Survey of Maol Ban

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The Team:

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1) Introduction

Maol Ban (Hill 1325, Section 17E, OS 1:50000 Map 49, OS 1:25000 Map 375E, Grid Ref NM683238) is listed as a Marilyn with a drop of 151m. (A Marilyn is any hill in England, Scotland, Wales, Isle of Man and Ireland with a minimum drop of 150m). There is a significant chance that the drop could be less than 150m thereby removing it from the list of Marilyns.

The purpose of this survey was to locate and measure accurately the heights of the bealach and summit of Maol Ban in order to clarify its status.

2) Equipment used and Conditions for Survey

Ground surveys to determine the positions of the bealach and summit were carried out using a Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a "1m" **E**-staff extendable to 5m.

Absolute heights were measured using a Leica Geosystems Viva GS15 Professional receiver. This instrument is a dual-frequency, multi-channel instrument, which means it is capable of locking on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, and receive two signals (at different frequencies) from each of these satellites. The latter feature reduces inaccuracies that result from atmospheric degradation of the satellite signals. As a stand-alone instrument it is capable of giving position and height to an accuracy of about two metres and five metres respectively. Note that small hand-held GPS receivers used for general navigation can only receive up to 12 GPS satellites and each at a single frequency and therefore these instruments have a poorer positional accuracy of +/-5metres and a height accuracy of no better than +/-10 metres. Some recently produced hand held GPS Garmin receivers can also receive signals from GLONASS satellites which greatly improve the speed at which these units can achieve a satellite "fix". Despite the on-board features of the Viva GS15 receiver, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GNSS (Global Navigation Satellite System) data via imported RINEX data from the Ordnance Survey which were post-processed using Leica Geo Office 8.3 software for the GS15 data.

Conditions for the survey, which took place between 11.45hr and 16.15hr BST, were satisfactory. The sky was quite cloudy but visibility was good. The temperature was about 10 degrees Celsius with light winds gusting up to 10 to 20mph.

2.1) Character of Hill

Maol Ban is the easterly of two Marilyns that lie on a peninsular in the South East corner of the Isle of Mull. This peninsular is joined in two places to the main island with Loch Uisg in between. The whole area is wild and the only road that exists is a minor one that runs from

Barachandroman along the North coast to Croggan. Access into the peninsular has to be from this road over pathless and rugged terrain. The northern flanks of Maol Ban consist of rough broken ground with a number of crags that bar progress, although generally these crags can be circumnavigated. To the South side from the summit, the ground slopes down at an easy angle and before dropping very steeply to the coast.

The summit of the hill has a cylindrical trig point which is not at the highest point of the hill. There is a fine view both into Mull itself and across the Firth of Lorn to the mainland. About 4.5km South West lies the other Marilyn Druim Fada. It is not possible to walk in a direct line to this hill because about half way between the two hills access is barred by very steep ground. Therefore the route for this takes one in a more Westerly direction and leads down to the area of the bealach whose position is easily seen to be confined to a grassy area about 50 metres square.

2.2) Summary of Survey Method

The survey commenced at the summit where the highest point was found by taking measurements with the Leica NA730 level and staff and confirmed to be a grassy mound. GNSS data were then collected with the Leica GS15 supported over this point. The height of the Flush bracket on the trig point was also levelled to the highest point.

Next the survey moved to the bealach. Visually the exact position for the bealach lay within an approximate 50 metre by 50 metre flat and rough grassy area. The presence of a shallow gully leading to the bealach on its South side in the valley to valley direction gave a good clue to aid identification of the bealach position. Staff readings were taken with the Leica NA730 level along this line in order to find the highest point. Sets of staff reading were then taken on lines parallel and on both sides of this gully to find the highest point of each line. The line of these high points then represents the hill to hill direction and the lowest point the position of the bealach. Finally the Leica GS15 was set up on a tripod over this point and GNSS data were collected.

2.3) The Summit

The summit of the hill had already been identified as a grassy mound about 25 metres West and approximately 1m higher than the trig point by an Abney level measurement taken on 28 September 2009. This position was confirmed with systematic staff readings having set up the Leica NA730 level on a tripod at a convenient position to view both the high ground and the flush bracket on the trig point. (See appendix for summit photograph).

The staff readings that were recorded were:-

Staff reading at summit = 0.335m

Staff reading at base of trig point = 1.043m

Staff reading at flush bracket on trig point = 0.715m

We estimated that we had located the summit position to a height uncertainty within +/- 0.05m.

The Leica GS15 was then set up on the “short tripod” over the summit position. The vertical offset measured on the tape was 0.642m (see photograph in the Appendix) plus 0.255m for the tribrach/hook system which is automatically taken into account in the processing

parameters if set up is defined as “short tripod”. GNSS data were collected for 1 hour with an epoch time of 15 seconds.

The ten-figure Grid References measured for the summit were:-

Garmin Montana 600	NM 68384 23873	Height = 341m
Garmin Etrex 20	NM 68384 23873	Height = 339m
Garmin Oregon 450	NM 68384 23873	Height = 341m
Magellan Explorist 100	NM 68382 23874	Height = 344m

The ten-figure Grid References measured for the trig point were:-

Garmin Montana 600	NM 68410 23867	Height = 342m
Garmin Etrex 20	NM 68408 23868	Height = 342m
Garmin Oregon 450	NM 68409 23867	Height = 349m
Magellan Explorist 100	NM 68405 23869	Height = 346m

The position and height data for the summit that were recorded by the Leica Viva GS15 was post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the five nearest base stations that were under 100km distance and the Hopfield model for tropospheric correction. These results are given in the table below and include the above offset value:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	168378.434	0.004	723882.074	0.003	338.474	0.014

The height of the Maol Ban is 338.47m

The OS Database gives the height of the trig flush bracket as 338.02m.

Our measurement for the height of the trig flush bracket is 338.474 + 0.335 – 0.715 = 338.09m

The summit of the hill is 1.043 – 0.335 = 0.7m higher than the base of the trig point and is in agreement with the approximate height difference of 1m measured previously by Abney level.

2.4) The Bealach

The location of the position of the bealach has already been described previously in Section 2.2. As can be seen from the photograph shown in the Appendix, the terrain here consists of tussock grass and this limited the accuracy to which the bealach could be located. We would estimate that this would give an uncertainty in the height measurement for the bealach of +/- 0.2m.

The ten-figure Grid References recorded for the bealach were:-

Garmin Montana 600	NM 66030 24185	Height = 190m
Garmin Etrex 20	NM 66028 24187	Height = 192m

Garmin Oregon 450	NM 66030 24185	Height = 198m
Magellan Explorist 100	NM 66032 24186	Height = 189m

The Leica GS15 was set up directly over the bealach on the "short tripod" system with a measured vertical offset of 0.556m. Data were collected for 1 hour with an epoch time of 15 seconds. (See photographs in Appendix for bwlch and vertical offset).

The position and height data for the summit that were recorded by the Leica Viva GS15 was post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the five nearest base stations that were under 100km distance and the Hopfield model for tropospheric correction. These results are given in the table below and include the above offset value:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	166023.204	0.003	724194.838	0.004	186.418	0.020

The height of the bealach is therefore 186.42m

3) Summary of Operating and Process Conditions

	GS15
Data Collection bwlch (min)	61
Data collection summit (min)	65
Number of Base Stations used in Processing for all points	5
Epoch Time (sec)	15
Tropospheric Model	Hopfield
Cut off Angle (degs)	15

4) Discussion of Results

The uncertainties in the height measurement taken by the GS15 for the summit are +/-0.05m associated with its location and +/-0.05m for the GNSS 1 hour data set. This gives an overall uncertainty in the summit height of +/-0.07m.

The agreement between the OS flush bracket height measurement (338.02m) and Leica GS15 measurements in this survey (338.09m) is good and consistent with an Order 3 Ordnance Survey levelling. (Orders range from 1 to 4 with 1 and 2 being the most precise).

We estimate that the height uncertainty in the location of the bealach is +/-0.2m.

The drop for Maol Ban is 338.474 – 186.418 = 152.06m and therefore this hill remains a Marilyn. The dominating uncertainty in the drop measurement is the height uncertainty

associated with the location of the bealach and overall we estimated the uncertainty to be +/- 0.25. Therefore, the drop is 152.1 +/-0.25m.

5) Summary and Conclusions

The **summit** of **Maol Ban** is at grid reference * NM 68384 23873 and is an unfeatured grassy mound 25metres West of the trig point. Its height is **338.47+/-0.08m**.

The **bealach** for Maol Ban is at grid reference *NM 66030 24186. Its height is **186.4+/-0.2m**.

The **re-ascent** from the **bealach to the summit is 152.1+/-0.25m** and therefore **Maol Ban remains a Marilyn.**

* NB average hand-held Garmin/Magellan GPS grids are quoted in the summary.

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Appendix

View of GS15 set-up at summit on "short tripod"

Summit - GS15 Vertical offset at 0.642m

Leica GS15 setup at bwlch on “short tripod”

Bealach - GS15 vertical offset at 0.556m