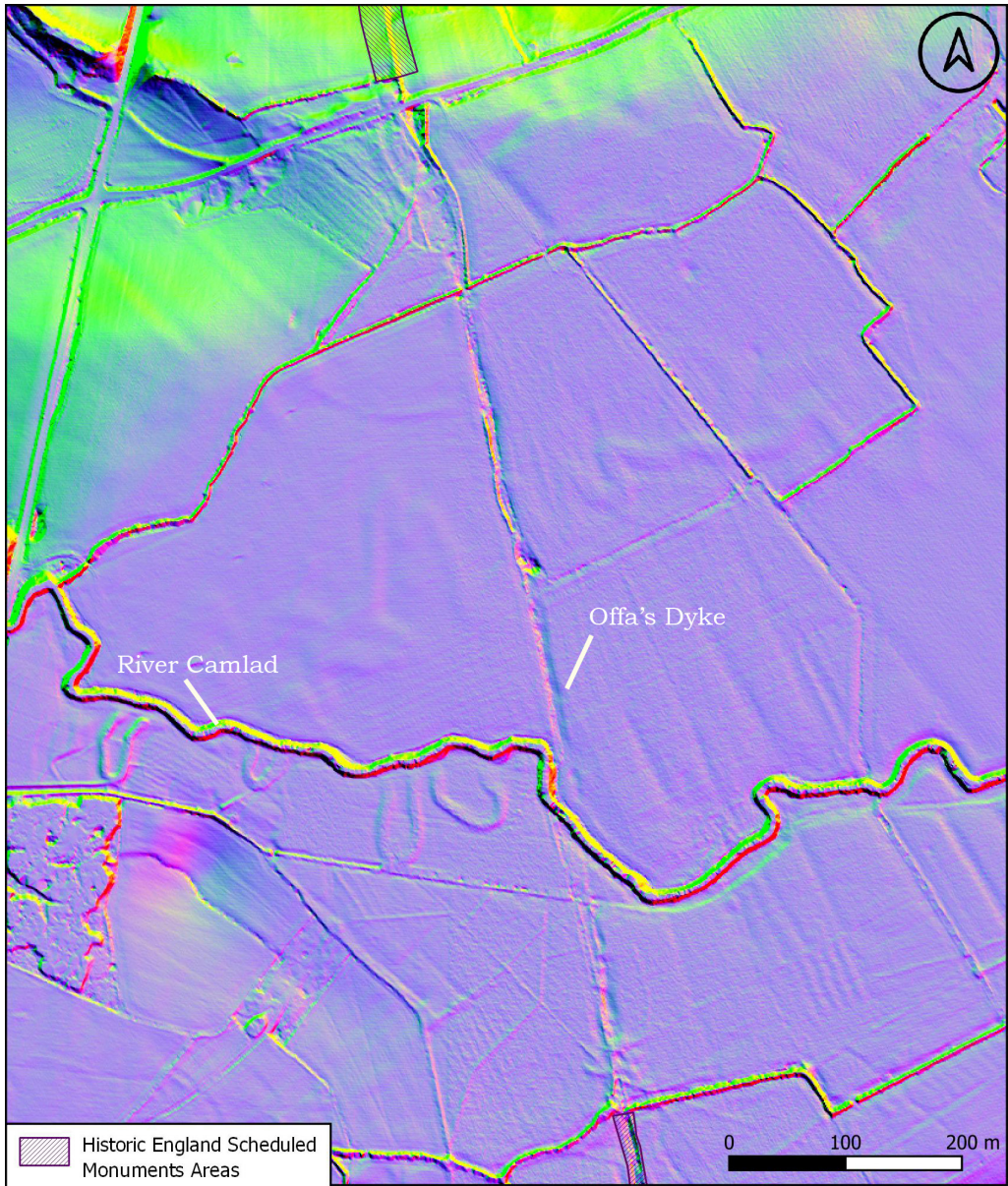


Figure 2: There is almost no visible trace of Offa's Dyke over the Camlad floodplain despite there being two scheduled extant segments either side of it. On lidar a continuous trace can be seen running between these two areas and navigating the Camald crossing. The floodplain has likely silted up around the dyke itself, leaving it intact, which could preserve some interesting elements if we were able to undertake some exploratory excavation (Base Map: PCA)

(Environment Agency 2021). In utilising this valuable resource, it is possible to systematically record the entirety of the monument digitally for the first time.

The Environment Agency lidar data for Herefordshire was downloaded, processed, and then analysed using QGIS 3.18 in 5km² blocks as per the OS Grid. At the time of the

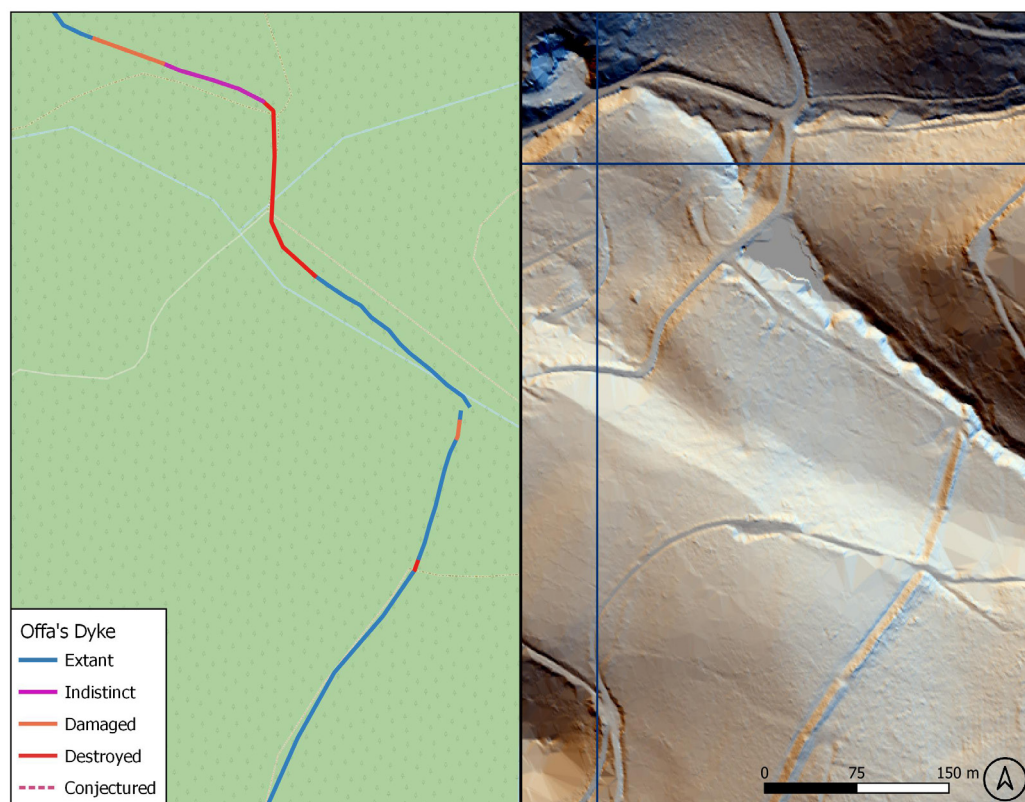


Figure 3: Fox was never able to trace the route of the Dyke through Leighton Woods, where thick post-medieval plantation made terrestrial survey incredibly difficult. However, the lidar data clearly reveals that as the Dyke enters the wood to the north, it has been destroyed by later landscaping but survives parallel to the watercourse before taking a right-angled turn heading south (Base Map: OpenStreet Map/Multi-Hillshade)

survey being undertaken Herefordshire has now largely 1m resolution though the study area of the Dyke, although there are small areas still with 2m and a large gap in the Herefordshire Plain where lidar has yet to be flown.¹ Where there are segments without lidar coverage these have been presented here with observations retrieved largely from Aerial Photography and Historic Map regression. It should be noted that this method is inferior to lidar study which means these interim results should be considered with a lower certainty of confidence.

The Digital Terrain Model (DTM) visualisations were created through RVT 2.0 tools (Kokalj *et al.* 2019) whilst alternative visualisations were also used during the mapping. It was found that an optimal mix of different visualisations could be used to enhance the

¹ This should only be seen as an interim solution; when the 1m lidar data is available this will be updated in the doctoral research. I felt it pertinent to present results in their current form to demonstrate the effectiveness of remote survey.

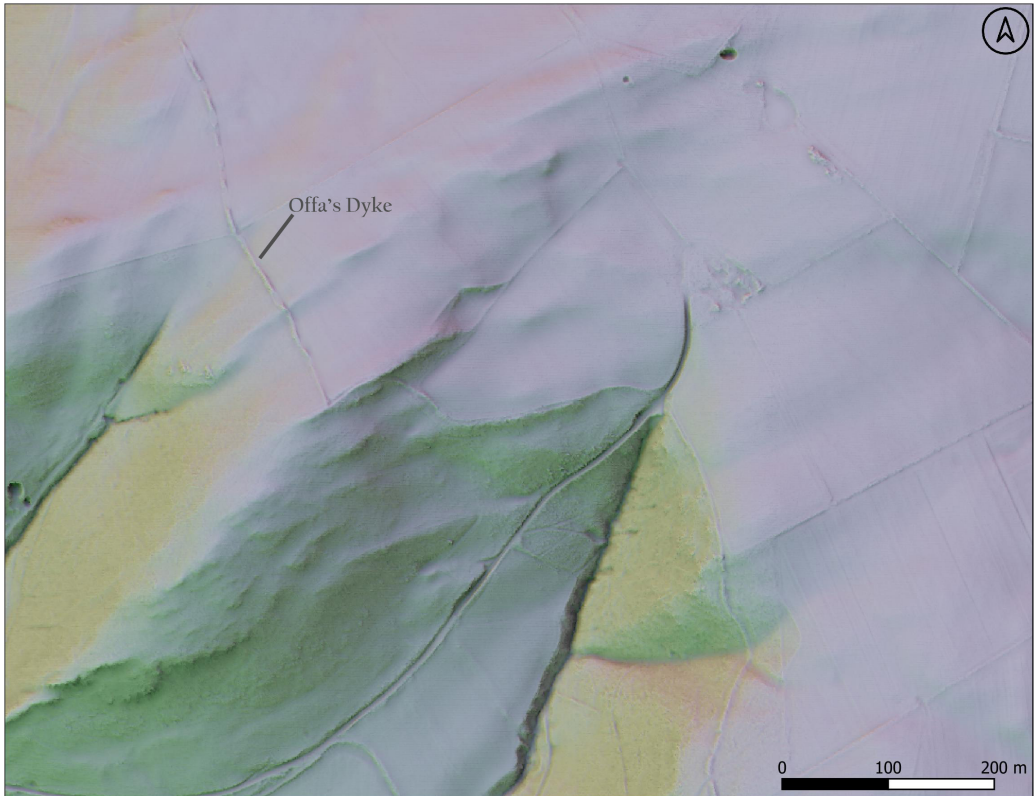


Figure 4: Section of Dyke crossing Cwm-Sanaham at showing the combined visualization of Anisotropic sky-view factor, positive openness, slope and PCA, designed to enhance the legibility and features of the Dyke.

Dyke's visual appearance in the data which assisted with identification and recording (Figure 4). This combined visualisation was used primarily throughout the mapping survey:

- Anisotropic sky-view factor (0.65–1.0, 50% opacity, multiply);
- positive openness (70–93, 50% opacity, overlay);
- slope (0–45°, 35% opacity, luminosity);
- Principal component analysis (PCA) as a base layer.

The resulting shape created a polyline which was designed to record route and existence of the Dyke.

Whilst undertaking the survey, several different dimensions were recorded, notably the monument's form (how the Dyke presents in the landscape) and type (the surviving components of the Dyke). This paper will concentrate on form, this classification was based upon continuousness, survivability, and surface expression in order to categorise the existence of the earthwork:

- Extant: Offa's Dyke can be seen in a continuous and above-ground form;
- Indistinct: it has limited positive expression, surviving mainly below-ground or through its ditch only;
- Damaged: it cannot be seen as a continuous above-ground or below-ground form, but fragments or remnants can be mapped;
- Destroyed: no remnants of the Dyke but clear indication it was removed in a later period (such as a modern construction);
- Conjectured: Lidar data has been inconclusive and there is neither clear evidence of the Dyke existing nor any clear indication of post-construction demolition. It is possible that these areas represent true gaps in the route.

An important aspect to this mapping was utilising 3D modelling to view the landscape relief in an environment from any perspective. This allowed the lighting to be controlled in real-time, allowed full control of both observation and visualisation of the landscape, and allowed a control and tangibility to the mapping which is simply not available in 2D GIS programs. This functionality brought to light aspects of the feature which would have been missed in standard 2D mapping. It really demonstrates the often-overlooked functionality of using 3D mapping for identification and mapping. To visualise the lidar data in 3D, planlaufTERRAIN was used (Meidlinger 2021)

The following results of the survey will be presented from north to south: from the North of Herefordshire south towards the River Wye. The most comprehensive data that exists is from the Offa's Dyke Conservation Management Plan (ODCMP) and Historic England's designation data, and these have been used to project the current recorded existing lengths of Offa's Dyke to provide a consistency in data standards (Figure 1). Additionally, within the text where roman numbers are presented, they refer to annotation on the figures to aid navigation and identification.

Results

North Herefordshire (Figure 5)

Utilising the same methodology DTM survey was undertaken in the area between Rushock Hill, through the Eywood estate and the River Arrow Valley to Lyonshall (covering around 7.7km²). The ODCMP in this area consists of only two small extant segments (measuring approx. 420m combined). The smaller lies just north of Berry's Wood (SO 32393 58708). Meanwhile, the larger stretch is situated on the southern banks of the River Arrow where it was later cut by the 1857 construction of the Leominster and Kington Railway (SO 32473 258028).

In the Eywood Estate, immediately after the designated segment along Rushock Hill, an extant but almost indistinct linear earthwork is visible in the data extending north-east

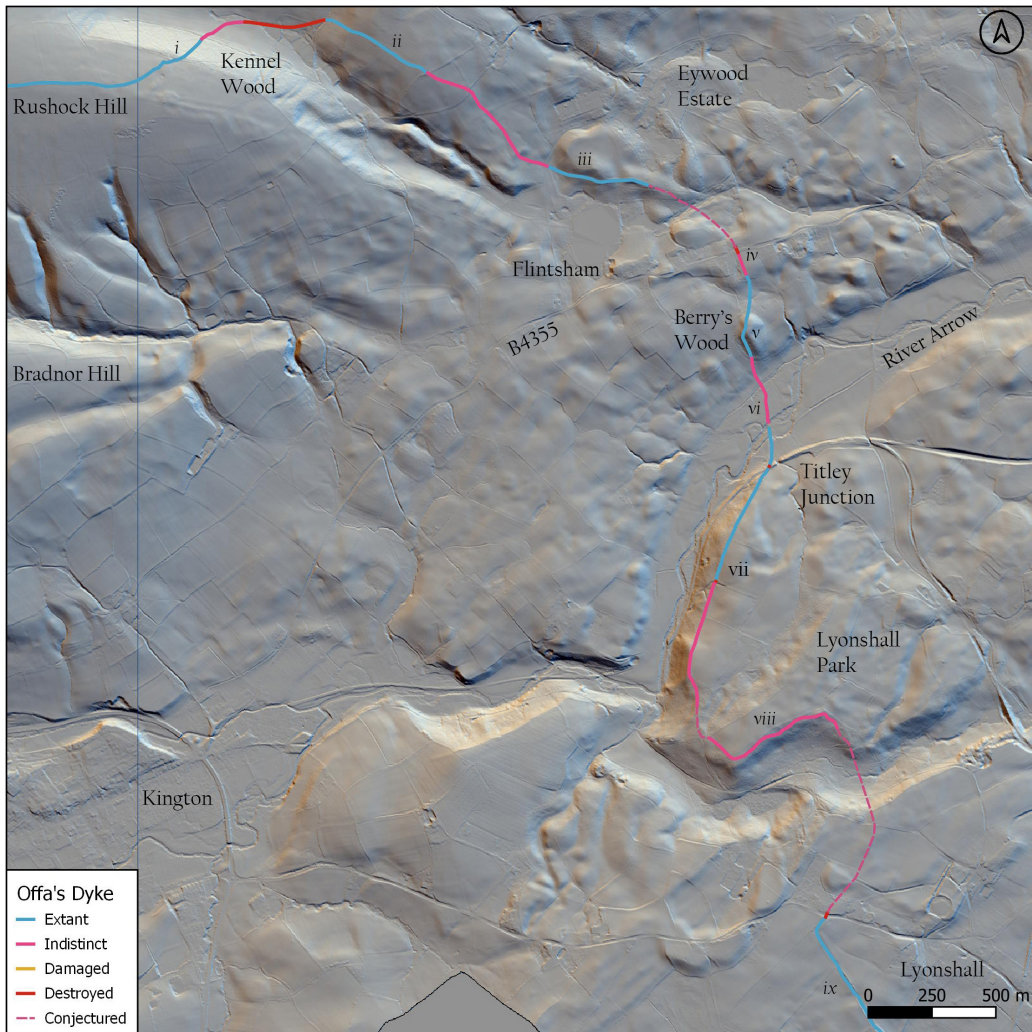


Figure 5: Map of Offa's Dyke traversing North Herefordshire and the Arrow Valley. After lidar survey there are only a few areas where a continuous earthwork cannot be traced suggesting this area was not just a series of smaller disjointed lengths. (Base Map: Multi-Hillshade)

through Kennel Wood (SO 30327 59752) beyond where it was identified by previous investigations, before quickly being lost in the landscape scattered with post-medieval ponds (i).

On the opposite side to the ponds is an unusually deep bank and ditch, slightly sinuous and traversing upslope and across higher ground along the west-facing slope to the west of Eywood Estate (ii). This earthwork, respected by post-medieval field boundaries, continues heading south-east before its physical expression in the landscape fades (SO 31147 59570). Still, the feature does continue indistinctly until the south-west slope of a rise in the landscape between Cave Wood and Garden Wood where it is preserved

by a historic trackway (iii) (SO 31798 59145). Further south, it skirts the ridge of this plateau before turning south and disappearing within the post-medieval landscaped Eywood Estate (SO 32083 59099). It then emerges again just north of the B4355, north of the River Arrow Valley (iv) (SO 32341 58887).

South of the B4355, the lidar data reveals a more continuous monument towards the River Arrow, an indistinct bank and ditch linear can be traced, surviving mainly as a subsurface feature through to join the extant segment north of Berry's Wood (SO 32393 58708). The Dyke then traverses Berry's Wood hill in a manner echoed along the whole route of Offa's Dyke (v); scaling the western slope of the hill's ridge, skirting the top of the hilltop before descending on the southern banks in what appears to be a more scarp-like form (Ray and Bapty 2016: 145–146). At the southern edge of the wood the Dyke can be seen as an indistinct linear feature crossing the floodplain of the River Arrow (vi) with only a slight surface expression, possibly a product of silt deposition from centuries of seasonal flooding. This feature continues to the north banks of the Arrow directly opposite the extant segment located there (SO 32461 58309), strongly suggesting this is indeed the continuation of Offa's Dyke.

South of the River Arrow, the Dyke ascends the valley slope, cut by the railway line, and continues along the ridge of the plateau-like high-ground atop the river cliffs. The DTM shows this linear feature continuing all the way along these clifftops, albeit in a much more damaged form (vii), akin to many similar lengths of Offa's Dyke recorded at Wyegate Hill, and Tutshill to Lancut, both in Gloucestershire above the River Wye (Fox 1955: 188–194). Other parallels include how the Dyke navigates Oswestry Old Racecourse south to Trefonen, Shropshire above the River Morda (Fox 1955: 60–61). This linear feature is recorded on the Herefordshire Historic Environment Record (HER) as a medieval wood bank or the medieval deer park pale (Herefordshire HER 1166). However, the continuous nature of the feature from the extant segment infers that originally it was same linear monument, perhaps later reused as a park pale. At the end of this clifftop, the earthwork turns east into the landscaped post-medieval Lyonshall Park, where it continues to skirt across a hilltop ridge (viii), eventually becoming untraceable. This regular behaviour is seen on many western facing hilltops throughout the route, such as Rushock Hill, Herefordshire (Fox 1955: 148–149), and Llynlyn Quarry (Fox 1955: 65–66). On the opposite side of Lyonshall there is then the longest extant segment of the Dyke in Herefordshire (1.6km) which continues towards Holme Marsh (ix).

Together, these new lengths of Offa's Dyke completely change the idea of north Herefordshire being an area of small, disjointed lengths of linear earthwork: it is an area where the Dyke can be now shown to have been as continuous as elsewhere. This explicitly counters the argument by Hill and Worthington (2003: 129–133) who were emphatic the monument did not extend south of Rushock Hill.

Herefordshire Plain (Figure 6)

Despite numerous surveys there has never been any proven segments of the Dyke recorded through the Herefordshire Plain. Yet, equally, there has been no satisfactory reason for the Dyke not to be constructed here. Cyril Fox proposed that this was due to thick primordial woodlands that prevented the construction of the Dyke and acted as a barrier itself (Fox 1955: 206–208). Noble surmised there was a wooden palisade constructed (Noble 1998: 25–28), whereas others have suggested that there simply was no construction through the low lying plain (Hill and Worthington 2003: 129–133). Ray and Bapty questioned the idea that the segments in Herefordshire were discrete and unrelated short dykes and indicated places where their orientation and placement was not plausible as cross-valley and cross-ridge dykes (Ray and Bapty 2016: 48–50); they argued that this region required a more detailed survey, which this article now can provide.

Through the Herefordshire Plain there is a gap of around 9.5km between the next recorded (and designated) segments of Offa's Dyke, which are between Holme Marsh in the north-west and at Clayfields in the south-east, encompassing the villages of Woonton and Sarnesfield. This landscape is ideal for agriculture, a stark contrast to the higher ground which dominates the more northern stretches of Offa's Dyke or its use of steep valley slopes along the Wye in Gloucestershire. The Herefordshire Plain was subject to later extensive agriculture, the heavy loam soils providing the perfect environment for the establishment and growth of substantial farmsteads from the fifteenth century, in association with the piecemeal enclosure and reorganisation of the fields, leading to production from intensive land use (Lake and Edwards 2006: 36; Lake and Edwards 2020: 2–3). These factors together mean the Dyke was likely modified or ploughed, essentially removing much of its physical appearance and former line.

An additional modern factor hindering interpretation for this area is that the main data source that has been used to undertake this project (Environment Agency Lidar data) is currently completely absent for a large part of the central part of the Herefordshire Plain. Although these results should be considered of a lower certainty, as these interim observations in this section of Herefordshire have been done from observations based on a mix of lidar data and aerial photography and will be updated when the lidar data is available.

The development of Holme Marsh has obscured any trace of the Dyke going through the village. It enters at the north-west side, from the designated segment (i) (SO 33665 54805), then at the south-eastern end of the village a very faint linear continuing on a similar alignment can be traced heading south-east. The modern road breaks this line, but it continues as a much larger, more distinct linear, utilised as a substantial field boundary with a bank to the north-east and a south-west facing ditch (ii) (SO 34247 54326). Indistinguishable from other lengths of the Dyke elsewhere, this linear extends for around 415m before its surface expression fades out of the data.



Figure 6: Map of Offa's Dyke through the Herefordshire Plain. A large part of the Plain is still not covered by accessible lidar, but Google Map images have helped identify possible lengths of the Dyke either side of the road and north of the Plain has revealed evidence for the Dyke. (Base map Multi-Hillshade)

Nearby, an earthwork bank and ditch can be seen skirting and cutting through the end of Newfield and Brown Moor Wood (iii). This earthwork is identified as a large wood bank and was highlighted by Ray and Bapty as a possible component of Offa's Dyke (Ray and Bapty 2016: 288), and as it traces the edge of the wood it makes a sharp turn east, followed by a right-angled turn south exiting the wood (iv) (SO 34796 53678). Then, in the DTM, this bank can be seen heading south becoming increasingly degraded, first through an orchard before it meets the A480 and is no longer visible in the data (v) (SO 34939 53234).

These remote observations do strongly suggest there is the possibility that the majority of Offa's Dyke now lies beneath the A480, from Brown Moor Wood (SO 34870 53622), through Wootton (SO 35299 52299) and Sarnesfield (SO 37009 50787) continuing a north-west to south-east trajectory to around Moorhouse Coppice (SO 37585 50311). It is

not unusual for Offa's Dyke to be subsumed by later features; elsewhere the Dyke's route has been supplanted by modern roads, such as the B5101 north and south of Llanfynydd in Flintshire (Fox 1955: 33). Where this has happened, relict earthwork evidence can be seen alongside the modern road, surviving in places where the road did not completely supplant the earthwork. This survival has been proven through excavation (Hill 2020).

If one continues this tentative theory, then either side of the A480 there would be evidence of Offa's Dyke. Therefore, using aerial photography, Infra-Red Photography and Google StreetView, a rapid survey was undertaken as there is currently no lidar data. In Woonton, a large linear earthwork bank facing south-west crosses a small area of green open space and is perpendicular to the northern side of the road (vi). This earthwork is clearly demarcated on the first edition OS (SO 35399 52277), and even though it is only a short segment it is a perfect candidate for a remnant of Offa's Dyke.

Furthermore, 500m to the south of this linear feature, at Ferny Common the A480 road takes a small chicane. This reveals a west facing earthwork bank ignoring this chicane and crossing through a field to the south and then connecting to the road again (vii) (SO 35918 51893). Notably, the linear crosses in front of an eighteenth-century house that has been named 'Sunnybank', presumably after the linear bank. This suggests a well-recognised and long-lived feature in the landscape, one explanation for which is the former presence of Offa's Dyke.

These are only small glimpses of possible surviving earthworks that provide an indication that the Dyke may have continued through the Herefordshire Plain. Together, lidar allow us to infer a hint of an original continuation of the feature which has not been possible before.

Yazor Wood, Burton Hill/Ladylift Clump (Figure 7)

The Herefordshire Plain ends around 2km south-east of Sarnesfield where lidar data is again available, and the topography starkly changes. Again, there are smaller areas of higher ground. After the long stretches of lowland these would presumably have been a target for the surveyors of Offa's Dyke in order to tactically utilise the high ground as at other stretches of the Dyke (Ray and Bapty 2016: 154–156). This area, known as Burton Hill and Ladylift Clump, is now densely covered by Yazor Wood. There has been no record of the Dyke neither on nor north-west of the hill, although there are known extant segments of Offa's Dyke running directly south of Burton Hill from Claypits to the Yazor Brook, then beyond to Garnon's Hill (Fox 1955: 179–180). The fact that there has been no confirmed trace of Offa's Dyke on Burton Hill (Fox 1955: 179; Ray and Bapty 2016: 74) can be reasonably explained: the hilltop has been subject to extensive post-medieval quarrying, tree planting and landscaping (particularly carriageways) which has no doubt had a large effect on the survival and visibility of any earthwork (Hoverd 2004: 8).

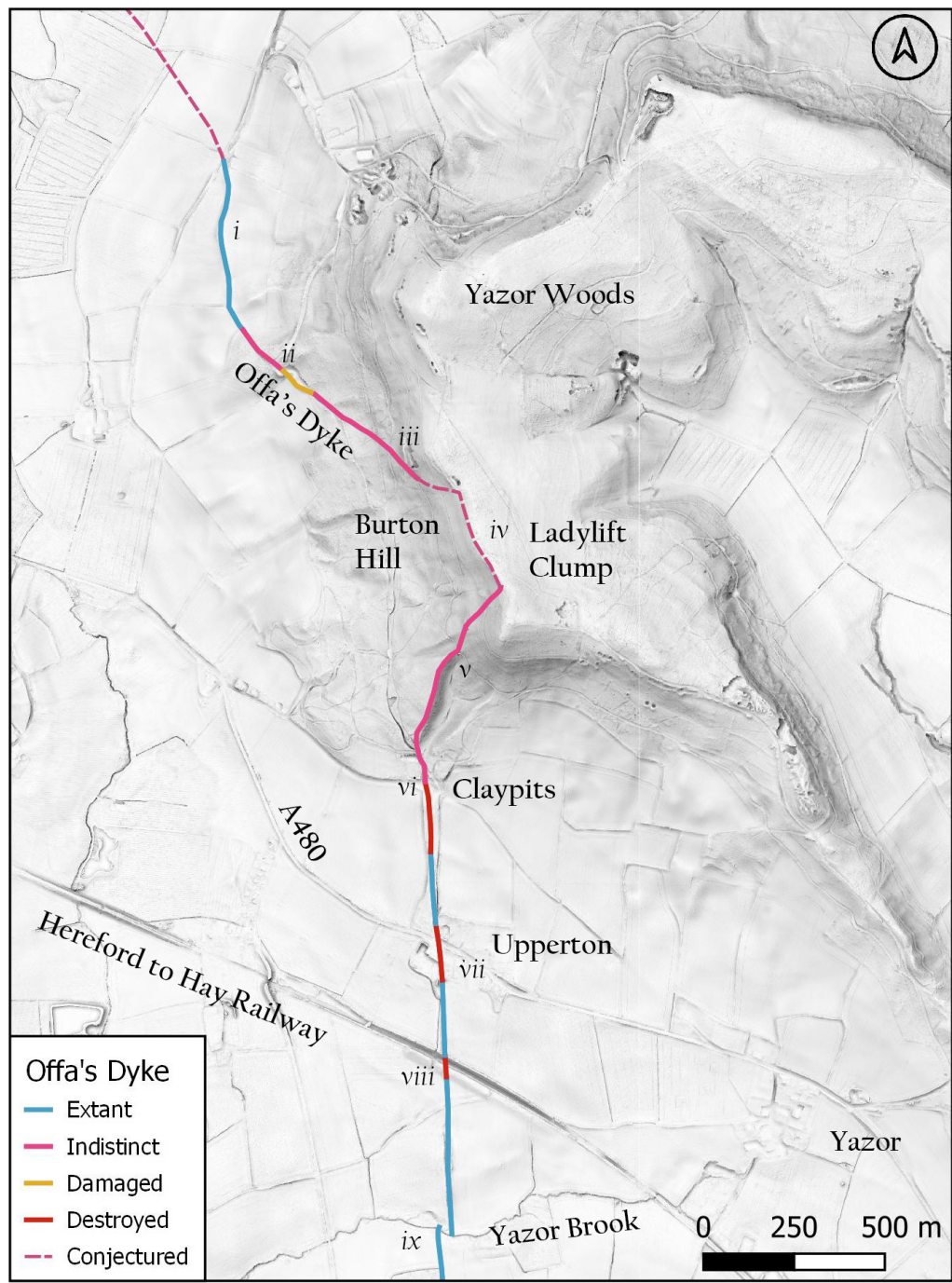


Figure 7: Map of Offa's Dyke through Burton Hill/Yazor Woods. An earthwork at the north end of Burton Hill possibly represents Offa's Dyke, but as it ascends Burton Hill the route of it becomes more confused. It is possible that in places it has been preserved by footpaths but the pattern on lidar data is not very clear as it heads towards Claypits. (Base map SVF-A)

There is no verifiable trace of the earthwork exiting the Herefordshire Plain, nevertheless, lidar survey has revealed an earthwork on the north-west side of Burton Hill which runs from the B4230 in the north-west to the base of Burton Hill in the south-east, around 480m in length (i) (SO 38861 48883). This earthwork is slightly sinuously, west facing with a ditch on the western side; it has not been preserved as a field boundary in the field systems but has survived as a large lynchet. Given its position, size and form it is likely this is Offa's Dyke emerging from the Herefordshire Plain to cross Burton Hill, with the sinuous form presumably a product of the adjusted segmented build practice preserved in the landscape (Ray and Bapty 2016: 203–208).

When it reaches Burton Hill, this linear earthwork has become a trackway and ascends the western slopes of the hill (ii), this characteristic occurrence is oft repeated across the entire length of Offa's Dyke (Ray and Bapty 2016: 154–156). It is structurally logical as the solid bank provides an ideal pathway above muddy areas of land. This trackway can be followed for a duration of 740m as it ascends Burton Hill before it presumably crests the ridge of the hill (iii). The route is unclear on lidar, however along the ridge of the hill there is a recorded 'bank and ditch' on the Herefordshire HER (Herefordshire HER 32190) which possibly could be the remains of the Dyke (iv). Again, the exact route back down the slopes of Burton Hill to Claypits is masked on lidar by a network of inter-crossing trackways (v); it may not be until further work has taken place that the route can be confidently established.

After Burton Hill the Dyke continues down towards Yazor Brook, surviving on the lidar as a low field bank. The earthwork is preserved quite differently north and south of Yazor Brook. North of the Yazor Brook it is obscured by the modern development of Claypits (vi) (SO 39434 47149), Upperton Farm (vii) (SO 39463 46777), and the former Hereford, Hay and Brecon Railway (viii) (SO 39477 46427). These have together caused significant damage and destruction to the earthwork, creating three surviving individual designated segments. In contrast, south of Yazor Brook, the low-lying earthwork is much more continuous surviving preserved in field boundaries (ix) (SO 39500 45560) as it heads further south to Garnon's Hill.

Garnon's Hill (Figure 8)

Garnon's Hill is an area of dense forest, thick vegetation cover, and extensive Victorian quarrying which together have obscured previous observation of any presence of the Dyke in this area. Previous excavations by the Offa's Dyke Project undertaken in this area were situated according to unreliable and simplistic mapped data of the Dyke, leading to the incorrect conclusion that it was not present (Hill and Worthington 2003: 137–139). The employment of a Digital Terrain Model (DTM) contradicts their preliminary determination, revealing a degraded linear feature that extends from the extant segment north of the River Wye.

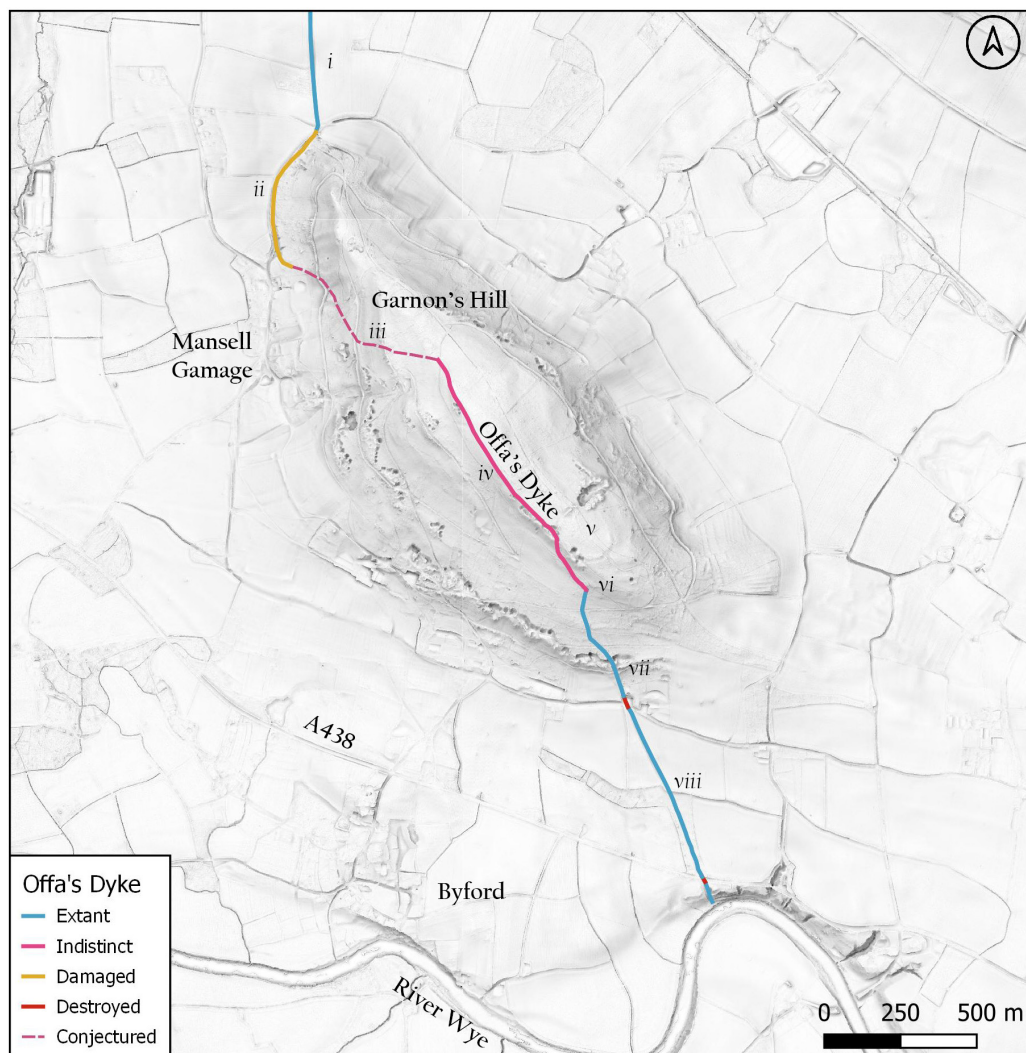


Figure 8: Offa's Dyke recorded navigating Garnon's Hill, Herefordshire. The clear earthwork trace disappears to the north of the hill but has in places no doubt been preserved by footpaths, although post-medieval forestry activities make it hard to be confident. (Base Map: SVF-A)

After the plain south of Yazor Brook where it is preserved in field boundaries (i), the Dyke seems to utilise the lower slopes of Garnon's Hill where it survives in a very damaged form, possibly utilised as a wood bank at some point but forming the edge of a trackway (ii) (SO 39736 44582). The exact route by which Offa's Dyke ascends the north-western slopes of Garnon's Hill is almost untraceable on lidar data (iii). It is possible that in places it has been incorporated into footpaths and trackways which cross the slope: the packed stone and earth of the bank would make an obvious route to place a footpath, echoing placement in Eywood. This, coupled with the thick forestry, easily conceal Offa's Dyke's former line.

Eventually, however, Offa's Dyke can be picked up as a very low earthwork, almost indistinct in the landscape, having been badly degraded by erosion, forestry operations and post-medieval quarrying. Nevertheless, it can be traced skirting just below the ridge of the hilltop before it descends on the south-western slope (iv) at a possible prehistoric hilltop enclosure (v). It notably descends in distinct stepped turns, before taking a right-angled turn (vi) as it goes directly down the southern slope to the base of the hill (Williams and Delaney 2019: 9–10, Figure 7) where there is an extant segment of monumental scale (vii). In other words, counter to the expectation of the Offa's Dyke Project, but matching with the Dyke's behaviour elsewhere (this can be seen on Hergan Hill, Shropshire (Fox 1955: 130–132), Panponton Hill and Llanfair Hill, Flintshire (Fox 1955: 137–140), and Llanymynech Hill, Shropshire (Fox 1955: 65–67)), the monument incorporates the western break of slope of the hill rather than its summit.

After Garnon's Hill there is an extant designed segment of Offa's Dyke that continues to the north banks of the River Wye (viii). This incredibly straight stretch of earthwork has been related to Rowe Ditch, Staunton-on-Arrow (Hill and Worthington 2003: 143) as a lone cross-valley dyke, designed to block the east–west Roman Road (Kenchester (Magnis) to Brecon (Brecon Gaer)) – if that road even existed (Noble 1983: 24). However, these newly identified lengths have redrawn the map in this area. With the confirmation that the Dyke navigates over Garnon's Hill, unlike Rowe Ditch, there is no northern terminus to this stretch. The verification of an almost continuous earthwork connecting the north of the Wye with the designated segments either side of Yazor Brook, north of Garnon's Hill transforms our appreciation of Offa's Dyke between the Severn and the Wye.

South Herefordshire Gap (Figure 9)

After Offa's Dyke reaches the north banks of the River Wye, there is no recorded presence of the Dyke until north Gloucestershire near Lower Lydbrook, some 32km south (Ray 2021). This is by far the largest gap in the route of the Dyke, and so far, any attempt to record extant segments have been unsuccessful. Within this DTM survey there has been no satisfactory segments discovered that could fit with the behaviour of Offa's Dyke elsewhere. There have been a number that have been seen as possible candidates which include the Perrystone Dyke, Upton Bishop (SO 62842 29493), the Linton Ridge, Ross-on-Wye (SO 66864 24173), Fownhope Park Dyke, Fownhope (SO 57603 35963), and Frith Wood Dyke, Ledbury (SO 71791 39391). However, they all seem unlikely to be part of the 'Offan' scheme in part due to a number of characteristics that make no sense in regard to Offa's Dyke, including their location, orientation, and isolation (lack of any clear continuous trajectory) in the landscape. Instead, they are more likely to be unassociated cross-valley dykes and a ridge dyke for which the region has many (Grigg 2018:167–168). It seems very likely that this gap is genuine and opens the possibility that the Mercian's adopted alternative solutions to managing their frontier in this region: the frontier work is replaced by the River Wye itself, as seems to have been the case for the

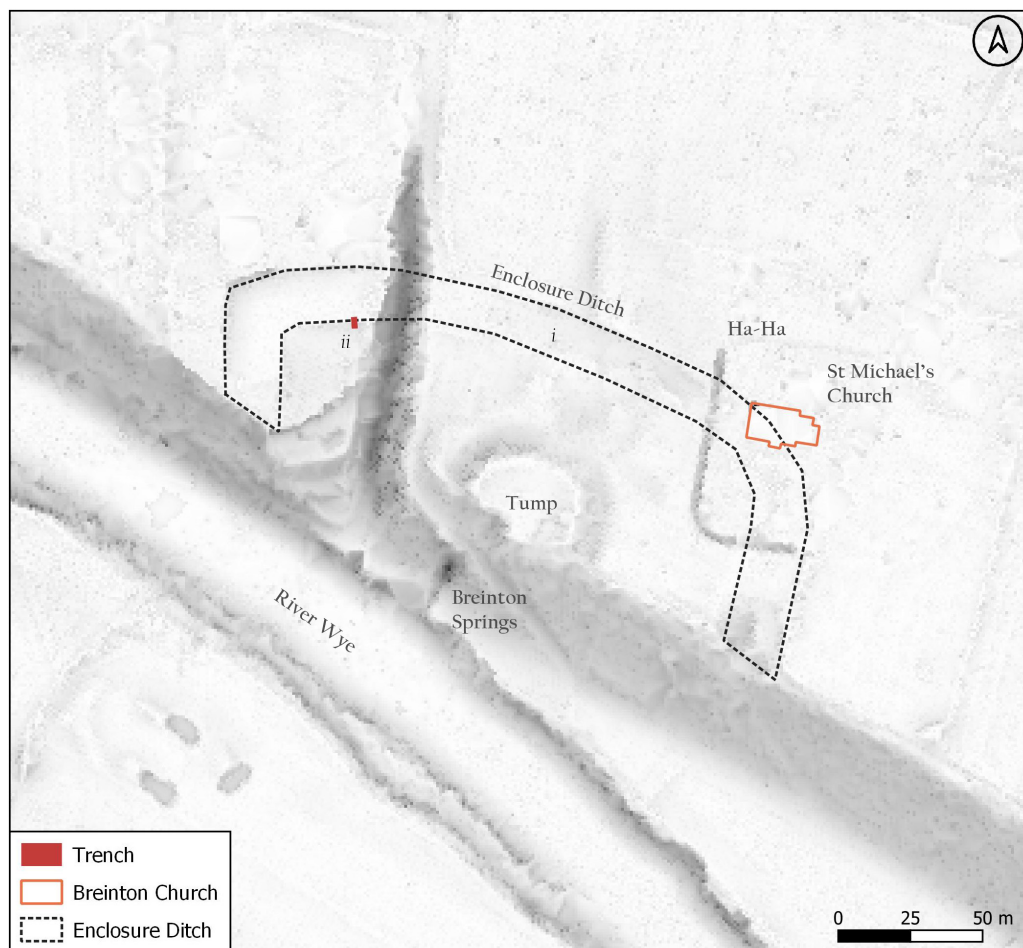


Figure 9: At Breinton Springs, Herefordshire a large enclosure ditch, below the Norman Church that encircles a smaller tump on the north banks of the River Wye. (Base map Multi-Hillshade)

River Severn and (for a far shorter stretch) the River Dee to the north (Ray and Bapty 2016: 288–289).

Through lidar survey discovery of a feature in Brienton, around 7km east of Garnon's Hill, seems to offer a possible suggestion for this expansive absence (Ray 2021). A central tump that is encircled by wide bank and ditch defences is suggestive of a type of fort (i) (Figure 9). Through the discovery of early medieval pottery and corn drying ovens during excavation of this site (ii), it has been dated to the early medieval period. Although these results are only preliminary and more excavation is required, this feature inspires close comparisons to both the Saxon defences of Hereford and the temporary fort at Repton (often attributed to the Viking Great Army (Jarman *et al.* 2018)). Preliminary results are suggestive of an early medieval defensive site located on the north bank of the Wye between Offa's Dyke and Hereford (Ray and Delaney 2018: 153–174).

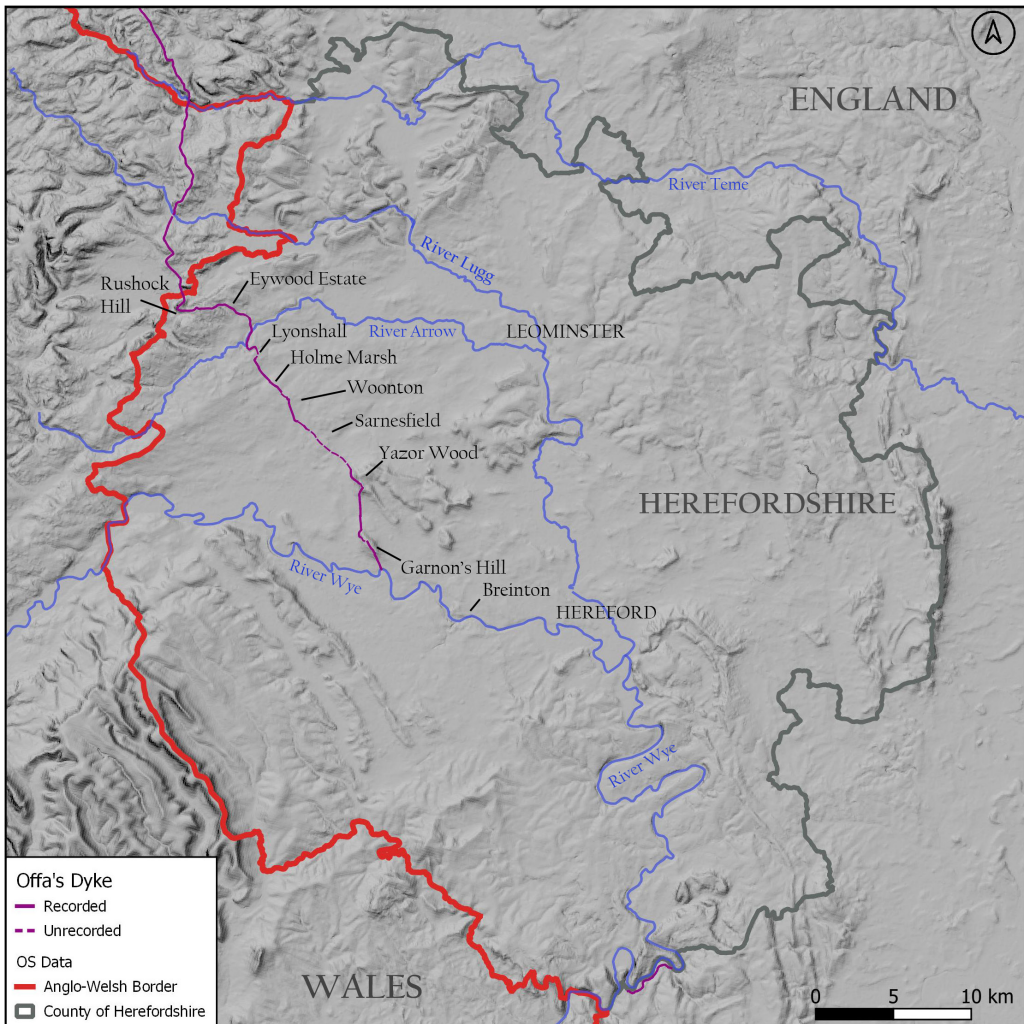


Figure 10: Plan of Offa's Dyke in Herefordshire after the lidar survey, a significant amount of recorded Dyke has been added to the map which adjusts the route and placement through Herefordshire. The Dyke is now looking much more likely to have crossed through Herefordshire.

It does seem confusing that there would be a part of the frontier without Offa's Dyke running along it, and this discovery is possibly unique evidence of a different sort of frontier than we have along the rest of the Anglo-Welsh borderlands. Presumably there never was a Dyke in southern Herefordshire and instead Mercia facilitated a different frontier solution. In effect, the River Wye *became* Offa's Dyke, and instead of the impassable earthwork shadowing the banks of the river the Mercian's created a managed fortified crossing point (or points) to funnel and control passage and trade. If this feature can be proven to be a fort, then it is possible that it highlights something which has only been theoretical (Ray and Bapty 2016: 288–289), that complexity is present in the relationship between Mercia and Ergyng which is different to the relationships of the other Welsh border kingdoms.

Discussion

If all these newly discovered earthwork segments, together with the remapped segments, represent Offa's Dyke in Herefordshire it provides an opportunity to confidently re-investigate what Herefordshire represents to the Mercian frontier (Figure 10). The differing levels of survival between segments of the Dyke are consistent with the fluctuating preservation found upon different sections of other early medieval earthwork monuments (Grigg 2018: 144–149). The impact of post-construction processes means where some earthworks are well preserved in the landscape (e.g., Fastaen Dic, Kent (White 2020: 81–103)), others are severely damaged from their original extent (e.g. Grim's Ditch (Harrow), London (Ellis 1982)) whilst some have nearly vanished entirely (e.g., Grims Ditch, Aberford, West Yorkshire (Weldrake 2011)). Understanding these differences in landscape activity brings into the question theories based on suppositions regarding the original constructed form of the Dyke versus modern survival appearance (Fox 1955: 81, Ray and Bapty 2016: 165–167). These contrasting modes of survival for earthworks, coupled with the practical hindrance of terrestrial survey, has caused some ambiguity over the existence of Offa's Dyke in some areas. However, the methodology adopted here has been able to demonstrate there is a use for digital mapping in assisting in identification and survey.

Lidar has given us the ability to trace an almost continuous linear earthwork from Rushock Hill to the south-east of Holme Marsh. Additionally, there are possible extant segments of the Dyke now recognised through the Herefordshire Plain, and then a near-continuous linear earthwork down to the River Wye. What looked like lone segments of Dyke (Figure 1) can be demonstrated to be part of a large scheme. These discoveries potentially establish that the Dyke traversed Herefordshire as much as any other region (Figure 10).

It is completely logical that the more low-lying topography of Herefordshire would subject Offa's Dyke to more intensive and extensive damage from later activity. The soil rich lowlands and hilltops were ideal areas to exploit in developing intensive agricultural regimes, leading to creation and expansion of open field systems (Williamson 2003: 181), especially due to rising economic activity (Rippon 2010: 41). It has been suggested that Offa's Dyke was possibly abandoned only decades after it was constructed (Ray and Bapty 2016: 355) associated with a relatively short duration of political and military hegemony by Mercia. Yet in the context of intense economic expansion of the long eighth century (Rippon 2010: 45–51; Higham and Ryan 2015: 181) it is possible that intensive agriculture took place in this region soon after the Dyke was built. If this is correct, then within a generation of Offa's Dyke's construction, the process of removing it from the landscape could have been initiated, building in intensity as a pressure on suitable soils became more severe (Costello 2021). This would have only intensified again as agriculture became further intensified and mechanised in the post-medieval period. Such successive processes were completely different to those affecting Offa's

Dyke in more marginal upland areas to the north, where the Dyke was more commonly constructed. This is a far more convincing explanation for the stark contrasts in the monument's modern survival than contrasting original modes of construction or the monument having been incomplete, replaced by a palisade or merely absent from long stretches of the Herefordshire Plain.

Herefordshire is also known for pronounced shifts in Offa's Dyke's alignment (notably at Rushock Hill (Ray and Bapty 2016: 234–235)). The general route of the Dyke turns at this point to head more south-east; digital mapping can illuminate these localised adjustments in the route. Offa's Dyke takes a very direct route through high ground, but when crossing low-lying landscape for extended distances its route can become more circuitous, utilising shorter lengths and more varied lengths of segments to adjust the route over the landscape (Ray and Bapty 2016: 131–135). This circuitous routing also makes it harder to trace and predict, as even though it seems to target west facing higher ground, it does not seem to follow contours in the landscape. It is therefore in these changes of orientation it is possible to see conscious design decisions behind the route and placement, hinting at the possible affects which the route and placement of the Dyke was subject to. Whether it be to satisfy tactical advantages in the landscape (Ray and Bapty 2016: 234–240), to emphasise the Dyke's appearance (Ray and Bapty 2016: 131–135), or owing to the Mercian's own perceived power, or not, in certain regions along the borderland (Delaney forthcoming).

This more sinuous nature of Offa's Dyke becomes even more apparent when viewed in a 3D environment (Figure 11). North Herefordshire (Rushock Hill to Lyonshall) is a fantastic example of this sinuosity and shows that angled turns are not arbitrary: the placement of the Dyke seems targeted to utilise even minor west-facing higher ground. Even the right-angled turn at Rushock Hill, which has been subject to debate, appears to avoid a vast swathe of the River Arrow plateau. Instead, the route through Eywood means smaller slopes and hills, like Berry's Wood, are utilised to improve upon the Dyke's visual impact westwards (Ray and Bapty 2016: 151–157), which is much decreased if it travels through the very low-lying landscape.

This utilisation of visually striking topography can be demonstrated in undertaking viewshed modelling. It has often been presumed that the Dyke was used to aid surveillance, highlighting Offa's Dyke's attributes as a functional frontier monument (Delaney forthcoming).

Conclusion

This presentation of the results of research into one of the most disputed sections of Offa's Dyke, demonstrates how this method of survey is of great assistance in revealing and mapping linear earthworks not possible via traditional terrestrial survey alone. The article suggests that Offa's Dyke in Herefordshire is not an area of disassociated short

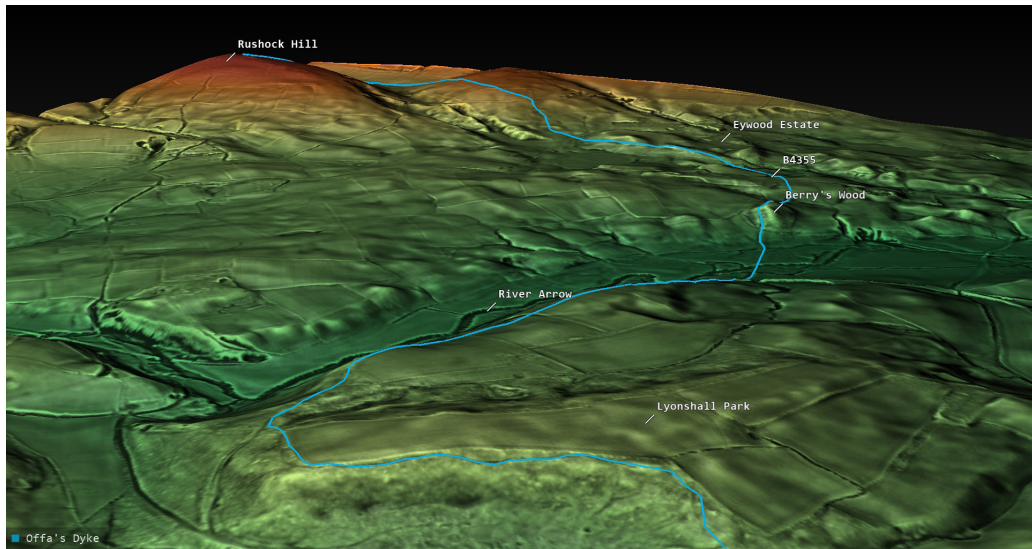


Figure 11: Viewing this region in 3D relief Offa's Dyke's use of the landscape is very clear, it clings on the west facing slopes of even relatively small hill slopes, improving its visible impact westwards.

dykes, but that the local topography has directly impacted the presentation and course of Offa's Dyke. Offa's Dyke passes through the county continuously, albeit subject to much more intensive post-construction activity and erosion than on the hill country of Powys and Shropshire.

This confirmation expands our understanding of Offa's Dyke, it not only allows a fuller picture of the Dyke, but it also reduces the supposition that can occur when studying the nature of the Mercian frontier. The lidar study goes some way towards confirming that Offa's Dyke is largely a continuous monument, and that breaks or gaps in the Dyke are therefore changes to that normality. The gaps in Offa's Dyke are thus important, and an indication of a choice in design, from a possible change in the function of the frontier. It has been suggested before that the Dyke's construction is a result of some unique relationship or hostilities with the kingdom of Powys urging a militarist approach to defending the landscape (Hill and Worthington 2013: 107–112, Worthington Hill and Grigg 2015: 162–166), but if the Dyke continues largely unbroken across northern Herefordshire, then the monument can be understood as built as part of a frontier landscape opposing other Welsh kingdoms including Maelienydd, Brycheninog (further west), and Gwent (further south). As discussed, in Herefordshire the largest gap is in south Herefordshire, which exposes a possible unique relationship with Eryng. Equally, gaps at rivers suggest the importance of water courses in the region. Now that we have an accurate record of the Dyke, we can start questioning reasons for placement and location.

Herefordshire is the area of greatest divergence between the modern Anglo-Welsh border and the postulated continuance of the monument and so the monument does not pervade in popular consciousness in this area; indeed, the Offa's Dyke Trail does not follow the route of the Dyke at all south of Rushock Hill (Noble 1981: 34). This separation from public awareness exacerbates other issues since conservation and management both require active participation and consideration; it is very hard to get the community to care for a monument that it cannot see or is uncertain in its location. Hence, without due recognition, it is far easier for to perpetuate and extend neglect for surviving stretches of this monument. This disconnection was securely evidenced in the recent Offa's Dyke Conservation Management Plan (ODCMP) where it was observed that Herefordshire suffers some of the worst degradation of the earthwork (Haygarth Berry Associates 2018). The generation of this new survey data can be used to improve the knowledge, and conservation of the Dyke, confirming Offa's Dyke as an important and notable part of Herefordshire's historic environment.

The study therefore has direct ramifications not only for the archaeological interpretation as well as the heritage conservation and management of Offa's Dyke in Herefordshire. Furthermore, it provides a pilot study for the fuller survey of the entire monument across every region in which it is postulated to have once existed. This has the potential to not only illuminate new insights into the course and placement of the early medieval monument where there has been debate regarding whether it ever ran, but also to provide a dataset of the entirety of the Dyke that can be queried and interrogated for research, management, and conservation purposes. If possible, this could be extended for other linear earthworks elsewhere in Britain, providing a reliable map of comparative analysis of their location, extent and the shared management and conservation issues they face in the twenty-first century.

Acknowledgements

I am especially grateful to Tim Hoverd, Keith Ray and Howard Williams for their input, guidance and support during research and production of this article. Additional thanks to the anonymous referees for volunteering their time to offer suggestions and guidance.

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