

**From findspot to site: a spatial examination of the Mesolithic resource in Surrey**

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**Appendix 3 Chi-Squared results****Elevation**

All assumptions were met for the elevation dataset. One category had expected frequencies below 5, but this accounted for less than 1% of the expected frequencies, meaning that the test was still robust (Cochran, 1952; Mitchell, 1971). The critical value of  $\chi^2$  was 12.59 with 5 degrees of freedom at  $\alpha = 0.05$  (table 1). As 73.742 > 12.59 there was a significant difference between the expected and observed distributions and a relationship existed between elevation and Mesolithic record distribution.

Table 1 Chi-Squared statistical test for Mesolithic records and their elevation

Height (m a.s.l)	No of cells	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
0–50	4794608	479.460	28.708	114	153.018	9.949
51–100	7458544	745.854	44.659	213	238.037	2.633
101–150	2585924	258.592	15.483	114	82.528	12.001
151–200	1436236	143.624	8.599	75	45.836	18.555
201–250	380284	38.028	2.277	9	12.136	0.810
251–300	45216	4.522	0.270	8	1.443	29.794
Total	16700812	1670.081	100	533	533	<b>73.742</b>

**Geology**

All assumptions were met for the geology dataset. Although two categories exhibited expected frequencies below 5, this equated to only 1% of the expected frequencies, so the Chi-Squared test was still robust (Cochran, 1952; Mitchell, 1971). The critical value of  $\chi^2$  was 19.68 with 11 degrees of freedom at  $\alpha = 0.05$  (table 2). As 496.00 > 19.68 the null hypothesis (no difference between expected and observed Mesolithic record distribution related to their geologies) could be rejected. This means there was a significant difference between the expected and observed distribution of Mesolithic records in relation to geology.

Table 2 Chi-Squared statistical test for Mesolithic records and their geological setting

Geology	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
Alluvium and peat	93.801	5.617	19	29.936	3.995
Bracklesham	197.911	11.850	23	63.163	25.538
Chalk group	151.471	9.070	33	48.342	4.869
Clay-with-Flints	72.779	4.358	36	23.227	7.024
Head	95.694	5.730	44	30.541	5.932
Lambeth group	13.269	0.795	12	4.235	14.238
London Clay	122.810	7.354	7	39.195	26.445
Lower Greensand	268.489	16.076	231	85.688	246.426
Selborne group	40.139	2.403	5	12.810	4.762
Sand and Gravel	221.813	13.282	69	70.791	0.045
Thanet Sand	4.849	0.290	14	1.547	100.212
Wealden group	387.046	23.175	40	123.525	56.478
Total	1670.072	100	533	533	<b>495.964</b>

### Aspect

The aspect dataset met the assumptions for the Chi-Squared test (table 3). The critical value of  $\chi^2$  was 15.51 with 8 degrees of freedom at  $\alpha = 0.05$ . The Chi-Squared statistic  $10.064 < 15.51$  so there was not a significant difference between the expected and observed distribution of Mesolithic records and therefore the distribution may have been due to chance. Aspect did not seem to be a controlling factor in determining Mesolithic locations in Surrey.

Table 3 Chi-Squared statistical test for Mesolithic records and their aspect category

Aspect category	No of cells	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
Flat	5204905	520.491	31.166	153	166.113	1.035
North	1503234	150.323	9.001	48	47.975	0.000
North-east	1562969	156.297	9.359	47	49.882	0.166
East	1211054	121.105	7.251	37	38.650	0.070
South-east	1580005	158.001	9.461	51	50.425	0.007
South	1282913	128.291	7.682	52	40.944	2.986
South-west	1308857	130.886	7.837	55	41.772	4.189
West	1184051	118.405	7.090	30	37.789	1.605
North-west	1862799	186.280	11.154	60	59.451	0.005
Total	16700787	1670.079	100	533	533	<b>10.064</b>

### Slope

One slope category had an expected frequency below 5; however, this accounted for only 0.25% of the expected frequencies so the test was considered robust. All other Chi-Square assumptions were met. The critical value of  $\chi^2$  was 14.07 with 7 degrees of freedom at  $\alpha = 0.05$ . The Chi-Square value (24.739) was greater than the critical value (14.07) and the null hypothesis was rejected. Therefore, a significant difference existed between expected and observed distribution of Mesolithic records compared to their slope angles.

Table 4 Chi-Squared statistical test between slope angles and Mesolithic records

Slope Angle (°)	No of cells	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
0–1.432	6500245	650.025	38.922	181	207.453	3.373
1.433–4.169	5764373	576.437	34.516	173	183.968	0.654
4.170–6.763	2320660	232.066	13.896	103	74.063	11.306
6.763–9.520	1029075	102.908	6.162	34	32.843	0.041
9.521–13.271	556894	55.689	3.335	15	17.773	0.433
13.271–17.753	328245	32.825	1.965	16	10.476	2.913
17.754–24.261	159385	15.939	0.954	7	5.087	0.720
24.262–63.706	41910	4.191	0.251	4	1.338	5.300
Total	16700787	1670.079	100	533	533	<b>24.739</b>

### Total Wetness Index (TWI)

A Chi-Squared test examined relationships between Mesolithic record locations and TWI (table 5). No assumptions were broken and the critical value of  $\chi^2$  was 7.81 with 3 degrees of freedom at  $\alpha = 0.05$ . A significant difference existed between the expected and observed distribution of Mesolithic records in relation to the Total Wetness Index, and the null hypothesis could be rejected as the Chi-Square statistic  $13.792 > 7.81$ .

Table 5 Chi-Squared statistical test for Mesolithic records and the Total Wetness Index

TWI category	No of cells	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
Very wet	107521	268.803	16.095	62	85.785	6.594
Wet	200702	501.755	30.043	144	160.128	1.624
Wet/dry	320412	801.030	47.962	292	255.637	5.172
Dry	39419	98.548	5.901	35	31.450	0.401
Total	668054	1670.135	100	533	533	<b>13.792</b>

### Distance to Strahler Order 3 and greater rivers

A Chi-Squared test assessed the link between rivers and Mesolithic records (table 6). The Chi-Squared assumptions were met, with only 0.7% of dataset with expected frequencies below 5 (Cochran 1952; Mitchell 1971). The critical value of  $\chi^2$  was 19.68 with 11 degrees of freedom at  $\alpha = 0.05$ . Because  $9.686 < 19.68$  the null hypothesis was accepted and there was no significant difference between expected and observed distribution of Mesolithic records in relation to their distances to >3 Strahler rivers.

Table 6 Chi-Squared test: Mesolithic records and distance to Order >3 Strahler rivers

Distance to >3 Strahler rivers (m)	No of cells	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
0–500	265175311	265.175	15.878	93	84.630	0.828
501–1000	238509002	238.509	14.281	89	76.120	2.180
1001–1500	217205554	217.206	13.006	62	69.321	0.773
1501–2000	200140580	200.141	11.984	62	63.874	0.055
2001–2500	176035442	176.035	10.541	55	56.181	0.025
2501–3000	147129367	147.129	8.810	52	46.956	0.542
3001–3500	130191162	130.191	7.796	32	41.550	2.195
3501–4000	112317051	112.317	6.725	31	35.846	0.655
4001–4500	89362546	89.363	5.351	24	28.520	0.716
4501–5000	55329179	55.329	3.313	17	17.658	0.025
5001–5500	27201954	27.202	1.629	10	8.681	0.200
>5501	11474683	11.475	0.687	6	3.662	1.492
Total	1670071831	1670.072	100	533	533	<b>9.686</b>

### Distance to Lower and Upper Greensand

A Chi-Squared test examined relationships between the distance to the Greensand and Mesolithic records (table 7). The Chi-Squared assumptions were met for the distance to Greensand data. The critical value of  $\chi^2$  was 11.07 with 3 degrees of freedom at  $\alpha = 0.05$ . As the Chi-Square statistic  $216.447 > 11.07$  there was a significant difference between the expected and observed distribution of

Mesolithic records and the null hypothesis was rejected. This showed a significant correlation between the distance to the Greensand and record location.

Table 7 Chi-Squared statistical test for Mesolithic records and the distance to Greensand

Distance to Greensand (m)	No of cells	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
0–1000	5395994	539.599	32.310	329	172.211	142.748
1001–5000	4477023	447.702	26.807	77	142.882	30.378
5001–10000	3355604	335.560	20.092	49	107.093	31.513
1001–15000	1743259	174.326	10.438	46	55.635	1.669
15001–20000	1120940	112.094	6.712	23	35.774	4.561
>21000	607990	60.799	3.640	9	19.404	5.578
Total	16700810	1670.081	100	533	533	<b>216.447</b>

### Distance to Clay-with-Flints

A Chi-Squared model examined links between the Clay-with-Flints outcrops and Mesolithic records to see if significant relationships existed (table 8). All assumptions of the test were met with the distance to Clay-with-Flints dataset. The critical value of  $\chi^2$  was 11.07 with 3 degrees of freedom at  $\alpha = 0.05$ . The Chi-Square statistic of 78.712 > 11.07 meant that there was a significant difference between the expected and observed distribution of Mesolithic records in relation to their distance to Clay-with-Flints outcrops.

Table 8 Chi-Squared test for Mesolithic records and the distance to Clay-with-Flints

Distance to Clay-with-Flints (m)	No of cells	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
0–1000	195599694	195.600	11.712	72	62.425	1.469
1001–5000	383808402	383.808	22.982	203	122.492	52.915
5001–10000	517525826	517.526	30.988	128	165.167	8.364
10001–15000	403295671	403.296	24.148	96	128.711	8.313
15001–20000	134695995	134.696	8.065	28	42.988	5.226
20001–25000	35145915	35.146	2.104	6	11.217	2.426
Total	1670071503	1670.072	100	533	533	<b>78.712</b>

### Land cover

Owing to the fragmented nature of land cover types in Surrey it was difficult to discern any pattern from the map of land cover type. The Chi-Squared test was therefore useful to examine these relationships (table 9). The land cover type dataset met the assumptions for the Chi-Squared test. The category 'inland rock' had expected frequencies below 5, but only accounted for 0.25% of the overall dataset, meaning that the test was still robust as it was less than 20% (Cochran 1952; Mitchell 1971). The critical value of  $\chi^2$  was 12.59 with 11 degrees of freedom at  $\alpha = 0.05$ . As 27.01284 > 12.59 the null hypothesis was rejected and so there was a significant difference between the expected and observed distribution of Mesolithic records. Therefore, land cover was influential in determining record discovery location.

Table 9 Chi-Squared statistical test for Mesolithic records and their land cover type

Land cover type	Area (km <sup>2</sup> )	Area	Observed no of records	Expected no of records	Chi-Square statistic
Grassland	610.142	36.533	146	194.723	12.191
Arable and horticulture	264.193	15.819	95	84.316	1.354
Freshwater	22.561	1.351	5	7.200	0.672
Inland rock	4.047	0.242	4	1.291	5.681
Woodland	427.018	25.569	148	136.280	1.008
Built-up	302.189	18.094	119	96.442	5.276
Dwarf shrub heath	39.942	2.392	16	12.747	0.830
Total	1670.092	100	533	533	<b>27.013</b>

### Distance to roads, paths and tracks (RPT)

It is important to find out if any significant relationships existed between the network and Mesolithic records (table 10). The Chi-Square assumptions were met for the roads, paths and tracks dataset. The critical value of  $\chi^2$  was 7.81 with 3 degrees of freedom at  $\alpha = 0.05$ . As  $7.164 < 7.81$  so there was not a significant difference between the expected and observed distribution of Mesolithic records and the null hypothesis was accepted. Therefore, there was no significant relationship between records and their relationship with the road, path and track. There also appeared to be no relationship between the type of record and the distance from the path, with records identified at all distance scales.

Table 10 Chi-Squared test of record location and the distance to roads, paths and tracks

Distance to RPT (m)	No of cells	Area (km <sup>2</sup> )	Area (%)	Observed no of records	Expected no of records	Chi-Square statistic
On path (0)	58151359	58.151	3.482	21	18.559	0.321
In verge (0.1–2.5)	46166349	46.166	2.764	17	14.734	0.349
In sight (2.6–10)	149644457	149.644	8.960	64	47.759	5.523
Unrelated (>10)	1416109409	1416.109	84.793	431	451.948	0.971
Total	1670071574	1670.072	100	533	533	<b>7.164</b>