

**Table 1. Climatic and Vegetational Post glacial History of England**

<b>Period</b>	<b>Vegetation</b>	<b>Climate</b>	<b>Temp.</b>
VIII Sub-Atlantic 2.5-0.9 <sup>1</sup>	Mixed wood & expanding open spaces	cool O <sup>2</sup>	0.5-1.0°C L <sup>3</sup>
VIIb Sub-Boreal 5.0-2.5	Mixed wood & expanding open spaces		
VIIa Atlantic 7.0-5.0	Mixed oak, Lime & Alder increasing Peat bogs developing	warm O	July 3.0°C H Jan. 2.0°C H
VI Boreal  9.0-7.0 (V & VI)	-Lime & Alder influx  -Oak expansion  -Elm & Oak increase Pine & Hazel codominant	warm C	
V Boreal	Birch & Hazel increase	warm C	
IV Pre Boreal 9.6-9.0	Birch expansion Herbs & shrubs decline	warmer	July = or H
Late Glacial III 10.8-9.6	Herbs dominant, Birch confined to SE	cold	
II 12.0-10.8	Birch spread, Pine in SE England	warm	
I 13.5-12.0	Herbs dominant	cold	

1: Approximate age (thousand years).

2: O Oceanic climate (mild, wet); C Continental climate (drier, more extreme seasons).

3: L lower than present; H higher than present.

Adapted from Dennis (1977).

**Table 2. Belle Vue weather station mean monthly rainfall 1892-1982**

Month	n	Mean (mm)	SE	Min (mm)	Max (mm)
Jan.	89	81.0	6.0	34.0	133.0
Feb.	89	66.8	8.5	4.8	174.8
Mar.	89	73.3	9.0	17.8	170.2
Apr.	89	64.3	6.0	6.8	122.2
May	89	63.0	6.0	11.0	118.2
June	88	57.8	6.5	15.0	148.8
July	89	69.0	7.5	6.8	163.0
Aug.	89	80.8	6.0	21.0	140.8
Sept.	89	81.0	10.0	6.8	204.2
Oct.	89	84.3	9.0	16.0	177.2
Nov.	89	101.0	8.5	27.5	178.0
Dec.	89	90.5	8.5	31.2	180.0
Yearly mean:		912.8mm			

**Table 3. Belle Vue weather station monthly mean number of rain days<sup>1</sup> and mean amount of rain per day**

Month	n	Mean No. Rain Days <sup>2</sup>	Mean Monthly Rainfall (mm) <sup>3</sup>	Mean Rain per day (mm)
Jan.	59	20	81.0	4.0
Feb.	59	16	66.8	4.2
Mar.	59	16	73.3	4.6
Apr.	59	15	64.3	4.3
May	59	14	63.0	4.5
June	59	13	57.8	4.4
July	59	15	69.0	4.6
Aug.	59	16	80.8	5.0
Sept.	59	14	81.0	5.8
Oct.	59	17	84.3	5.0
Nov.	59	18	101.0	5.6
Dec.	59	19	90.5	4.8

- 1: Number of days with more than c0.5mm of precipitation.  
 2: Figures only available for 1892-1951  
 3: From table 2

**Table 4. Belle Vue weather station monthly mean temperatures (°C) 1892-1982**

Month	n	Mean (°C)	SE	Min (°C)	Max (°C)
Jan.	87	3.1	0.2	-1.7	8.7
Feb.	87	3.1	0.2	-2.5	6.8
Mar.	86	4.7	0.2	-1.8	8.2
Apr.	85	7.1	0.1	3.9	9.3
May	86	10.2	0.1	7.1	12.6
June	87	13.3	0.1	10.8	16.4
July	86	15.0	0.1	12.6	17.5
Aug.	87	14.6	0.1	5.9	17.9
Sept.	87	12.6	0.1	7.7	15.3
Oct.	90	9.2	0.1	5.9	12.8
Nov.	85	5.8	0.1	2.7	8.2
Dec.	85	3.9	0.1	-1.2	7.2

**Table 5. Vegetation classes used in mapping**

<b>Class</b>	<b>Symbol</b>	<b>Main features</b>
<i>Calluna</i> 0-1 year old burn	0	Bare, charred ground with varying amounts of old stems
2-3 year old burn	1	Old stems absent; <i>Calluna</i> shoots growing c4cm per year. Bilberry often common
Less than 30cm	2	c3-5 year old burns; thin, upright <i>Calluna</i> in regular sward
More than 30cm	3	Old, leggy <i>Calluna</i> , forming a stand of irregular height and with many plants tumbling at the base
Senescent	3a	Highly eroded community typical of the edge of high plateaux with areas of bare peat and <i>Empetrum nigrum</i> between very thin <i>Calluna</i>
Bracken	B	Normally absolutely dominant on slopes, and often invading <i>Molinia</i>
<i>Molinia</i>	Mol	<i>Molinia caerulea</i> forming tussocks of various size
Burnt <i>Molinia</i>	bMol	<i>Molinia</i> burnt in spring as summer grazing for sheep
<i>Nardus</i>	N	<i>Nardus stricta</i> , normally forming short tussocks; diagnostic of extreme overgrazing
<i>Agrostis/Festuca</i>	A/F	Grassland dominated by <i>Agrostis tenuis</i> , <i>Festuca rubra</i> & <i>F.ovina</i> , often with small amounts of <i>Deschampsia flexuosa</i>
<i>Juncus</i>	J	Damp, mineral enriched flushes or redundant pastures. Various species, but mainly <i>J.squarrosus</i> & <i>J.conglomeratus</i>
<i>Eriophorum</i>	Er	<i>Eriophorum vaginatum</i> dominant on wet plateaux; <i>E.angustifolium</i> present throughout in smaller quantities
<i>Empetrum</i>	Em	<i>Empetrum nigrum</i> found scrambling over bare rock or the thinnest soil, or in eroded peat
Bilberry	By	<i>Vaccinium myrtillus</i> found on well drained slopes with thin soil

Two small patches of *Erica cinerea* and *E.tetralix* and *Scirpus caespitosus* were mapped. Woodland, conifer plantation, reservoir and reservoir edge, and quarry bottom were also mapped.

**Table 6. Enclosed land classification**

<b>Class</b>	<b>Symbol</b>	<b>Main Features</b>
Improved (Pasture or reseed) short	Is	Very short grass (<10cm), mainly <i>Agrostis</i> , <i>Festuca</i> and <i>Poa</i> and no wild flowers. Pasture land, often with <i>Juncus</i> flushes
long	II	Longer grass (>10cm to 50cm); reseeds, with Italian Rye Grass <i>Lolium perenne</i> predominating. Very dense grass with no wild flowers other than some Dandelions and buttercups
cut	cut	Cut within two weeks for hay or silage
Unimproved (Meadow) short	Ms	Moderately short (10-15cm); wild flowers and grasses common
long	MI	Longer sward (>15cm); wild flowers and grasses common, especially Yorkshire Fog <i>Holcus lanatus</i>

**Table 7. Habitat features recorded at nest sites**

<b>Feature</b>	<b>Classes</b>
Slope	<30°, 30-45°, >45°
Aspect	Direction of nest slope, and the direction to which the nest faced (ie. where bird would enter)
Nest Height	Height from the ground to the top of the nest cup
Vegetation	Vegetation class (see Table 5)
Surrounding vegetation	The proportion (to nearest 10%) which each vegetation class (see Table 5) formed in a 30m radius around the nest site
Vegetation height	Height of five highest points (to nearest 5cm) in 1m <sup>2</sup> quadrats, one centred over the nest, and adjacent quadrats uphill, downhill, to left and right of the nest; in the case of nests in Bracken, the number of stems in each quadrat was also recorded

**Table 8. Land proportions in the Midgley study area**

<b>Class<sup>1</sup></b>	<b>n<sup>2</sup></b>	<b>Total (ha)</b>	<b>Mean (ha)<sup>3</sup></b>	<b>SE</b>	<b>% of Total Area</b>	<b>% of Land Available<sup>4</sup></b>
0	34	10.65	0.31	0.06	3.50	7.43
1	36	11.67	0.32	0.06	3.84	8.14
2	39	19.88	0.51	0.13	6.54	13.87
3	34	30.39	1.90	0.33	9.99	21.20
B	5	7.14	1.43	0.84	2.35	4.98
M	4	14.57	3.64	2.72	4.79	10.16
bM	3	1.11	0.37	0.14	0.36	0.77
N	13	34.77	2.67	0.76	11.43	24.26
A/F	6	8.01	1.34	0.39	2.63	5.59
J	2	1.19	0.60	0.18	0.39	0.83
By	4	2.67	0.67	0.16	0.88	1.86
Quarry	6	1.30	0.22	0.05	0.43	0.91
Wood	9	4.89	0.54	0.12	1.61	----
Reservoir	2	0.85	----	----	0.28	----
Other	---	12.30	----	----	4.04	----
Fields	169	142.75	1.22	0.39	46.94	----
TOTAL:		304.14				

1: See Table 5 for explanation of abbreviations.

2: Number of patches.

3: Mean patch size.

4: "Total available" is total area available to nesting Twite which is the Total minus woods, reservoirs, other, and fields; this equals 143.35ha.

**Table 9. Land proportions in the Withens Clough study area**

<b>Class<sup>1</sup></b>	<b>n<sup>2</sup></b>	<b>Total (ha)</b>	<b>Mean (ha)</b>	<b>SE</b>	<b>% of Total</b>	<b>% of Land Available<sup>3</sup></b>
0	17	1.80	0.11	0.04	0.14	0.19
1	23	7.12	0.31	0.10	0.54	0.76
2	13	35.10	2.70	1.55	2.66	3.73
3	14	31.94	2.28	1.01	2.42	3.39
3a	6	126.15	21.03	10.22	9.56	13.39
Erica	1	0.23	----	----	0.02	0.02
B	66	94.32	1.43	0.32	7.10	10.01
M	23	278.81	12.12	5.56	21.14	29.60
N	2	19.30	----	----	1.42	2.05
A/F	31	43.60	1.41	0.39	3.31	4.63
J	18	23.44	1.30	0.59	1.78	2.49
Er	21	235.02	11.19	5.36	17.82	24.95
By	2	2.64	----	----	0.20	0.28
Em	6	9.29	1.55	0.88	0.70	0.99
Conifer	1	33.18	----	----	2.52	3.52
Wood	14	42.02	3.00	0.97	3.19	----
Reservoir	1	26.05	----	----	1.97	----
Other	---	15.25	----	----	1.16	----
Fields	183	293.75	1.61	0.27	22.27	----
<b>TOTAL:</b>		<b>1319.10</b>	<b>(Total available 942.03ha)</b>			

3: "Total available" is the total area available to nesting Twite which is the Total minus Wood, Reservoir, Other, and Fields.

See Table 8 for explanation of symbols 1 & 2.

**Table 10. Land proportions in the Rishworth study area**

<b>Class<sup>1</sup></b>	<b>n<sup>2</sup></b>	<b>Total (ha)</b>	<b>Mean (ha)</b>	<b>SE</b>	<b>% of Total</b>	<b>% of Land Available<sup>3</sup></b>
B	80	70.53	0.88	0.18	9.63	12.52
M	20	130.36	6.52	3.62	17.81	23.15
N	15	80.25	5.35	1.74	10.96	14.25
A/F	12	44.79	3.73	0.94	6.12	7.95
J	4	4.88	1.22	0.40	0.67	0.87
Er	9	231.52	25.72	18.00	31.62	41.11
Quarry	2	0.80	----	----	0.11	0.14
Wood	5	3.31	0.66	----	0.45	----
Reservoir	3	20.20	----	----	2.76	----
Other	--	10.66	----	----	1.46	----
Fields	92	134.78	1.47	0.19	18.41	----
<b>TOTAL:</b>		<b>732.08</b>	<b>(Total available 563.13ha)</b>			

3: "Total Available" is the total land available to nesting Twite which is the Total minus Wood, Reservoir, Other, and Fields; this is equal to 563.13ha.

See Table 8 for explanation of symbols 1 & 2.

**Table 11. Twite densities in different field types in the Midgley study area May 18th - June 13th**

Class <sup>1</sup>	No. Days <sup>2</sup>	Cum. ha <sup>3</sup>	Twite Days	Total Twite	Total/Cum ha <sup>4</sup>	T Days/Cum ha <sup>5</sup>
Is D0	320	267.19 (73)	7	16	0.06	0.03
D1	19	15.31 (3)	1	5	0.33	0.07
II D0	43	30.28 (10)	0	0	0.00	0.00
Cut (D0)	12	11.87 (11)	0	0	0.00	0.00
Ms D0	17	22.62 (3)	0	0	0.00	0.00
Ms D1	166	120.30 (29)	9	49	0.41	0.07
Ms D2	5	4.15 (1)	0	0	0.00	0.00
MI D1	207	159.70 (45)	2	6	0.04	0.01
D2	55	41.74 (9)	3	6	0.14	0.07
Urban	8	c49.20	3	6	c0.12	c0.06

Rearranged<sup>6</sup>:

D0	392	668.96 (111)	7	16	0.02	0.01
D1	392	295.31 (77)	12	60	0.20	0.04
D2	60	45.89 (10)	3	6	0.13	0.07

- 1: See Table 6 and section 2.2 (Methods) for explanation of abbreviations.
- 2: Cumulative number of days for each class; two visits to the same field contribute two days to the appropriate class.
- 3: Cumulative hectareage for each class; two visits to a 1ha field contribute 2ha to the appropriate class. Numbers of fields contributing to each class are given in brackets.
- 4: "Total/Cum Ha" gives the total number of Twite divided into the cumulative area, giving density (Twite.ha<sup>-1</sup>).
- 5: "T Days/Cum Ha" gives the number of occasions on which at least one Twite was present (ie. a Twite day) in a particular class divided by the cumulative hectareage of that class; this figure removes some of the bias in the Total/Cum Ha figure resulting from large flocks.
- 6: Urban not included, as Dandelion density extremely variable.

See also Appendix II



**Table 12. Twite densities in different field types in the Withens Clough study area May 18th - June 13th**

<b>Class<sup>1</sup></b>	<b>No. Days<sup>2</sup></b>	<b>Cum. ha<sup>3</sup></b>	<b>Twite Days</b>	<b>Total Twite</b>	<b>Total/Cum ha<sup>4</sup></b>	<b>T Days/Cum ha<sup>5</sup></b>
Is D0	743	1099.19 (113)	12	33	0.03	0.01
Is D1	17	30.92 (2)	0	0	0.00	0.00
II D0	31	14.73 (3)	0	0	0.00	0.00
II D1	82	51.79 (8)	0	0	0.00	0.00
II D2	26	13.91 (2)	2	8	0.58	0.14
Ms D1	38	54.76 (9)	1	1	0.02	0.02
MI D1	104	108.28 (18)	7	12	0.11	0.06
MI D2	12	21.36 (1)	1	1	0.05	0.05
Mol	20	47.20 (2)	0	0	0.00	0.00
Urban	13	c99.13	5	13	c0.13	c0.05

Rearranged<sup>6</sup>:

D0	794	1161.12 (118)	12	33	0.03	0.01
D1	241	242.75 (37)	8	13	0.05	0.03
D2	38	35.27 (3)	3	9	0.26	0.09

See Table 11 for explanation of symbols 1-6.

**Table 13. Twite densities in different field types in Midgley & Withens Clough May 18th-June 13th grouped**

<b>Class<sup>1</sup></b>	<b>No. Days<sup>2</sup></b>	<b>Cum. ha<sup>3</sup></b>	<b>Twite Days</b>	<b>Total Twite</b>	<b>Total/Cum ha<sup>4</sup></b>	<b>T Days/Cum ha<sup>5</sup></b>
D0	1186	1830.08 (229)	19	49	0.03	0.01
D1	633	538.06 (114)	20	73	0.14	0.04
D2	98	81.16 (13)	6	15	0.18	0.07

See Table 11 for explanation of symbols 1-5.

**Table 14. Twite densities in different field types in the Midgley study area June 14th - August 5th**

<b>Class<sup>1</sup></b>	<b>No. Days<sup>2</sup></b>	<b>Cum. ha<sup>3</sup></b>	<b>Twite Days</b>	<b>Total Twite</b>	<b>Total/ Cum ha<sup>4</sup></b>	<b>T Days/ Cum ha<sup>5</sup></b>
Is S0	427	353.58 (77)	2	6	0.10	0.04
Is S1	7	7.77 (1)	0	0	0.00	0.00
Is S3	8	8.92 (2)	0	0	0.00	0.00
II S0	14	17.98 (3)	0	0	0.00	0.00
II S1	7	16.87 (1)	0	0	0.00	0.00
Cut(S0)	178	149.23 (39)	0	0	0.00	0.00
Ms S1	107	82.43 (18)	7	35	0.42	0.08
Ms S2	14	13.27 (2)	0	0	0.00	0.00
MI S1	96	79.96 (28)	0	0	0.00	0.00
MI S2	66	38.40 (15)	0	0	0.00	0.00
MI S3	44	25.33 (10)	1	4	0.16	0.04
Urban	7	c43.05 (2)	2	4	c0.09	c0.05

Rearranged<sup>6</sup>:

S0	619	520.79 (119)	2	6	0.01	0.01
S1	217	186.83 (48)	7	35	0.19	0.04
S2	80	51.67 (29)	0	0	0.00	0.00
S3	52	34.25 (12)	1	4	0.12	0.03

See Table 11 for explanation of symbols 1-6.

**Table 15. Twite densities in different field types in the Withens Clough study area June 14th - August 5th**

<b>Class<sup>1</sup></b>	<b>No. Days<sup>2</sup></b>	<b>Cum. ha<sup>3</sup></b>	<b>Twite Total Days Twite</b>		<b>Total/ Cum ha<sup>4</sup></b>	<b>T Days/ Cum ha<sup>5</sup></b>
Is S0	932	1366.18 (133)	7	14	0.01	0.01
Is S1	10	11.70 (1)	1	5	0.23	0.05
Is S3	10	8.50 (1)	2	10	1.18	0.24
II S0	61	34.49 (17)	0	0	0.00	0.00
II S1	6	2.94 (3)	0	0	0.00	0.00
Cut(S0)	97	80.32 (23)	0	0	0.00	0.00
Ms S1	18	13.62 (3)	0	0	0.00	0.00
Ms S2	9	6.66 (1)	0	0	0.00	0.00
MI S0	6	11.46 (10)	0	0	0.00	0.00
MI S1	57	72.43 (13)	4	69	0.95	0.06
MI S2	43	68.16 (5)	8	18	0.26	0.12
MI S3	44	9.72 (5)	3	6	0.62	0.31
Mol	18	42.48 (2)	1	1	0.02	0.02
Urban	10	c76.25	4	7	c0.09	c0.05
Rearranged <sup>6</sup> :						
S0	1114	1534.93 (176)	8	15	0.01	0.01
S1	82	100.69 (20)	4	74	0.73	0.04
S2	52	74.82 (6)	5	18	0.24	0.07
S3	54	18.22 (6)	5	16	0.88	0.27

See Table 11 for explanation of symbols 1-6.

**Table 16. Twite density in different field types in the Rishworth study area June 14th - August 5th**

<b>Class<sup>1</sup></b>	<b>No. Days<sup>2</sup></b>	<b>Cum. ha<sup>3</sup></b>	<b>Twite Days</b>	<b>Total Twite</b>	<b>Total/Cum ha<sup>4</sup></b>	<b>T Days/Cum ha<sup>5</sup></b>
Is S0	180	325.09 (45)	2	4	0.01	0.01
Is S1	4	4.12 (1)	0	0	0.00	0.00
II S0	4	6.28 (1)	0	0	0.00	0.00
Cut(S0)	25	55.96 (7)	0	0	0.00	0.00
Ms S1	11	11.75 (3)	0	0	0.00	0.00
MI S0	8	4.88 (2)	0	0	0.00	0.00
MI S1	51	73.31 (14)	2	20	0.27	0.03
MI S2	48	54.95 (14)	3	25	0.45	0.05
MI S3	36	48.09 (10)	8	133	2.77	0.17
Juncus	4	8.56 (1)	0	0	0.00	0.00
Urban	4	21.32	3	6	0.28	0.14
Rearranged <sup>6</sup> :						
S0	221	400.77 (56)	2	4	0.01	0.01
S1	66	89.18 (18)	2	20	0.22	0.02
S2	48	54.95 (14)	3	25	0.45	0.05
S3	36	48.09 (10)	8	133	2.77	0.17

See Table 11 for explanation of symbols 1-6.

**Table 17. Twite densities in different field types in all study areas June 14th - August 5th grouped<sup>6</sup>**

<b>Class<sup>1</sup></b>	<b>No. Days<sup>2</sup></b>	<b>Cum. ha<sup>3</sup></b>	<b>Twite Days</b>	<b>Total Twite</b>	<b>Total/Cum ha<sup>4</sup></b>	<b>T Days/Cum ha<sup>5</sup></b>
S0	1954	2456.49 (351)	12	25	0.01	0.00
S1	365	376.70 (86)	13	129	0.34	0.03
S2	180	181.44 (49)	8	43	0.24	0.04
S3	142	100.56 (12)	14	153	1.52	0.14

See Table 11 for explanation of symbols 1-5.

**Table 18. Changes in field usage in the Midgley study area**

**Fields used in both Dandelion and Sorrel periods<sup>1</sup>**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D1		3 (1.87)		
				Mean Dandelions: 1.00
				Mean Sorrel: 1.00

**Fields used only when Dandelions were available (May 18th - June 13th)**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D0	5 (2.99)			
D1		1 (0.50)	1 (0.83)	1 (0.26)
D2	2 (2.08)	2 (3.33)		
				Mean Dandelions: 0.92
				Mean Sorrel: 0.67

**Fields used only when Sorrel available (June 14th - August 5th)**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D0	2 (1.41)	1 (1.35)		1 (1.93)
D1	1 (0.93)			1 (0.67)
D2			1 (0.34)	
				Mean Dandelions: 0.57
				Mean Sorrel: 1.29

1: Figures are numbers of fields; figures in brackets are hectarages.

**Table 19. Changes in field usage in the Withens Clough study area**

**Fields used in both Dandelion and Sorrel periods<sup>1</sup>**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D0	2 (8.04)	1 (1.17)		1 (0.85)
D1		3 (3.30)		
			Mean Dandelions:	0.43
			Mean Sorrel:	1.00

**Fields used only when Dandelions available (May 18th - June 13th)**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D0	1 (0.74)			
D1	1 (0.51)	3 (1.71)		1 (0.70)
D2	1 (0.75)			
			Mean Dandelions:	1.00
			Mean Sorrel:	0.86

**Fields used only when Sorrel available (June 14th - August 5th)**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D0	1 (4.15)			
D1	2 (4.64)	2 (1.93)	1 (0.57)	
			Mean Dandelions:	0.83
			Mean Sorrel:	1.50

1: Figures are numbers of fields; figures in brackets are hectarages.

**Table 20. Changes in field usage in the Midgley and Withens Clough study areas grouped**

**Fields used in both Dandelion and Sorrel periods<sup>1</sup>**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D0	2 (8.04)	1 (1.17)		1 (0.85)
D1		6 (5.17)		
				Mean Dandelions: 0.60
				Mean Sorrel: 1.00

**Fields used only when Dandelions available (May 18th - June 13th)**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D0	6 (3.73)			
D1	1 (0.51)	4 (2.21)	1 (0.83)	2 (0.96)
D2	3 (3.83)	2 (3.33)		
				Mean Dandelions: 0.97
				Mean Sorrel: 0.74

**Fields used only when Sorrel available (June 14th - August 5th)**

Dandelion Class	Sorrel Class			
	S0	S1	S2	S3
D0	3 (5.96)	1 (1.35)		1 (1.93)
D1		2 (4.64)	2 (1.93)	2 (1.24)
D2			1 (0.34)	
				Mean Dandelions: 0.67
				Mean Sorrel: 1.50

1: Figures are numbers of fields; figures in brackets are hectarages.

**Table 21. Nests found in the three study areas**

<b>Area</b>	<b>Year</b>	<b>n</b>	<b>Nests found<sup>1</sup></b>
Midgley	1993	3	2 c/5; 1 c/6
	1994	6	1 c/4*; 3 c/5; 2 c/6
Withens Clough	1993	5	4 c/5; 1 c/6
	1994	4	1 c/5; 1 c/6; 1 h/5; 1 f/6
Rishworth	1989	7	5 c/5; 1 c/6; 1 h/5
	1992	5	4 c/5; 1 c/6
	1993	4	4 c/5
	1994	5	1 c/5; 2 c/6; 1 h/6; 1 f/5

The mean clutch sizes are as follows:

<b>Area</b>	<b>n</b>	<b>Mean</b>	<b>SE</b>
Midgley	8	5.38	0.17
Withens Clough	7	5.29	0.17
Rishworth	18	5.22	0.10
1989	6	5.17	0.15
1992	5	5.20	0.18
1993	12	5.17	0.11
1994	10	5.50	0.16
Total	33	5.27	0.08

1: c indicates clutch size (eg. c/5= clutch of 5), h indicates number of nestlings, and f number of fledglings. The numbers given are the maximum for the nest at the state of discovery, so "c" indicates that a nest was found at egg stage etc.; the numbers are not necessarily the number present at discovery (because of incomplete clutches).

\*: This nest could not be relocated and the clutch may have been incomplete.



**Table 22. Timing of breeding**

Study area	Year	n	First Egg Dates <sup>1</sup>		
			Mean	Earliest <sup>2</sup>	Latest <sup>2</sup>
Midgley	1993	1	15 May		
	1994	2	19-21 May	14 May	25 May
	1994 2nd broods <sup>3</sup>	2	6 July	5 July	7 July
Withens Clough	1993	1	11 May		
	1994	3	19-21 May	13-15 May	25-28 May
Rishworth	1989	7	16-18 May	8-10 May	1 June
	1992	1	13 May		
	1993	2	7-9 May	9 May	6-11 May
	1994	3	3-5 June	31 May-1 June	9-10 June
Grouped	1st broods	20	19-21 May	9 May	9-10 June
	2nd broods	2	6 July	5 July	7 July

- 1: First egg date calculated on the basis of a twelve day incubation period, incubation beginning with the fourth egg (Taylor 1935, Newton 1972, Brown et al. 1994, and see Table 23), and estimates of young chicks' age. Dates were split into three day classes (eg. class 1 = 1-3 May, 2 = 4-6 etc.) and nests divided between the appropriate classes; nests were only included if the first egg date could be calculated to within three days.
- 2: Earliest and latest dates are those calculated and are often in less than three day intervals.
- 3: Nests were divided into first and second broods depending if the first egg date was before or after June 16th; this allows for a twelve day incubation period and fifteen day nestling period from May 19th (mean first egg date), and Twite are known to have a short gap between broods (Marler & Mundinger 1975).

**Table 23. Known hatching & fledging dates**

Nest <sup>1</sup>	Hatching Date	Fledging date	Period
M4	1 June	12 June	12 days
W8	3 June	11-14 June	9-12 days

- 1: See Appendix I for nest histories.

These are the only two nests for which the fledging date is known to within four days; in the case of M4 the birds fledged when HM approached the nest and never returned to it, and the chicks were known to have hatched on June 1st.

**Table 24. Causes of loss of nests found at the egg stage, and breeding success 1989-1994**

Of 158 eggs in 30 clutches which were revisited at least once

<b>No. Eggs</b>	<b>No. Clutches</b>	<b>Reason for loss</b>	<b>% of Eggs<sup>1</sup></b>	<b>% of Clutches</b>
5	1	Unknown	3.2	3.3
10	2	Washed out	6.3	6.6
27	5	Predated	17.1	16.7
5	1	Disturbed by sheep	3.2	3.3
9 <sup>2</sup>	8	Failed to hatch	5.7	26.7

Leaving 102 young from 21 clutches, of which:

9	2	Washed out	5.7	6.7
12	2	Predated	7.6	6.7

56 young (35.4%) in 11 broods (36.7%) are known to have fledged.

An additional 17 young (10.8%) in 4 broods (13.3%) are known to have reached ten days old, so almost certainly fledged.

The remaining 8 young (5.1%) in 2 broods (6.7%) were not visited after the young were five days old, giving error around breeding success:

56+17 young fledged, and 8 possibles=  
 73-81 fledglings (46.2-51.3% of eggs)  
 in 15-17 broods= 50-56.7% of clutches

Another 3 nests were found with young, and of these 16 young, all fledged.

- 1: Percentages are of the original 158 eggs in 30 clutches throughout.
- 2: Partial losses.

**Table 25. Nest failure rates compared with those of NRC from the southern Pennines (from Brown et al. 1994)**

Nest failure rates were calculated using the Mayfield method (Mayfield 1961, 1975), and standard errors from Johnston (1979). The daily nest failure rate is calculated by dividing the total period in days for which a set of nests were visited (the "exposure") into the number of nests which failed in that time (partial losses are not considered). Where a nest failed between visits, it is assumed to have survived for half of the period between visits, thus:

Daily nest failure rate (m) = Number failing / Exposure

$$\text{Standard Error} = \sqrt{\frac{(\text{Exposure} - \text{No. failing}) \times \text{No. failing}}{(\text{Exposure})^3}}$$

Stage	Present study			Brown et al. (1994)			z-test <sup>1</sup>
	n	m	SE	n	m	SE	
Egg	25	0.0307	0.0114	335	0.0199	0.0025	NS
Nestling	20	0.0177	0.0088	285	0.0164	0.0025	NS
Egg-Fledge	28	0.0243	0.0072	445	0.0210	0.0018	NS

1. z-test for the difference between two means.

**Table 26. Large scale selection: vegetation types in which nests were situated**

<b>Area &amp; Vegetation</b>	<b>n</b>	<b>% of Nests</b>	<b>ha<sup>1</sup></b>	<b>% of Area<sup>2</sup></b>	<b>Nests/ha<sup>3</sup></b>
<u>Midgley</u>					
Burnt <i>Calluna</i> (0)	2	20	10.65	7.43	0.188
Mature <i>Calluna</i> (3)	8	80	30.39	21.20	0.263
<u>Withens Clough</u>					
Bracken (B)	13	100	94.32	10.01	0.138
<u>Rishworth</u>					
Bracken (B)	23	92	70.53	12.52	0.326
<i>Eriophorum</i> (Er)	1	4	231.52	41.11	0.004
<i>Molinia</i> (M)	1	4	130.36	23.15	0.008

- 1: Hectarage of the appropriate vegetation class in the appropriate study area (see Tables 8-10).
- 2: Percentage which that vegetation class forms of the land available to nesting Twite (see Tables 8-10).
- 3: Number of nests per hectare. Figures give the relative importance of vegetation types within each study area, and cannot be compared between study areas, as observations have been made on the three areas for different lengths of time.

**Table 27. Selection of patch sizes for nest sites (ha)**

<b>Area &amp; Vegetation</b>	<b>Nest Sites<sup>1</sup></b>			<b>Study Area<sup>2</sup></b>			<b>P<sup>3</sup></b>
	<b>n</b>	<b>Mean</b>	<b>SE</b>	<b>n</b>	<b>Mean</b>	<b>SE</b>	
<u>Midgley</u>							
Burnt <i>Calluna</i> (0)	2	0.15	0.00	34	0.31	0.06	NS
Mature <i>Calluna</i> (3)	7	4.23	2.83	34	1.90	0.35	NS
<u>Withens Clough</u>							
Bracken (B)	13	7.22	1.23	66	1.43	0.32	<0.001
<u>Rishworth</u>							
Bracken (B)	18	3.66	0.51	80	0.88	0.18	<0.001

- 1: From Maps 2-4 and 5-7.
- 2: From Tables 8-10.
- 3: One tailed z test for difference between means.

**Table 28. Vegetation in 30m radius around nests**

Study area	n	Nest vegetation <sup>1</sup>	Adjacent vegetation
<u>Midgley</u>	2	Burnt <i>Calluna</i> (0)	70% Mature <i>Calluna</i> (3) 30%
	1	Mature <i>Calluna</i> (3)	80% Young <i>Calluna</i> (1) 20%
	5	Mature <i>Calluna</i> (3)	100%
<u>Withens Clough</u>	1	Bracken (B)	50% Mature <i>Calluna</i> (3) 50%
	1	Bracken (B)	60% Mature <i>Calluna</i> (3) 40%
	1	Bracken (B)	70% <i>Eriophorum</i> (Er) 30%
	7	Bracken (B)	100%
<u>Rishworth</u>	1	<i>Eriophorum</i> (Er)	100%
	1	Bracken (B)	50% <i>Molinia</i> (M) 50%
	1	Bracken (B)	70% <i>Eriophorum</i> (Er) 30%
	1	Bracken (B)	80% <i>Molinia</i> (M) 20%

1: Figures are to the nearest 10%.

**Table 29. Mean height of nests**

Vegetation	n	Mean Height (cm)	SE
Burnt <i>Calluna</i> (0)	2	0.0	0.0
Mature <i>Calluna</i> (3)	5	17.0	3.4
Bracken (B) <sup>1</sup>	14	1.1	1.1

1: Thirteen nests on ground and one 15cm up.

**Table 30. Height of nest vegetation**

Vegetation	n	Nest	Nest 1m <sup>2</sup> <sup>1</sup>		1m <sup>2</sup> to NEWS <sup>2</sup>	
			Mean	SE	Mean	SE
Burnt <i>Calluna</i> (0)	2	M1	15	1.4	18	1.2
		M2	15	1.4	23	1.3
Mature <i>Calluna</i> (3)	5	M4	71	2.6	72	1.4
		M5	69	1.7	69	1.1
		M6	71	3.3	68	2.4
		M8	78	4.8	78	1.6
		M9	76	4.1	82	1.5
Bracken (B)	3	W8	35	---	51 (7)	4.5
		W9	55	---	55 (6)	3.0
		W10	35	---	55 (5)	5.0

1: Mean height (cm) of five tallest spikes of vegetation in 1m<sup>2</sup> centred on nest; in case of nests in bracken, the height of the bracken clump (cm), and number of clumps in brackets.

2: Mean height (cm) of twenty tallest spikes of vegetation, five each from 1m<sup>2</sup> to north, east, west, and south of 1m<sup>2</sup> over nest.

**Table 31. Gradient of nest slopes**

<b>Area</b>	<b>Gradient</b>		
	<b>&lt;30°</b>	<b>30-45°</b>	<b>&gt;45°</b>
Midgley	7	1	0
Withens	9	1	0
Rishworth	6	13	0

Figures are numbers of nests

**Table 32. Altitude of nests**

<b>Area</b>	<b>n</b>	<b>Altitude ( metres asl)</b>			
		<b>Mean (m)</b>	<b>SE</b>	<b>Min</b>	<b>Max</b>
Midgley	6	323	4	310	335
Withens	10	312	6	285	355
Rishworth	15	298	4	280	325
Total	31	307	3	280	355

**Table 33. Aspect of nest in relation of that of the nest slope**

<b>Area</b>	<b>Nest Slope</b>	<b>n</b>	<b>Nest</b>	<b>n</b>
Midgley	E	3	E	1
	ESE	1	SE	1
	S	2	S	1
			E	1
	SSW	1	ENE	1
Withens	N	1	NNW	1
	NNE	2	NNE	1
			ESE	1
	NE	1	ENE	1
	E	1	E	1
	ESE	2	ESE	1
			NNW	1
	NW	1	NW	1
NNW	2	NNW	2	
Rishworth	N	6		
	ENE	1		
	E	1		
	ESE	1	ESE	1
	SE	1		
	S	1	N	1
	WNW	5		
	NW	1		

Grouped:

<b>Area</b>	<b>n</b>	<b>Mean Direction to which SE nests faced</b>	
Midgley	8	135.0° (=SE)	15.4
Withens	10	29.2° (=NNE)	16.5
Rishworth	17	1.3° (=N)	15.4

The direction to which the nest faced was significantly correlated with the aspect of the slope ( $P < 0.001$ ,  $t = 4.36$  at 17 degrees of freedom).

**Table 34. Known feeding sites of pairs**

It was difficult to prove that birds were indeed flying long distances between the nesting and feeding grounds, but the lines given below are certain.

Site	Nest <sup>1</sup>	Fields <sup>2</sup>
Midgley	M4	32 (0.10), 33 (0.10), 36 (0.30), <u>44</u> (0.70), <u>45</u> (0.75)
	M5	44 (0.10), 45 (0.15),
	M8	111 (0.95), 156 (0.95)
	M9	111 (0.75), 156 (0.75)
Withens	W1	Cockhill
	W3	118 (0.85)
	W4	118 (1.15)
	W5	Cockhill
	W6	Cockhill
	W7	Cockhill
	W8	115 (1.10), 118 (1.55)
	W9	23 (1.75), 24 (1.65), <u>26</u> (1.50), <u>27</u> (1.50), 29 (1.75)
	W10	118 (0.95)
	WA	125 (c0.10)
WB	26 (2.15)	
WC	26 (c2.60)	

Mean = 1.13km; SE = 0.139

1: See Maps 2-4 and 5-7.

2: Numbers are field numbers (see Maps 2-4), numbers in brackets are distances (km) from the nest to the nearest 0.05km. Underlined field numbers indicate the main feeding site



## MAPS

Map 1. Location of the study area in West Yorkshire

Maps 2-4. 1:10,000 maps with field numbers and vegetation classes marked.

Map 2. Midgley study area:

- 2A. north Midgley Moor
- 2B. south Midgley

Map 3. Withens Clough study area:

- 3. Key to the 7 maps composing Withens Clough (1:35,000)
- 3A. Stoodley Pike and west Withens Clough
- 3B. Bell House Moor and east Withens Clough
- 3C. Cragg Vale
- 3D. Great Manshead Hill
- 3E. Turvin Clough
- 3F. Turley Holes Moor and north White Holme Moss
- 3G. south White Holme Moss

Map 4. Rishworth study area:

- 4A. north-west Rishworth
- 4B. north-east Rishworth
- 4C. south-east Rishworth
- 4D. south-west Rishworth

Maps 5-7. 1:10,000 maps showing the position of Twite nests.

Map 5. Midgley Moor

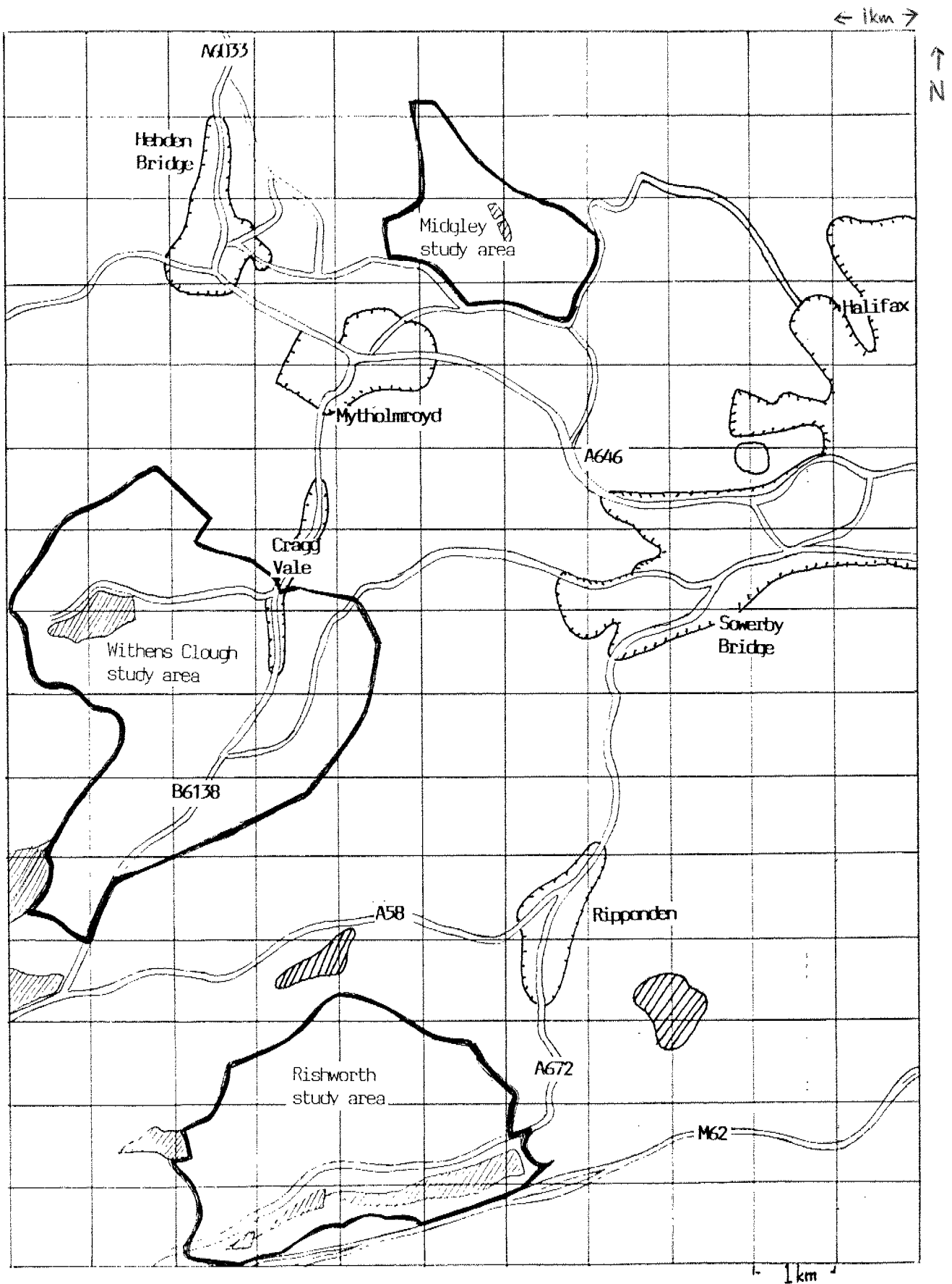
Map 6. Withens Clough:




- 6A. Turvin Clough
- 6B. Withens Clough

Map 7. Rishworth Moor:

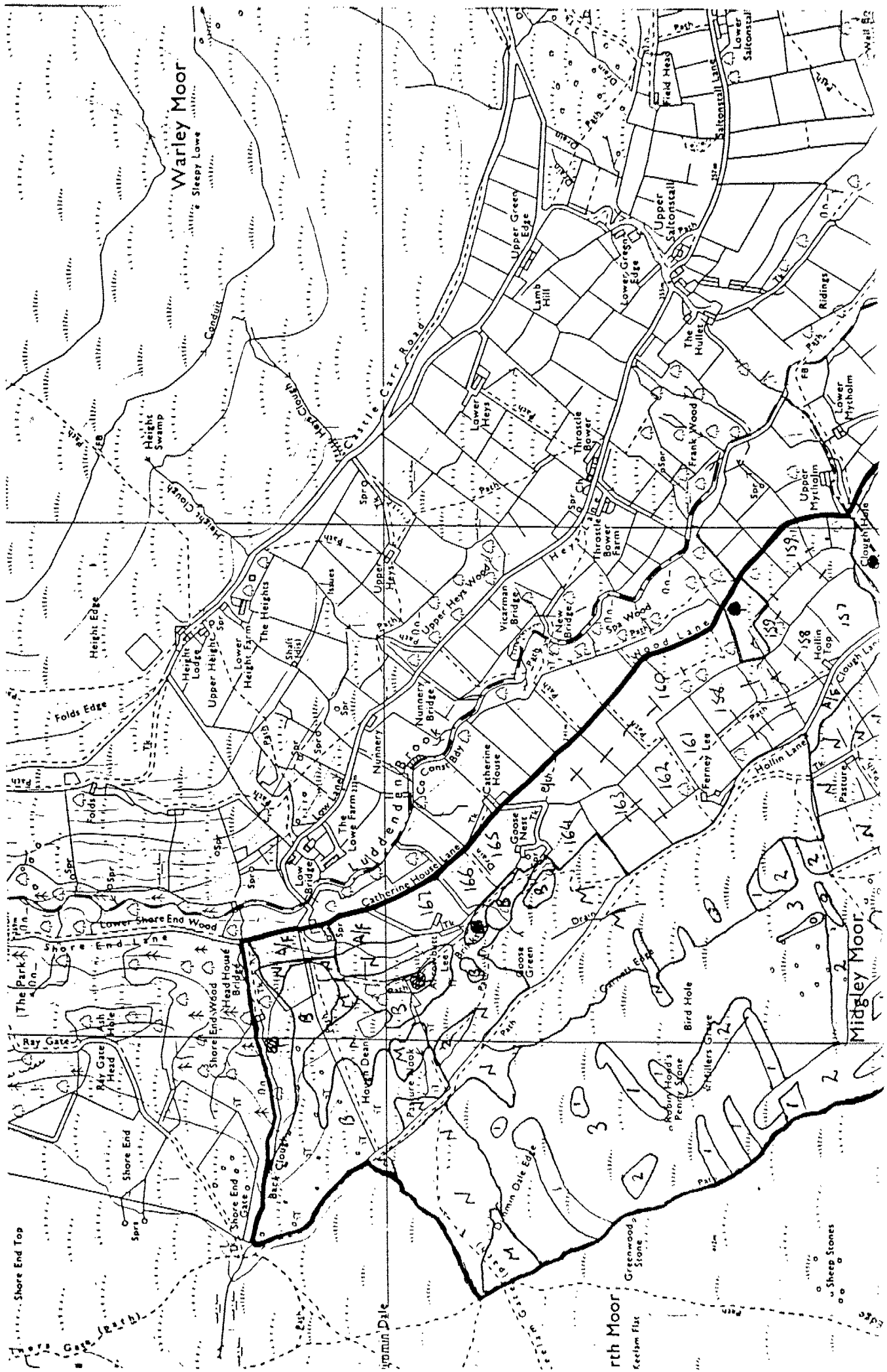
- 7A. south-west Rishworth
- 7B. west Rishworth

Map 1. Location of the study areas in West Yorkshire

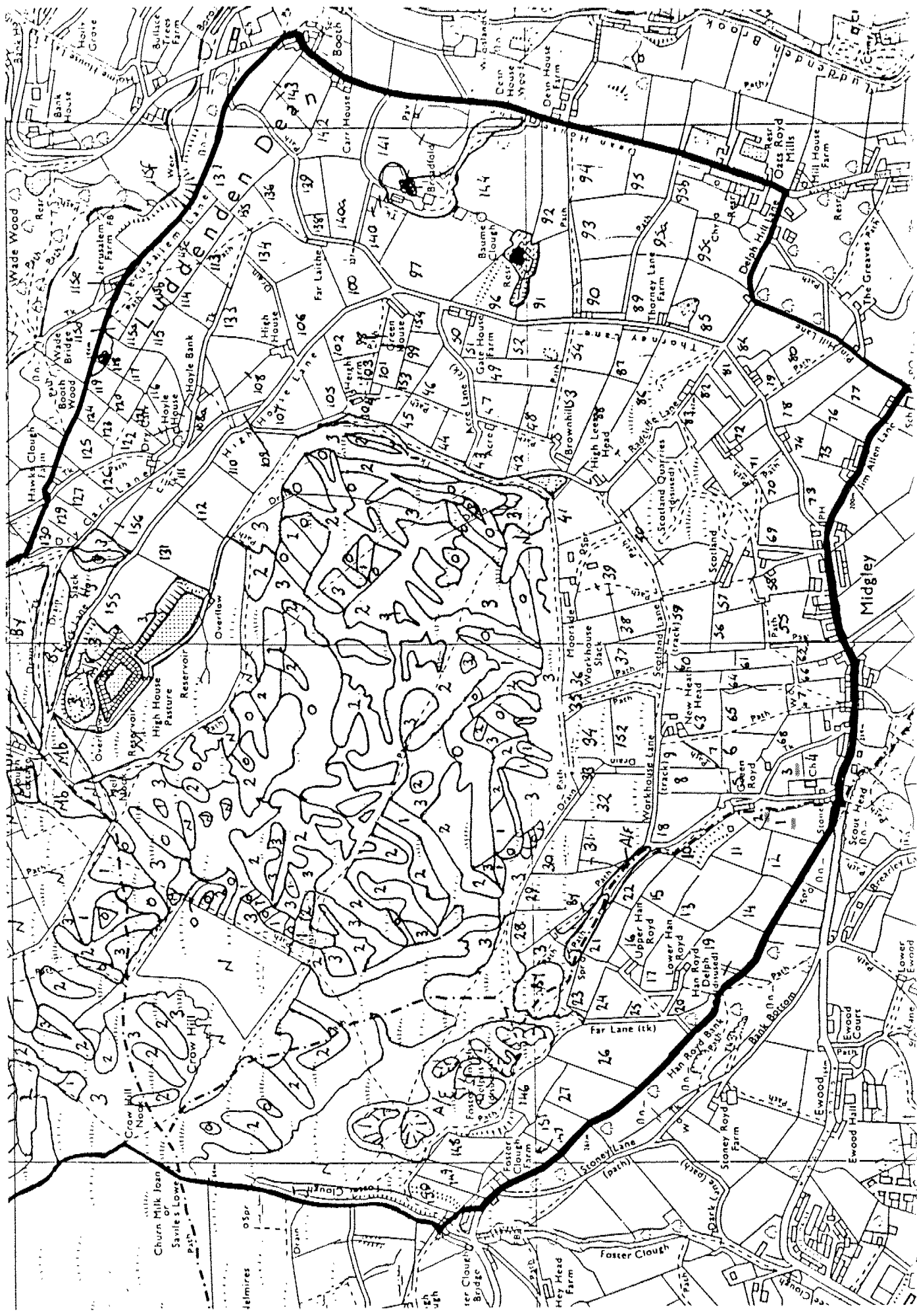


 study area boundary     built up areas     reservoirs

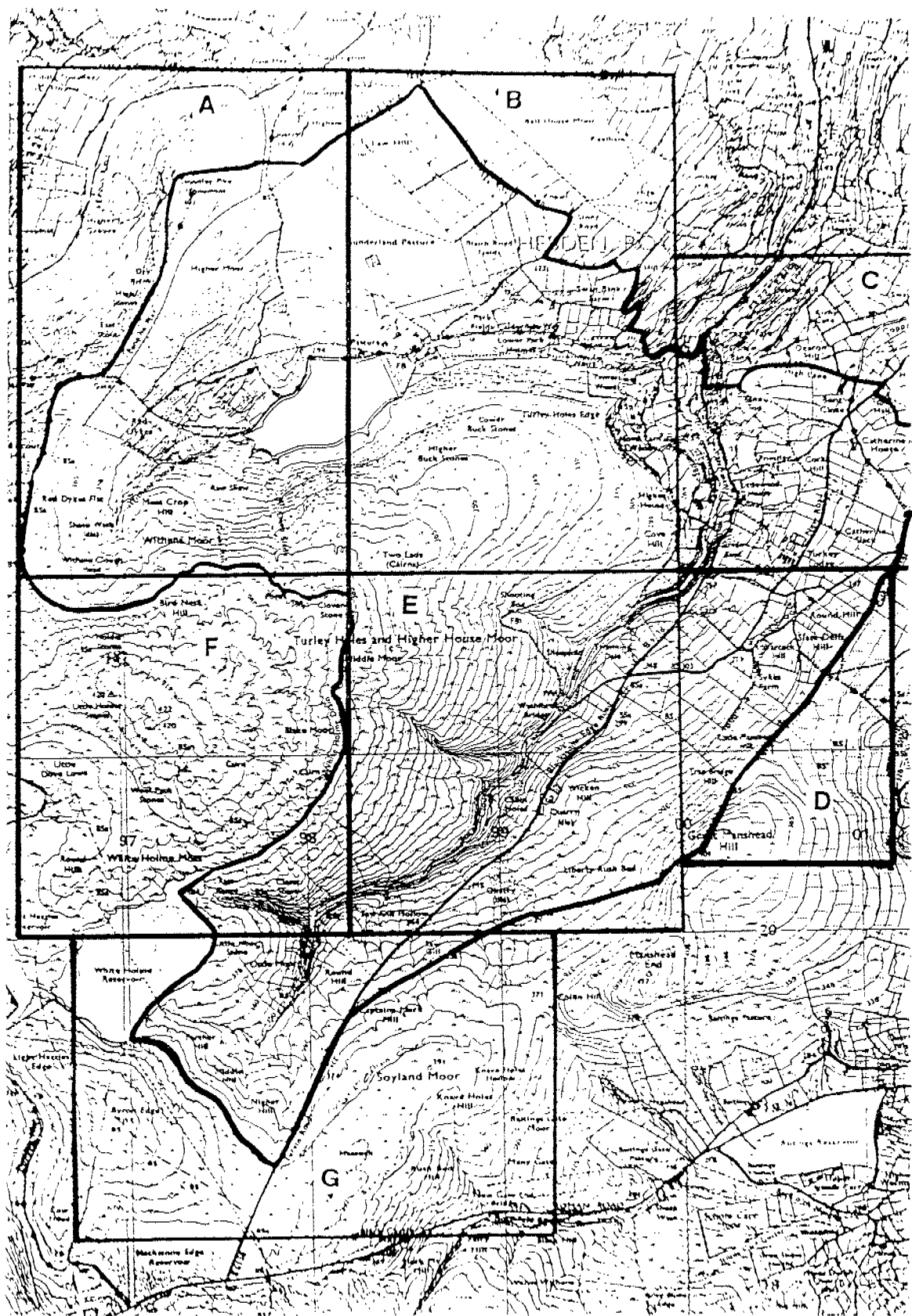
# Map 2A. Midgley Moor (north)



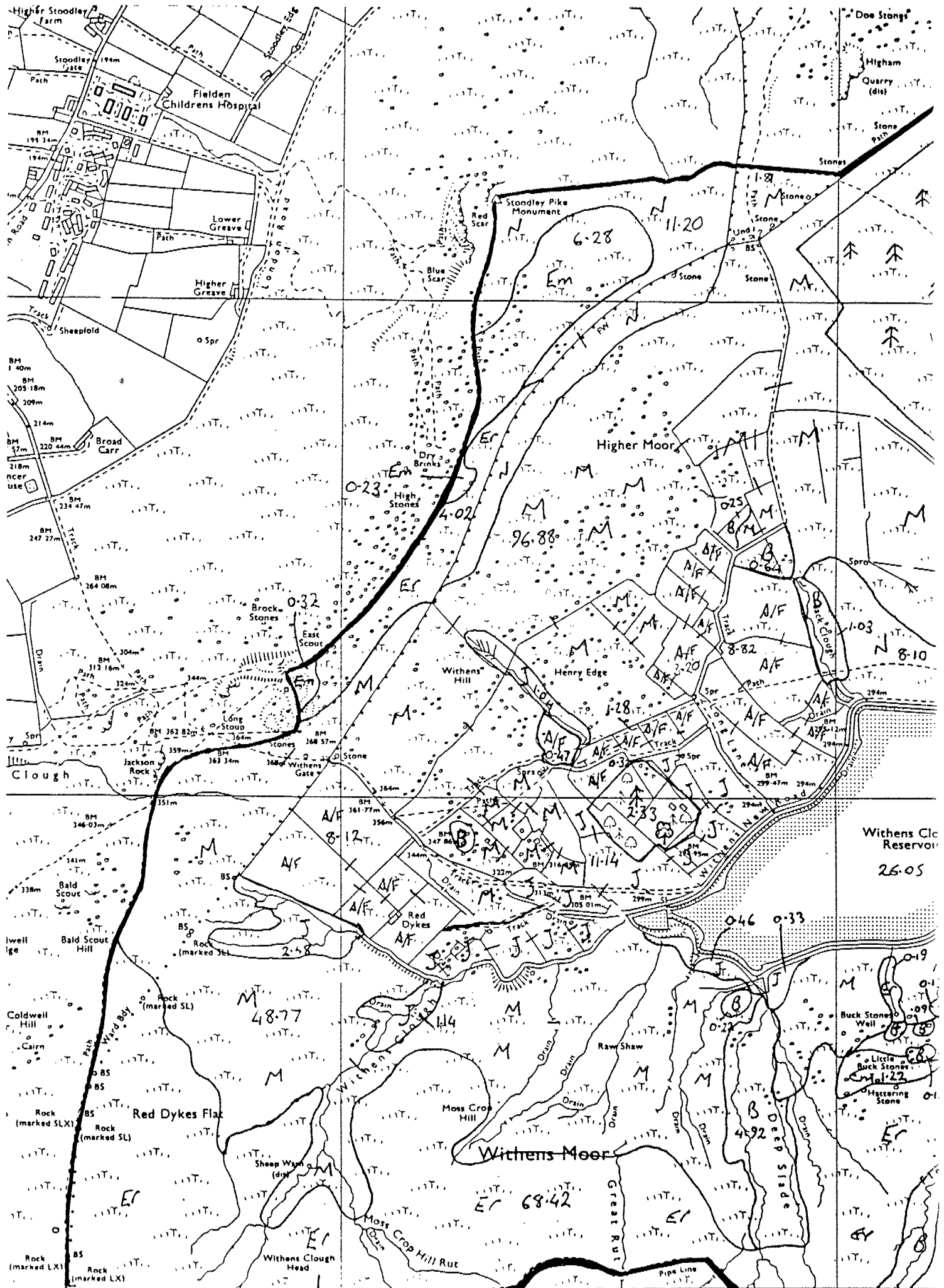
Map 2B. Midgley Moor (south)



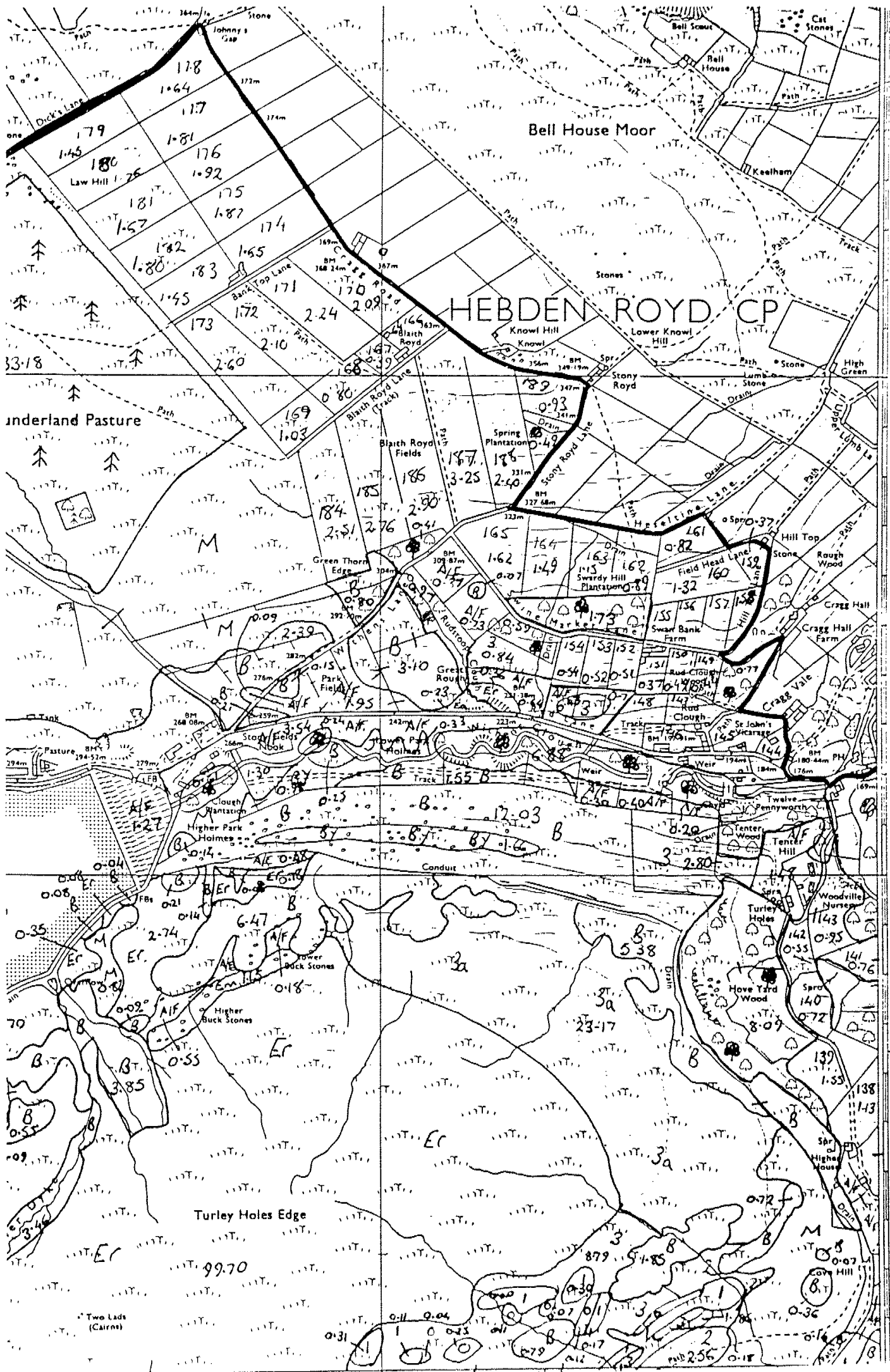
Map 3. Key to the seven maps composing the Withens Clough study area



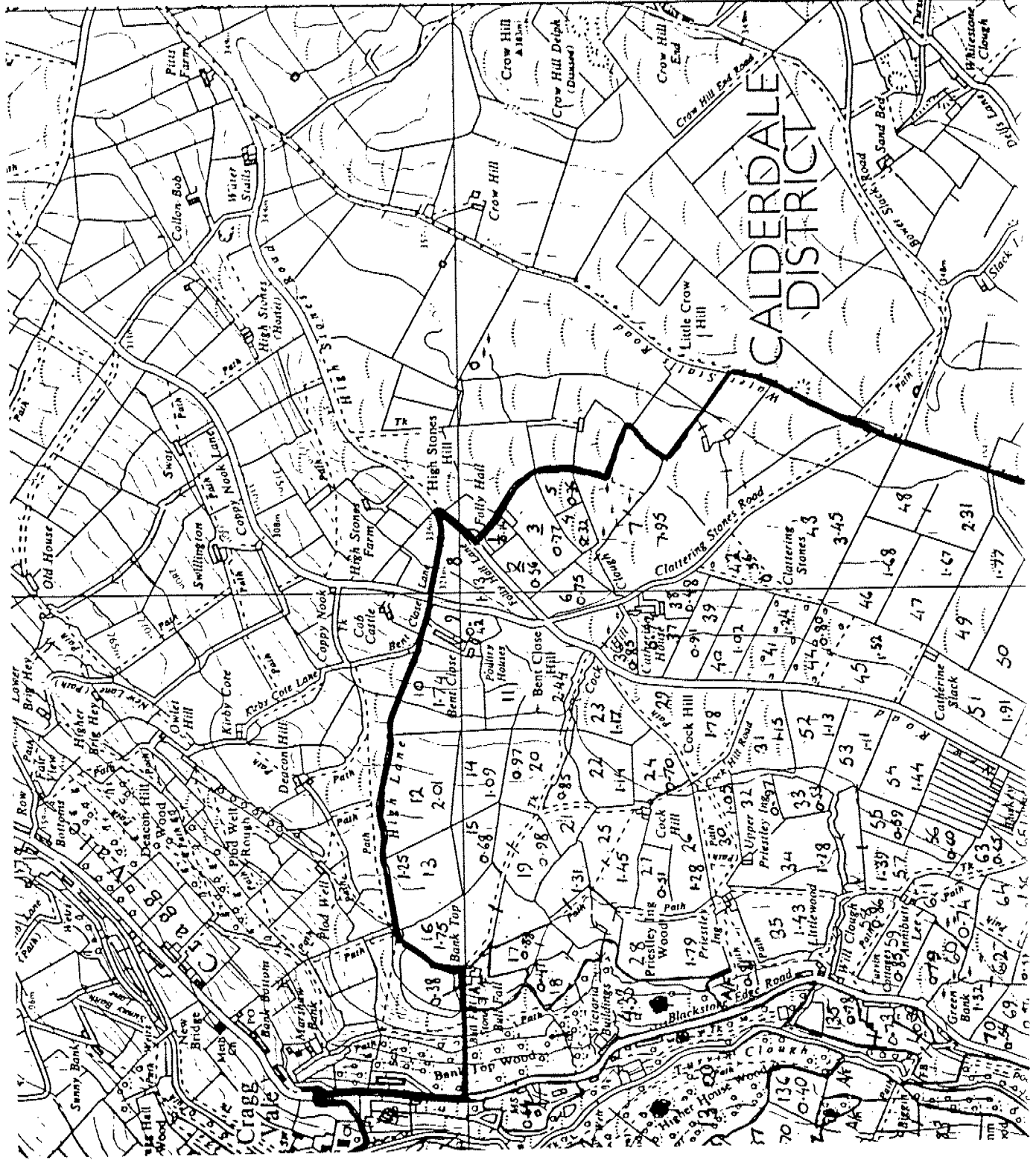
# Map 3A. Withens Clough (Stoodley Pike and west Withens Clough)



Map 3B. Withens Clough (Bellhouse Moor and east Withens Clough)



Map 3C. Withens Clough (Cragg Vale)





# Map 3D. Withens Clough (Great Manshead Hill)

