Sk-011 / Dunmore, Callander

Aerial Survey and Imaging

Report
March 2019
Dunmore, Callander, Stirling

Archaeological Aerial Survey and Imaging

On Behalf of:

Forest Enterprise Scotland Head Office
1 Highlander Way
Inverness Business Park
Inverness

National Grid Reference: NN 6014 0759

Prepared by: David Connolly

Date: March 2019

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Skyscape Survey would like to thank Matt Ritchie; Forestry Commission, Scotland, Ross Crawford; Community Heritage Adviser (Callander Landscape Partnership) and Hamish Thomson; Estate Manager - Glen Finglas – Woodland Trust.

The project was undertaken by David Connolly (Pilot), with the Hana Kdolska (Flight Safety Officer and Photographer).

The report was written by David Connolly
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- **Figure 1:** Site Location Map
- **Figure 2:** Derived 0.10m interval contour plan of site with 1m contours highlighted in black.
- **Figure 3:** Annotated Contour image of Dunmore
- **Figure 4:** Annotated orthographic Image of Dunmore
- **Figure 5:** 3D perspective digital image of Dunmore (photographic and contour).

**OASIS ID:** connolly1-346493
Introduction

Skyscape Survey was commissioned by Matt Ritchie of Forest Enterprise Scotland to carry out aerial works at the hillfort of Dunmore, Callander (Ref: SK-011) on the Glen Finglas Estate in an area run by the Woodland Trust, for the benefit of Callander Landscape Partnership.

The site lies 3 km to the west of Callander town, at NN 6014 0759.

Although the site has been subject to survey in the past, the need was recognised to enhance the most recent survey and interpretation, as well as provide a 3D model and aerial images. In addition, an onsite interpretive meeting was organised with the Callander Landscape Partnership to bring locals into the scheme and both explain the process of aerial survey and involve the group in interpretation of the monument.

Topography

The site lies 3 km to the west of Callander town, at NN 6014 0759. Set on a knoll on the southern slopes of Ben Ledi, the site is situated on open ground with a steep cliff to the south, which includes some tree cover. The site itself is free of trees though there are a number of small gorse bushes.

Plate 1: View to east down towards Callander.
Figure 1: Site Location Map

Contains OS data © Crown Copyright [and database right] 2018
Site Survey Background

Canmore: [https://canmore.org.uk/site/24375/dunmore](https://canmore.org.uk/site/24375/dunmore)

**Site Number** NN60NW 7 (later banked enclosure) and NT24SE 48 (earlier palisaded settlement)

Dunmore was first planned and described by Christine Maclagan in the 1870s, Christison in 1900 and then subsequently resurveyed by RCAHMS at 1:2500 as part of the Marginal Land Survey (Field Visit 10 June 1957).

Maclagan noted a 5th bank, which is missing from the later survey;

“The one half of its circumference has a perpendicular precipice for its very sure defence, and the other, which is also almost a precipice, is made strong by five walls, all of which, with the exception of the outer one, are more than 10 feet broad, and that outer, or fifth wall, is 4 feet in thick-ness.”

and also the material used to create the rampart banks;

“All the walls are built of sandstone as is the rock on which they rest; but they are now so covered with thick green turf that it is usual to hear them spoken of as earthworks; but a moment’s reflection would teach any one the impossibility of such being the case, for there is no soil, this lofty steep out of which to construct them” (Maclagan 1870)

Most recent survey is represented by digital elevation map ([TurkeyRedMedia](https://www.turkeyredmedia.com)), published on Canmore but with no further interpretation or supporting documentation.
Plate 2: Oblique image showing the northern annexe and the multivallate nature of the site.
Plate 3: Two earlier surveys of Dunmore by Maclaggan and Christison with the new Skyscape survey below.
Results

Forest Enterprise Scotland Archaeologist Matt Ritchie requested oblique photographs of site for publication and promotional material for the Callander Landscape Partnership. A vertical shot of the site – potentially created from stitched images and a SUA based aerial survey for creation of a detailed topographic image. Which would allow onsite interpretation and engagement with local groups.

Using over 220 oblique images across the site, a high resolution 3D model of the site was created using Agisoft Photoscan – the resulting Data Surface Model (DSM) was processed to remove vegetation, to leave a Data Terrain Model (DTM).

The resulting high resolution model was transformed into a referenced GeoTIFF Digital Elevation Model (DEM) used as the base for a 5cm interval contour model in CAD and as GIS shp files (see section 8 – list of included files). In addition, a georeferenced ortho-image of the site was produced and 3d model viewable on html browser.

The area covered by the survey included the site and up to 60m from the outer ramparts to all directions.

The final project archive comprises:

- A summary statement of results
- A location plan of the site and works
- A folder of Publication images
- A folder of Terrain Modelling images
- A georeferenced CAD format flat file of the contours
- A georeferenced contour file and DEM and orthographic image
- A pointcloud ply file

A digital copy of this report with plans in PDF format has been supplied to the Forest Enterprise Scotland on a usb. Photographs, plans and illustrations fall within the current guidelines for archival standards set by the Archaeology Data Service. A full copy of all digital photographs and digital data is included on the usb in archive stable format. A DES Entry has been created and presented at the end of this report as well as submitted for inclusion within the relevant year for publication.

In addition to the above requirements, the project details are recorded via the online OASIS (Online Access to the Index of Archaeological InvestigationS).
Plate 4: Near vertical view of whole site, with annexe to left and central well. Note the slight bank on the inner rampart. And potential routeway around the outer bank and into the annexe.

Plate 5. Photograph view to the north, showing the topographic situation of the site on the rounded knoll with the steep cliff to the south and east.
**Interpretation notes**

Although the intention was not to interpret or indeed re-interpret the site in any great detail, the following points are worth noting after the site was revisited and examined as part of the training and interpretation phase in association with the Callander Landscape Partnership tour.

See Figures 2-5 for visual clarification for each point

1. There are potentially three (3) hut circles within the inner banked enclosure but none visible within the enclosure.

2. Although Maclaggan noted 5 banks, it is likely this “5th bank” exterior is the surviving fragment of an earlier enclosing work.

3. The route into the site winds around the north and east of the site (at least in it’s final phase) the revetment is clear on the ground as it ascends the steep north route.

4. There is a potential for at least 3 phases of enclosing works. It is difficult to state the chronological origin of the north annexe though it is possible this could relate to the earliest phase as the Bank 5 lies at the same contour height.

5. The entrance into the annexe, is definitely original, with massive stone end stones to the bank delineating the narrow entrance (sub 2m).

6. The Annexe bank extends along the northeast edge of the slope and curves into the steep drop to the northeast of the main enclosure.

7. A slight cliff edge bank runs down the side of the steep cliff from the site down to the west.

8. The current southeast entry to the site interior and the blocked ditch between bank 4 and 3 is likely created by breaching an already existing bank as the stone footings can be seen across the “entrances”.

9. The inner bank is slight to the interior, and may represent a palisade base – which would extend around the entire circuit.

10. Only the interior Bank 1 forms a complete circuit of the hill, forming an oval enclosure.

11. The central cistern/well is still visible.

12. The large crater to the east is a bomb crater from an unexploded WWII bomb – which was located and destroyed some 30 years previously (Information provided by walker)

13. At least two terrace platforms are visible to the southeast – whether these relate to structural platforms is unclear.
Figure 2: Derived 0.10m interval contour plan with 1m contours highlighted in black.
Figure 3: Annotated Contour image of Dunmore
Figure 4: Annotated orthographic Image of Dunmore

Skyscape Survey
Figure 5: 3D perspective digital image of site (photographic and contour).

Skyscape Survey
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Plate 6: View to southwest with site in foreground (annexe to right) commanding the surrounding area and Loch Venacher in distance.
### LOCAL AUTHORITY:
Stirling – Loch Lomond National Park

### PROJECT TITLE/SITE NAME:
Dunmore, Callander

### PROJECT CODE:
Sk-011

### PARISH:
Callander

### NAME OF CONTRIBUTOR:
David Connolly

### NAME OF ORGANISATION:
Skyscape Survey

### TYPE(S) OF PROJECT:
Aerial Survey

### NMRS NO(S):
NN60NW 7

### SITE/MONUMENT TYPE(S):
Fort

### SIGNIFICANT FINDS:
N/A

### NGR:
NN 6014 0759

### START DATE (THIS SEASON):
17th Jan 2019

### END DATE (THIS SEASON):
18th Jan 2019

### PREVIOUS WORK:
Visual land surveys

### MAIN (NARRATIVE) DESCRIPTION:
Aerial survey of the site was carried out using a camera mounted on a SUA (drone) in order to capture images for processing into a detailed contour plan of the site at 10cm interval, allowing for 3D modelling and manipulation of data for use in new interpretation. In addition, images were taken of the site from a variety of angles, placing it into the landscape for the benefit of the Callander Landscape Partnership and local groups

### FUTURE WORK?:
- 

### FUNDING BODY:
Forestry Commission Scotland

### ADDRESS OF MAIN CONTRIBUTOR:
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Dunbar
EH42 1QT

### EMAIL ADDRESS:
info@bajr.org
**References**


**RCAHMS.** (1979b) *The Royal Commission on the Ancient and Historical Monuments of Scotland. The archaeological sites and monuments of Stirling District, Central Region, The archaeological sites and monuments of Scotland series no 7.* Edinburgh. Page(s): 17, No.128 RCAHMS Shelf Number: A.1.2.ARC(7)

**RCAHMS.** (1950-9) *Marginal Land Survey (unpublished typed site descriptions), 3 volumes.* RCAHMS Shelf Number: A.1.1.MAR

**Cartographic references:**

OS 1866. 6-inch 1st edition Ordnance Survey Map Perthshire, Sheet CXXIII (includes: Aberfoyle; Callander; Port Of Menteith). National Park[accessed 6/03/2019]

OS 1901. 6-inch 2nd edition Ordnance Survey Map Perth and Clackmannan Sheet CXXIII.NE (includes: Callander) [https://maps.nls.uk/view/75656115](https://maps.nls.uk/view/75656115) [accessed 6/03/2019]


Supplied digital files (usb)

Text and PDF

Final Text and PDFs\DunmoreHowtoSurveywith SUA.docx
Final Text and PDFs\Figure 1.pdf
Final Text and PDFs\Figure 2.pdf
Final Text and PDFs\Figure 3.pdf
Final Text and PDFs\Figure 4.pdf
Final Text and PDFs\Figure 5.pdf
Final Text and PDFs\SK-011_Dunmore_Callander - Report.docx

Final Illustrations

Final Illustrations\Figure 1.cdr
Final Illustrations\Figure 2.cdr
Final Illustrations\Figure 3.cdr
Final Illustrations\Figure 4.cdr
Final Illustrations\Figure 5.cdr

CAD/GIS

CAD\10cm Contours.shp
CAD\20cm Contours.shp
CAD\1m Contours.shp
CAD\Banks.shp
CAD\Boundary.shp

3D Model

3D Model\DEM.tfw
3D Model\DEM.tif
3D Model\Dunmore3.files
3D Model\Dunmore3.psx
3D Model\DunmorePointCloud.ply
3D Model\HTML_3d model\index.html
3D Model\HTML_3d model\indexImageVersion.html

Images\Inspire
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Images\Phantom
DJI_0001.JPG - DJI_0302.JPG

Images\Phone
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Images\Other Images\Layout-4a.jpg
Images\Other Images\Untitled-1.pdf
Digital Image Survey notes.
Survey Data

Fig. 1. Camera locations and image overlap.

Table 1. Cameras.

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<th>Resolution</th>
<th>Focal Length</th>
<th>Pixel Size</th>
<th>Precalibrated</th>
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<td>4000 x 2250</td>
<td>3.61 mm</td>
<td>1.7 x 1.7 μm</td>
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**Camera Calibration**

![Image residuals for FC300X (3.61 mm).](image)

**FC300X (3.61 mm)**

220 images

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<td>3.61 mm</td>
<td>1.7 x 1.7 μm</td>
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<td>B1:</td>
<td>-2.36682</td>
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<tr>
<td>Cy:</td>
<td>12.5611</td>
<td>B2:</td>
<td>0.587362</td>
</tr>
<tr>
<td>K1:</td>
<td>-0.00228278</td>
<td>P1:</td>
<td>-0.00019824</td>
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<tr>
<td>K2:</td>
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<td>P2:</td>
<td>-0.000174717</td>
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<td>K3:</td>
<td>0.0730352</td>
<td>P3:</td>
<td>0</td>
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<tr>
<td>K4:</td>
<td>-0.0368868</td>
<td>P4:</td>
<td>0</td>
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Camera Locations

Fig. 3. Camera locations and error estimates. Z error is represented by ellipse color. X,Y errors are represented by ellipse shape. Estimated camera locations are marked with a black dot.

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<tr>
<th>X error (m)</th>
<th>Y error (m)</th>
<th>Z error (m)</th>
<th>XY error (m)</th>
<th>Total error (m)</th>
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<td>5.36419</td>
<td>2.47282</td>
<td>211.979</td>
<td>5.90672</td>
<td>212.061</td>
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</table>

Table 2. Average camera location error.
Ground Control Points

Fig. 4. GCP locations.

Table 3. Control points RMSE.

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<th>Count</th>
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<th>Y error (cm)</th>
<th>Z error (cm)</th>
<th>XY error (cm)</th>
<th>Total (cm)</th>
<th>Image (pix)</th>
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<td>X error (cm)</td>
<td>Y error (cm)</td>
<td>Z error (cm)</td>
<td>Total (cm)</td>
<td>Image (pix)</td>
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<tr>
<td>---------</td>
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<td>--------------</td>
<td>--------------</td>
<td>------------</td>
<td>-------------</td>
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<tr>
<td>point 1</td>
<td>-2.64721</td>
<td>-8.66444</td>
<td>-18.1159</td>
<td>20.255</td>
<td>2.333 (23)</td>
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<td>point 2</td>
<td>6.52735</td>
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<td>15.2294</td>
<td>2.189 (20)</td>
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<td>point 3</td>
<td>0.837752</td>
<td>-2.49634</td>
<td>-10.7888</td>
<td>11.1055</td>
<td>2.288 (17)</td>
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<td>point 4</td>
<td>-4.71196</td>
<td>7.53925</td>
<td>14.4952</td>
<td>17.0045</td>
<td>2.423 (17)</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>4.25789</strong></td>
<td><strong>6.15393</strong></td>
<td><strong>14.4108</strong></td>
<td><strong>16.238</strong></td>
<td><strong>2.307</strong></td>
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</table>

Table 4. Control points.
Fig. 5. Reconstructed digital elevation model.

Resolution: 11.9 cm/pix
Point density: 71 points/m²
## Processing Parameters

### General
- **Cameras**: 220
- **Aligned cameras**: 220
- **Markers**: 4
- **Coordinate system**: OSGB 1936 / British National Grid (EPSG::27700)

### Point Cloud
- **Points**: 164,871 of 215,243
- **RMS reprojection error**: 0.223798 (0.522766 pix)
- **Max reprojection error**: 0.673852 (22.026 pix)
- **Mean key point size**: 2.1315 pix
- **Effective overlap**: 4.29043

### Alignment parameters
- **Accuracy**: Highest
- **Pair preselection**: Disabled
- **Key point limit**: 40,000
- **Tie point limit**: 4,000
- **Constrain features by mask**: No
- **Adaptive camera model fitting**: Yes
- **Matching time**: 2 hours 18 minutes
- **Alignment time**: 2 minutes 20 seconds

### Depth Maps
- **Count**: 216

### Reconstruction parameters
- **Quality**: Medium
- **Filtering mode**: Moderate
- **Processing time**: 1 hours 4 minutes

### Dense Point Cloud
- **Points**: 6,840,900

### Reconstruction parameters
- **Quality**: Medium
- **Depth filtering**: Moderate
- **Depth maps generation time**: 1 hours 4 minutes
- **Dense cloud generation time**: 43 minutes 49 seconds

### Model
- **Faces**: 500,000
- **Vertices**: 251,574
- **Texture**: 15,000 x 15,000, uint8

### Reconstruction parameters
- **Surface type**: Arbitrary
- **Source data**: Dense
- **Interpolation**: Enabled
- **Quality**: Medium
- **Depth filtering**: Moderate
- **Face count**: 1,368,165
- **Processing time**: 4 minutes 40 seconds

### Texturing parameters
- **Mapping mode**: Generic
- **Blending mode**: Mosaic
- **Texture size**: 15,000 x 15,000
- **Enable color correction**: Yes
- **Enable hole filling**: Yes
- **UV mapping time**: 24 seconds
- **Blending time**: 9 minutes 57 seconds

### DEM
- **Size**: 3,284 x 3,529
- **Coordinate system**: OSGB 1936 / British National Grid (EPSG::27700)
<table>
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<tr>
<th><strong>Reconstruction parameters</strong></th>
<th><strong>Source data</strong></th>
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<tbody>
<tr>
<td>Interpolation</td>
<td>Enabled</td>
<td></td>
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<tr>
<td>Processing time</td>
<td>19 seconds</td>
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</tr>
</tbody>
</table>

**Orthomosaic**

| Size                          | 12,568 x 13,812 |
| Coordinate system             | OSGB 1936 / British National Grid (EPSG::27700) |
| Channels                      | 3, uint8        |
| Blending mode                 | Mosaic          |

**Reconstruction parameters**

| Surface                      | DEM             |
| Enable color correction      | No              |
| Processing time              | 5 minutes 37 seconds |

**Software**

| Version                      | 1.2.5 build 2735 |
| Platform                     | Windows 64 bit   |