

Surveys of Long Fell and Tinside Rigg

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The Team:

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1) Introduction

Long Fell (Hill Number 2762, Section 35A, OS 1:50000 Map 91, OS 1:25000 Map OL19N, Grid Ref. NY768198) is listed as a deleted Nuttall, Buxton & Lewis and Bridge summit in the Database of British and Irish Hills (DoBIH) while Tinside Rigg (Hill Number 2930, Section 35A, OS 1:50000 Map 91, OS 1:25000 Map OL19N, Grid Ref. NY775199) is listed as a Buxton & Lewis summit. However, both these hills exceed 2000 feet (609.6m) in height, but with listed drops just below 15m they do not qualify for Anne and John Nuttalls' list of 2000 foot Mountains in England and Wales. In 2011 Chris Crocker, from a study of old maps, raised the possibility of Tinside Rigg being a Nuttall. This prompted Jim Bloomer to visit Tinside Rigg and Long Fell to make Abney level measurements of the hills. He suggested that the drop for Tinside Rigg could be nearer 19m and therefore this hill might qualify for Anne and John Nuttalls' list.

Both hills are situated in the Warcop Military Range in the Northern Pennines and therefore access is only possible when firing is not taking place. A list of dates is published each year when access is permitted.

The main purpose of this survey was to measure accurately the drop of Tinside Rigg to confirm Jim Bloomer's observations. However, the opportunity was also taken to survey Long Fell to measure its drop in order to establish if this hill also has more than 15m of drop. Therefore, there could be up to two new additions to Anne and John Nuttalls' list of hills.

2) Equipment used and Conditions for Survey

Optical work and Line Surveys 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 dual-frequency and multi-channel, which means it can lock 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.

Conditions were good for the survey which took place between 10.00 and 17.00hrs BST. The weather was mild, 12 degrees Celsius, with sunny intervals and a light wind but light rain developed towards the end of the survey.

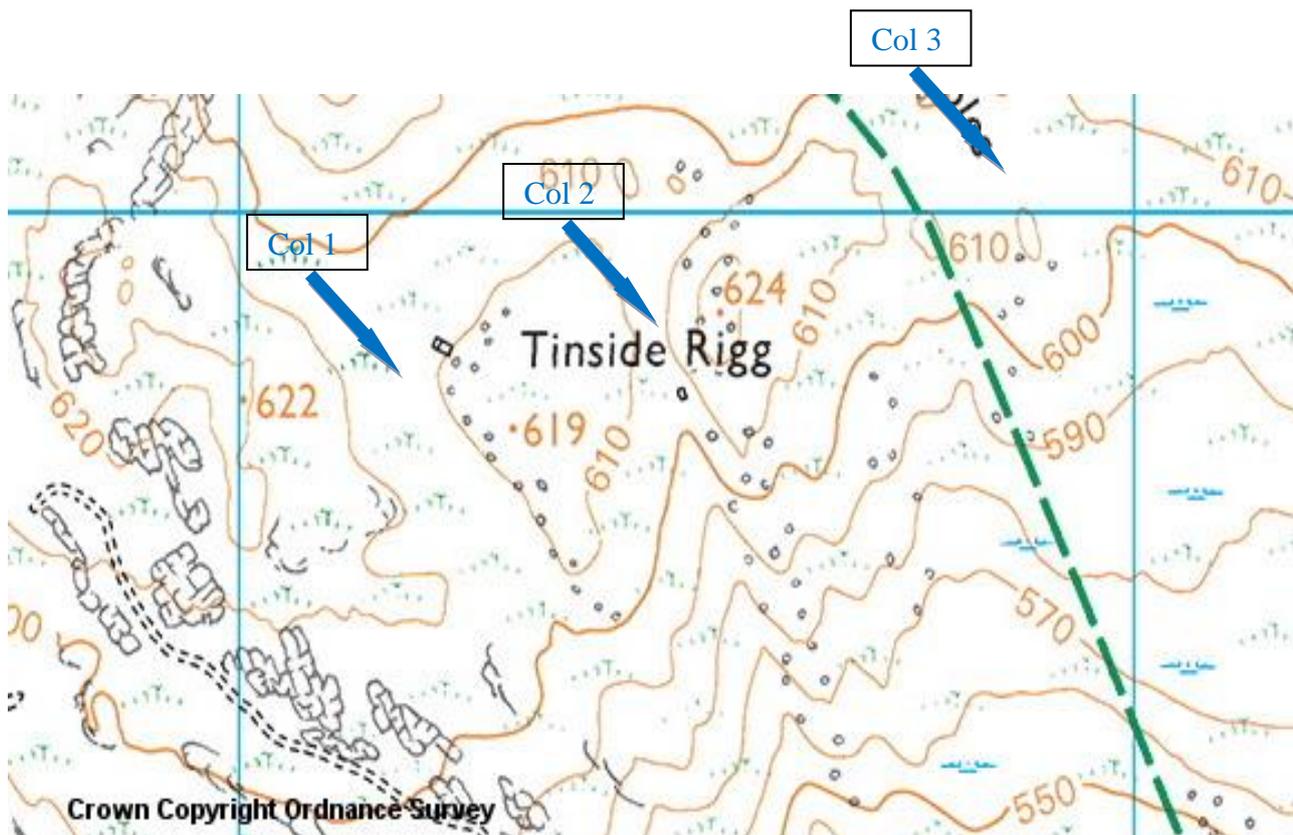
3) Character of Hills

Long Fell and Tinside Rigg lie in the Western Fells of the North Pennines about 5km East of the village of Hilton. They form part of an extensive area of bleak moorland hills that make up this region of Cumbria. Long Fell and Tinside Rigg also lie on Warcop Military Range (Ministry of Defence Land) where access is limited to a small number of days of the year when shooting is not taking place. The hills are rather characterless being largely grassy mounds interspersed with areas of bog and peat which often makes walking this area rather tedious. Occasionally there are rocky outcrops that break up the monotony of the terrain. However, if you like being alone in the world this is a good place to be!

Access is most easily gained from Hilton where there is parking for a few cars at the end of the lane. A wide track leads into the Warcop Range and follows the stream into a narrowing valley. After about 2km this track is left to follow a path that leads South East along the northern flank of Swindale Edge. This track is followed for about 3km until it reaches the col between Warcop Fell to the North East and Tinside Rigg to the South West. The final few metres of ascent up grass leads to the summit of Tinside Rigg. Long Fell can then be reached by a 500m walk in a WSW direction over an intermediate grassy hill.

4) The Survey

An extract of the Ordnance Survey 1:25000 scale map is shown below. Tinside Rigg is marked with a spot height of 624m and about 500m WSW from it Long Fell is marked with a spot height of 622m. The key feature of this survey are the three cols that are labelled on the map extract. Tinside Rigg is the highest of the hills at 624m. If the drop to "Col 3" is greater than 15m then Tinside Rigg



would qualify for the list of “Nuttalls”. However, if either “Col 1” or “Col 2” is low enough to give a drop from Long Fell of more than 15m, then Long Fell qualifies for the list of “Nuttalls” as well. Therefore, the task for the survey was to locate and measure the heights of the two summits and three cols to determine whether there are no, one or two new “Nuttalls”.

As daylight time was limited the survey group had to be split into two teams. One team focussed on using the Leica GS15 to obtain accurate height data for the two summits and Cols 1 and 3 while the other team used the Leica NA730 Automatic Level and Staff to carry out Line Surveys for Tinside Rigg summit to Col 2 and Long Fell Summit to Col 1.

Summit positions were found by setting up the Leica NA730 automatic level on its tripod and staff measurements were taken on candidate positions until the highest points had been found. These positions were then marked with flags for subsequent GNSS measurements.

A col position was found by first identifying visually its approximate position in addition to the hill to hill and valley to valley directions. Next rows of flags 5m apart were set out in the valley to valley direction so that they included the line of the col in the hill to hill direction. Three rows of flags were considered adequate for each of the cols. We then used a standard procedure for each col. The Leica NA730 automatic level was set up on a tripod at a convenient position and staff measurements were taken at each of the flags on the lines in the valley to valley direction. The highest flag in each of these lines was marked with a different coloured flag. The line of the different coloured flags in the hill to hill direction then represents the line of the col and the lowest flag the position of the col. If deemed necessary, further measurements were taken between the flags to improve the identification of the exact position of the col.

Having identified and marked summit and col positions, line surveys were carried out using the standard procedure for line surveying. For example, for a summit to col line survey, the staff was held vertically on the summit position and the Leica NA730 automatic level set up on a tripod in a convenient position lower on the hill. Once a set of readings had been taken (Backsight Reading), the staff was then moved to a position further down the hill towards the col, but the level was not moved apart from a rotation through “180 degrees” to take another set of readings (Foresight Readings). Each set comprised a reading of the central level line and the upper and lower stadia lines. The average of these three reading was then calculated and, provided this average was within 1mm of the central line reading, then the set was accepted and the line survey continued. The process of alternately moving the staff and level was repeated until the final reading was taken with the staff positioned at the col.

For the absolute height measurements in each case the Leica GS15 was mounted on a 2.000m pole and held in a Leica Quickset tripod over either the exact position of the col or summit. For the two summits and Col 3, GNSS data were collected for 1 hour with an epoch time of 15 seconds. Unfortunately, time only allowed a 30 minute GNSS dataset to be collected on the summit of Long Fell. The data for the Leica Viva GS15 were processed in Leica GeoOffice 8.3 using the ten nearest base stations under 100km distance. These were: - Wearhead-WEAR 22km, Shap – SHAP 22km, Catterick – CATT 47km, Carlisle – CARL 52km, Giggleswick - GIGG 55km, Newcastle – NCAS 66km, St Bees-STBE 81km, Morpeth-MORP 84km, Yearsley-YEAL 93km and Leeds –LEED 97km). We used Broadcast Ephemeris data received by the GPS during the survey rather than Precise Ephemeris data, since we have found this makes little difference to the height results. The computed Tropospheric model was chosen for the calculations to suit the data collection times and the wide difference in height between the base stations and the summit of the mountain. (Normally for a 30-minute dataset, as collected on Long Fell, the Hopfield Tropospheric Model would be used but this only gives a height difference to the result from the Tropospheric model of 0.03m).

4.1) Surveys of “Col 3” and Tinside Rigg

“Col 3”, approximately 300m NE of the summit of Tinside Rigg is the critical col for the determination of its status. The exact positions of the col and the summit were located as described earlier and GNSS data were collected at both points. Photographs of the GS15 setup on these points are shown in the Appendix. Unfortunately, there was insufficient time to carry out a line survey between “Col 3” and the summit, so the drop for Tinside Rigg was calculated from the absolute heights. The results are shown in the Table below: -

	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
Summit	377546.736	0.001	519905.187	0.002	623.957	0.010
Col	377914.590	0.002	520051.670	0.002	604.695	0.006

The measured height for the summit of Tinside Rigg is 623.96m and is consistent with 624m on the OS 1:25000 scale map. The height of the col was measured to be 604.70m and therefore the calculated drop for Tinside Rigg is 19.26m well above the 15m criterion for admission to the list of Nuttalls.

4.2) Survey of “Col 2”

The location of the position of “Col 2” with level and staff was quite easy as this col is well defined. Once it had been located a line survey was then carried out to the summit of Tinside Rigg, which again was relatively straightforward as distances were short. In fact, the whole line survey, shown in the Appendix, was completed in four sets of readings.

The results were: -

Height of Tinside Rigg = 623.96m

Drop as measured by line survey = 14.73m

Therefore, Height of “Col 2” = 609.23m

These measurements indicated that there was insufficient drop (less than 15m), at “Col 2” for both Tinside Rigg and Long Fell to be two new “Nuttalls”. However, that conclusion is based on the assumption that Long Fell is not higher than Tinside Rigg and “Col 1” is not lower. These assumptions were tested in subsequent measurements.

4.3) Survey of “Col 1” and Summit of Long Fell

“Col 1” and the summit of Long Fell were located and marked as already described. The actual position of the hill’s summit was about 130m West of the 622m spot height that is marked on the OS 1:25000 scale map. Again, it was not difficult to locate the position of the col since it was quite well defined. The drop for Long Fell to “Col 1” was measured as the difference between GNSS heights and also by line survey. The results for the GS15 measurements are shown in the table below: -

	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
Summit	376870.434	0.001	519810.327	0.002	623.501	0.010
Col	377220.175	0.002	519730.791	0.001	606.984	0.005

The height of Long Fell is 623.50m which is 1.5m higher than the map spot height. This is consistent with the observation that the ground was rising West of the spot height position.

The measured drops from Long Fell to “Col 1” are: -

Drop measured from GS15 readings = 16.52m

Drop measured from Line Survey (see Appendix) = 16.54m

Height of “Col 1” = 606.98m

Height of “Col 2” = 609.23m

Therefore, “Col 1” is lower than “Col 2” by 2.25m and “Col 1” is the critical col determining the status of Long Fell. At 16.53m (average of two measurements) the drop exceeds 15m and therefore Long Fell also qualifies as a new “Nuttall”.

5) Summary of GNSS parameters and Discussion of Errors

The summary of the conditions used for the GS15 GNSS measurements are shown in the table below: -

Variable	Tinside Rigg “Col 3”	Tinside Rigg Summit	Long Fell “Col 1”	Long Fell Summit
Data collection summit (min)	64	65	62	34
Number of Base Stations used in Processing for all points	10	10	10	10
Epoch Time (sec)	15	15	15	15
Tropospheric Model	Computed	Computed	Computed	Computed
Geoid Model	OSGM36(15)	OSGM36(15)	OSGM36(15)	OSGM36(15)
Cut off Angle (degs)	15	15	15	15

For a 1 hour GNSS dataset previous work has shown the measurement uncertainty in height to be +/-0.06m. The associated uncertainty in height in determining the correct position for the col we estimate to be +/-0.05m. Therefore, the overall uncertainty in any absolute height measurement is +/-0.08m and the calculated measurement uncertainty for a drop measurement is +/-0.1m. As only a 34-minute dataset was collected for Long Fell we would estimate the uncertainty in this measurement to be +/-0.1m.

The drop measurements for Long Fell are 16.52m and 16.54m for the GS15 measurements and line survey respectively. These two methods of measurement, within 0.02m are in excellent agreement and well within the expected uncertainties of the individual measurements.

6) Summary and Conclusions

The **summit** of **Tinside Rigg** is at grid reference NY 77546 19904 and is the highest point of grass adjacent to a rock. **Its height is 624.0+/-0.08m.**

The **col** for Tinside Rigg is at NY 77914 20050 and its **height is 604.7+/-0.08m.**

The **ascent from col to summit** of **Tinside Rigg** is **19.3 +/-0.1m**

Tinside Rigg has sufficient drop to be included in Anne and John Nuttalls’ list of 2000ft hills for England and Wales.

The **summit** of **Long Fell** is at grid reference NY 76870 19809 and is the highest point of grass. **Its height is 623.5+/-0.1m.**

The **col** for Long Fell is at NY 77220 19729 and its **height is 607.0+/-0.08m.**

The **ascent from col to summit of Long Fell is 16.5 +/-0.1m**

Long Fell has sufficient drop to be included in Anne and John Nuttalls' list of 2000ft hills for England and Wales.

* Grid references given in Summary and Conclusions are for users of Garmin GNSS receivers

Footnote: For those wishing to climb Tinside Rigg and Long Fell it should be emphasised that they lie on the Warcop Military Range and the Ministry of Defence restricts access to only a few days a year. Access days should be checked via M.O.D at Warcop. On any other day, red flags fly at access points and entry to the range is then strictly forbidden for obvious reasons.

John Barnard and Graham Jackson, 20 November 2016.

Appendix



Leica Viva GS 15 set up on summit of Tinside Rigg



Leica Viva GS15 set up on col for Tinside Rigg (Col 3)



Leica GS15 set up on Col for Long Fell (Col 1)

Instrument:- Leica NA730

01-Oct-16

Point Number	Horizontal Line		Lower Stadia Line		Upper Stadia Line		Mean BS	Mean FS	Ht Difference	BS Distance	FS Distance
	Backsight R	Foresight F	Backsight R	Foresight F	Backsight R	Foresight F					
"Col 2" to Summit (CC Staff and GJ Level)- Tinside Rigg											
1	3.470	0.353	3.296	0.286	3.643	0.421	3.470	0.353		34.700	13.500
2	3.923	0.510	3.815	0.415	4.030	0.605	3.923	0.510		21.500	19.000
3	4.604	0.559	4.506	0.492	4.703	0.627	4.604	0.559		19.700	13.500
4	4.755	0.604	4.655	0.575	4.855	0.633	4.755	0.604		20.000	5.800
						Sum =	16.752	2.027	14.725	95.900	51.800
"Col 1" to Summit (CC Staff and JB level) - Long Fell											
1	0.984	0.584	0.974	0.560	0.994	0.607	0.984	0.584		2.000	4.700
2	3.209	1.186	2.956	1.073	3.460	1.301	3.208	1.187		50.400	22.800
3	3.972	0.711	3.684	0.628	4.262	0.794	3.973	0.711		57.800	16.600
4	4.349	1.192	4.156	1.075	4.539	1.312	4.348	1.193		38.300	23.700
5	4.749	0.802	4.597	0.626	4.902	0.980	4.749	0.803		30.500	35.400
6	4.258	0.508	3.753	0.419	4.764	0.596	4.258	0.508		101.100	17.700
						Sum =	21.521	4.985	16.536	280.100	120.900