



HYNISH BOUNDARY PROJECT

June & October 2019 Survey Report

Abstract

This report describes the methods used and results obtained in the ACFA survey of the field boundaries in the Ben Hynish area of Tiree.
The surveys were undertaken from 15th to 23rd June
and 11th to 16th October 2019.

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Executive Summary

The hillside of Ben Hynish on the island of Tiree has a network of field boundaries which appear as linear features on Ordnance Survey aerial photographs. This report discusses the information collected on these field boundaries in the 2019 surveys and the techniques used to collect and analyse it.

The boundary lines were traced on the aerial photographs using the geographical information software QGIS. The resulting information was exported to the smartphone app ViewRanger as gpx tracks and also exported to iPads as a “Blue Line” map. This information was used, in the field survey, to locate and identify each line. In addition, the iPad app Tap Forms was used to collect data on the characteristics of each line; such as construction material, height and width. The resulting Tap Forms information was merged with the line data in QGIS and used to display these characteristics on a map of the landscape.

The information on the line location and characteristics was used to identify potential enclosures. Maps of these were drawn in QGIS and compared with historic maps. The enclosures classified as Stone & Turf are visible on historic maps but those classified as Dragons Teeth are not.

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Introduction

On aerial photographs of the area around Ben Hynish, there are various linear features formed by field boundaries, rivers, ditches and tracks. In the Hynish Boundary Project the information on the field boundaries was recorded using two different software packages. The geographical information system QGIS (QGIS, 2020) was used to trace the lines which are visible on aerial photographs while the Tap Forms app was used to record the attributes of the lines by survey teams who visited the sites.

This report presents the results of the June and October 2019 surveys of Ben Hynish and discusses how these software programs were used to collect, analyse and present the data. The methodology was refined following ACFA's 2018 surveys (Smith & Smith, 2018).

Methodology

Introduction

In the Hynish Boundary Project there are three tasks which involve the linear features.

1. Recording their location in the landscape.
2. Recording their attributes.
3. Identifying the patterns which they form.

This report concentrates on tasks 1 and 2 but discusses some ideas around task 3. Although 'Identifying the patterns' is one of the main reasons for recording the lines, task 3 is at an early stage and only some initial findings are presented.

The flow chart in Figure 1 shows the steps involved in creating the navigation tools for the survey.

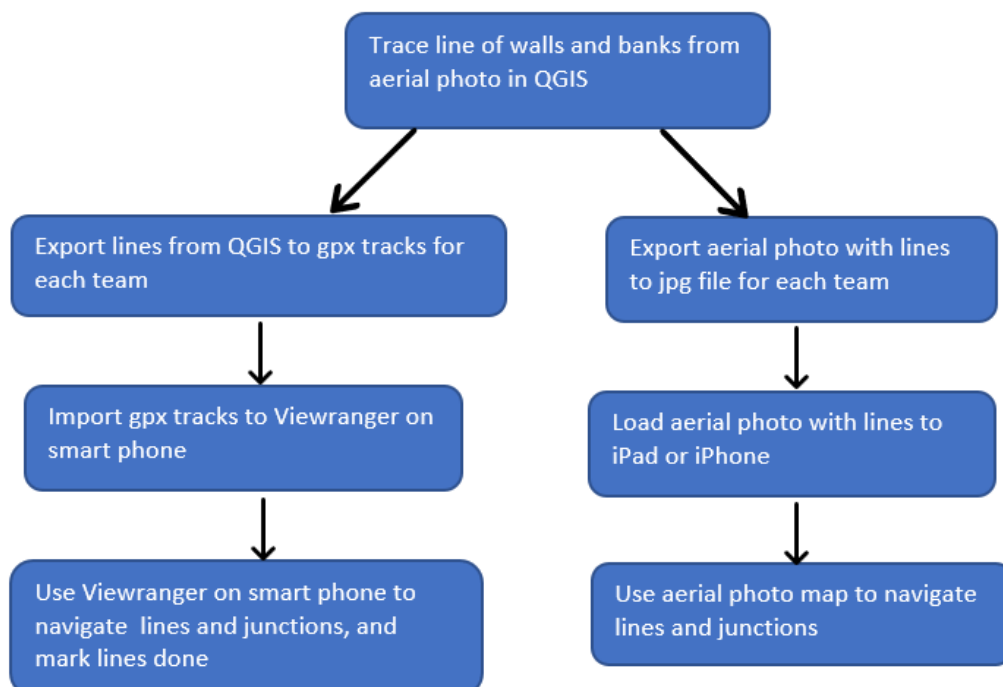


Figure 1 Navigation flow-chart

To record the location of the field boundaries, it was decided to trace those that are visible on aerial photographs, and to record the information in a geographical information system. For this purpose, QGIS was used to digitize the lines and store the information (Gandhi, 2020). The aim of this process is to identify patterns formed by field boundaries and so it is important that there is an accurate identification of places where lines meet or where they pass by without touching. The position of a line, measured by its coordinates on the Ordnance Survey grid, is less important than recording the pattern formed by the lines. It has been found that this level of accuracy can be achieved by tracing the lines that are visible on aerial photographs.

It has also been found that standard smart phones using the View Ranger app in combination with Blue Line maps (such as **Figure 6**) provide a system which is accurate enough to navigate the lines and identify the patterns they form. It has not been necessary to use the more expensive GPS devices with their sub-metre accuracy.

The Attributes of the lines were recorded using the Tap Forms app on iPads or iPhones by survey teams who visited the sites. This information was then transferred to Excel as shown in **Figure 7**.

The survey information was stored in two data sets. The position of the lines was recorded in QGIS as a desk based activity . The attributes of the lines were recorded in Tap Forms by the survey team in the field. The information recorded by these two methods was merged to produce a visual representation of the attribute data of the linear features.

QGIS

The network of field boundaries, which appear as linear features on Ordnance Survey aerial photographs, were traced as blue lines on aerial photographs using the geographical information system software QGIS (QGIS, 2020) which is free and widely used by the archaeological community (BAJR, 2016).

Figure 2 shows an example of such an aerial photograph. Taken in 2009, it shows an area of field boundaries near the sheep pen on Ben Hynish. The image was downloaded from EDINA Aerial Digimap Service (2018) and is typical of the aerial photographs of Ben Hynish.

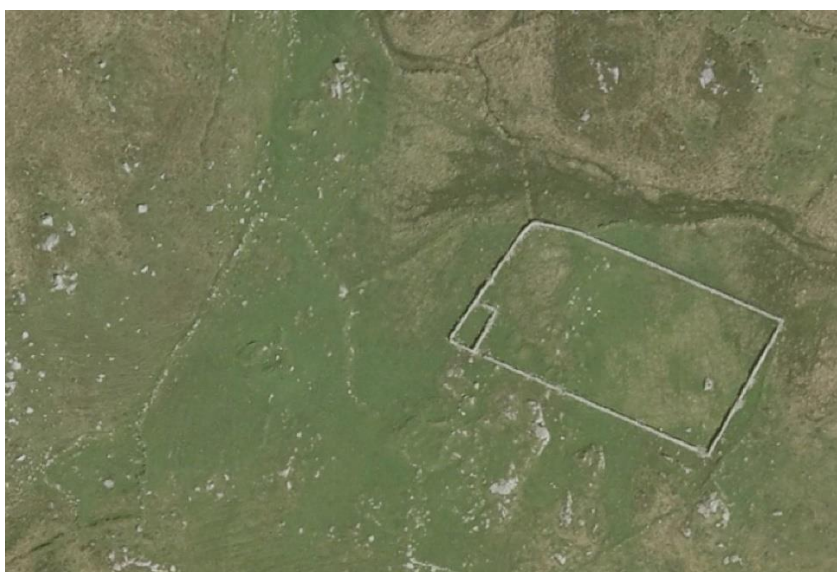


Figure 2 Some field banks are visible as linear features on an Ordnance Service aerial photograph of the area near a sheep pen on Ben Hynish. The photograph, taken in 2009, was downloaded from EDINA Aerial Digimap Service (2018).

Some of the lines, traced in QGIS, are shown as blue lines in **Figure 3**, where they are labelled with the numbers which QGIS automatically gives them.

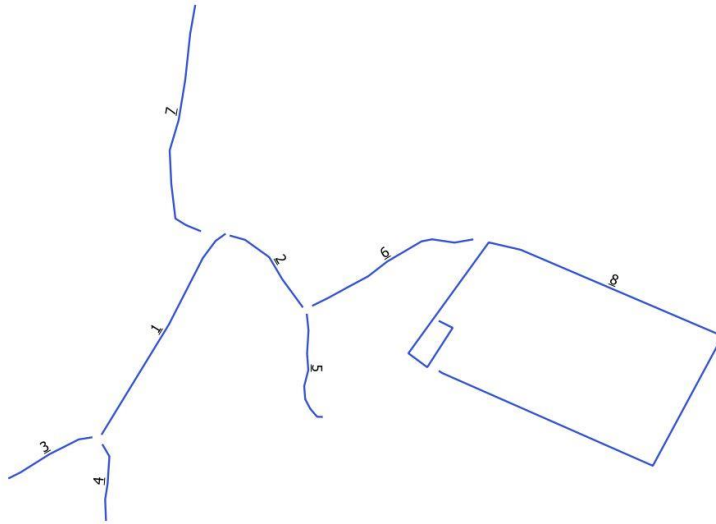


Figure 3 Blue Line Map

The linear features on the aerial photographs are drawn on the Blue Line map with gaps where the lines meet, as shown in **Figure 3**. Gaps are left so that any of the lines can be joined to any other line, at a later stage, to form larger features such as enclosures and Long Walls. The identification of larger features, which takes place after the lines have been surveyed, is discussed in Section: **Enclosures**. After the features have been identified, the gaps in the lines are removed.

Data preparation for the survey

With several teams involved in surveying the lines in the area round Ben Hynish, it was necessary to divide the area into seven zones (**Figure 4**) so that each team could concentrate on their own area without duplicating the work of another team.

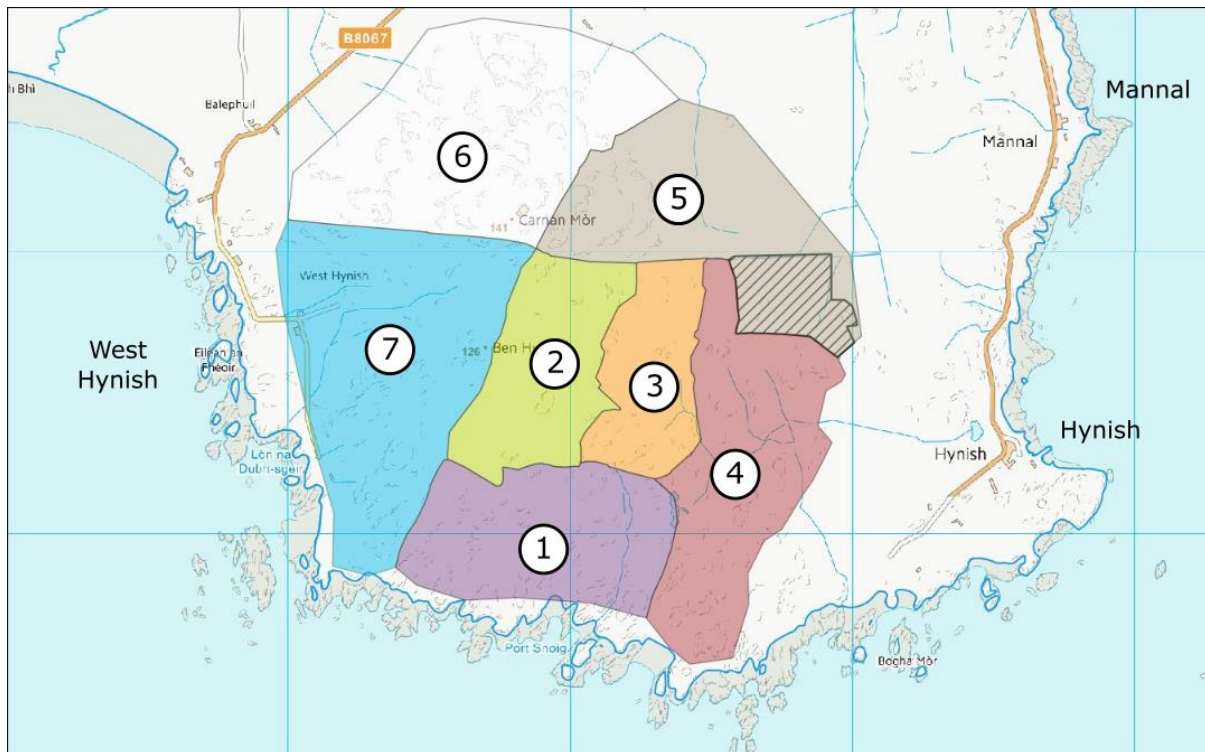


Figure 4 Survey areas. Contains OS data © Crown Copyright and database rights (2020).

Each of the seven areas contains the set of lines to be surveyed. To navigate to these lines, the teams were given a set of gpx tracks to load into View Ranger on their smartphones. They were also given a Blue Line Map of their area on an iPad. They provide similar aids to navigation

The gpx tracks were prepared in QGIS. But care was taken to ensure that the lines were in the right form before exporting them to View Ranger. There are two issues which have to be dealt with. Firstly, View Ranger expects the gpx tracks to be in the WGS 84 Coordinate Reference System whereas the Ordnance Survey grid is normally used with OS aerial photographs and maps. QGIS can convert between the two systems. Secondly, it is important that the line number is exported with the gpx track for each line. As discussed in Section: **ViewRanger**, it is useful to be able to identify the line number in View Ranger. To do this, the information has to be exported from QGIS.

The Blue Line Map can be used as an aid to navigation by showing the pattern which the lines form in a particular area.

Figure 5 shows a screenshot of part of the blue line map for the purple team. It was loaded as a jpg into Photos on an iPad and the area of interest could be zoomed into so that the line numbers at a junction could be read.

The lines from QGIS were exported as gpx files and imported to Viewranger. In the screenshot of Viewranger on an Android mobile phone (**Figure 6**), the black lines are the original traced lines and the blue lines are the lines already recorded. The line selected appears in red and the number of the line, 21, appears at the top of the screen. To get the numbers of the other lines at any junction, tap the line to get the number. Tapping the two black lines at the north end of 21 gives 22 and 23. These are the numbers that should be recorded in the End section of the Boundary form on the iPad or iPhone. Once a line has been recorded, its colour is changed from black to blue (or another colour) in Properties.

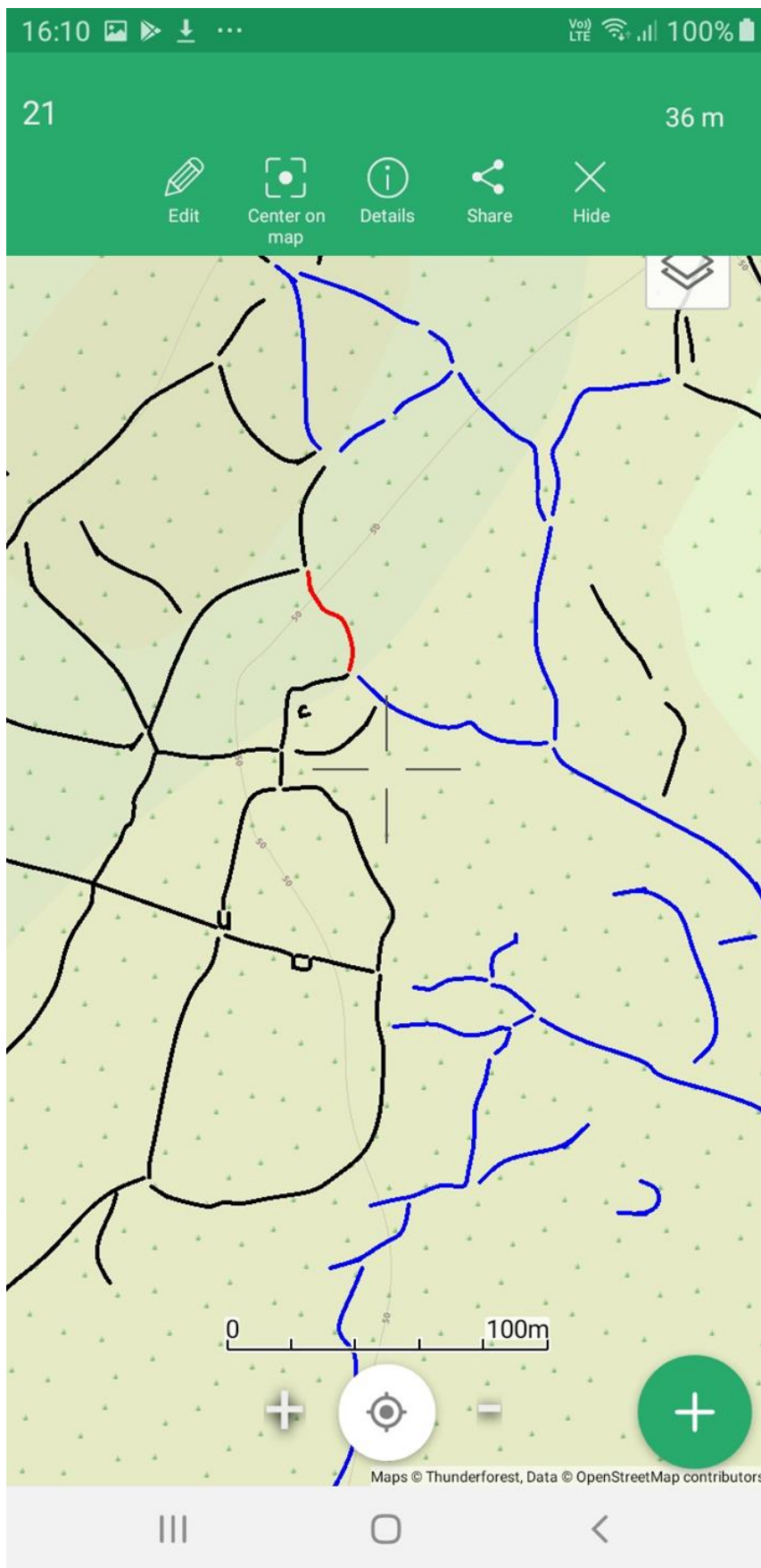


Figure 6 Screenshot of Viewranger on an Android phone. The currently selected line is red and the lines still to be surveyed are black,

Tap Forms

The Tap Forms app (Tap Forms, 2020) was used to record the data on each surveyed line. The flow chart in **Figure 7** shows the steps involved in creating a form, recording data and producing the finished maps.

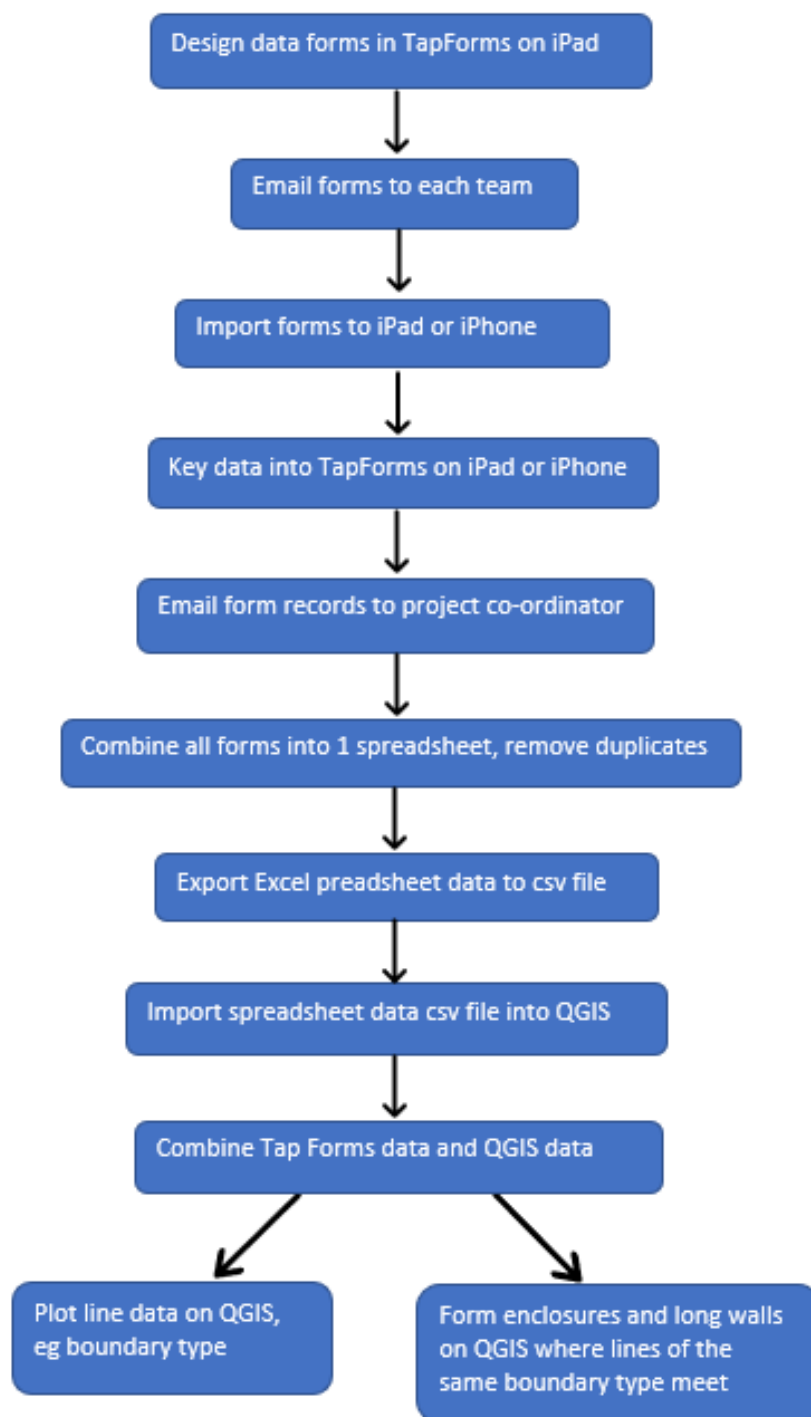


Figure 7 Flow chart of the Tap Forms and QGIS process.

Use of Tap Forms

Tap Forms was chosen for recording data on each line as it is inexpensive, can be used on an iPad and iPhone, and is used by some professional archaeologists. Two forms were constructed, a boundary form and a photo form. They were designed to be quick and easy to fill in with tick boxes and pick lists. The only free text boxes are the End 1 and End 2 line number boxes, the 'Grid Reference of Structure' box and the 'Comments' box at the end. There are 3 numeric fields - line number, maximum height and width.

Adding a new record is done by tapping the + sign. The row number and date are added automatically. Tick boxes have a blue circle (**Figure 18**). Tapping the circle ticks the box. Pick lists have an icon with 4 horizontal lines at the right hand side of the screen (**Figure 17**). Tapping the icon displays a list of the possibilities. Tapping one of these selects it. The remaining boxes are white. Tapping on a numeric field, such as Line Number, displays a numeric keypad. Tapping on a text field, such as 'End 1 – same line as line numbers' displays a qwerty keyboard. If numbers are needed tap the ?123 key to get the numeric keypad. Entries are automatically saved.

Recording a line in the Tap Forms Boundary Form

Data was entered in the boundary form for any particular line at usually 3 times, although it could be more.

- End 1
- The middle section
- End 2

At the start of a line, the line number, line type and 'End 1' data were entered. If the line was seen to be natural or a ditch, no more data values were recorded in this form. A filled in example of this section is displayed in **Figure 17**. Where the wall/bank looked to be its highest, the height and width at this point was measured and entered in the form. All the other characteristics from Degradation to 'Width at maximum height' were considered and entered appropriately. Left and Right for Land Type and Cultivation depended on the direction of travel along the line. Back in the office, this can be worked out from the lines recorded at each end (junction). A filled in example of this section is displayed in **Figure 18** and **Figure 19**. After walking to the end of the line, the 'End 2' data were entered. A filled in example of this section is displayed in **Figure 20**.

Use of Tap Forms Data

The boundary type is determined by the material the boundary is made off, Stone, Turf, Stone & Turf. It is the single most important field. The End 1 and the End 2 fields are the next most important as they give the evidence for enclosures and the existence of field systems overlying older ones. It is very important that all the lines at each junction are recorded unless they are natural. The only way that the fields, enclosures or pens can be drawn on QGIS is if it is known which lines are of the same material and interconnect.

Merging QGIS with the Tap Forms Data

As part of the Hynish Boundary project, two sets of data were collected

- Data Set 1: the location of all the lines which were traced on the aerial photographs
- Data Set 2: the attributes of all the lines which have been surveyed.

Data Set 1 contains only the geographical location of the lines while Data Set 2 stores all the other information or attributes, recorded for the surveyed lines. These two sets can be merged in QGIS to produce a map which shows both the position and attributes of the lines. For example, Data Set 2 contains information on lines classified as ‘Stone & Turf’. Once the data sets have been merged, this information can be displayed in QGIS to show where the ‘Stone & Turf’ walls are located (**Figure 13**). This section briefly describes how the data sets are merged.

Data Set 1 contains the positions for all the lines and these can be displayed in QGIS as Blue Line maps such as that shown in **Figure 8**.



Figure 8 The location of the lines in Data Set 1 shown in dark blue on the Hynish area of Tiree outlined by its coast line in light blue. Contains OS data @ Crown copyright and database rights 2020

The information in Data Set 1 contains the location of each line and identification number given to it when it was traced. All the other information on the line recorded in the survey, is kept in Data Set 2. Some of this information is shown in **Figure 9**.

Line Number	Line Type	Boundary Type
10	Field Boundary	Stone and Turf
27	Field Boundary	Stone and Turf
28	Field Boundary	Stone and Turf
29	Field Boundary	Stone and Turf

Figure 9 Data Set 2

Data Set1 and Data Set 2 are linked to each other in QGIS as illustrated in **Figure 10**.

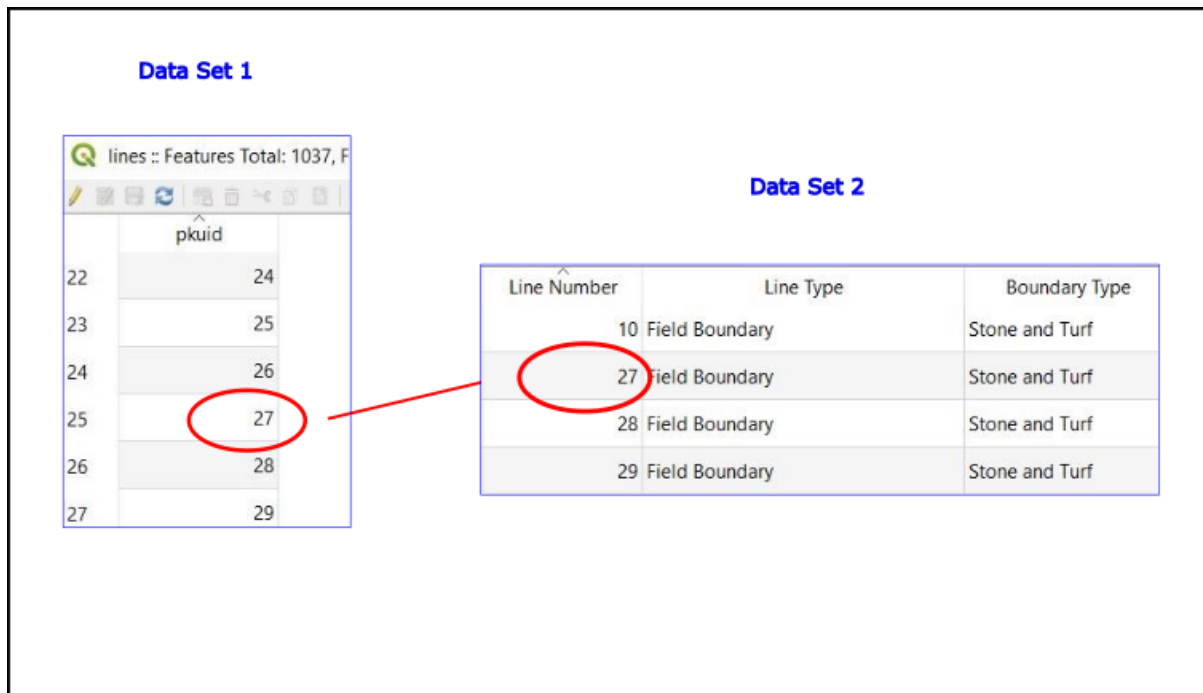


Figure 10

The line identification number is used to link the two data sets. In this way, the line with the identification number 27 in Data Set 1 will be given the attribute 'Boundary Type' = 'Stone & Turf' from Data Set 2. After the two data sets are merged, the lines can be plotted to show their Boundary Type using different colours. Examples are shown in the next section of lines plotted in different colours to illustrate the different attributes of the lines.

Survey

Results

Figure 11 shows the 380 lines which were surveyed in June and the 291 which were surveyed in October. The white lines are those still to be visited.

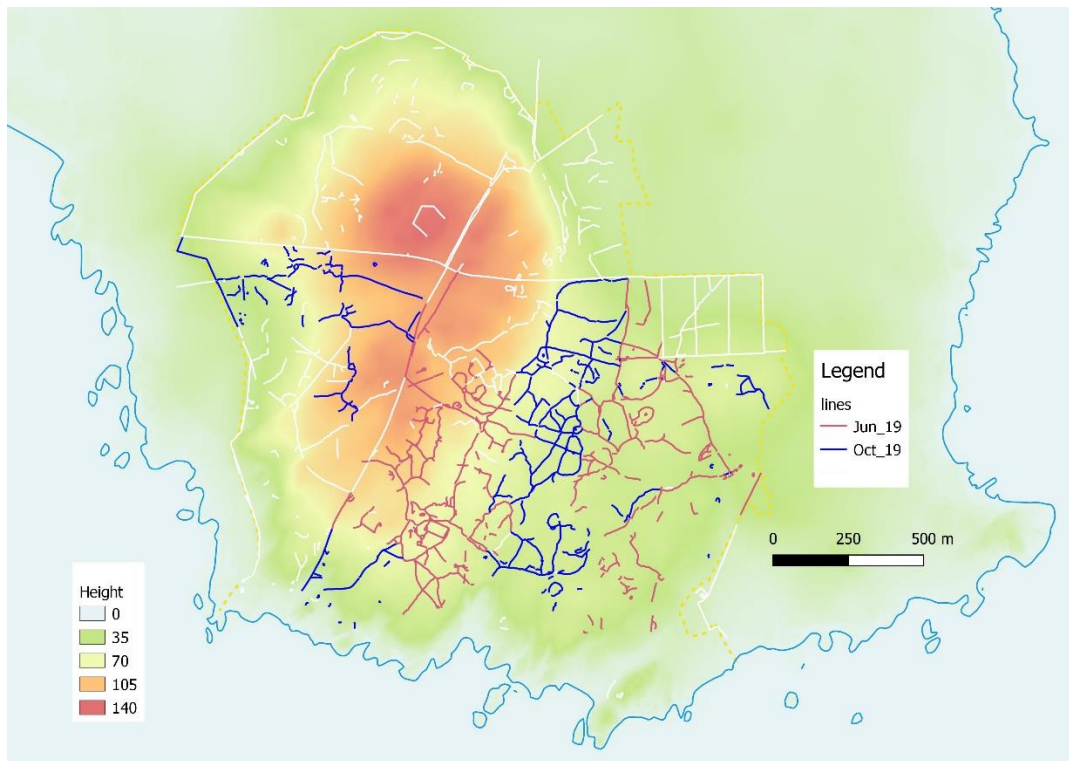


Figure 11 shows the lines which were surveyed during each of the months in 2019. Contains OS data @ Crown copyright and database rights 2020

The 'line type' classification which was recorded for each line during the survey is shown in **Figure 12**. This shows that most of the lines recorded from the aerial photographs are Field Boundaries.

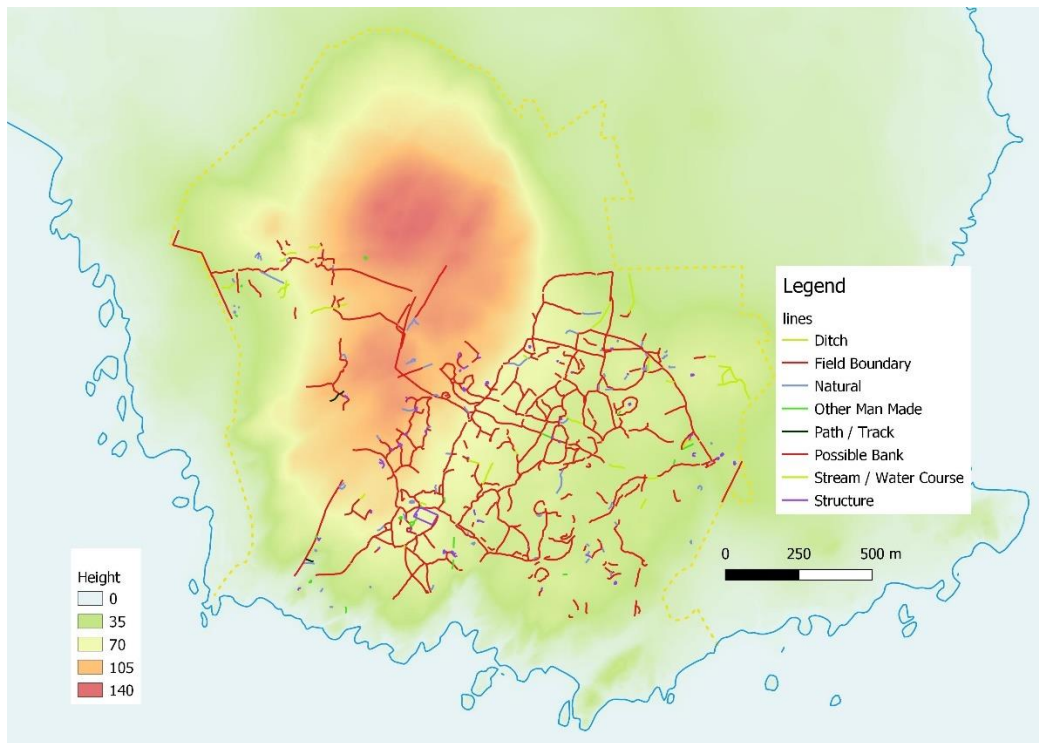


Figure 12 shows the types of line recorded in the survey. Contains OS data @ Crown copyright and database rights 2020

Details on the ‘type of boundary’ classification for each line are shown in **Figure 13**. This shows that most of the lines are either Stone & Turf or Dragons Teeth. There seems to be a mixture of line types over the survey area but the Stone & Turf lines are mainly on the more level green area in the eastern part of the survey area while on the brown hillside, the line type seems to be mainly Dragons Teeth. This has consequences for the results discussed in the Section: **Identification of Enclosures**.

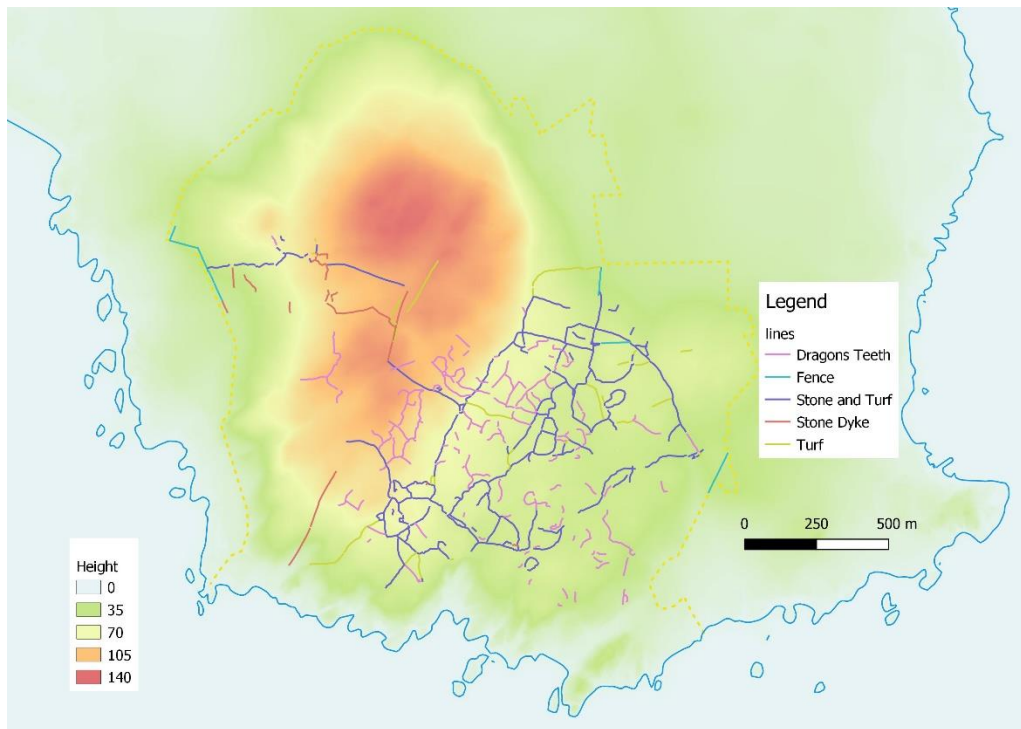


Figure 13 shows the types of boundary which form the lines. Contains OS data @ Crown copyright and database rights 2020

Turnbull's Map

Figure 14 shows Turnbull's map for part of the survey area in Hynish (Turnbull, 1768). The yellow line shows the edge of the area of rough pasture marked on the OS first edition map. The blue curved line is a Stone & Turf boundary recorded in this survey which is also shown on the OS first edition map. This curved line may be the curved line which is shown on Turnbull's map in this area, which suggests that it was being used in the mid 18th century or earlier.

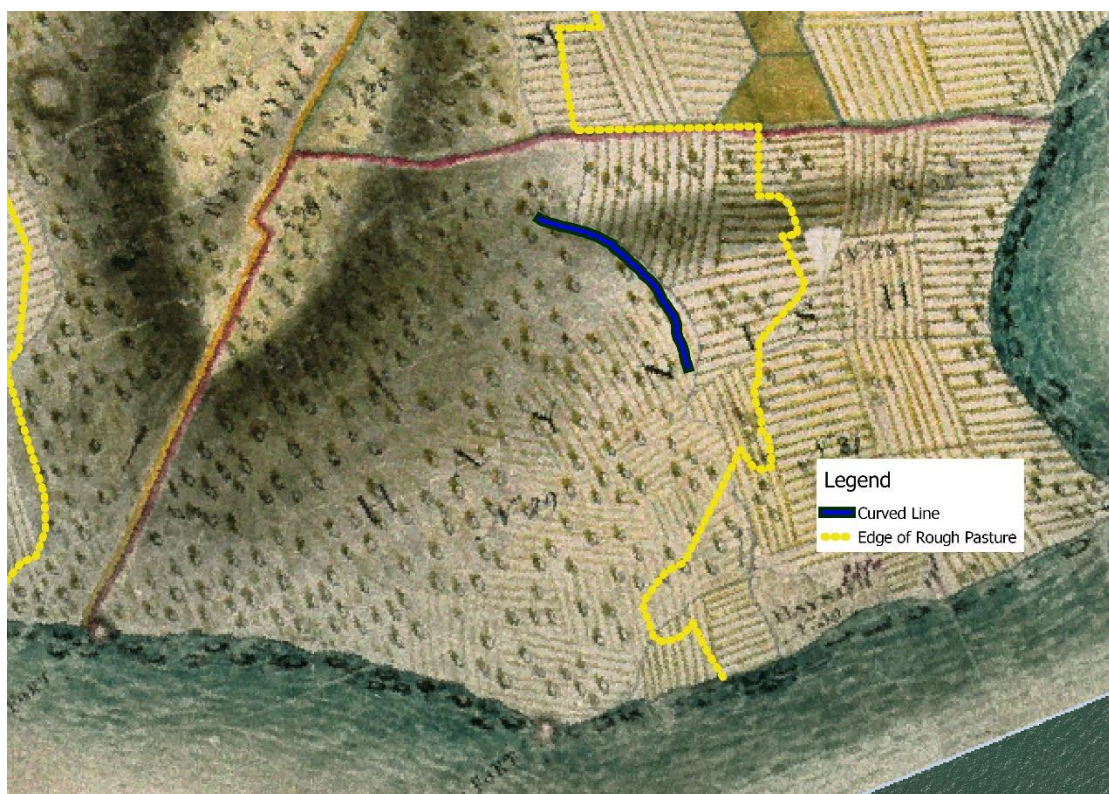


Figure 14 Turnbull's Plan of the Island of Tiree, 1768, showing part of Ben Hynish. © Argyll Papers, Inveraray Castle. A 'Curved Line' on the map is visible on the ground today.

Lines which lie under others

The Stone & Turf lines are mixed together with Dragons Teeth lines, in the area surveyed. There are ten examples where the Dragons Teeth lines lie underneath those made of Stone & Turf. This indicates that the Dragons Teeth lines are older than the Stone & Turf lines. At this stage it is not clear what function the Dragons Teeth lines performed but, as noted later, it is likely that they were not in agricultural use when the Ordnance Survey first recorded the site in the mid nineteenth century.

Enclosures

Identification of Enclosures

One of the main tasks in this project is to identify the patterns formed by the field boundaries at different times. The only pattern, considered at this stage, is that formed by enclosures. The major land divisions across the landscape will be considered once the Long Walls which divide the land, have been surveyed.

The survey has recorded the boundary type of each line classified as field boundary or bank. The association between the lines was also recorded. The lines form an enclosure if they are of the same type and are recorded as joining each other in a closed loop.

The twenty seven enclosures which have been recorded so far are shown in **Figure 15**. Nineteen enclosures are mainly made of Stone & Turf but with some short sections of turf. These are called Stone & Turf enclosures in this report. Another six enclosures are classified as Dragons Teeth enclosures. One enclosure is Stone and the other is a mixture of Stone & Turf and Dragons Teeth.

The Stone & Turf enclosures are shown in blue. The darker blue areas are where a small enclosure lies on top of a larger one. Note that the Stone & Turf and Stone enclosures lie in a separate area

from the others. All the Dragons Teeth enclosures are on the relatively steep side of the hill. The one enclosure which is a mixture of both types will have to be examined later.

In the mixed enclosure, it may be that two field systems were built at different times or that the differences were caused by robbing or weathering. There seems to be a gap between the Stone & Turf lines and the Dragons Teeth lines which form this mixed enclosure.

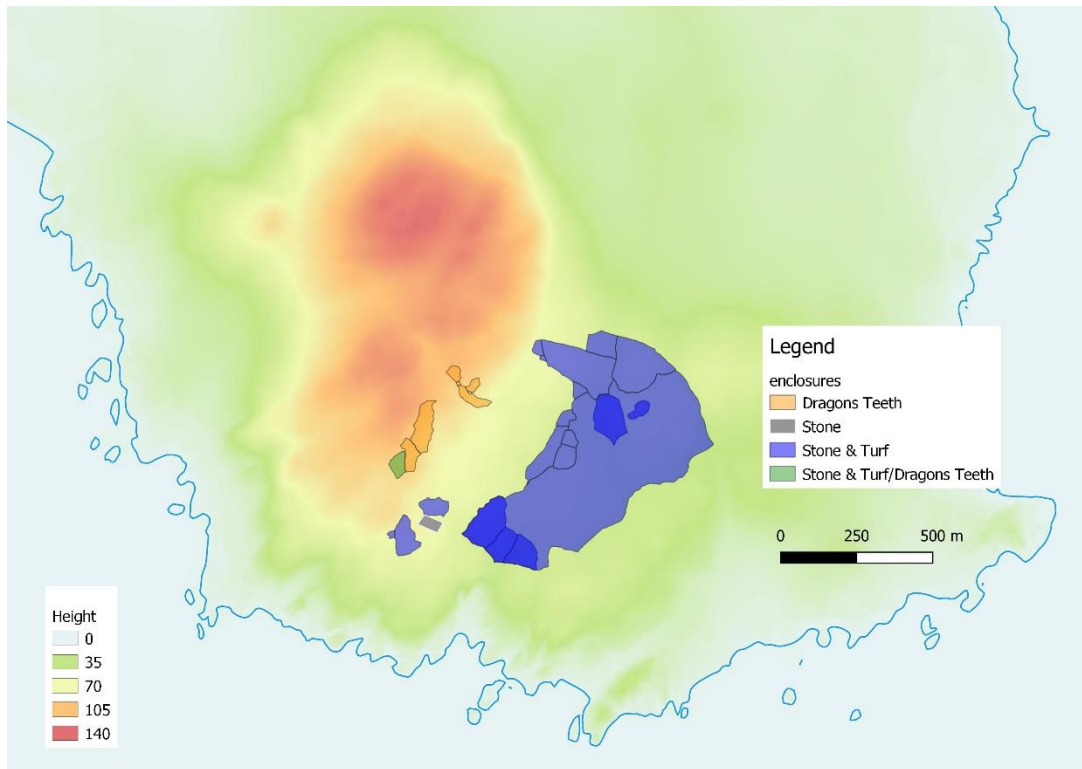


Figure 15 Contains OS data @ Crown copyright and database rights 2020

Several of the enclosures in the surveyed area were also recorded on the OS 25 inch 1st edition map of the Hynish area. **Figure 16** shows the number given to each of these areas in the OS Book of Reference (1879). This book records the acreage of each “parcel of land” and describes the vegetation of each enclosed area as ‘rough pasture’. The Ordnance Survey marks the boundary of each area by a solid line and these lines are on the current version of the map.

These are all Stone & Turf enclosures (except for the Stone enclosure that is a sheep fank) and are still visible on the ground. However, the situation is different for the Dragons Teeth enclosures which, although visible on the ground were not recorded on the Ordnance Survey 1st edition map or in later editions. In the one enclosure that is a mixture, only the Stone & Turf section of the boundary was drawn on the OS map. It is possible that the Stone & Turf enclosures and boundaries were in agricultural use when the Ordnance Survey first recorded them in the mid 19th century but that the Dragons Teeth enclosures and boundaries were not in use.

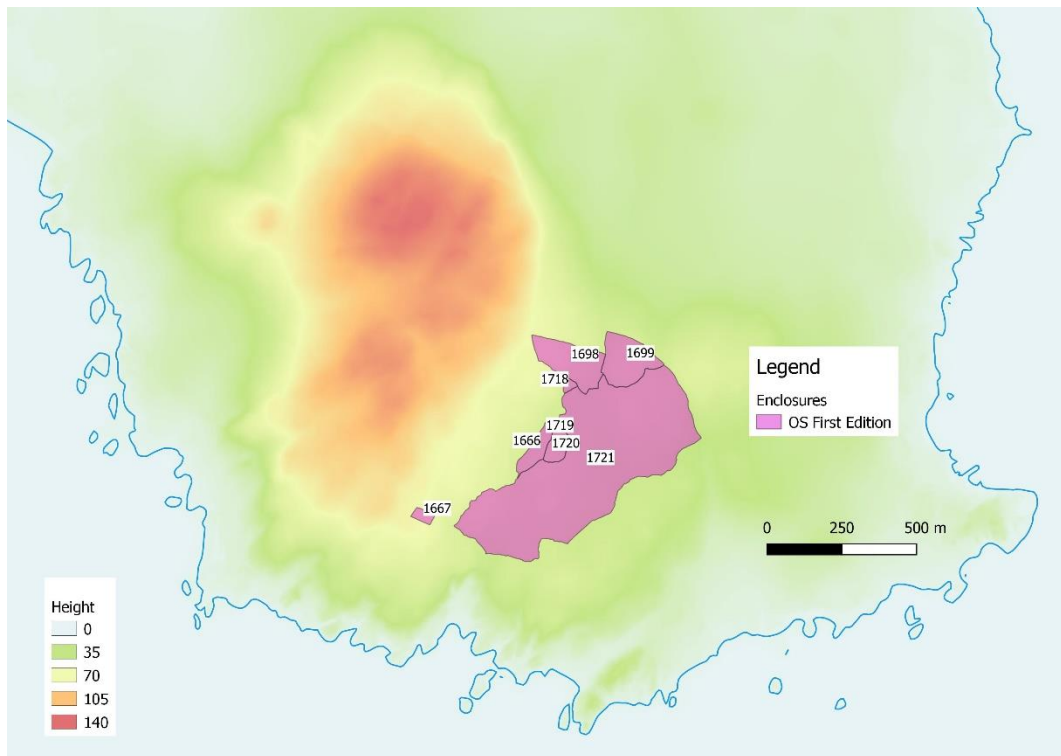


Figure 16 Surveyed enclosures recorded in the OS Book of Reference with their 'Plan Number'. Contains OS data @ Crown copyright and database rights 2020

Problems with forming enclosures

During the enclosure forming exercise described in Section: **Enclosures**, it was noticed that not all lines had been split at junctions as described in Section: **QGIS**. To correct this problem, the lines have now been split but the new sections of line will have to be surveyed, particularly at the junctions.

Incomplete data recording at some junctions was a problem because it was not possible to decide if enclosures had been formed there. These junctions will have to be revisited.

Incomplete data recording was a problem where the boundary type was not recorded. These lines will be revisited.

Discussion

The classification of Boundary Types was simplified for the 2019 surveys. The various types of Stone & Turf were combined into one. Similarly, the various types of single stone walls were combined into the Dragons Teeth classification. This was done for two reasons; to make it easier to record and to analyse the field patterns.

More work is planned on the link between vegetation and enclosures.

Drainage patterns have yet to be traced and surveyed.

The work on enclosures is continuing.

The Long Walls have yet to be surveyed along their entire length.

There are a large number of Partially Enclosed Areas where some lines are joined together but do not form an enclosure. A way of analysing these areas has yet to be devised.

Fence lines have yet to be fully traced and surveyed. The interaction of these fence lines with the other field boundaries will be analysed.

The survey teams have observed field boundaries which were not on the lines database in QGIS. Some of these are visible on the aerial photographs and have been added to the database. Others will have to be recorded in the field using a GPS device.

Structures such as pens which are attached to field boundaries, have been ignored in this report. A way of incorporating them into the analysis of enclosures, has yet to be developed.

Conclusion

The Stone & Turf enclosures, identified in this survey, can be seen on the OS 1st edition map of the area but not the Dragons Teeth enclosures.

A curved line visible today in the field and on the first and current editions of the OS map is also on Turnbull's 18th century map of the area.

In areas where some lines lie under other lines, it has been observed that Dragons Teeth lines lie under the Stone & Turf lines. Thus, if the Dragons Teeth lines are all of a similar age, the Dragons Teeth enclosures will be older than the Stone & Turf enclosures.

Viewranger was a very useful tool in navigating to and along lines.

Tap Forms was an efficient method of recording data on the lines.

QGIS is proving to be a very useful way of displaying the survey results on maps and aerial photographs. It is a very robust and flexible piece of software.

Appendix

Boundary Form

16:11 Thu 20 Feb

48 of 50

+ ☆ ☰


Row Number	48
Date	23/06/2019
Team Name	Orange
Recorded By	MG
Line Number	201
Line Type	Field Boundary
Boundary Type	Stone and Turf
End 1 - same line as line numbers	23
End 1 - abuts line numbers	202
End 1 - underlies line numbers	
End 1 - overlies line numbers	
End 1 - gap with line numbers	
End 1 Gap Type	
End 1 - Stop	

Figure 17 Boundary Form Part 1


Degradation	Medium	
Fragmentary	<input checked="" type="radio"/>	
Sunken	<input type="radio"/>	
Change In Ground Level	<input type="radio"/>	
Revetment	<input type="radio"/>	
Terrace	<input type="radio"/>	
Associated stream / water course	<input checked="" type="radio"/>	
More than 1 Boundary Type along line	<input type="radio"/>	
Unrecorded line seen nearby	<input type="radio"/>	
Associated Structure on Line	<input type="radio"/>	
Nearby Structure	<input type="radio"/>	
Grid Reference of Structure		

Figure 18 Boundary Form part 2






Vegetation on Line	Heather Turf	
Land Type Side 1 (left)	Rough grass Rushes Bog	
Land Type Side 2 (right)	Rough grass Heather	
Cultivation Side 1 (left)		
Cultivation Side 2 (right)		
Maximum Height	0.8	
Width at Maximum Height	1.3	

Figure 19 Boundary Form Part 3





End 2 - same line as line numbers	200	
End 2 - abuts line numbers		
End 2 - underlies line numbers		
End 2 - overlies line numbers		
End 2 Gap Type	Water	
End 2 - gap with line numbers	200	
End 2 - Stop		
Photo(s) taken		
Sketch (if required)		
Comments (if required)		

Figure 20 Boundary Form Part 4

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Turnbull, J. (1768) Plan of the Island of Tiree, 1768 (Plan R38) Extract showing part of Ben Hynish. © Argyll Papers, Inveraray Castle.

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