Observations on Lidar data from Gorrick Wood

At the BAS Day School on 1 April 2023, Fiona McDonald showed a lidar scan of Gorrick Wood with 'interesting features', see Figure 1(L). I recognised an area I had walked many times along all marked (and many unmarked) tracks and paths, so I decided to investigate what could be seen 'on the ground'. In particular I was interested in:

- The irregular patches in the middle of the image (to the south of the roughly east–west track)
- The irregular patches in the block next to the railway (to the left of the above)
- Linear features that don't align with existing paths and tracks

Figure 1 shows an area approx 1000x800 yards. I looked for features in areas 1, 2, 3 & 4.

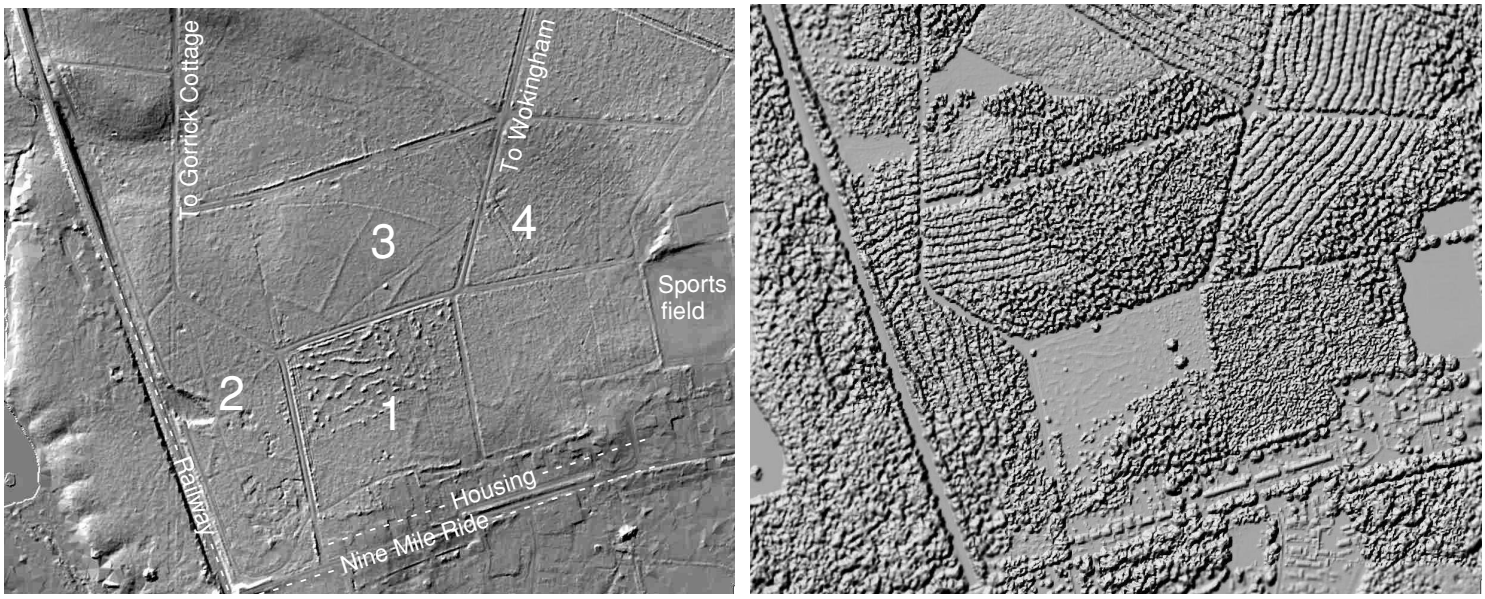

Figure 1: (L) Enhanced 1m DTM (R) 2m DSM

1 Approach

I scanned the lidar looking for features that didn't correspond to what I knew was on the ground (on the map and/or from observation). I then made several trips to see if I could find anything to match the lidar features.

Lidar imagery – I downloaded lidar images (1m DSM, 2m DSM, 1m DTM & 2m DTM) from the National Library of Scotland website. I mainly used the 1m DTM image. The source is shaded green and of very limited contrast (about 1/6 of the dynamic range of the image format) so to make the detail easier to see I expanded the images to occupy the whole dynamic range, and also converted them to monochrome.

Lidar interpretation – Lidar measures the height (of the ground or the canopy surface) which is converted into light and dark areas where highlights and shadows would be if the surface were illuminated by a light. It therefore represents local changes in height rather than absolute height. To determine whether a feature is a bank or a ditch requires knowing where the assumed the light source is. From known features I deduced that it is at the top left of the image (ie shining from the northwest). So a bank running north–south will appear as a bright line to the left of a dark line, and a ditch running north–south will appear as a dark line to the left of a bright line. Similarly a bank running east–west will appear as a bright line above a dark line and vice versa. In practice digging the earth to form a man-made bank (or ditch) may create slight ditch(s) (or bank(s)) alongside it. A ditch or bank running directly towards the light source will not register, or will generate a weaker trace than it otherwise would (unless there are multiple light sources).

Images – I have included pictures of the features that I found, though the flat images don't all convey the 3-D topography as well as it appeared to the eye. The pictures embedded in the document are 1200 pixels wide[1], so will give high quality printing on A4, but that is a higher resolution than a screen can resolve at normal size. So to see full detail on screen the document should be viewed at least double its normal size.

Positions – I did not use any GPS reference, and located the position of lidar features by reference to existing tracks, pacing approximate distances along or from the tracks. This enabled me to find ground features corresponding to many of the lidar features.

1 The originals are higher resolution but reduced to keep down the document size.

2 Irregular shapes in block 1

Block 1 (see Figure 1) is roughly square, bounded by three forest tracks and the path behind the houses in Nine Mile Ride. It is all wooded but the character of the two halves is very different. The northern half is quite dense and coppiced, as shown in Figure 2 (L), while the southern half has taller, less densely packed trees, with little evidence of coppicing, and certainly not recently.

Figure 2: (L) Northern part of block[2], (R) Southern part of block

Figure 3: Boundary between the north and south parts of the block – (L) western edge, (R) eastern edge

The DSM in Figure 4 shows significant difference between north and south halves of the block. Most of the northern part shows the same features as the DTM, ie the coppiced trees, probably 4-5m tall, are invisible on the DSM. The only tree-like returns are from the few much taller isolated trees among the coppicing. The taller trees in the southern half of the block generate canopy returns over most of the area on the 2m DSM, but interestingly over a smaller area of the 1m DSM.

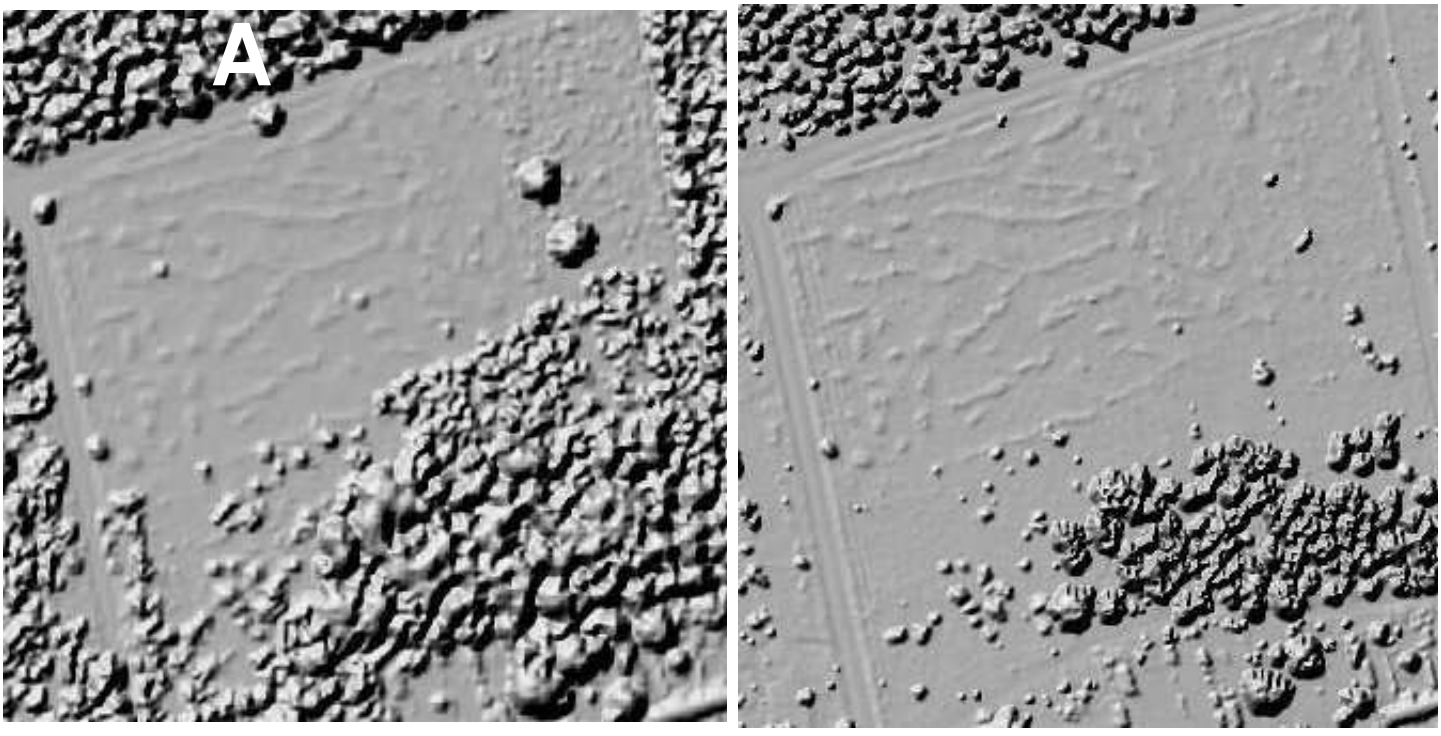

Figure 4: (L) 2m DSM, (R) 1m DSM

2 The bank in the foreground is formed by the ditch alongside the current forest track.

Access within the coppiced area is not easy but I managed to penetrate around 10–15m from the northern edge of the block south of A in Figure 4. The most visible features were artificial 'banks' of felled poles and brushwood, see Figure 5, running roughly parallel to the track, ie in the same general direction as many of the DTM features. These dense masses, many of which incorporated mats of un-decomposed leaves, would not be penetrable by the vertical laser, and so would appear as the base 'terrain'.

Figure 5: 'Banks' of poles, brushwood and leaves in the northern part of the block

I found two satellite images of the coppiced area. One dated 2013 shows the area covered with small trees in leaf. The other, more recent image in Figure 6 (L) shows the area cleared and dark marks that look similar to the lidar features. I could not find a source date, but from other content it must have been taken in the summer of 2019 or 2020[3].

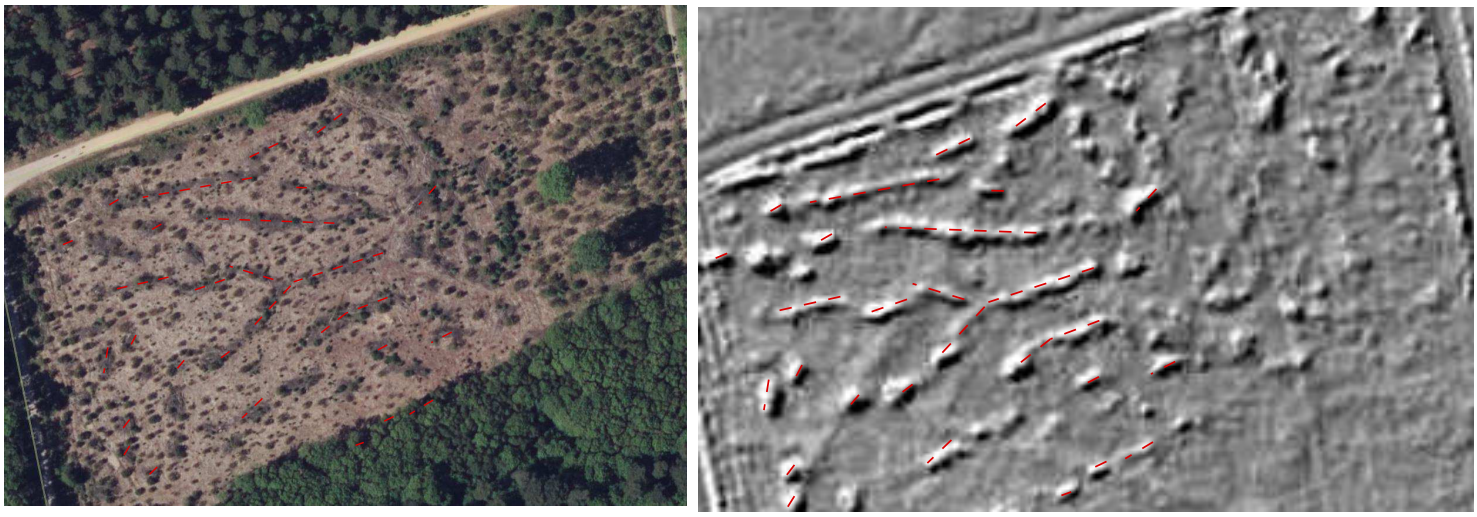

Figure 6: The coppiced area with features marked – (L) 2019 or 2020 satellite images of, (R) lidar 1m DTM

The different colour in the satellite image between the features and the surrounding ground, implies they are a different material. The red lines on both halves of Figure 6 are the same, and show a good match between the visual features and the lidar features. This strongly supports the interpretation of the lidar features as banks of felled timber, brushwood and leaves.

3 The irregular shapes in block 2

Block 2 (on Figure 1) is the area between the railway and block 1. It varies in character, with the southern part deciduous, relatively open and easy to access, and the northern part more densely planted, mainly conifers. This is reflected in the DSM in Figure 7 (L&M).

The 1m DTM in Figure 7 (R) shows many hollows, some of which are clustered together.

[3] The satellite imagery shows half built houses on the west side of Elms Field in Wokingham. They were started in 2019 and completion was delayed by Covid. Lawns and parks in the town were brown so it would have been in high summer.

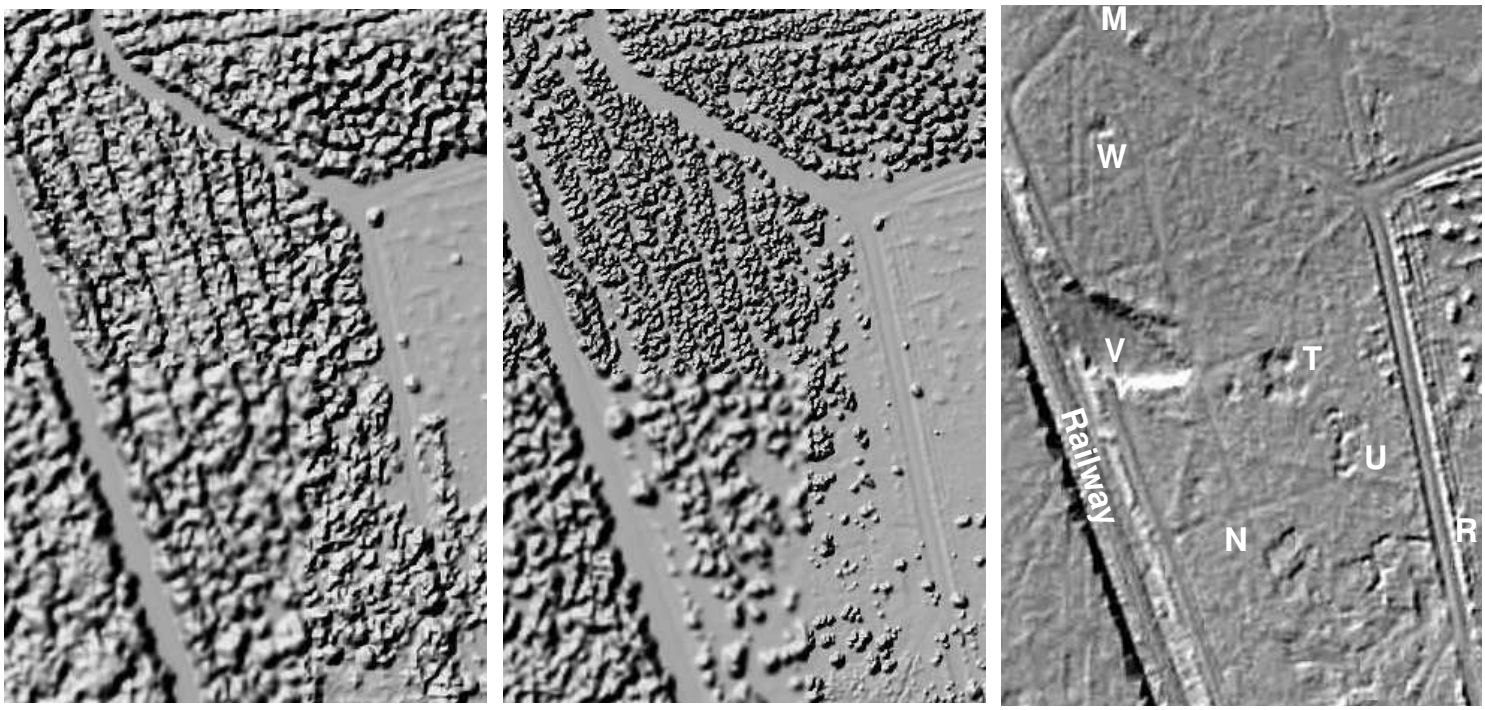

Figure 7: Western block – (L) 2m DSM, (M) 1m DSM, (R) enhanced 1m DTM

The hollow near T is quite large, maybe 15m x 20m and ~1m deep. It appears as a single feature on the DTM, but is actually several connected hollows, see Figure 8.

Figure 8: Large hollow near T

The hollows are crossed by a pair of ruts that may have been left by forest operations rather than directly related to the creation of the hollows. Figure 9 is looking north along the ruts towards the walkers' path.

Figure 9: Ruts that run north across the hollow at T (east-west path in the background)

The string of hollows between N and R are clearly visible on the ground, some of them shown in Figure 10. They seemed to be connected but didn't follow any particular pattern. They look man made. The area is covered by forest detritus so it was hard to see detail, and not possible to be sure of the depth of the hollows, or whether there were any 'heaps' above natural ground as well as 'hollows' below it, which might provide clues to their purpose.

Figure 10: Hollows in block 2 west of R

The hollow near W is well away from the other groups of hollows. One end of it is crossed by a disused forest track, see Figure 11.

Figure 11: Large hollow near W – (L) hollow, (R) ruts across it

The large hollow at V is several metres deep, with steep sides except where it faces the railway. I have always assumed it was a quarry, possibly associated with the railway construction, see Figure 12.

Figure 12: 'Quarry' near railway at V – (L) looking into it, (R) looking south along the path through it

I didn't explore the weaker lidar features in the area south of M–R, or near U.

4 'Circular' feature in block 3

Just across the track from block 2, at the western end of block 3, is a feature that looks like a circular bank. However, when enlarged – see lidar image southeast of M in Figure 6 (R) – only the northwest and southeast sides are visible (ie the brain is completing the circle by filling in the northeast & southwest sides, which might not show anyway with illumination from the northwest).

I found no banks, but there dense masses of vegetation that might be the source of the two halves of the lidar feature, see Figure 13.

Figure 13: Vegetation masses near the track at the west of block 3

5 Linear features

The lidar images show many linear features in the DTM. A lot of them correspond to existing tracks and footpaths, which are overlaid in orange on Figure 14 (L). There are some other well used paths, notably between approximately B & D and approximately E & D, which don't appear on the DTM, so I assume they are modern and have not yet worn a significant profile on the ground. The varied texture of the 1m DSM in Figure 14 (R) – and the 2m DSM in Figure 1 (R) – reflect the varied tree cover across different parts of the forest.

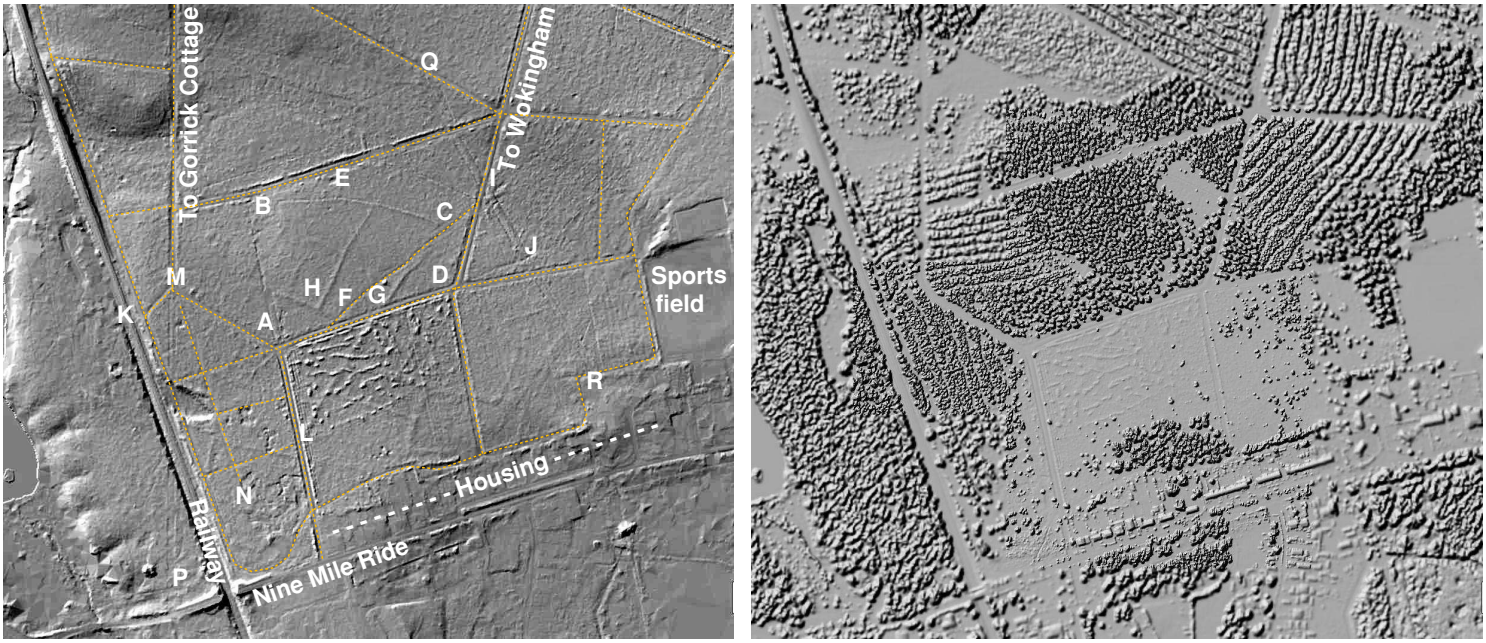

Figure 14: Current tracks and paths overlaid on – (L) 1m DTM, (R) 1m DSM

There is no path along the lidar feature running from A to B, but the 1888-1913 OS 6" map shows it as an extension of the main north-south track into the wood from Nine Mile Ride. Nothing is visible looking in from the edge of the trees, but a short way in from A there are two ditches about 8m apart, see Figure 15, and there appears to be a single ditch at B, shown in Figure 16 (L). This matches the lidar, with two ditches at one end and one at the other.

Figure 15: Clear ditches running north at A (L-R as viewed)

There is no sign of a path along the line of these ditches but a path enters the trees near here, seen crossing the bank next to the track in Figure 16 (R) – one of several well used paths through the relatively open area east of A–B.

Figure 16: (L) Apparent ditch running south at B, (R) Access to path from track near B

The trees are well spaced with high canopy and minimal surface vegetation, making it easy to walk almost anywhere, see Figure 17 (L) The DSM, particularly 1m, is distinctive, with smaller more sharply defined blobs.

There are several well trodden paths across this open area, some clearer than others. A prominent one runs roughly south from near E to meet the marked path near F. There is a very faint lidar trace along this route, though not a very convincing one. The other prominent worn path heads east from near B and via a rather indistinct split – see Figure 17 (R) – one branch meeting the marked path at C and the other crossing it to emerge by the track at D. The northern branch of this path might correspond to the lidar feature between B & C.

Figure 17: (L) Open forest floor, (R) Path junction (from B to C/D)

At G the DTM shows a clear bank running northeast towards C. There is a slight bank here, seen in Figure 18 looking from the track and back towards the track.

Figure 18: Possible bank – (L) looking northeast from F, (R) looking southwest toward F

The same lidar feature runs southwest towards L but the confused nature of the coppiced area makes it impossible to see anything coherent on the ground.

I could find nothing corresponding to the strong lidar ridge running northeast from H, nor the weaker feature running northwest.

The DTM shows twin ditches running northwest – southeast across the track at I. Looking northwest they are clearly visible, see Figure 19.

Figure 19: Ditches running northwest from the track at I (L-R as viewed)

One ditch is visible southeast from the track, behind the local hollows in Figure 20 (L), complicated by the fact that it crosses a natural hollow that was flooded at the time. It is clearer a little farther from the track.

Figure 20: Ditch running southeast from the track at I – (L) from track, (R) some yards from track

Further still into the wood it is possible to identify both ditches. A short distance from I the DTM shows a strong short join between the two ditches. This is cut quite narrow and so probably modern, see Figure 21 (L). It is possible to follow the line of the ditches towards J until the trees become more dense. The lidar trace continues beyond J, albeit very faint, towards the edge of the wood, but I didn't attempt to follow it.

Figure 21: Ditch running southeast from the track at I – (L) cut between ditches, (R) approaching J

South of I, near where the path going southwest towards C & F leaves the track, there is a ditch running slightly north of west, which is much deeper than suggested by the very faint lidar trace. That may be because it is roughly aligned with the notional light source assumed by the lidar visualisation algorithm.

Figure 22: Ditch running west from south of I

6 Comparison with early maps

Linear features may be former paths or tracks that left an imprint on the terrain. Figure 23 is dated 1816[4] but with later revision, notably the railway. The map shows a network of rides through the forest, five of which pass through the area under study (white dotted rectangle) in which the position of current tracks and paths[5] are shown in orange. The B road (Nine Mile Ride) runs X1–X2. A forest track runs X3–X4 but not to X5 (see below). A forest track (Hatch Ride) runs through X6–X7. Nothing exists along the line X6–X8. The line X9–X10 is problematic but could relate to the twin ditch lidar feature (yellow line), see below.

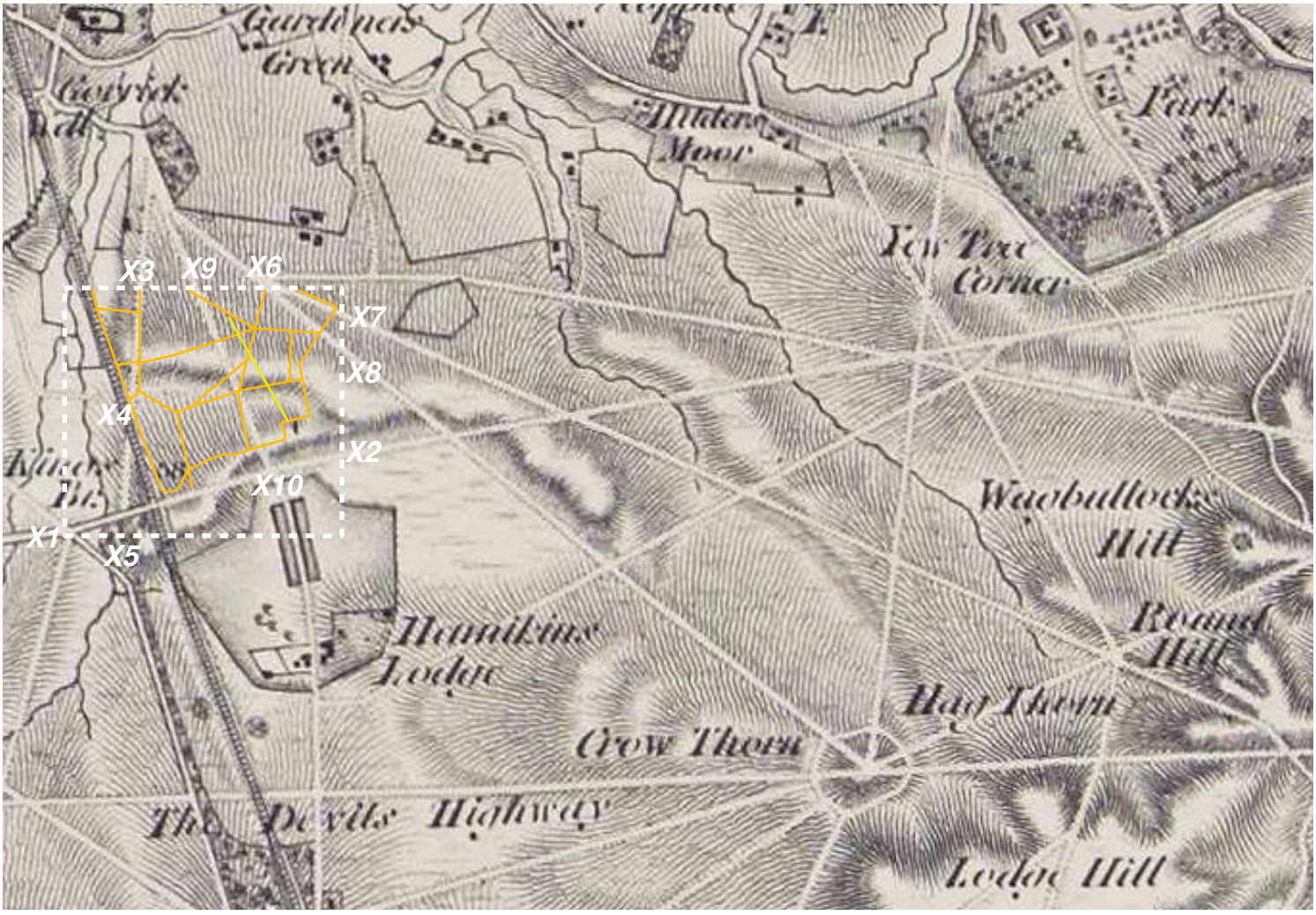

Figure 23: Historic routes on OS 1" 'Old Series' map

4 The printed sheet includes: '*Published 1st . May 1816. by Col*l*. Mudge, Tower*'. The NLoNZ website says: '*Publisher: London : Lt. Col. Mudge, Tower [and later] by Lt. M. Colonel Colby of the Royal Engineers : Sold by Jas. Gardner : Publication Date: 1805-1873*'.

5 The pattern is based on modern imagery and then fitted

Figure 24 shows later maps of the area – OS 6" maps surveyed in 1872, 1910, 1932 & 1938. The last two appear identical to this area so only one is shown. The DTM is shown alongside them to help match features. Note that the upper maps extend beyond the study area (shown by the square outline).

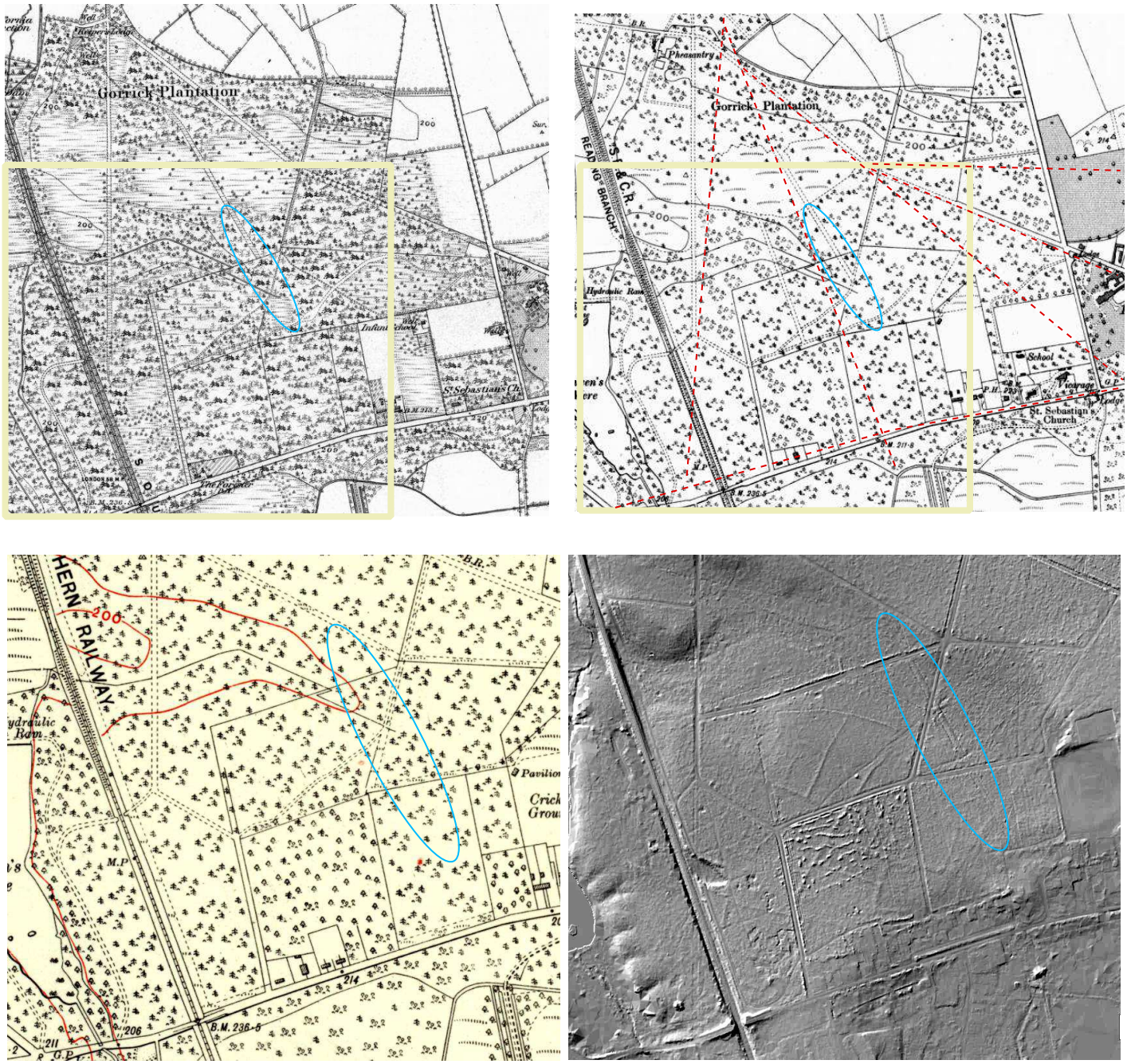

Figure 24: OS 6" maps – (Top L) 1872, (Top R) 1910, (Bottom L) 1932 & 1938, (Bottom R) 1m DTM

The blue ellipses show the location of a prominent lidar feature where a pair of ditches cross the track at I (see Figures 19 – 21). It is visible in the DTM over the full length of the ellipse but is strongest is strongest in the middle.

Both the 1872 and 1910 versions of the OS 6" maps show a track along part of this alignment but in neither case is it complete, and neither covers all of the strong part of the lidar feature. On the 1872 map the track stops at a boundary around 60m north of I, on the 1910 map it reaches as far as I but doesn't continue any further south and on the 1932 map the track is absent. This variability suggests a former track that had probably already gone out of use.

The 1910 map is overlaid in red with the lines of the tracks from the 1810 map. They were copied as a pattern, then scaled and positioned to provide the closest fit of the triangle formed by Hatch Ride, Nine Mile Ride and the north-south track. The fit for Hatch Ride and Nine Mile Ride is quite good but the alignment of the north-south track is out by around 5°. If that were ascribed to a surveying error then a similar error would account for the misalignment between the middle track on the 1810 map and the later partial tracks and the lidar feature.

Many maps, as early as 1872, show the track west at K continuing west with a bridge under the railway as shown right in the OS 2½" map. My copy was published in the 1960s but it was based on 6" sheets surveyed between 1902 & 1932 with 'partial systematic revision' between 1937 & 1956. There are differences in tracks and paths between the 1910 and 1932 OS 6" maps, so the presence of the bridge in both suggests it was still there in 1932, but the later revision might have been confined to roads and buildings rather than woodland, so might not have captured removal of the bridge. The bridge is not shown on my OS 1" map, which was fully revised in 1956, so we can only be sure that the bridge was removed some time between 1932 and 1956.

Figure 25: Former bridge under the railway at K.

The track now stops when it meets the track that runs alongside the railway (not shown in Figure 25). There is no sign of the former bridge nor track now, though there is a slight depression in the bank alongside the railway where the track would have been (Figure 13). It's difficult to see how a path could have gone under the railway here since the trackbed is less than a metre above grade. Even a cattle creep, let alone a pedestrian bridge, would have required an excavation a few metres deep, and it would have flooded quite often.

Figure 13: Site of the path that on early maps crossed the railway

7 Discussion

I have made some progress correlating the lidar features with what can be seen on the ground on on maps. In many places 'the ground' was not visible under thick layers of dense forest detritus, and in some places access was constrained by dense vegetation. However I have reached some tentative conclusions, and also raised several questions:

- Many (perhaps all) of the apparent banks and humps shown by the DTM of the northern part of block 1 are piles wood and leaves, not the underlying terrain, and they may be fairly recent.
- Why would so much wood be cut and then stacked rather than extracted for use? Was it a low grade by-product of the primary harvest? Was it stacked to prevent it hampering future operations or were the artificial banks created to promote wildlife?
- Why were the extensive series of hollows in block 2 dug? Are they the relic of small scale extractive activity? If so, for what purpose?
- How was it possible to build a footbridge under the railway where the trackbed is close to the natural ground level?
- Why did some of the routes through the wood disappear?
- Why are some tracks on 'old series' OS maps 5° out of alignment with later (assumed accurate) maps?

8 Credits

All photographs were taken by me and maps were obtained from websites linked via oldmapsonline.org/