THE MESOLITHIC LANDSCAPE OF THE SOUTHERN NORTH SEA

By

SIMON FITCH

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2nd of 3 files

Appendices 1-3

The main thesis is in an additional file

Appendix 4 is in a separate zip folder

APPENDIX 1

MODEL RESULT TABLES AND
CATCHMENT ANALYSIS RESULT TABLES

(Note: Study area and individual catchment table data is available in Appendix 4. Due to the tables size this is provided as a digital appendix on CD.)

8.1 Model resource tables: Boreal

Resource	Av. Weight (Kg	Group Size	Mobility	ensity per Km(sq) (Lan	ensity per Km Coastlir	W*D	W*GS	W*GS/M	W*D/M	SUM	Fract W*D/M	FractW*GS/M	Average	Search Time	Persuit Time	alorific Value (Kcal/K	% Edible	alorific Value of 1 Individ	KC*KM
Beaver	20	5	1	1.3		26	100	100	26	126	0.20634921	0.79365079	0.603175	0.0384615	0.01	4000	0.7	56000	72800
Boar	135	13.5	1.4	6		810	1822.5	1301.786	578.5714	1880.357	0.30769231	0.69230769	0.653846	0.0017284	0.0007682	4000	0.7	378000	2268000
Comman Seal	93.75	3	1.7	N/A	5.17	484.688	281.25	165.4412	285.1103	450.5515	0.63280294	0.36719706	0.816401	0.0035074	0.0060444	4283	0.7	281071.875	1453142
Fish FluvioLacustrine	1.2	3	0.05	98		117.6	3.6	72	2352	2424	0.97029703	0.02970297	0.985149	0.0004252	0.0138889	1300	0.5	780	76440
Fish Marine	1.9	3	0.05		60	114	5.7	114	2280	2394	0.95238095	0.04761905	0.97619	0.0004386	0.0087719	1400	0.5	1330	79800
Grey Seal	185	4	1.6	N/A	16.7	3089.5	740	462.5	1930.938	2393.438	0.80676329	0.19323671	0.903382	0.0005179	0.0021622	4283	0.7	554648.5	9262630
Red Deer	217	13	1.5	6		1302	2821	1880.667	868	2748.667	0.31578947	0.68421053	0.657895	0.0011521	0.0005317	2000	0.5	217000	1302000
Roe Deer	34	2.5	1.2	18		612	85	70.83333	510	580.8333	0.87804878	0.12195122	0.939024	0.0019608	0.0141176	2000	0.5	34000	612000
Small Game	3.6	2	0.2	103		370.8	7.2	36	1854	1890	0.98095238	0.01904762	0.990476	0.0005394	0.0277778	1800	0.6	3888	400464
hale (Large) (Strande	1266.67	3.5	0.02	N/A	0.000765	0.969	4433.3	221667.3	48.45013	221715.7	0.00021852	0.99978148	0.500109	0.0206398	4.511E-06	N/A	N/A	N/A	#VALUE!
hale (Small) (Strande	173.2	4	0.02	N/A	0.013322	2.30737	692.8	34640	115.3685	34755.37	0.00331944	0.99668056	0.50166	0.0086679	2.887E-05	N/A	N/A	N/A	#VALUE!

Yearly Mobility

Species	Mobility (A	J	F	M	A	M	J	J	A	S	O	N	D	
Beaver	1	0.2	0.2	0.2	0.2	1	1.8	1.8	1.8	1.8	1.8	1	0.2	
Boar	1.4	1	1	1	1.4	1.5	1.6	1.6	1.6	1.8	1.8	1.2	1.2	
Comman S	1.7	2	2	2	2	1	0.7	1	2	2	2	2	2	
Fish Fluvic	0.05	0.08	0.07	0.06	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.06	0.07	
Fish Marin	0.05	0.06	0.06	0.05	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.06	0.06	
Grey Seal	1.6	2	2	2	2	2	2	1.5	1	0.5	1	1.5	1.5	
Red Deer	1.5	1	1	1	1.5	1.7	2	2	2	1.3	1.3	1.7	1.5	
Roe Deer	1.2	1	1	1	1.2	1.2	1.4	1.4	1.2	1.2	1.3	1.2	1.1	
Small Gan	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
Whale (La	0.02	0.01	0.015	0.01	0.015	0.02	0.025	0.025	0.025	0.02	0.02	0.02	0.015	
Whale (Sn	0.02	0.015	0.02	0.02	0.02	0.02	0.02	0.015	0.02	0.02	0.02	0.02	0.02	

W*D/M Rating

Species	Mobility	J	F	M	A	M	J	J	A	S	O	N	D	
Beaver	1	130	130	130	130	26	14.44444	14.44444	14.44444	14.44444	14.44444	26	130	
Boar	1.4	810	810	810	578.5714	540	506.25	506.25	506.25	450	450	675	675	
Comman S	1.7	242.3438	242.3438	242.3438	242.3438	484.6875	692.4107	484.6875	242.3438	242.3438	242.3438	242.3438	242.3438	
Fish Fluvic	0.05	1470	1680	1960	3920	3920	2940	2940	2940	3920	3920	1960	1680	
Fish Marin	0.05	1900	1900	2280	2850	2850	2850	2850	2850	2280	2280	1900	1900	
Grey Seal	1.6	1544.75	1544.75	1544.75	1544.75	1544.75	1544.75	2059.667	3089.5	6179	3089.5	2059.667	2059.667	
Red Deer	1.5	1302	1302	1302	868	765.8824	651	651	651	1001.538	1001.538	765.8824	868	
Roe Deer	1.2	612	612	612	510	510	437.1429	437.1429	510	510	470.7692	510	556.3636	
Small Gan	0.2	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	
SUM Total		9865.094	10075.09	10735.09	12497.67	12495.32	11490	11797.19	12657.54	16451.33	13322.6	9992.893	9965.374	

W*GS/M Rating

Species	Mobility	J	F	M	A	M	J	J	A	S	O	N	D	
Beaver	1	500	500	500	500	100	55.55556	55.55556	55.55556	55.55556	55.55556	100	500	
Boar	1.4	1822.5	1822.5	1822.5	1301.786	1215	1139.063	1139.063	1139.063	1012.5	1012.5	1518.75	1518.75	
Comman S	1.7	140.625	140.625	140.625	140.625	281.25	401.7857	281.25	140.625	140.625	140.625	140.625	140.625	
Fish Fluvic	0.05	45	51.42857	60	120	120	90	90	90	120	120	60	51.42857	
Fish Marin	0.05	95	95	114	142.5	142.5	142.5	142.5	142.5	114	114	95	95	
Grey Seal	1.6	370	370	370	370	370	370	493.3333	740	1480	740	493.3333	493.3333	
Red Deer	1.5	2821	2821	2821	1880.667	1659.412	1410.5	1410.5	1410.5	2170	2170	1659.412	1880.667	
Roe Deer	1.2	85	85	85	70.83333	70.83333	60.71429	60.71429	70.83333	70.83333	65.38462	70.83333	77.27273	
Small Gan	0.2	36	36	36	36	36	36	36	36	36	36	36	36	
SUM Total		5915.125	5921.554	5949.125	4562.411	3994.995	3706.118	3708.916	3825.076	5199.514	4454.065	4173.953	4793.076	

%W*D/M Rating

Species	Mobility	J	F	M	A	M	J	J	A	S	O	N	D	
Beaver	1	0.013178	0.012903	0.01211	0.010402	0.002081	0.001257	0.001224	0.001141	0.000878	0.001084	0.002602	0.013045	
Boar	1.4	0.082108	0.080396	0.075453	0.046294	0.043216	0.04406	0.042913	0.039996	0.027353	0.033777	0.067548	0.067735	
Comman S	1.7	0.024566	0.024054	0.022575	0.019391	0.03879	0.060262	0.041085	0.019146	0.014731	0.01819	0.024252	0.024319	
Fish Fluvic	0.05	0.14901	0.166748	0.182579	0.313659	0.313717	0.255875	0.249212	0.232273	0.238279	0.294237	0.196139	0.168584	
Fish Marin	0.05	0.192598	0.188584	0.212388	0.228043	0.228085	0.248042	0.241583	0.225162	0.138591	0.171138	0.190135	0.19066	
Grey Seal	1.6	0.156587	0.153324	0.143897	0.123603	0.123626	0.134443	0.17459	0.244084	0.375593	0.231899	0.206113	0.206682	
Red Deer	1.5	0.13198	0.12923	0.121284	0.069453	0.061294	0.056658	0.055183	0.051432	0.060879	0.075176	0.076643	0.087102	
Roe Deer	1.2	0.062037	0.060744	0.057009	0.040808	0.040815	0.038046	0.037055	0.040292	0.031001	0.035336	0.051036	0.05583	
Small Gan	0.2	0.187935	0.184018	0.172705	0.148348	0.148376	0.161358	0.157156	0.146474	0.112696	0.139162	0.185532	0.186044	

% W*GS/M Rating

Species	Mobility	J	F	M	A	M	J	J	A	S	O	N	D
Beaver	1	0.084529	0.084437	0.084046	0.109591	0.025031	0.01499	0.014979	0.014524	0.010685	0.012473	0.023958	0.104317
Boar	1.4	0.308108	0.307774	0.306348	0.285328	0.304131	0.307347	0.307115	0.297788	0.19473	0.22732	0.363864	0.316863
Comman S	1.7	0.023774	0.023748	0.023638	0.030823	0.070401	0.108411	0.075831	0.036764	0.027046	0.031572	0.033691	0.029339
Fish Fluvic	0.05	0.007608	0.008685	0.010086	0.026302	0.030038	0.024284	0.024266	0.023529	0.023079	0.026942	0.014375	0.01073
Fish Marin	0.05	0.016061	0.016043	0.019162	0.031233	0.03567	0.03845	0.038421	0.037254	0.021925	0.025595	0.02276	0.01982
Grey Seal	1.6	0.062552	0.062484	0.062194	0.081097	0.092616	0.099835	0.133013	0.19346	0.284642	0.16614	0.118193	0.102926
Red Deer	1.5	0.476913	0.476395	0.474187	0.412209	0.415373	0.380587	0.3803	0.368751	0.417347	0.487195	0.397564	0.392372
Roe Deer	1.2	0.01437	0.014354	0.014288	0.015525	0.017731	0.016382	0.01637	0.018518	0.013623	0.01468	0.01697	0.016122
Small Gan	0.2	0.006086	0.006079	0.006051	0.007891	0.009011	0.009714	0.009706	0.009412	0.006924	0.008083	0.008625	0.007511

Species	J	F	M	A	M	J	J	A	S	O	N	D
Beaver	0.048853	0.04867	0.048078	0.059997	0.013556	0.008124	0.008102	0.007833	0.005781	0.006779	0.01328	0.058681
Boar	0.195108	0.194085	0.190901	0.165811	0.173673	0.175703	0.175014	0.168892	0.111042	0.130549	0.215706	0.192299
Comman S	0.02417	0.023901	0.023106	0.025107	0.054595	0.084337	0.058458	0.027955	0.020888	0.024881	0.028971	0.026829
Fish Fluvic	0.078309	0.087716	0.096332	0.16998	0.171878	0.140079	0.136739	0.127901	0.130679	0.160589	0.105257	0.089657
Fish Marin	0.104329	0.102313	0.115775	0.129638	0.131878	0.143246	0.140002	0.131208	0.080258	0.098366	0.106448	0.10524
Grey Seal	0.109569	0.107904	0.103046	0.10235	0.108121	0.117139	0.153801	0.218772	0.330117	0.19902	0.162153	0.154804
Red Deer	0.304447	0.302812	0.297736	0.240831	0.238333	0.218622	0.217741	0.210091	0.239113	0.281186	0.237103	0.239737
Roe Deer	0.038203	0.037549	0.035649	0.028167	0.029273	0.027214	0.026712	0.029405	0.022312	0.025008	0.034003	0.035976
Small Gan	0.097011	0.095049	0.089378	0.078119	0.078693	0.085536	0.083431	0.077943	0.05981	0.073622	0.097078	0.096778
	1	1	1	1	1	1	1	1	1	1	1	1

Species	Winter	Spring	Summer	Autumn
Beaver	0.052068	0.040544	0.008019	0.008613
Boar	0.193831	0.176795	0.173203	0.152432
Comman S	0.024967	0.034269	0.056917	0.024914
Fish Fluvic	0.085227	0.146063	0.134906	0.132175
Fish Marin	0.103961	0.125764	0.138152	0.095024
Grey Seal	0.124092	0.104506	0.163237	0.23043
Red Deer	0.282332	0.258967	0.215485	0.252467
Roe Deer	0.037243	0.031029	0.027777	0.027108
Small Gan	0.096279	0.082064	0.082303	0.076837
	1	1	1	1

8.2 Model resource tables: Atlantic

Resource	Av. Weight (Kg)	Group Size	Mobility	Density per Km(sq) (Land)	Density per Km Coastline	W*D	W*GS	W*GS/M	W*D/M	SUM	Fract W*D/M	FractW*GS/M	Average	Search Time	Persuit Time	Calorific Value (Kcal/Kg)	% Edible	Calorific Value of 1 Individual	KC*KM
Beaver	20	5	1	1.3		26	100	100	26	126	0.206349206	0.793650794	0.603175	0.038461538	0.01	4000	**0.7**	56000	72800
Boar	135	13.5	1.4	12		1620	1822.5	1301.786	1157.1429	2458.9286	0.470588235	0.529411765	0.735294	0.000864198	0.000768176	4000	**0.7**	378000	4536000
Comman Seal	93.75	3	1.7	N/A	5.17	484.6875	281.25	165.4412	285.11029	450.55147	0.632802938	0.367197062	0.816401	0.003507415	0.006044444	4283	**0.7**	281071.875	1453142
Fish FluvioLacustrine	1.2	3	0.05	98		117.6	3.6	72	2352	2424	0.97029703	0.02970297	0.985149	0.00042517	0.013888889	1300	**0.5**	780	76440
Fish Marine	1.9	3	0.05		60	114	5.7	114	2280	2394	0.952380952	0.047619048	0.97619	0.000438596	0.00877193	1400	**0.5**	1330	79800
Grey Seal	185	4	1.6	N/A	16.7	3089.5	740	462.5	1930.9375	2393.4375	0.806763285	0.193236715	0.903382	0.000517883	0.002162162	4283	**0.7**	554648.5	9262630
Red Deer	217	13	1.5	4		868	2821	1880.667	578.66667	2459.3333	0.235294118	0.764705882	0.617647	0.001728111	0.000531726	2000	**0.5**	217000	868000
Roe Deer	34	2.5	1.2	12		408	85	70.83333	340	410.83333	0.827586207	0.172413793	0.913793	0.002941176	0.014117647	2000	**0.5**	34000	408000
Small Game	3.6	2	0.2	103		370.8	7.2	36	1854	1890	0.980952381	0.019047619	0.990476	0.000539374	0.027777778	1800	**0.6**	3888	400464
Whale (Large) (Stranded)	1266.67	3.5	0.02	N/A	0.000765	0.969003	4433.345	221667.3	48.450128	221715.7	0.000218524	0.999781476	0.500109	0.020639781	4.51127E-06	N/A	**N/A**	N/A	#VALUE!
Whale (Small) (Stranded)	173.2	4	0.02	N/A	0.013322	2.30737	692.8	34640	115.36852	34755.369	0.003319445	0.996680555	0.50166	0.008667876	2.88684E-05	N/A	**N/A**	N/A	#VALUE!

Yearly Mobility

Species	Mobility (A	J	F	M	A	M	J	J	A	S	O	N	D
Beaver	1	0.2	0.2	0.2	0.2	1	1.8	1.8	1.8	1.8	1.8	1	0.2
Boar	1.4	1	1	1	1.4	1.5	1.6	1.6	1.6	1.8	1.8	1.2	1.2
Comman S	1.7	2	2	2	2	1	0.7	1	2	2	2	2	2
Fish Fluvic	0.05	0.08	0.07	0.06	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.06	0.07
Fish Marin	0.05	0.06	0.06	0.05	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.06	0.06
Grey Seal	1.6	2	2	2	2	2	2	1.5	1	0.5	1	1.5	1.5
Red Deer	1.5	1	1	1	1.5	1.7	2	2	2	1.3	1.3	1.7	1.5
Roe Deer	1.2	1	1	1	1.2	1.2	1.4	1.4	1.2	1.2	1.3	1.2	1.1
Small Gam	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Whale (La	0.02	0.01	0.015	0.01	0.015	0.02	0.025	0.025	0.025	0.02	0.02	0.02	0.015
Whale (Sm	0.02	0.015	0.02	0.02	0.02	0.02	0.02	0.015	0.02	0.02	0.02	0.02	0.02

W*D/M Rating

Species	Mobility	J	F	M	A	M	J	J	A	S	O	N	D
Beaver	1	130	130	130	130	26	14.44444	14.44444	14.44444	14.44444	14.44444	26	130
Boar	1.4	1620	1620	1620	1157.143	1080	1012.5	1012.5	1012.5	900	900	1350	1350
Comman S	1.7	242.3438	242.3438	242.3438	242.3438	484.6875	692.4107	484.6875	242.3438	242.3438	242.3438	242.3438	242.3438
Fish Fluvic	0.05	1470	1680	1960	3920	3920	2940	2940	2940	3920	3920	1960	1680
Fish Marin	0.05	1900	1900	2280	2850	2850	2850	2850	2850	2280	2280	1900	1900
Grey Seal	1.6	1544.75	1544.75	1544.75	1544.75	1544.75	1544.75	2059.667	3089.5	6179	3089.5	2059.667	2059.667
Red Deer	1.5	868	868	868	578.6667	510.5882	434	434	434	667.6923	667.6923	510.5882	578.6667
Roe Deer	1.2	408	408	408	340	340	291.4286	291.4286	340	340	313.8462	340	370.9091
Small Gam	0.2	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854
SUM Total		10037.09	10247.09	10907.09	12616.9	12610.03	11633.53	11940.73	12776.79	16397.48	13281.83	10242.6	10165.59

W*GS/M Rating

Species	Mobility	J	F	M	A	M	J	J	A	S	O	N	D
Beaver	1	500	500	500	500	100	55.55556	55.55556	55.55556	55.55556	55.55556	100	500
Boar	1.4	1822.5	1822.5	1822.5	1301.786	1215	1139.063	1139.063	1139.063	1012.5	1012.5	1518.75	1518.75
Comman S	1.7	140.625	140.625	140.625	140.625	281.25	401.7857	281.25	140.625	140.625	140.625	140.625	140.625
Fish Fluvic	0.05	45	51.42857	60	120	120	90	90	90	120	120	60	51.42857
Fish Marin	0.05	95	95	114	142.5	142.5	142.5	142.5	142.5	114	114	95	95
Grey Seal	1.6	370	370	370	370	370	370	493.3333	740	1480	740	493.3333	493.3333
Red Deer	1.5	2821	2821	2821	1880.667	1659.412	1410.5	1410.5	1410.5	2170	2170	1659.412	1880.667
Roe Deer	1.2	85	85	85	70.83333	70.83333	60.71429	60.71429	70.83333	70.83333	65.38462	70.83333	77.27273
Small Gam	0.2	36	36	36	36	36	36	36	36	36	36	36	36
SUM Total		5915.125	5921.554	5949.125	4562.411	3994.995	3706.118	3708.916	3825.076	5199.514	4454.065	4173.953	4793.076

%W*D/M Rating

Species	Mobility	J	F	M	A	M	J	J	A	S	O	N	D
Beaver	1	0.012952	0.012687	0.011919	0.010304	0.002062	0.001242	0.00121	0.001131	0.000881	0.001088	0.002538	0.012788
Boar	1.4	0.161401	0.158094	0.148527	0.091714	0.085646	0.087033	0.084794	0.079245	0.054886	0.067762	0.131802	0.132801
Comman S	1.7	0.024145	0.02365	0.022219	0.019208	0.038437	0.059519	0.040591	0.018968	0.014779	0.018246	0.02366	0.02384
Fish Fluvic	0.05	0.146457	0.163949	0.1797	0.310694	0.310864	0.252718	0.246216	0.230105	0.239061	0.29514	0.191358	0.165263
Fish Marin	0.05	0.189298	0.185418	0.209038	0.225887	0.226011	0.244981	0.238679	0.223061	0.139046	0.171663	0.1855	0.186905
Grey Seal	1.6	0.153904	0.15075	0.141628	0.122435	0.122502	0.132784	0.172491	0.241806	0.376826	0.232611	0.201088	0.202612
Red Deer	1.5	0.086479	0.084707	0.079581	0.045864	0.040491	0.037306	0.036346	0.033968	0.040719	0.050271	0.049849	0.056924
Roe Deer	1.2	0.040649	0.039816	0.037407	0.026948	0.026963	0.025051	0.024406	0.026611	0.020735	0.02363	0.033195	0.036487
Small Gam	0.2	0.184715	0.180929	0.169981	0.146946	0.147026	0.159367	0.155267	0.145107	0.113066	0.139589	0.181009	0.18238

%W*GS/M Rating

Species	Mobility	J	F	M	A	M	J	J	A	S	O	N	D
Beaver	1	0.084529	0.084437	0.084046	0.109591	0.025031	0.01499	0.014979	0.014524	0.010685	0.012473	0.023958	0.104317
Boar	1.4	0.308108	0.307774	0.306348	0.285328	0.304131	0.307347	0.307115	0.297788	0.19473	0.22732	0.363864	0.316863
Comman S	1.7	0.023774	0.023748	0.023638	0.030823	0.070401	0.108411	0.075831	0.036764	0.027046	0.031572	0.033691	0.029339
Fish Fluvic	0.05	0.007608	0.008685	0.010086	0.026302	0.030038	0.024284	0.024266	0.023529	0.023079	0.026942	0.014375	0.01073
Fish Marin-	0.05	0.016061	0.016043	0.019162	0.031233	0.03567	0.03845	0.038421	0.037254	0.021925	0.025595	0.02276	0.01982
Grey Seal	1.6	0.062552	0.062484	0.062194	0.081097	0.092616	0.099835	0.133013	0.19346	0.284642	0.16614	0.118193	0.102926
Red Deer	1.5	0.476913	0.476395	0.474187	0.412209	0.415373	0.380587	0.3803	0.368751	0.417347	0.487195	0.397564	0.392372
Roe Deer	1.2	0.01437	0.014354	0.014288	0.015525	0.017731	0.016382	0.01637	0.018518	0.013623	0.01468	0.01697	0.016122
Small Gam	0.2	0.006086	0.006079	0.006051	0.007891	0.009011	0.009714	0.009706	0.009412	0.006924	0.008083	0.008625	0.007511
Check		1	1	1	1	1	1	1	1	1	1	1	1

Species	J	F	M	A	M	J	J	A	S	O	N	D
Beaver	0.048741	0.048562	0.047982	0.059947	0.013547	0.008116	0.008094	0.007827	0.005783	0.00678	0.013248	0.058553
Boar	0.234755	0.232934	0.227437	0.188521	0.194888	0.19719	0.195954	0.188517	0.124808	0.147541	0.247833	0.224832
Comman S	0.023959	0.023699	0.022928	0.025015	0.054419	0.083965	0.058211	0.027866	0.020913	0.024909	0.028676	0.026589
Fish Fluvic	0.077032	0.086317	0.094893	0.168498	0.170451	0.138501	0.135241	0.126817	0.13107	0.161041	0.102866	0.087997
Fish Marin-	0.102679	0.100731	0.1141	0.12856	0.13084	0.141716	0.13855	0.130157	0.080485	0.098629	0.10413	0.103363
Grey Seal	0.108228	0.106617	0.101911	0.101766	0.107559	0.11631	0.152752	0.217633	0.330734	0.199376	0.159641	0.152769
Red Deer	0.281696	0.280551	0.276884	0.229037	0.227932	0.208946	0.208323	0.201359	0.229033	0.268733	0.223707	0.224648
Roe Deer	0.02751	0.027085	0.025847	0.021237	0.022347	0.020716	0.020388	0.022564	0.017179	0.019155	0.025083	0.026304
Small Gam	0.0954	0.093504	0.088016	0.077418	0.078019	0.08454	0.082487	0.077259	0.059995	0.073836	0.094817	0.094945
	1	1	1	1	1	1	1	1	1	1	1	1

Species	Winter	Spring	Summer	Autumn
Beaver	0.051952	0.040492	0.008013	0.008604
Boar	0.23084	0.203616	0.193887	0.173394
Comman S	0.024749	0.034121	0.056681	0.024833
Fish Fluvic	0.083782	0.144614	0.13352	0.131659
Fish Marin-	0.102258	0.1245	0.136808	0.094415
Grey Seal	0.122538	0.103745	0.162231	0.229917
Red Deer	0.262298	0.244618	0.20621	0.240491
Roe Deer	0.026966	0.023144	0.021223	0.020472
Small Gam	0.094617	0.081151	0.081429	0.076216
	1	1	1	1

8.3 Catchment analysis summary tables

Catchment summary for 10,000BP

Catchment ID	Population Density	Catchment Area	Total Population
10_1	1.2934	62.52	80.87
10_2	1.5038	52.93	79.59
10_3	1.3975	44.17	61.73
10,000BP Average	**1.398233**	**53.20667**	**74.06333**

Catchment summary for 9,500BP

Catchment ID	Population Density	Catchment Area	Total Population
9_5_1	1.53383	64.84	99.45
9_5_2	1.73597	59.47	103.23
9_5_3	1.19269	48.32	57.63078
9_5_4	1.45205	41.7	60.55049
9_5_5	1.55649	63.54	98.89937
9_5_6	1.57328	65.02	102.2947
9_5_7	1.57666	62.075	97.87117
9,500BP Average	**1.56881**	**63.545**	**99.69003**

Catchment summary for 9,000BP

Catchment ID	Population Density	Catchment Area	Total Population
9_1	2.22	55.017	122.1377
9_2	0.97162	43.528	42.29268
9_3	0.93029	46.771	43.51059
9_4	0.88598	68.136	60.36713
9_5	1.36734	46.292	63.2969
9,000BP Average	***1.061203***	***53.733***	***57.02164***

Catchment summary for 8,500BP

Catchment ID	Population Density	Catchment Area	Total Population
8_5_1	0.87078	39.966	34.80159
8_5_2	1.00146	47.604	47.6735
8_5_3	1.02179	24.09	24.61492
8,500BP Average	**0.964677**	**37.22**	**35.90527**

Catchment summary for 8,000BP

Catchment ID	Population Density	Catchment Area	Total Population
8_1	1.188	32.419	38.51377
8_2	1.249	50.462	63.02704
8_3	1.30918	36.165	47.34649
8,000BP Average	**1.248727**	**39.682**	**49.55197**

Appendix 2

Model detail figures for total population and population density (whole area) and Catchment analysis detail figures

9.1 Total Population 10,000BP

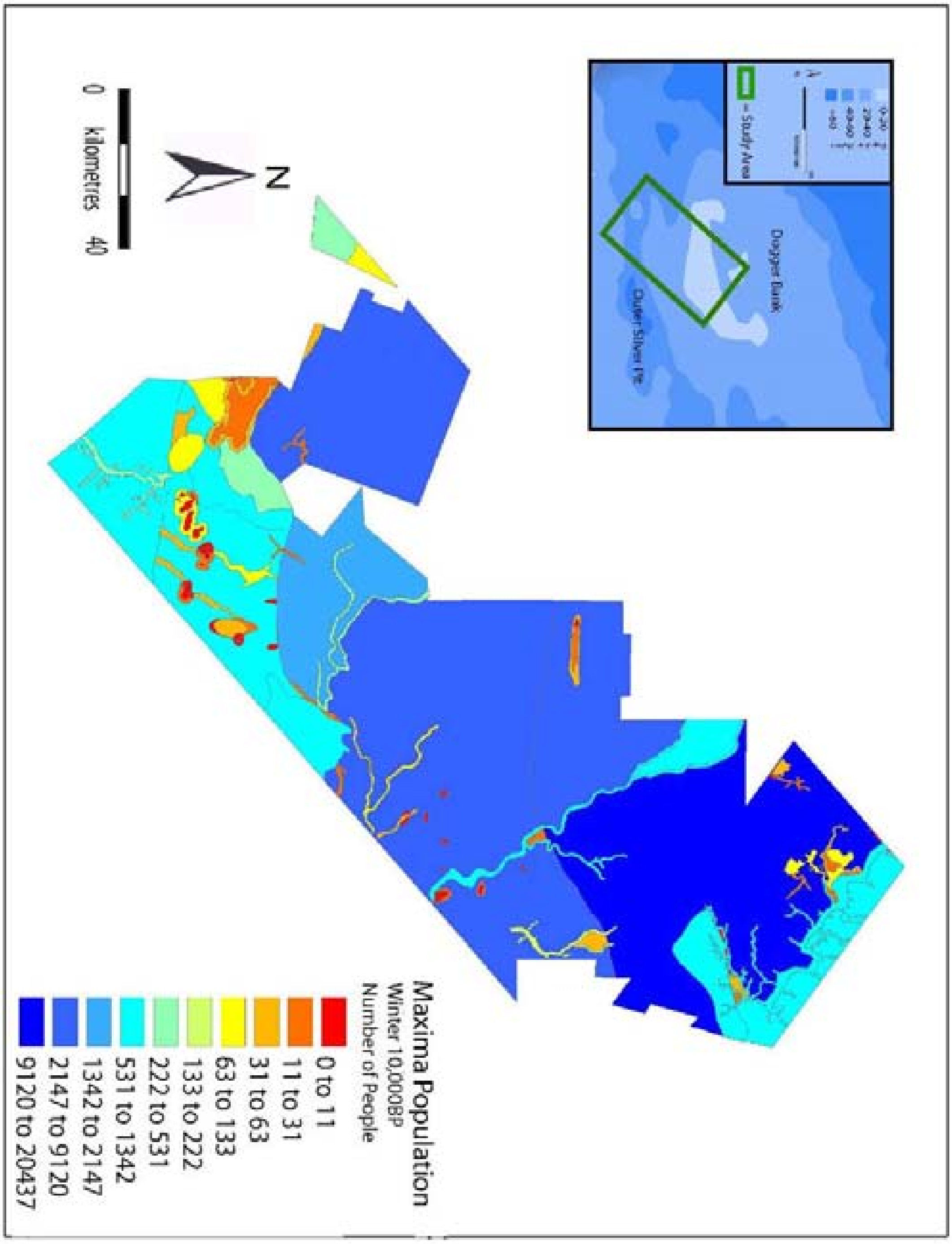

Figure 9.1 Total population map for the winter (10,000BP)

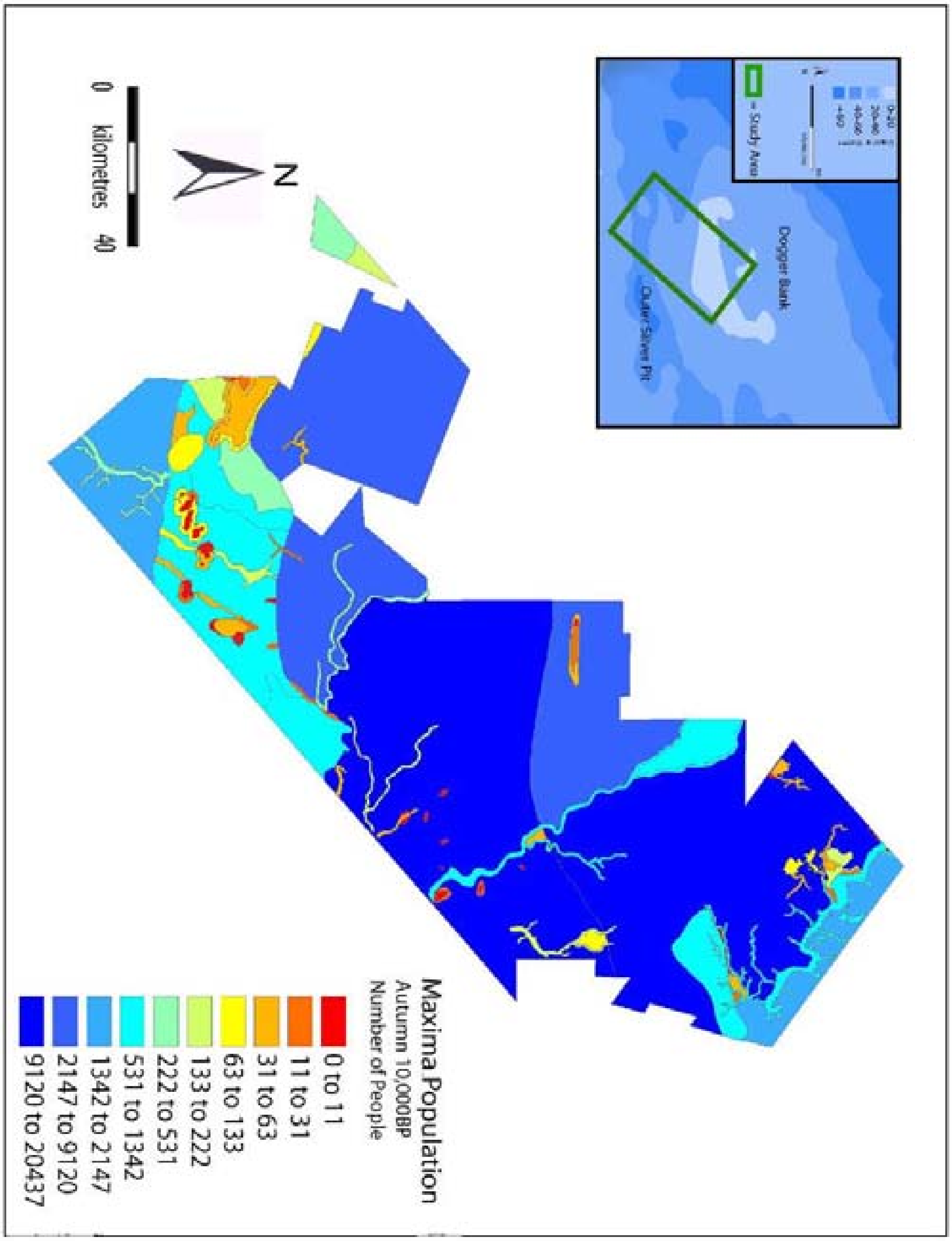

Figure 9.2 Total population map for the autumn (10,000BP)

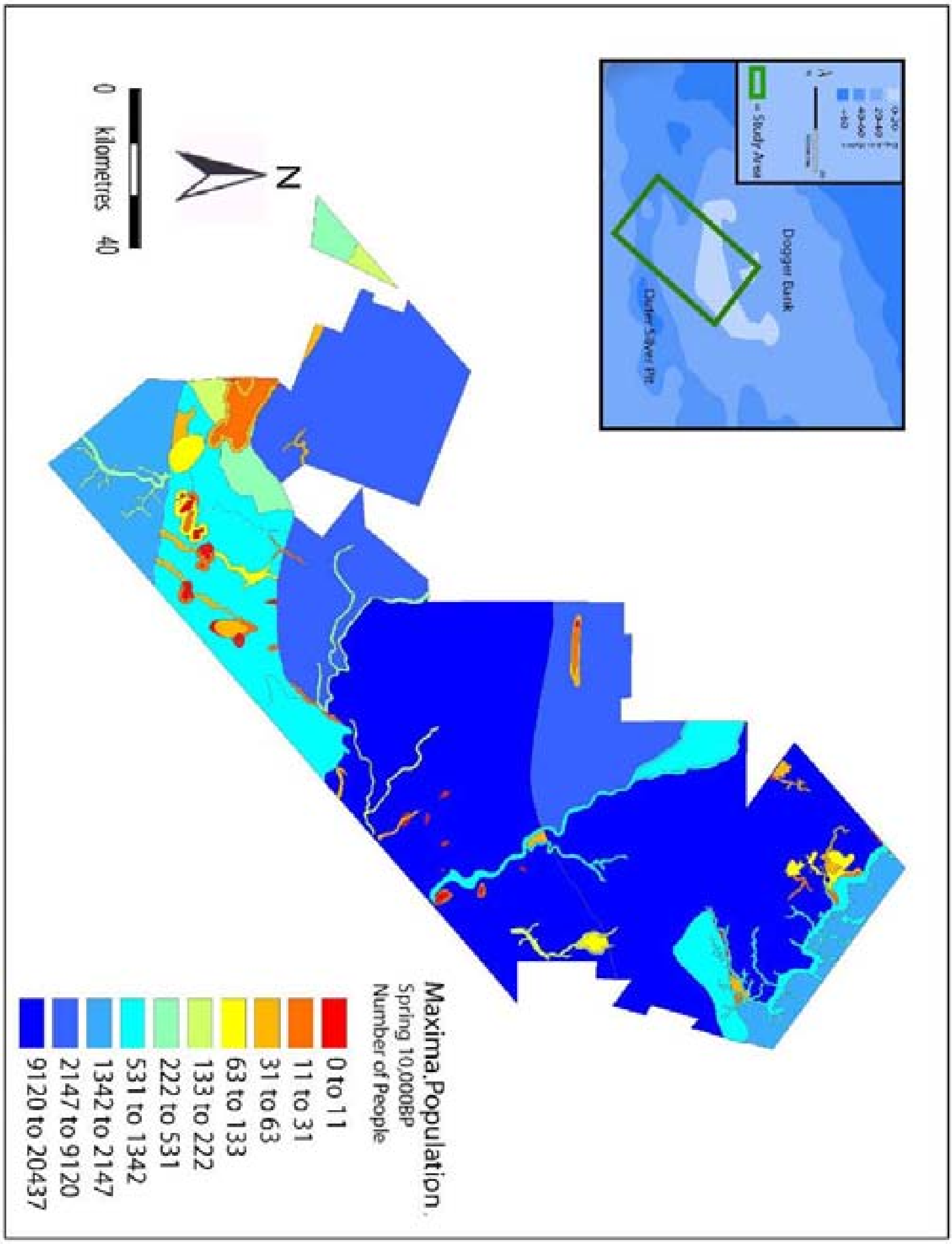

Figure 9.3 Total population map for the spring (10,000BP)

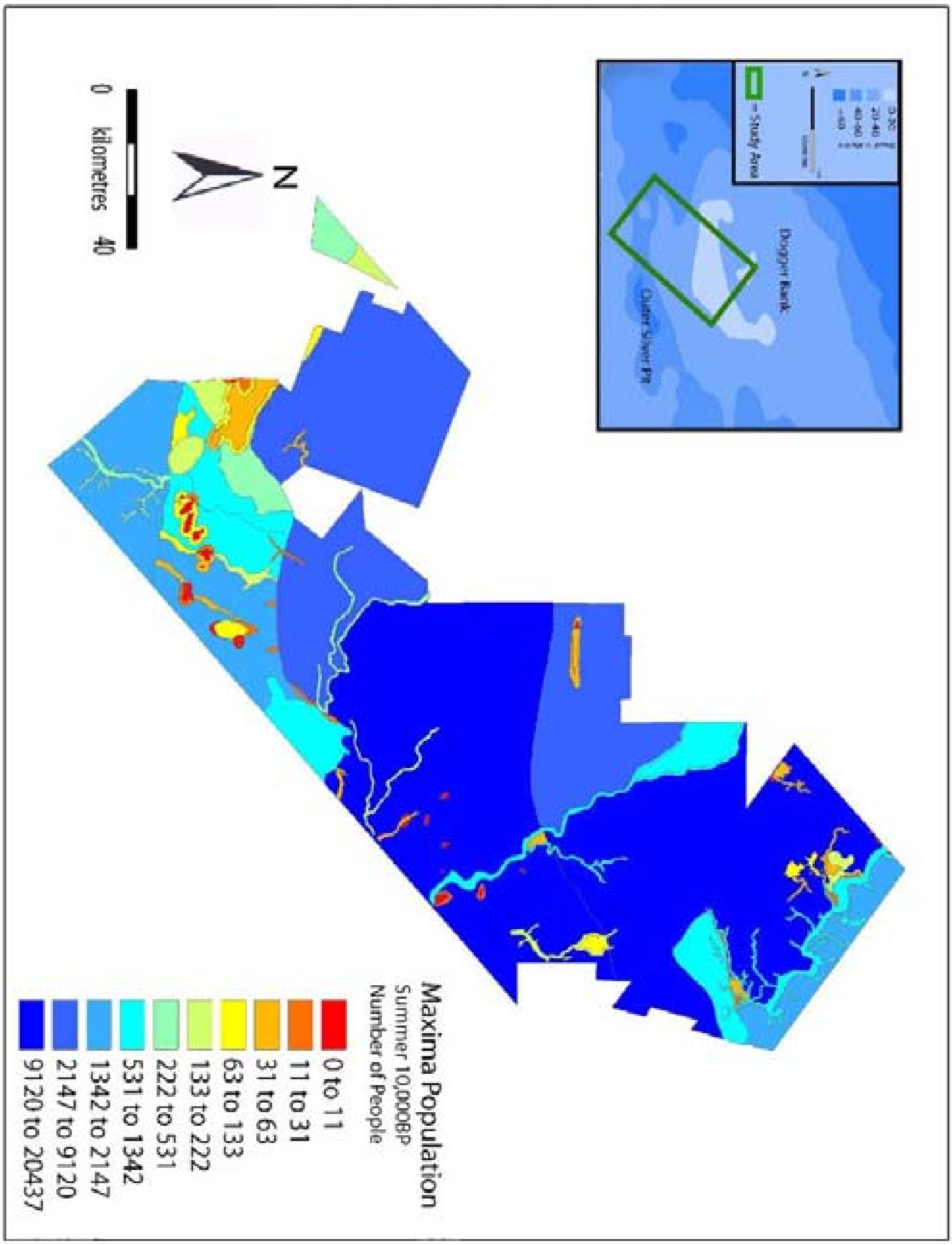

Figure 9.4 Total population map for the summer (10,000BP)

9.2 Total Population
9,500BP

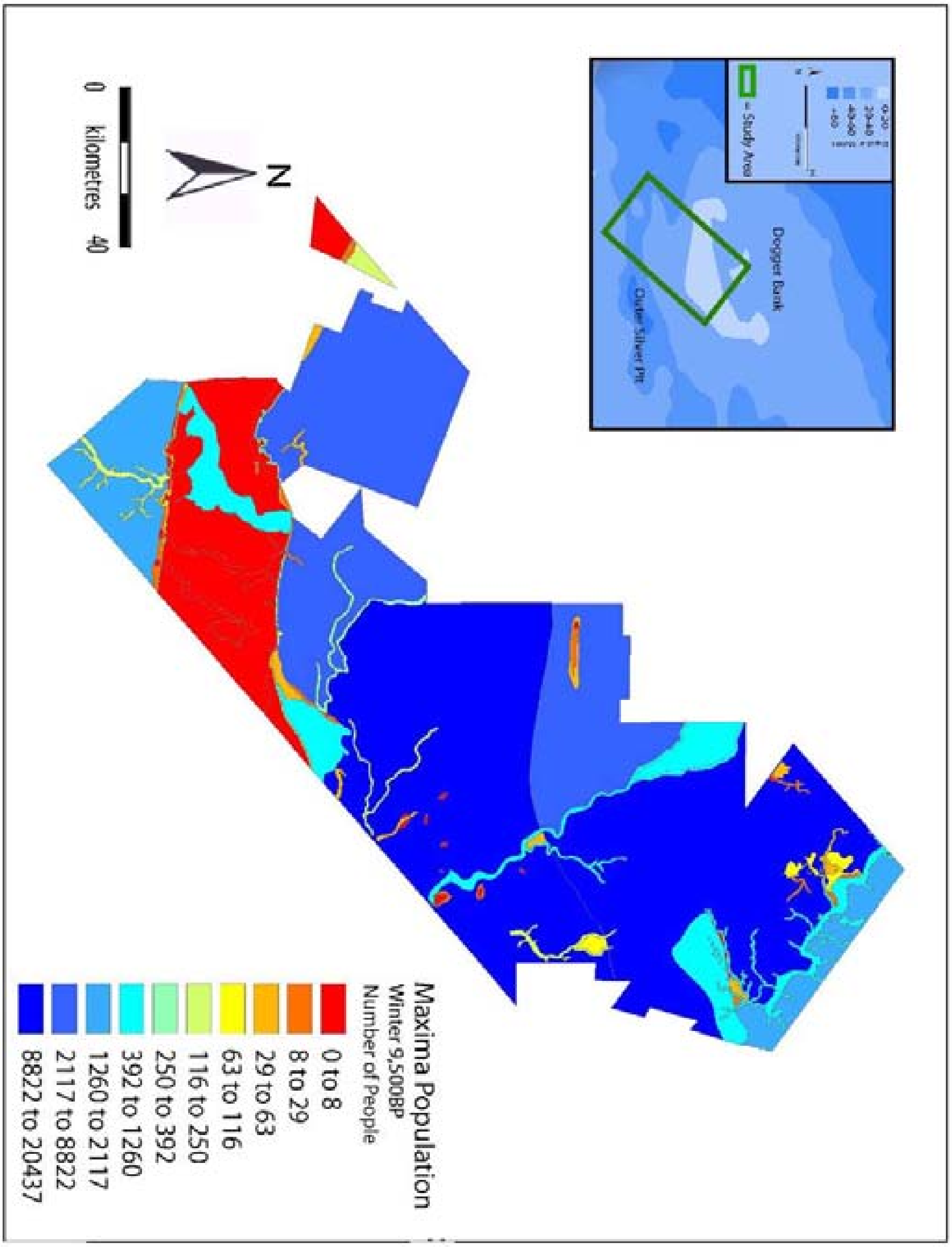

Figure 9.5 Total population map for the winter (9,500BP)

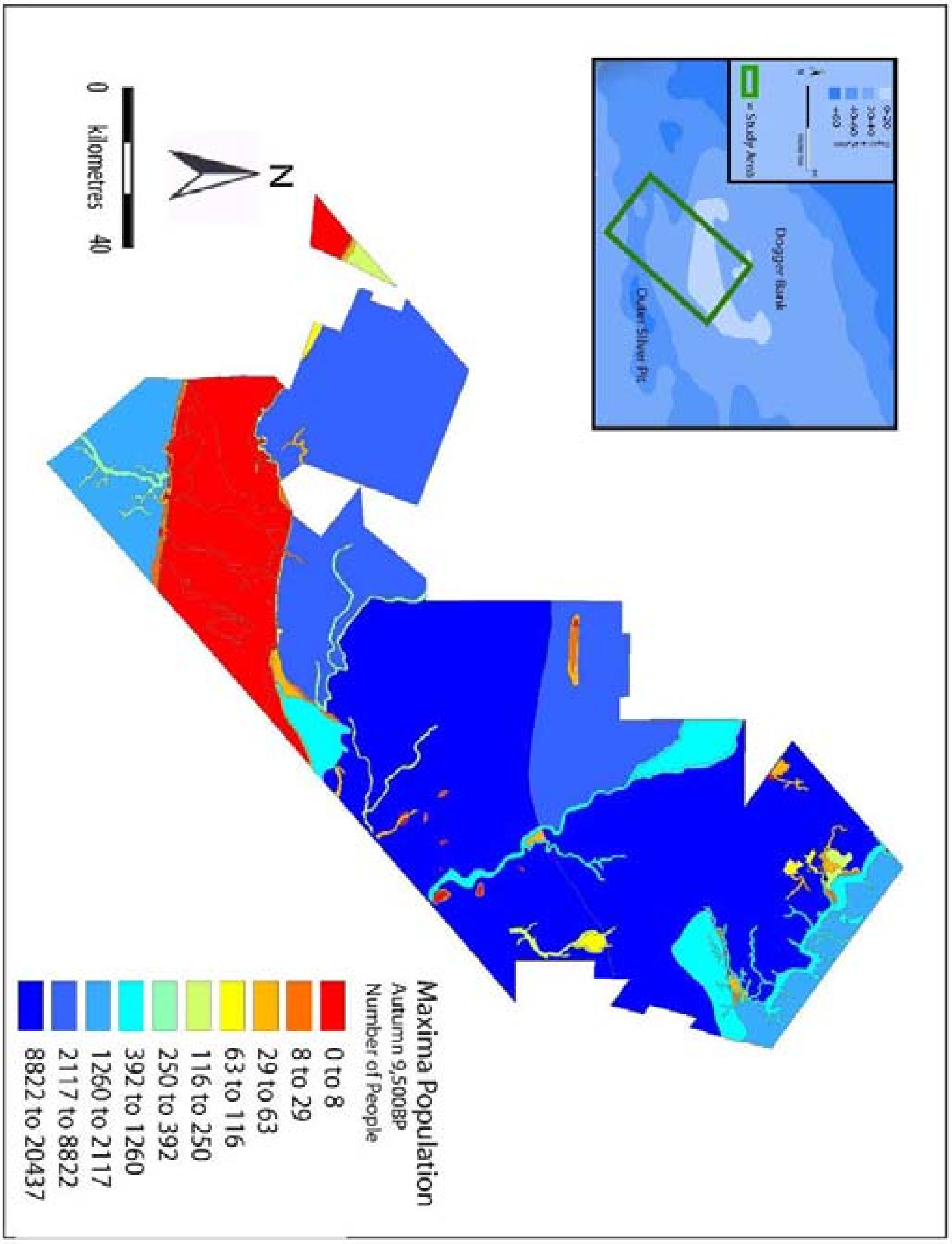

Figure 9.6 Total population map for the autumn (9,500BP)

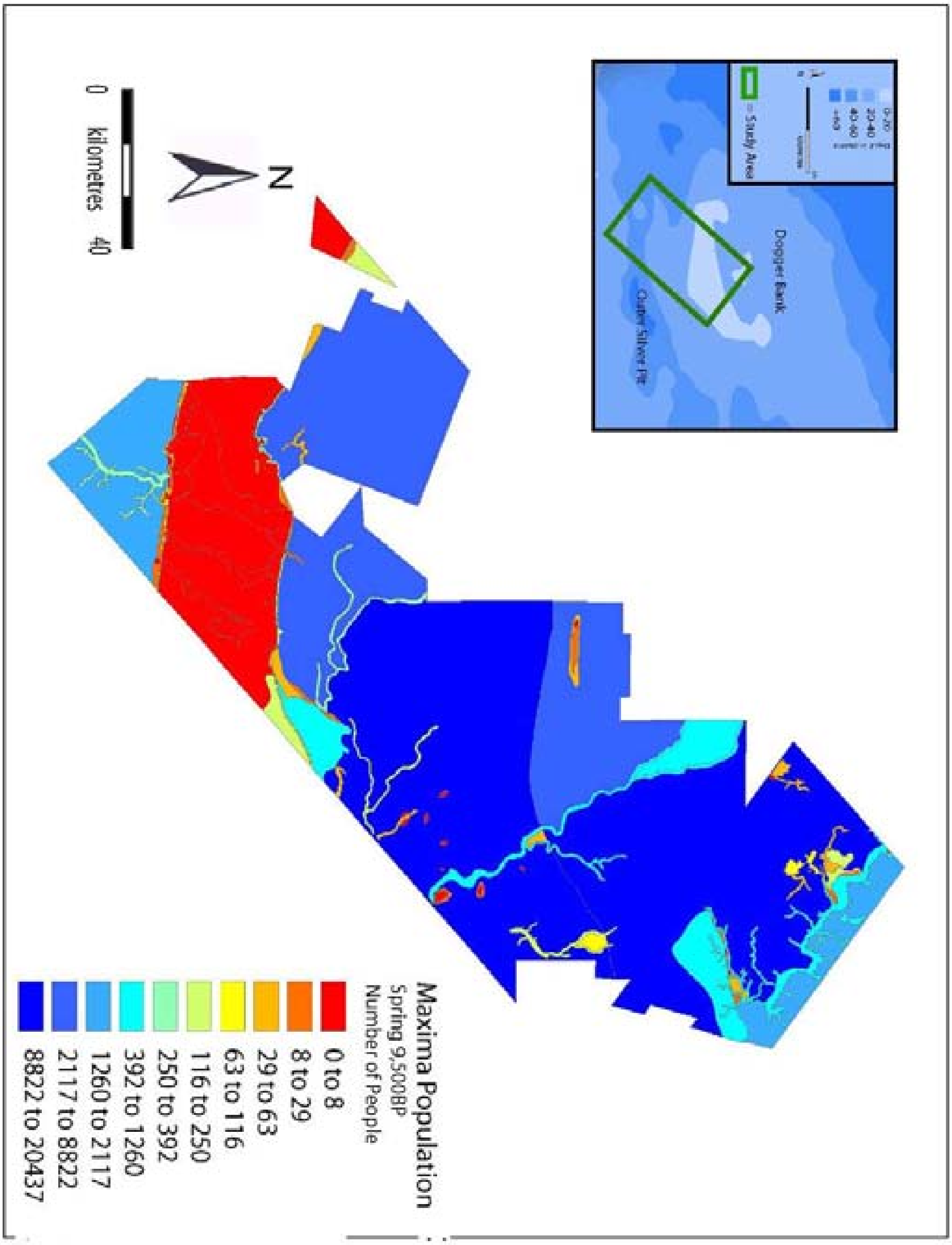

Figure 9.7 Total population map for the spring (9,500BP)

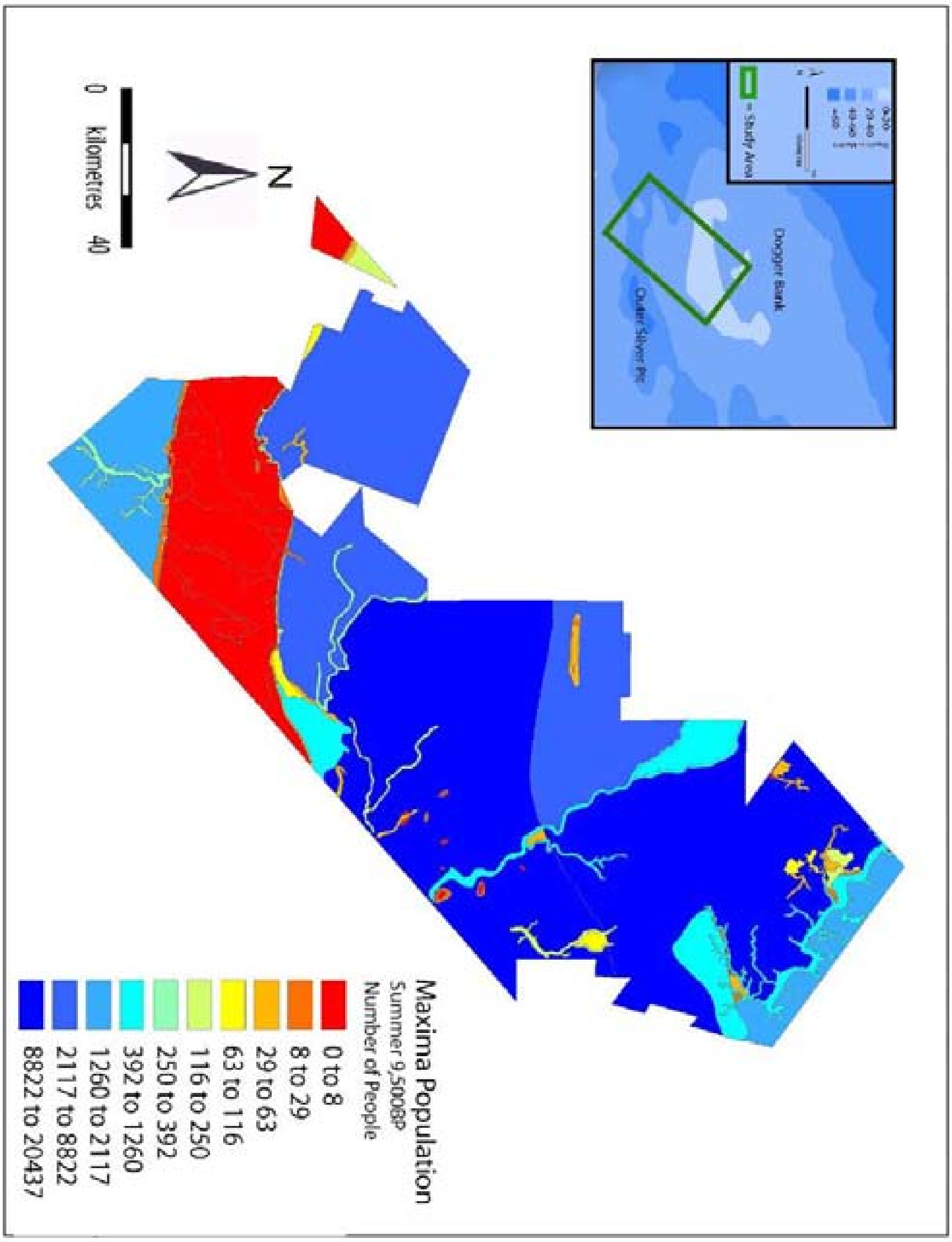

Figure 9.8 Total population map for the summer (9,500BP)

9.3 Total Population
9,000BP

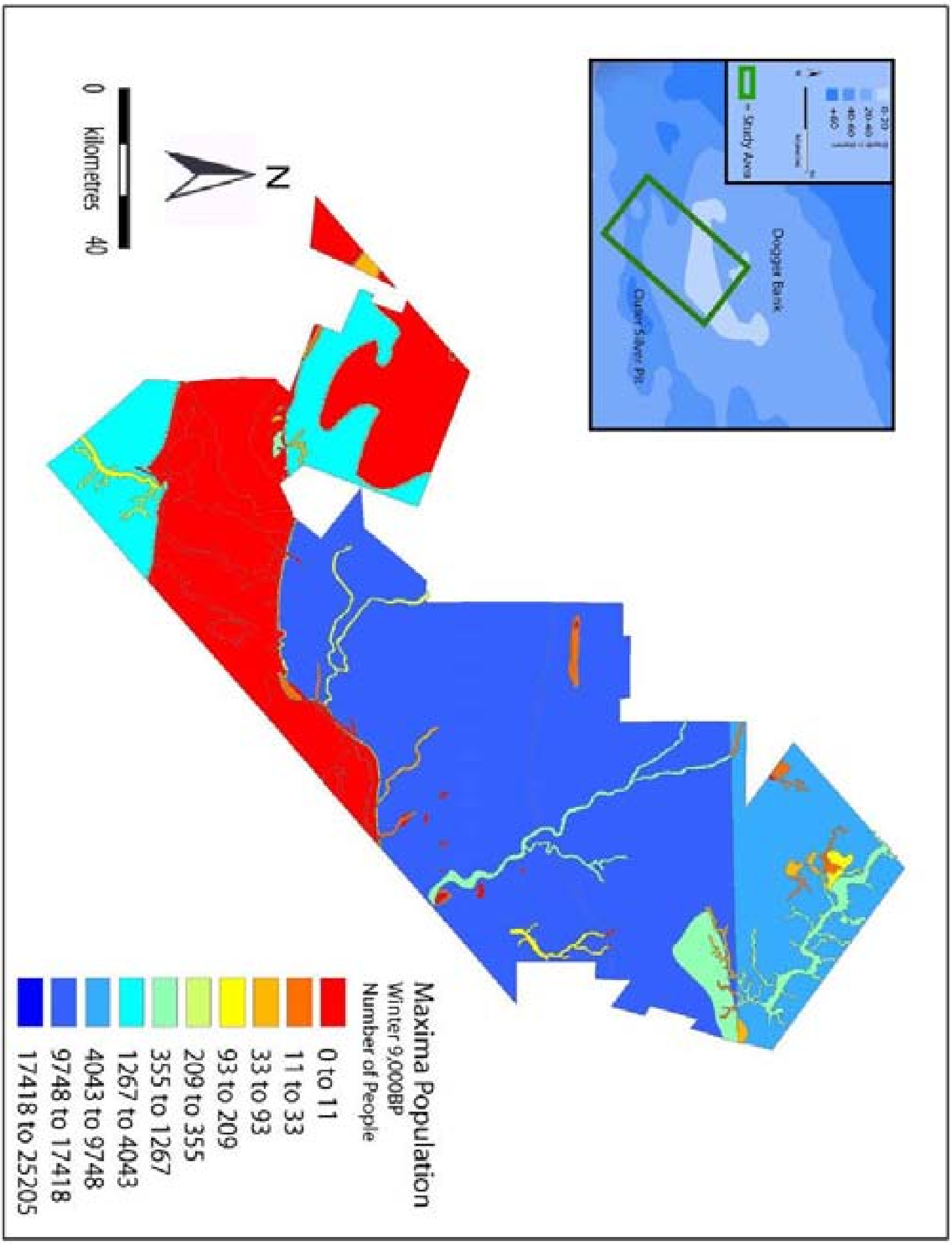

Figure 9.8 Total population map for the winter (9,000BP)

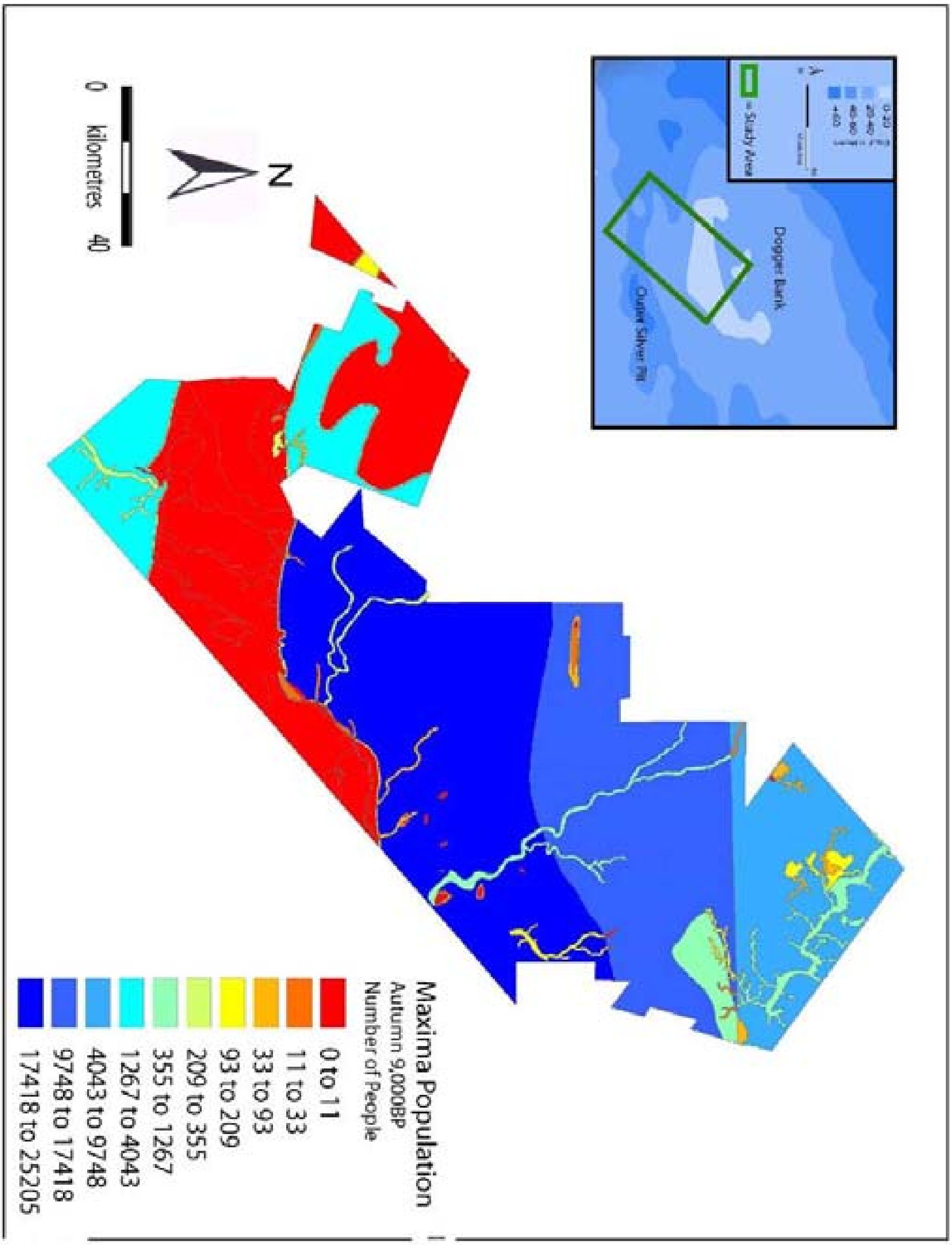

Figure 9.9 Total population map for the autumn (9,000BP)

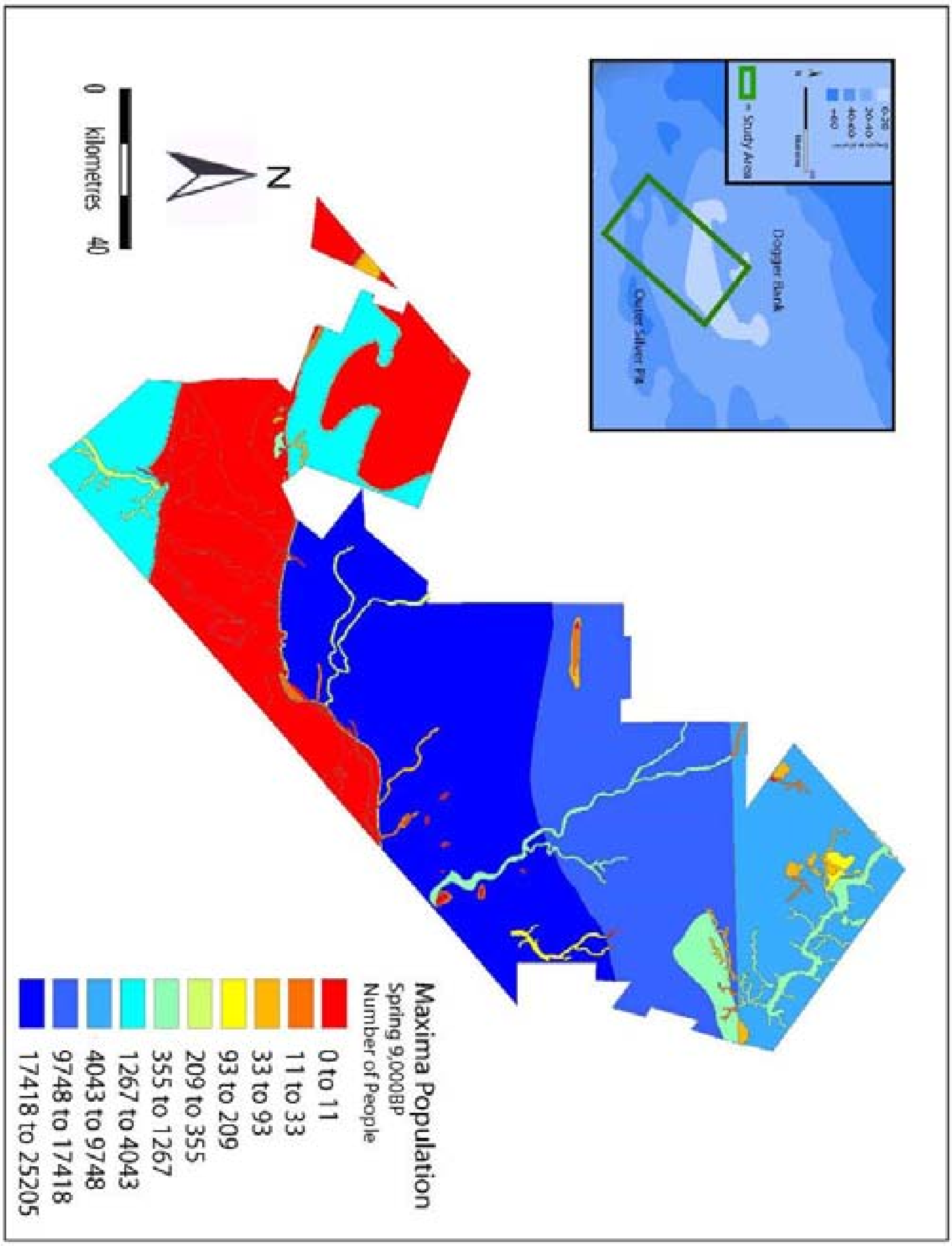

Figure 9.10 Total population map for the spring (9,000BP)

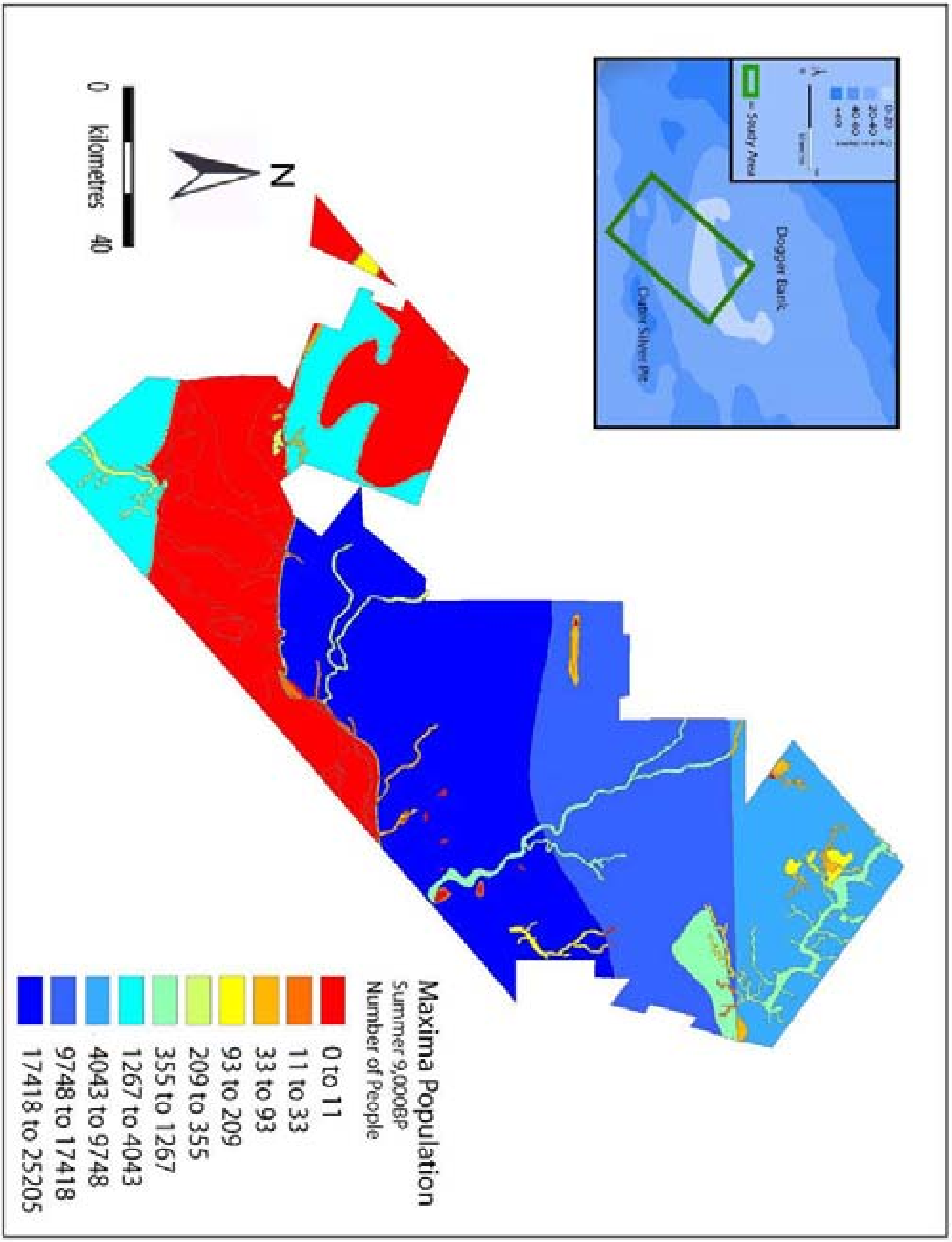

Figure 9.11 Total population map for the summer (9,000BP)

9.4 Total Population 8,500BP

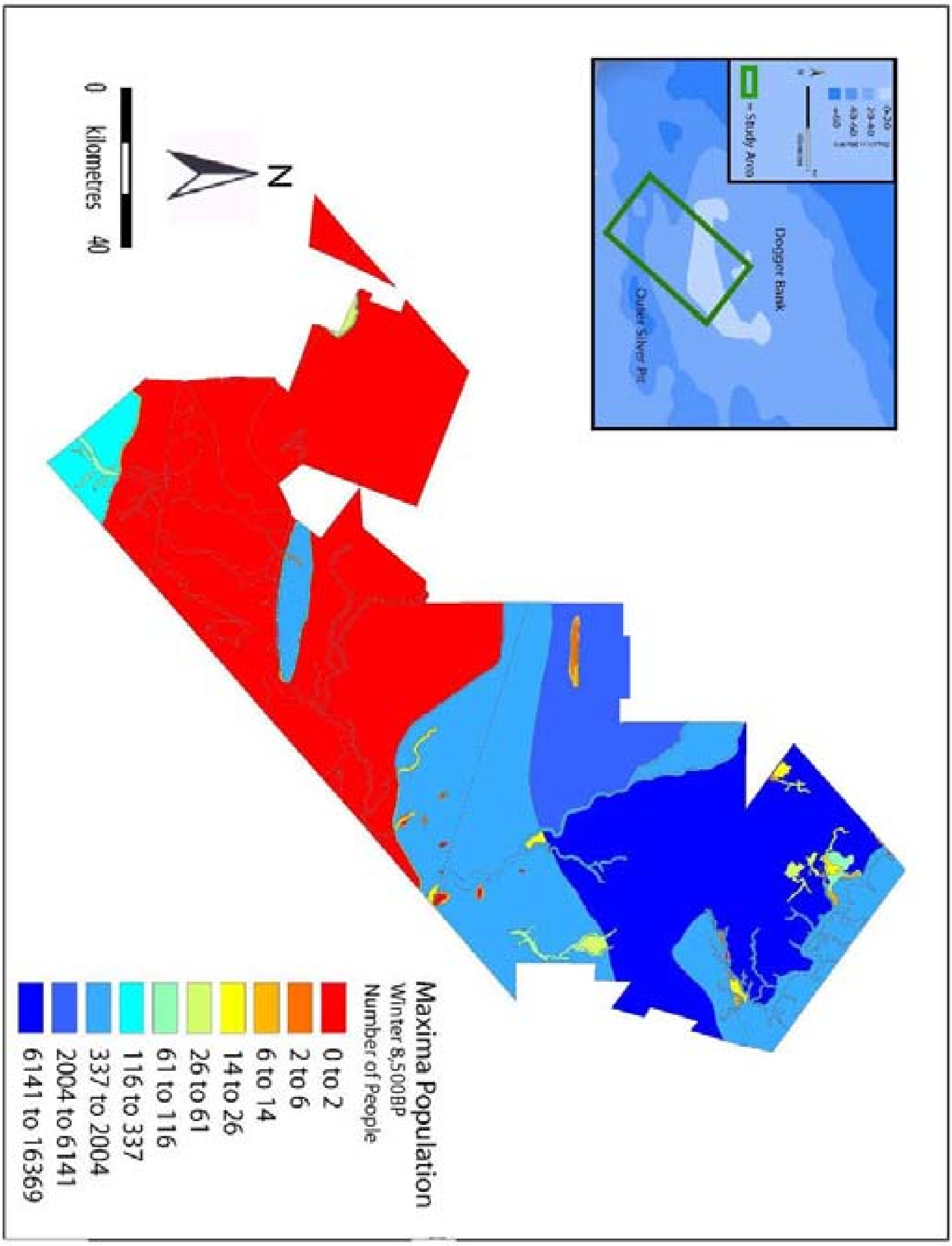

Figure 9.12 Total population map for the winter (8,500BP)

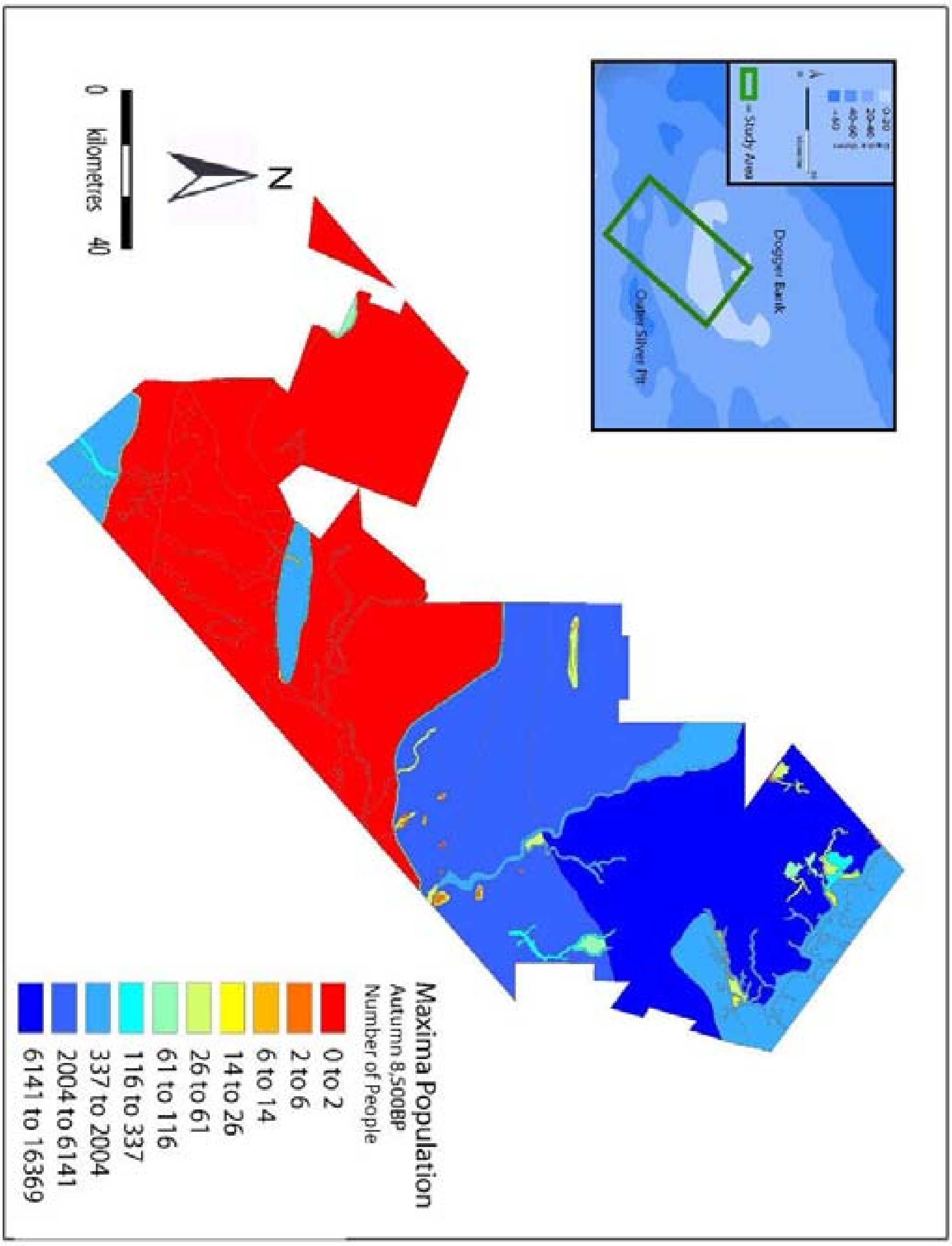

Figure 9.13 Total population map for the autumn (8,500BP)

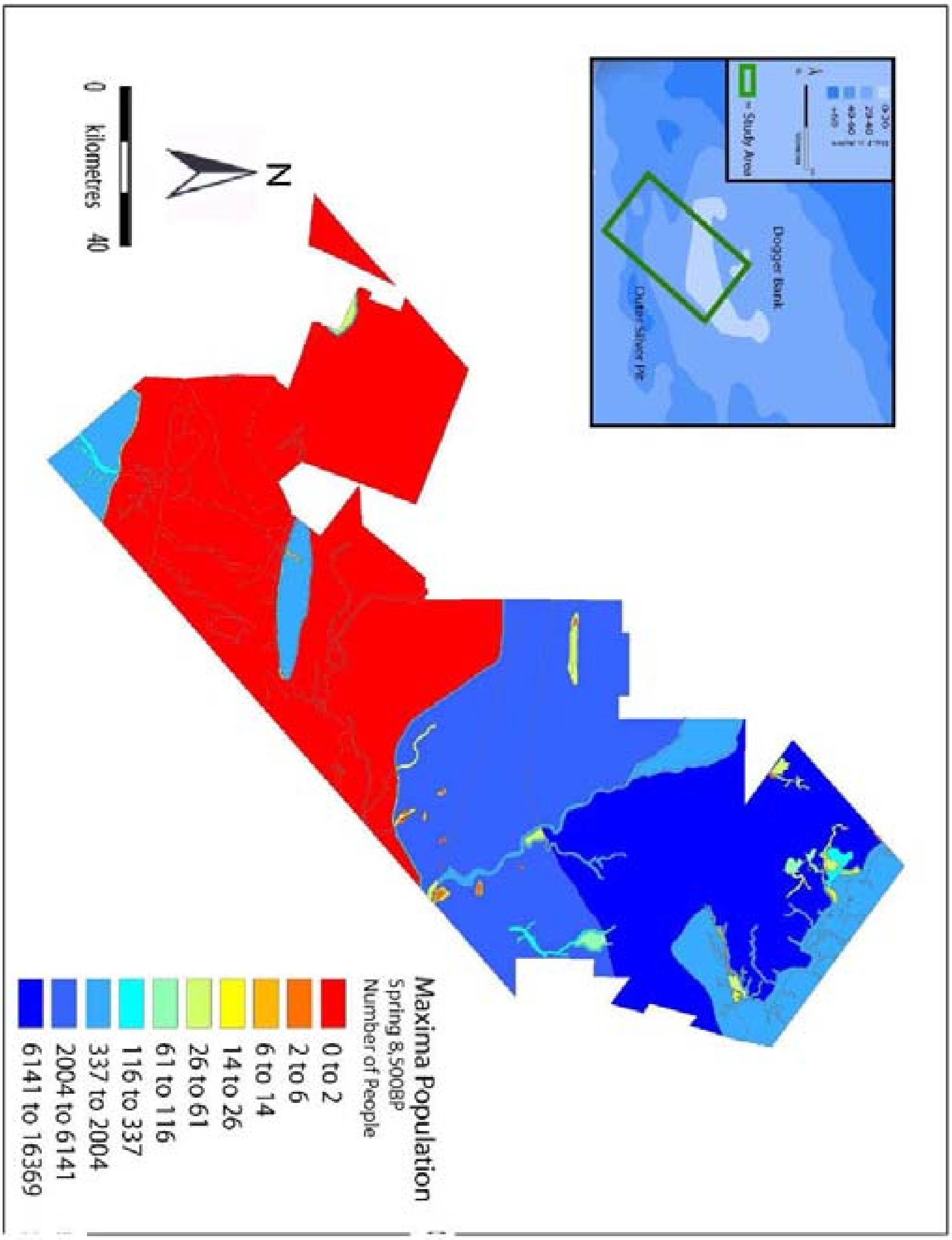

Figure 9.14 Total population map for the spring (8,500BP)

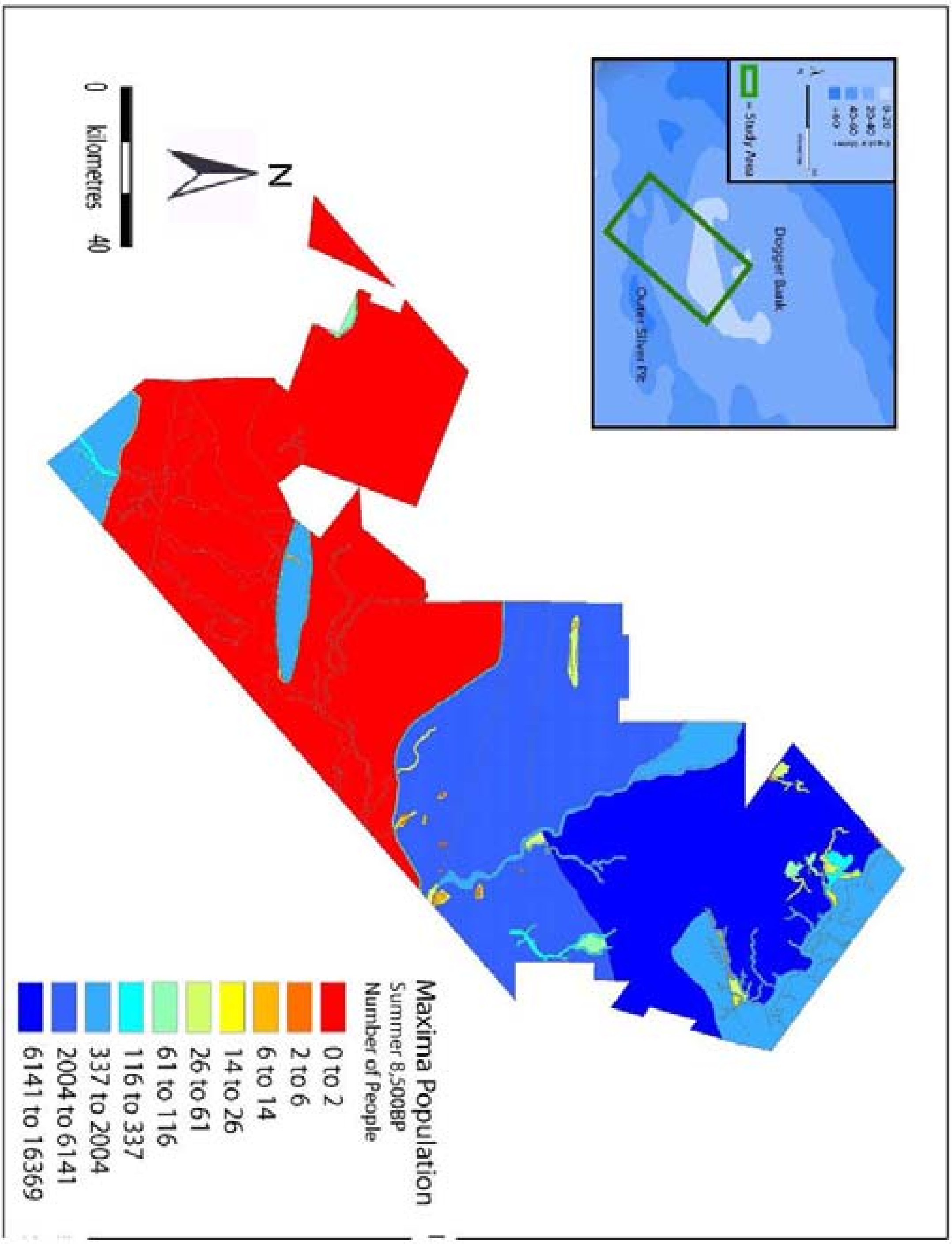

Figure 9.15 Total population map for the summer (8,500BP)

9.5 Total Population 8,000BP

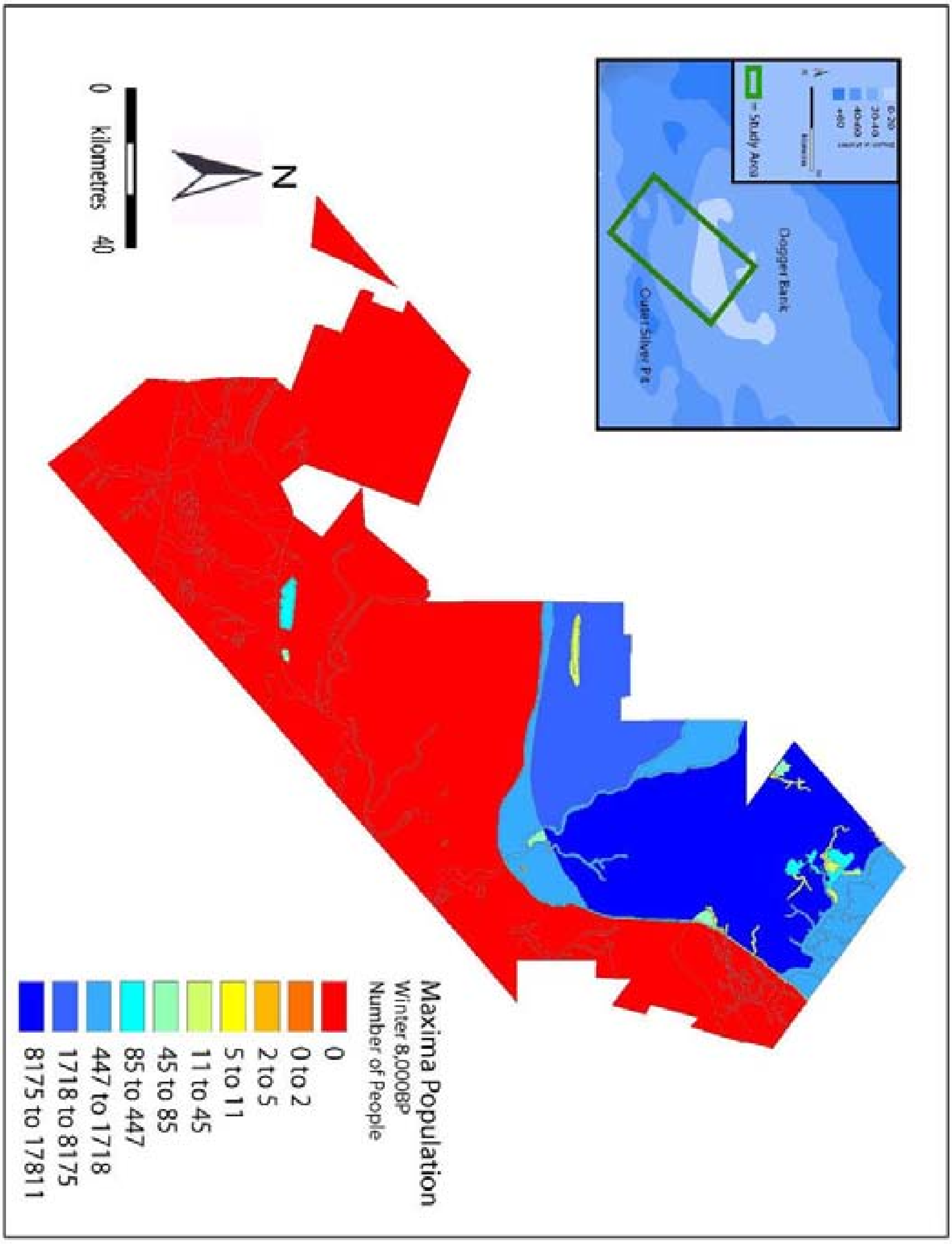

Figure 9.16 Total population map for the winter (8,000BP)

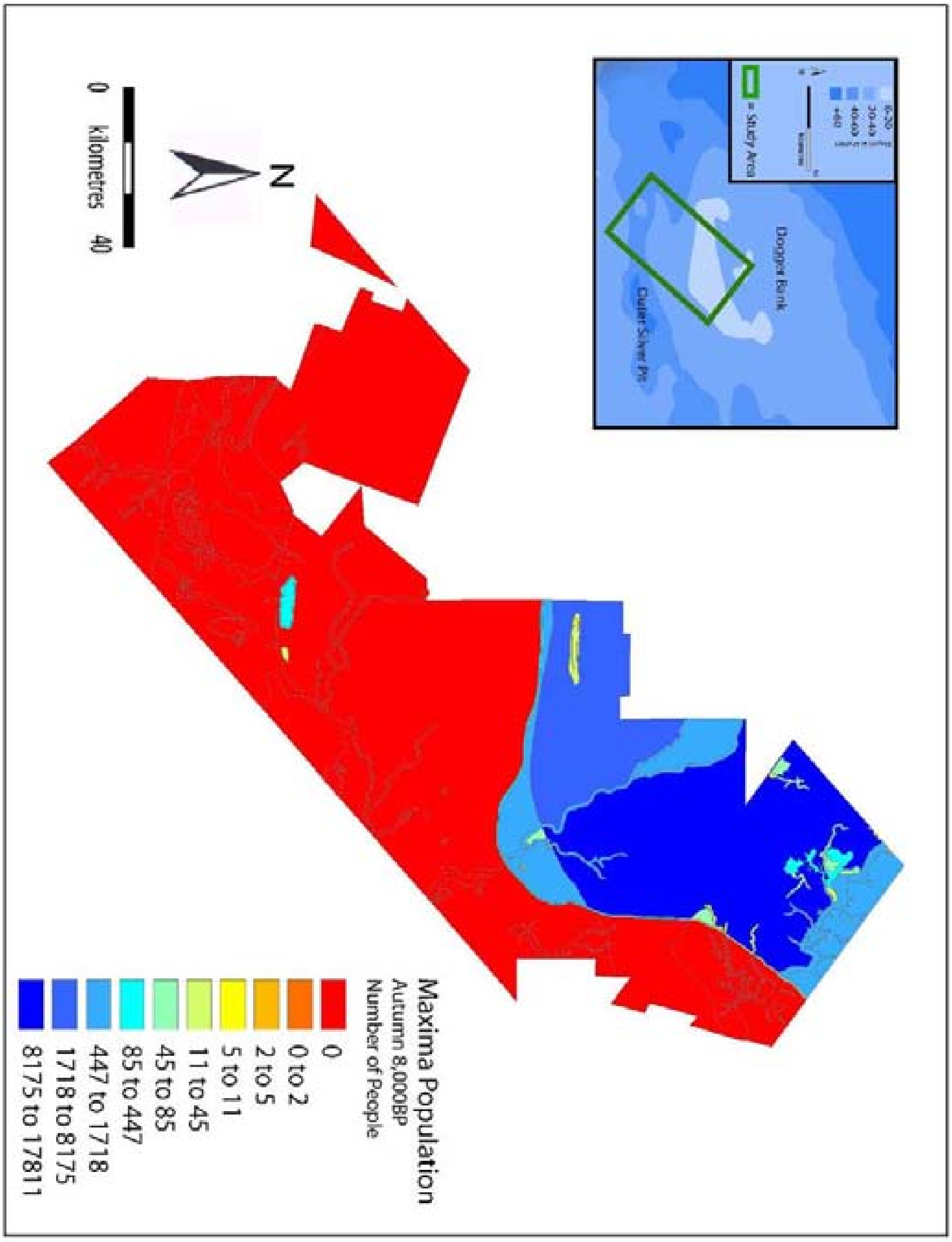

Figure 9.17 Total population map for the autumn (8,000BP)

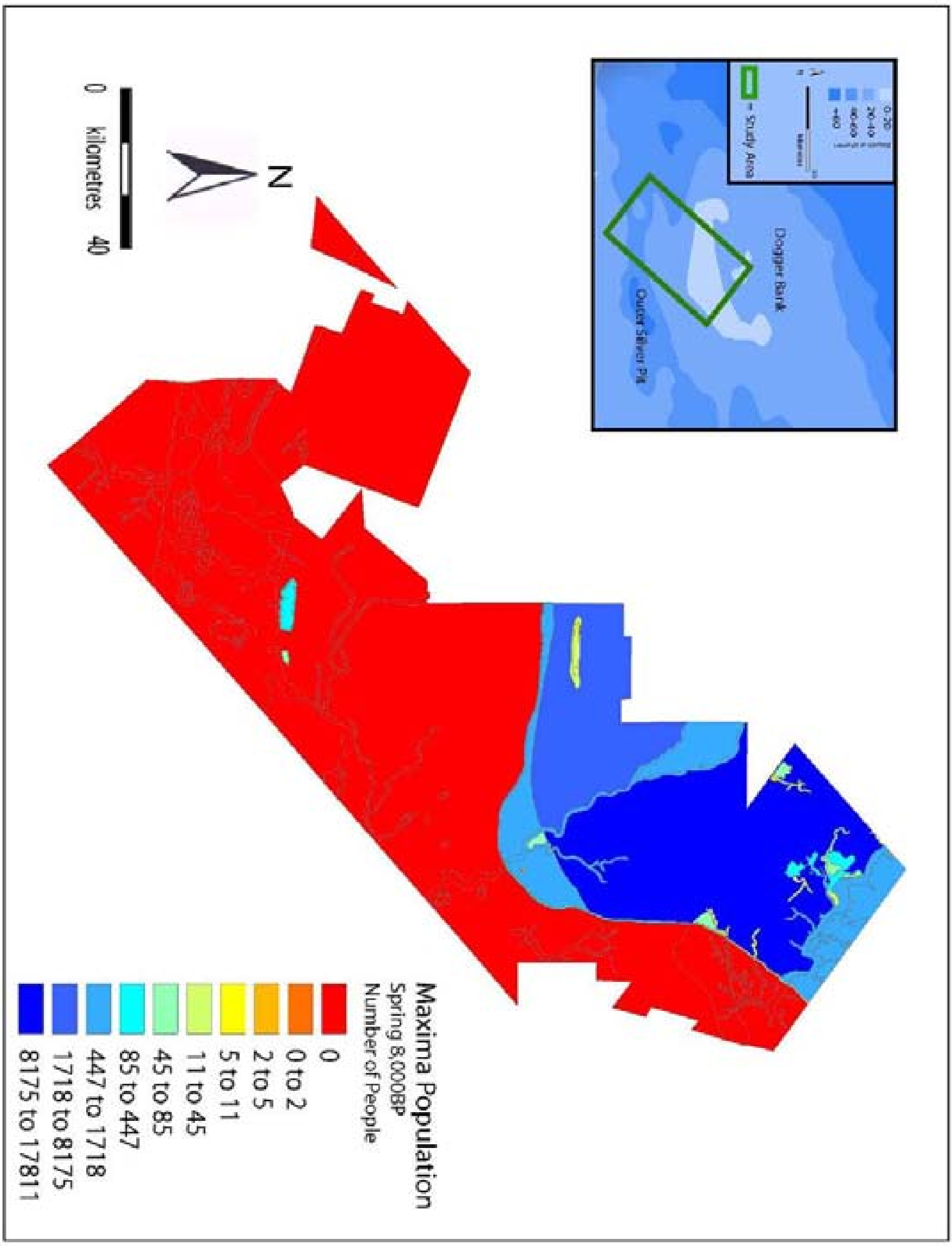

Figure 9.18 Total population map for the spring (8,000BP)

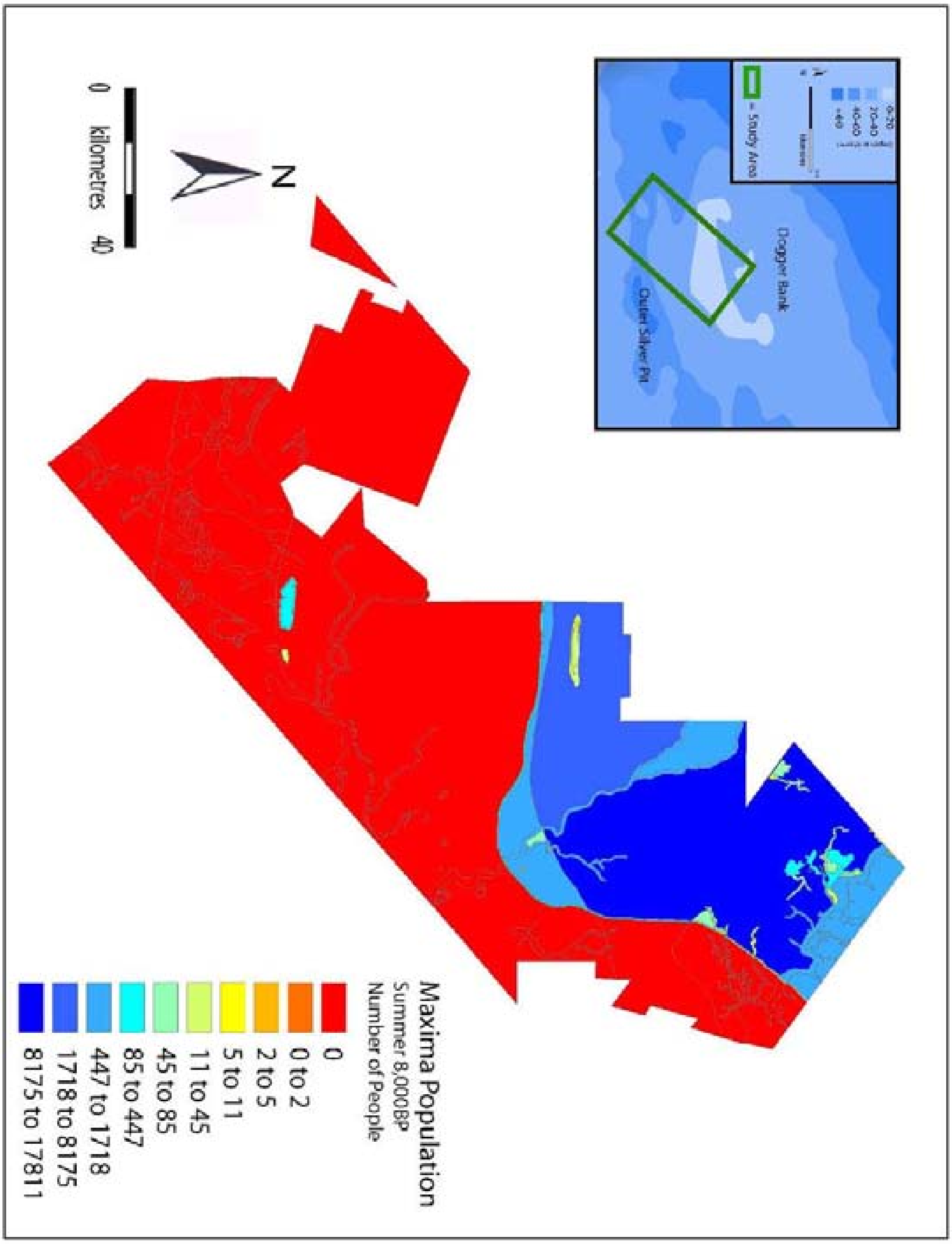

Figure 9.19 Total population map for the summer (8,000BP)

9.6 Total Population
7,500BP

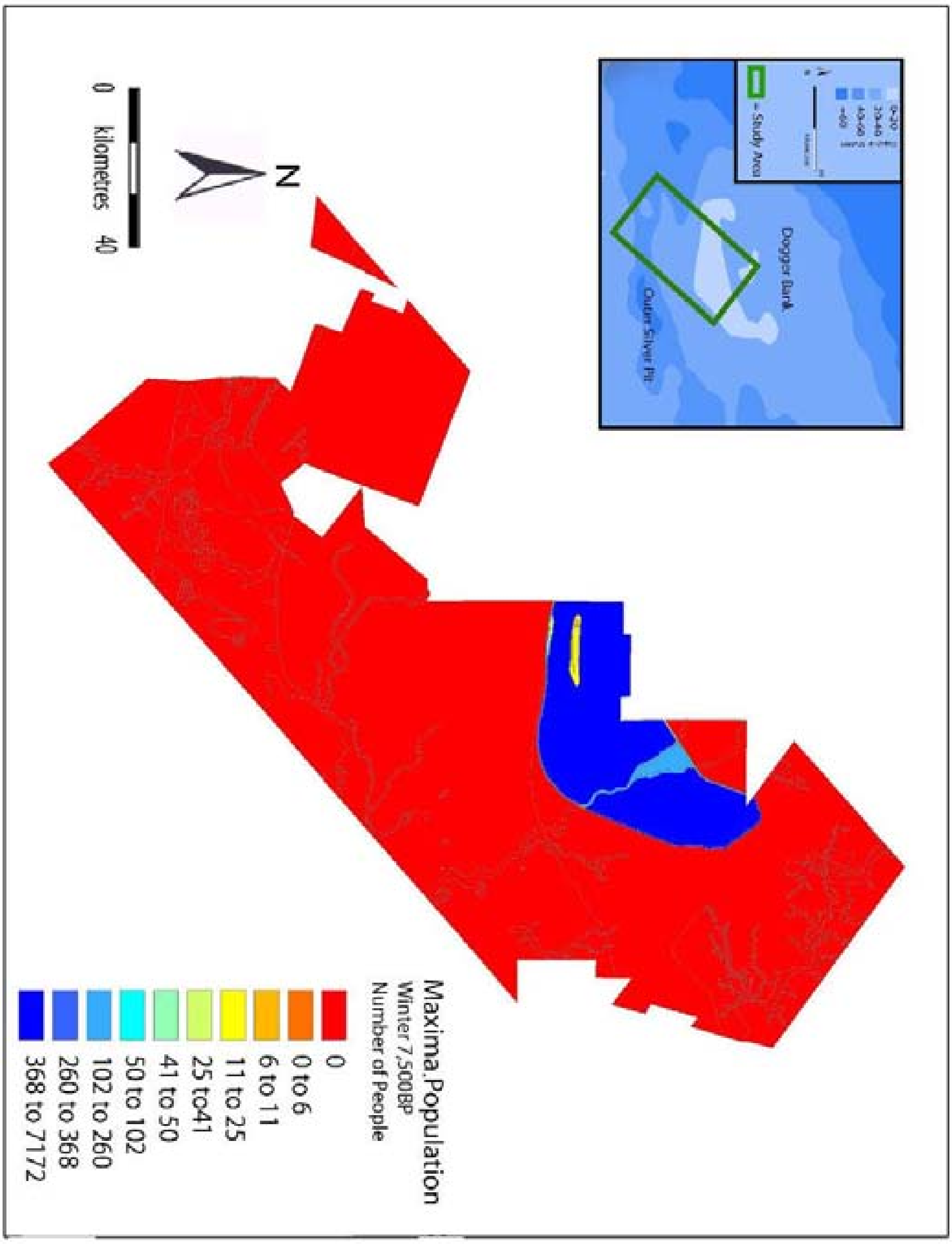

Figure 9.20 Total population map for the winter (7,500BP)

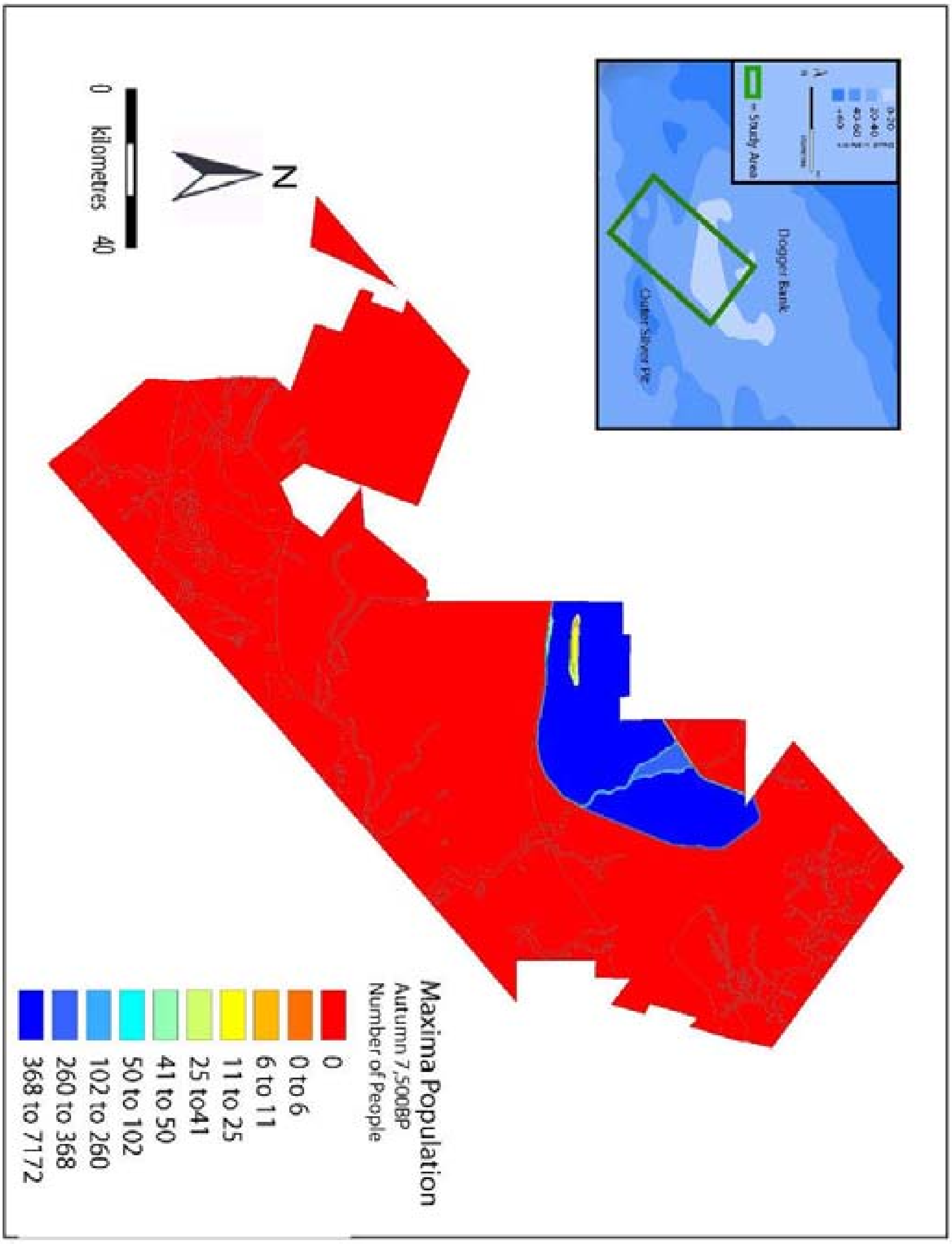

Figure 9.21 Total population map for the autumn (7,500BP)

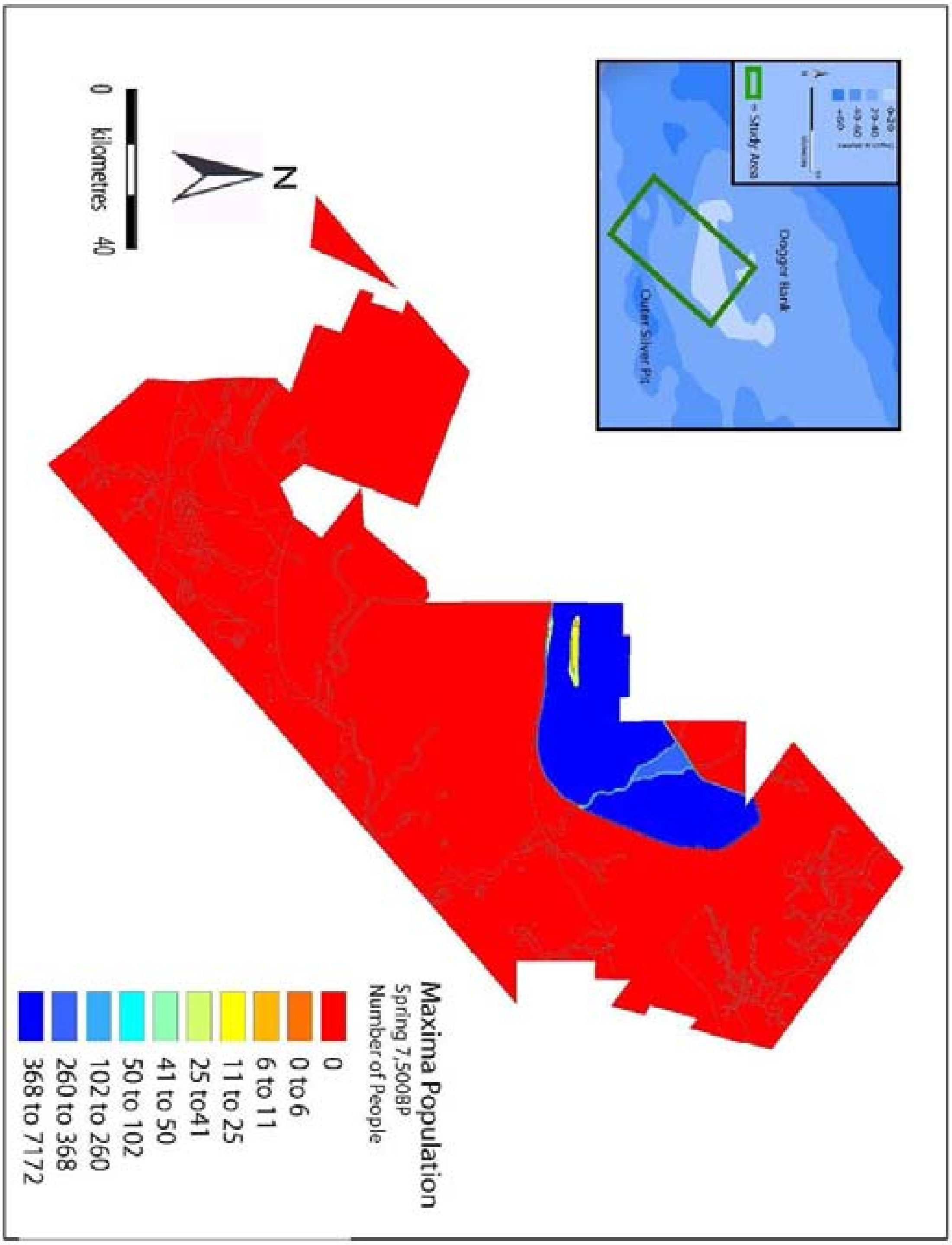

Figure 9.22 Total population map for the spring (7,500BP)

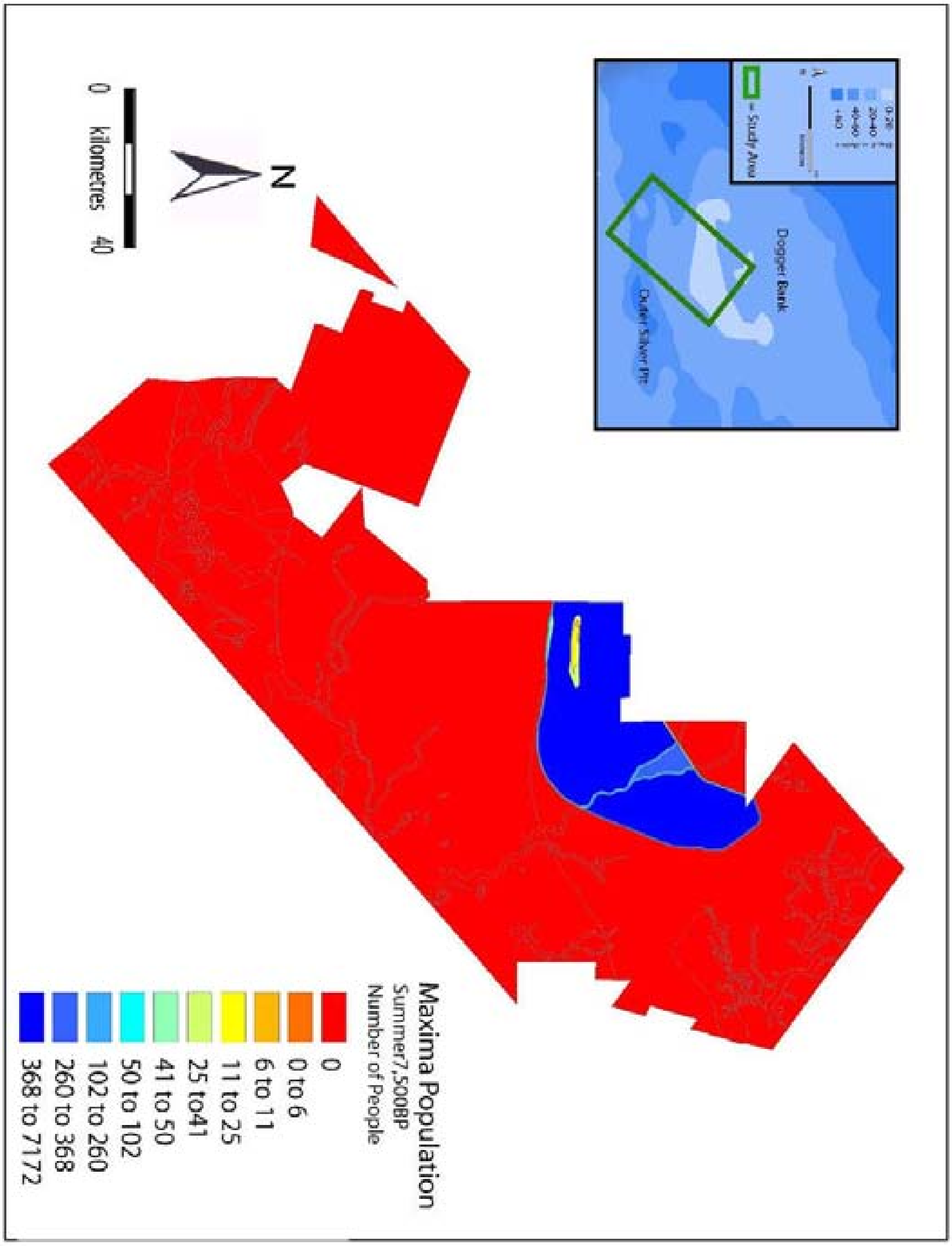

Figure 9.23 Total population map for the summer (7,500BP)

9.7 Population Density 10,000BP

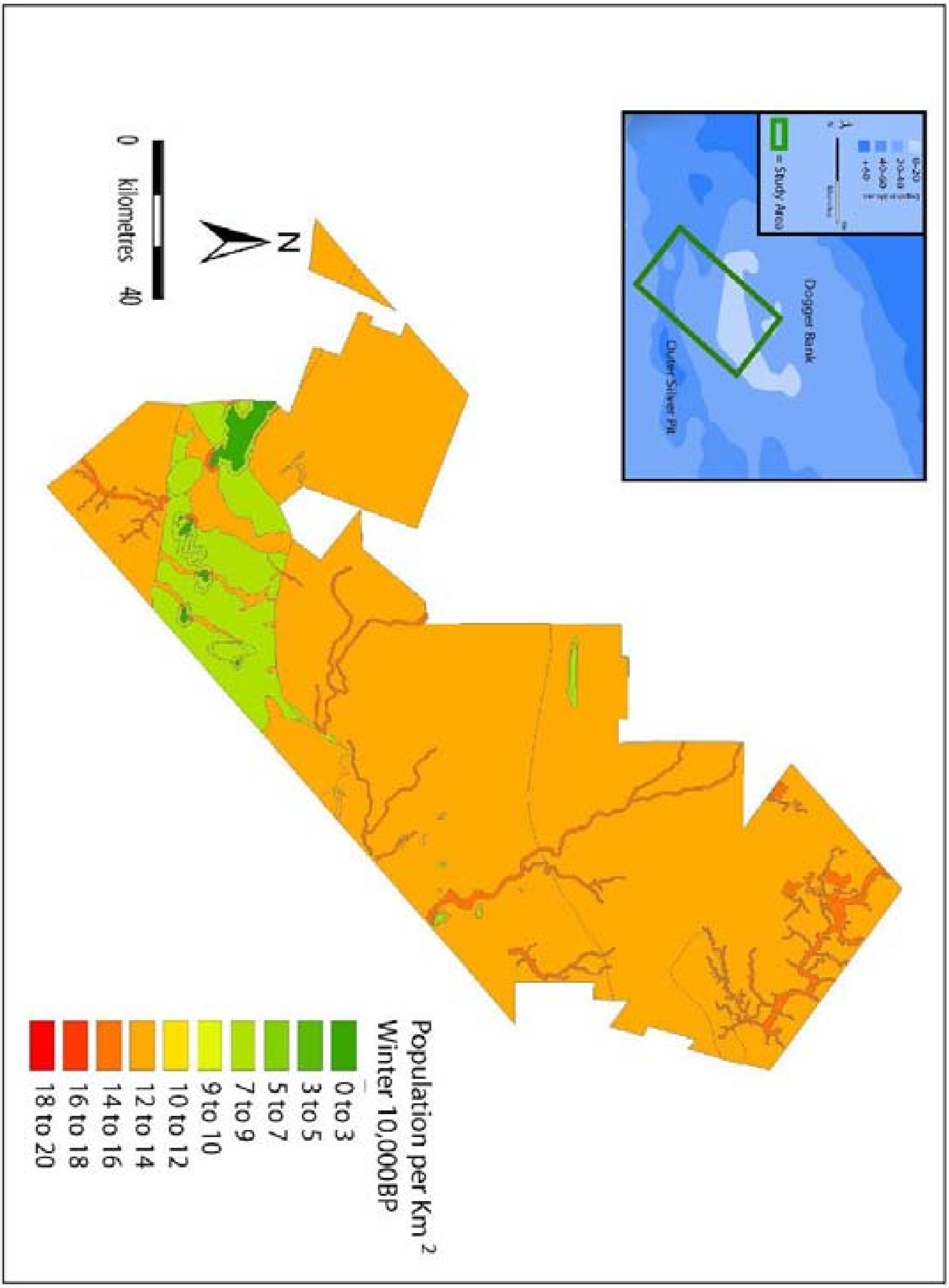

Figure 9.24 Population density map for the winter (10,000BP)

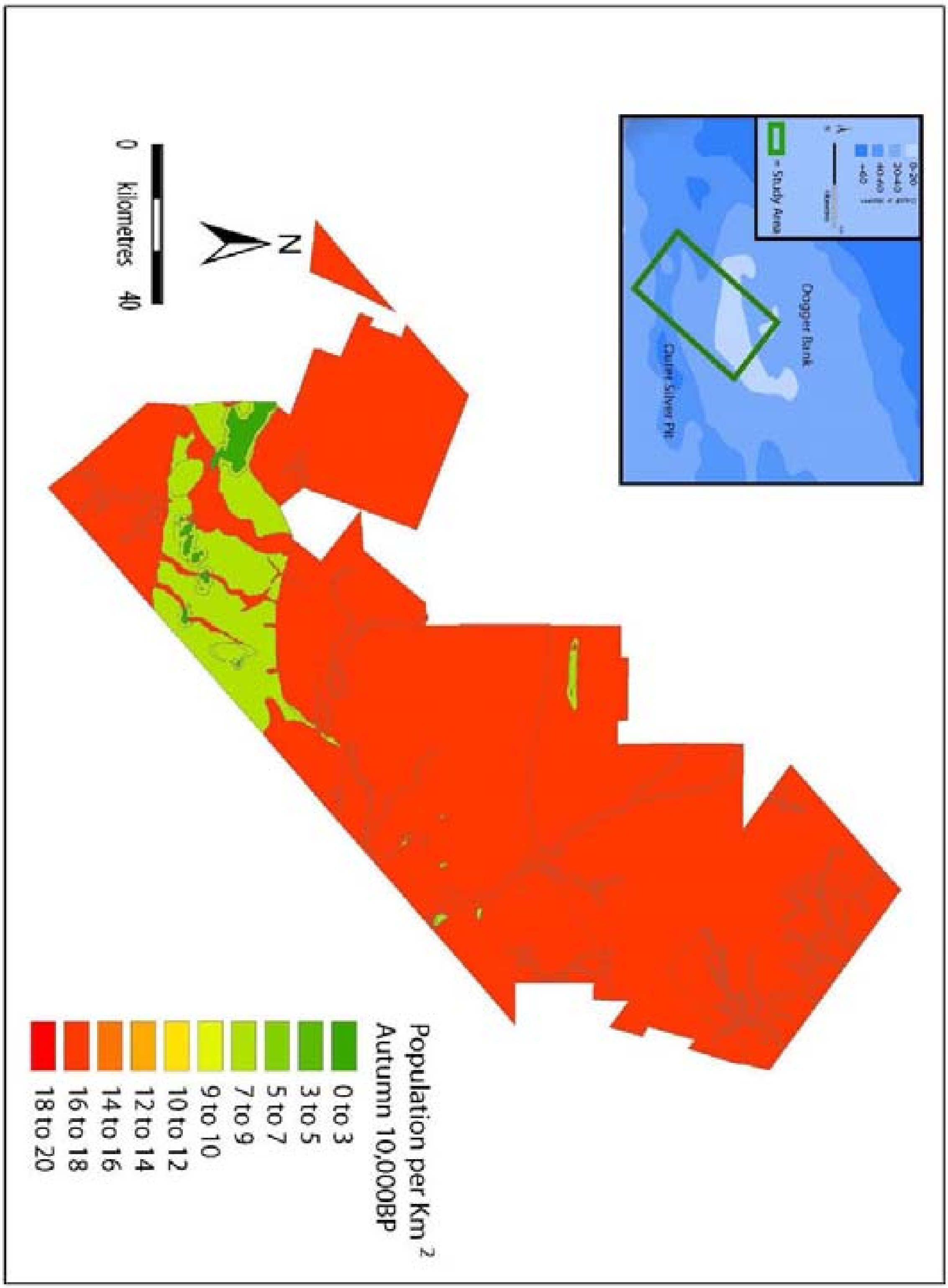

Figure 9.25 Population density map for the autumn (10,000BP)

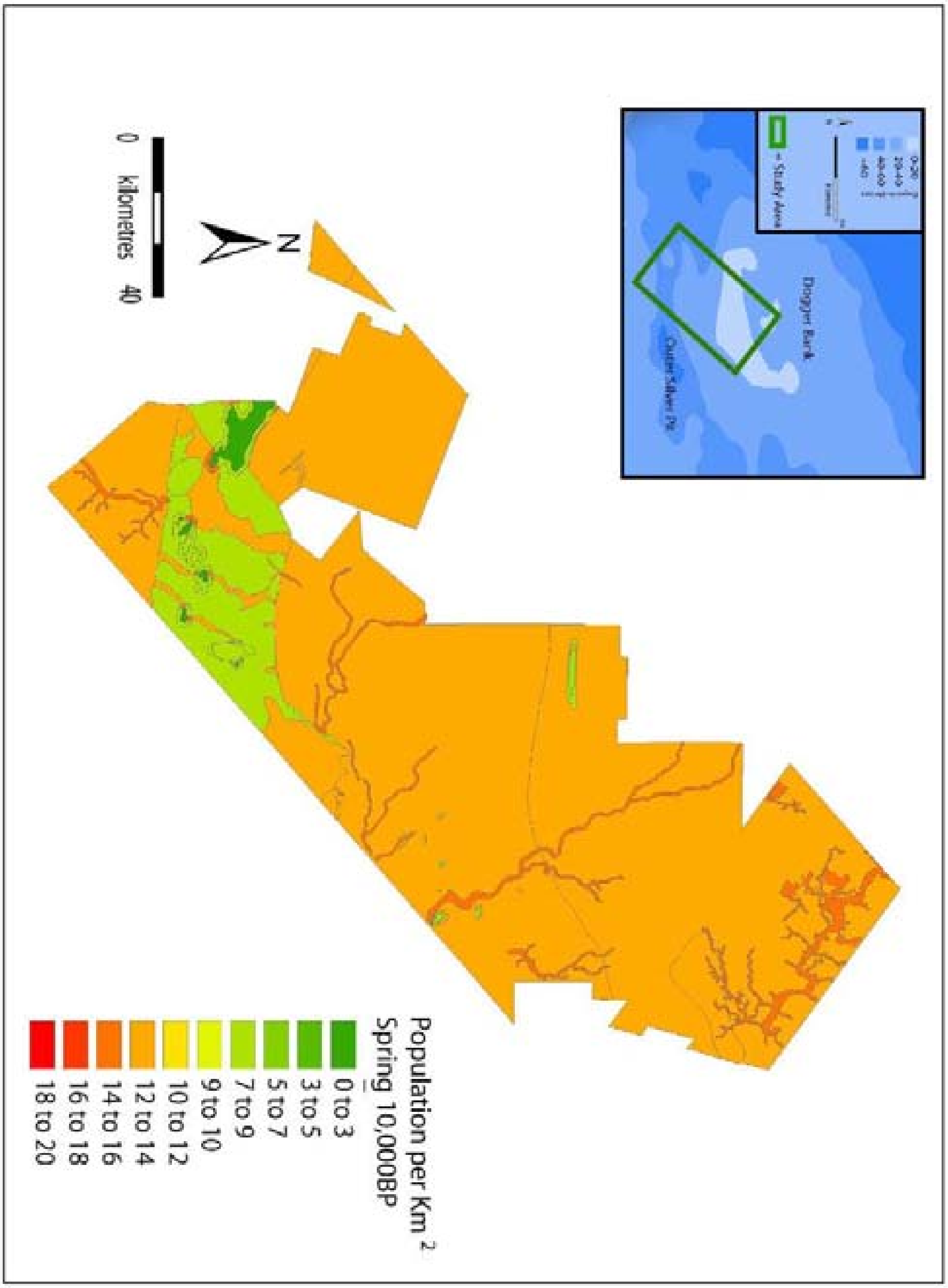

Figure 9.26 Population density map for the spring (10,000BP)

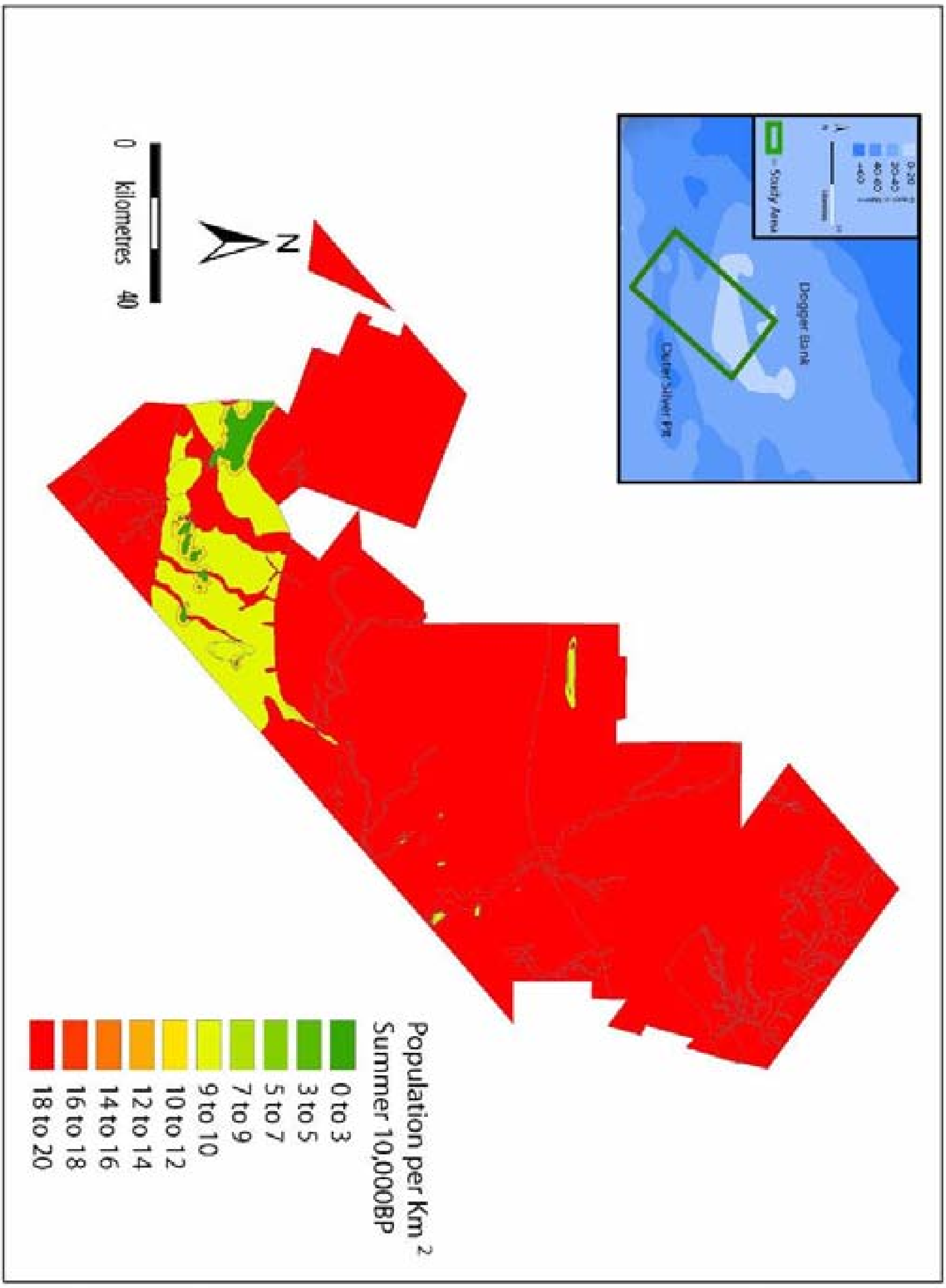

Figure 9.27 Population density map for the summer (10,000BP)

9.8 Population Density 9,500BP

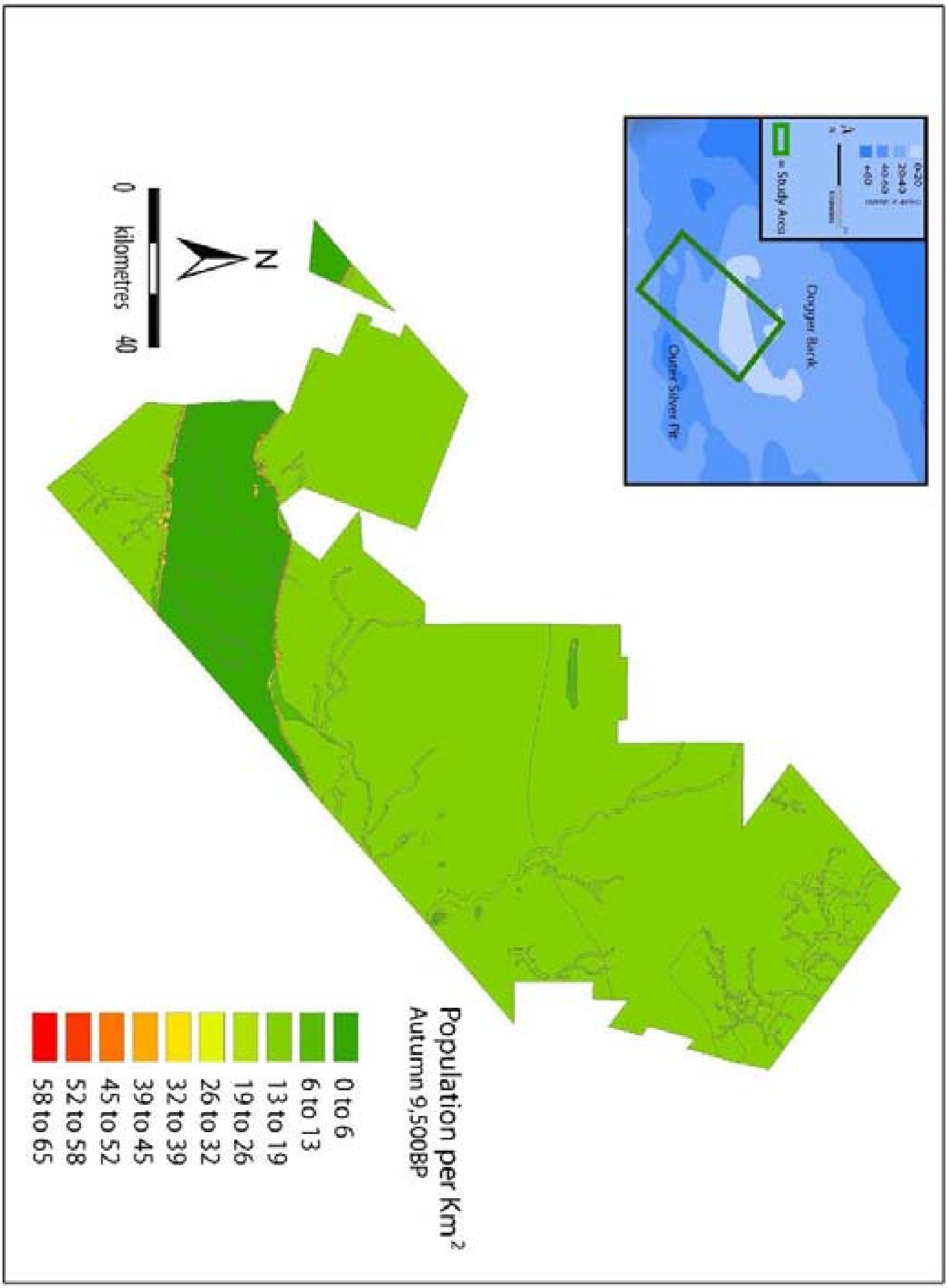

Figure 9.28 Population density map for the autumn (9,500BP)

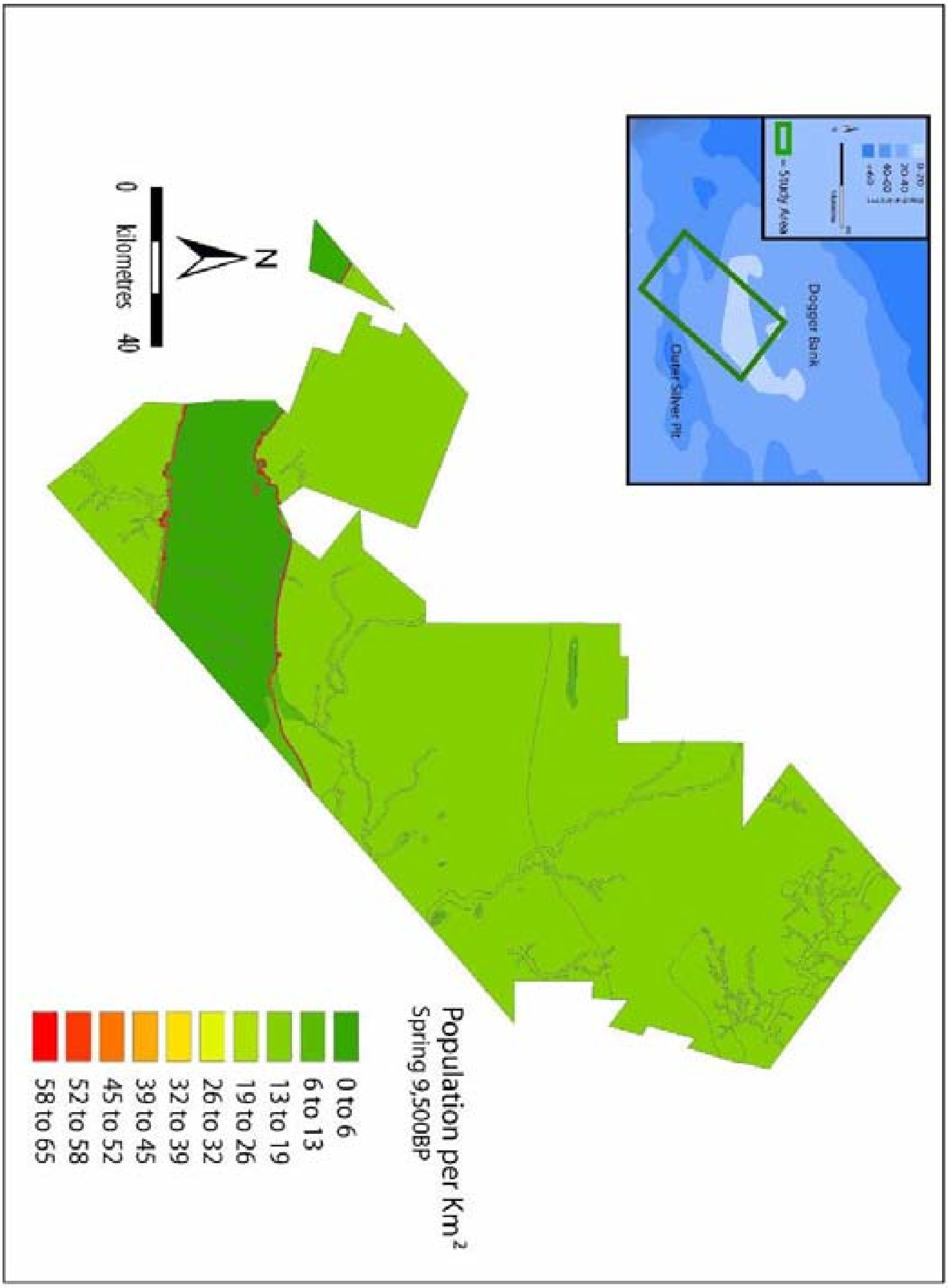

Figure 9.29 Population density map for the spring (9,500BP)

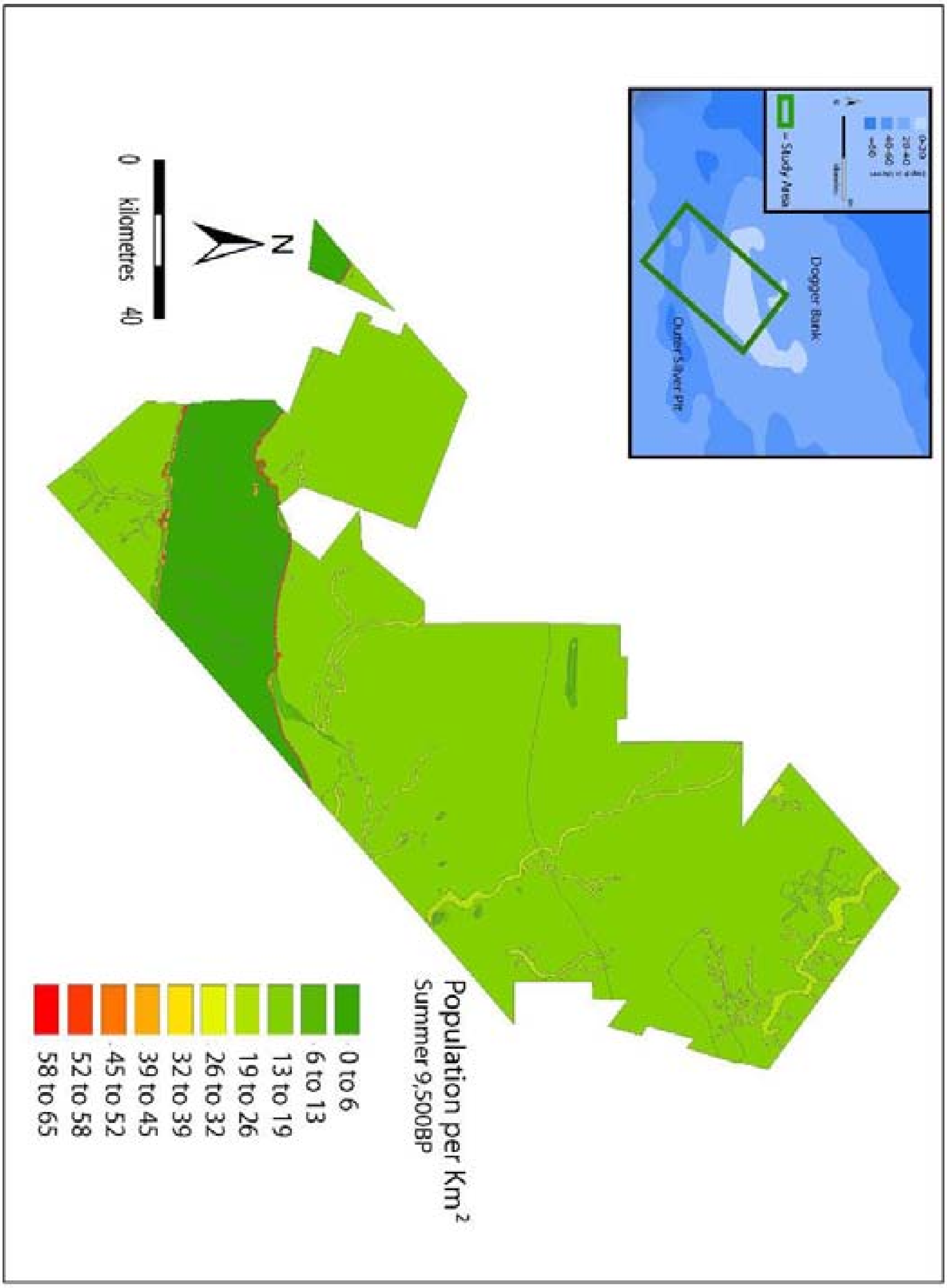

Figure 9.30 Population density map for the summer (9,500BP)

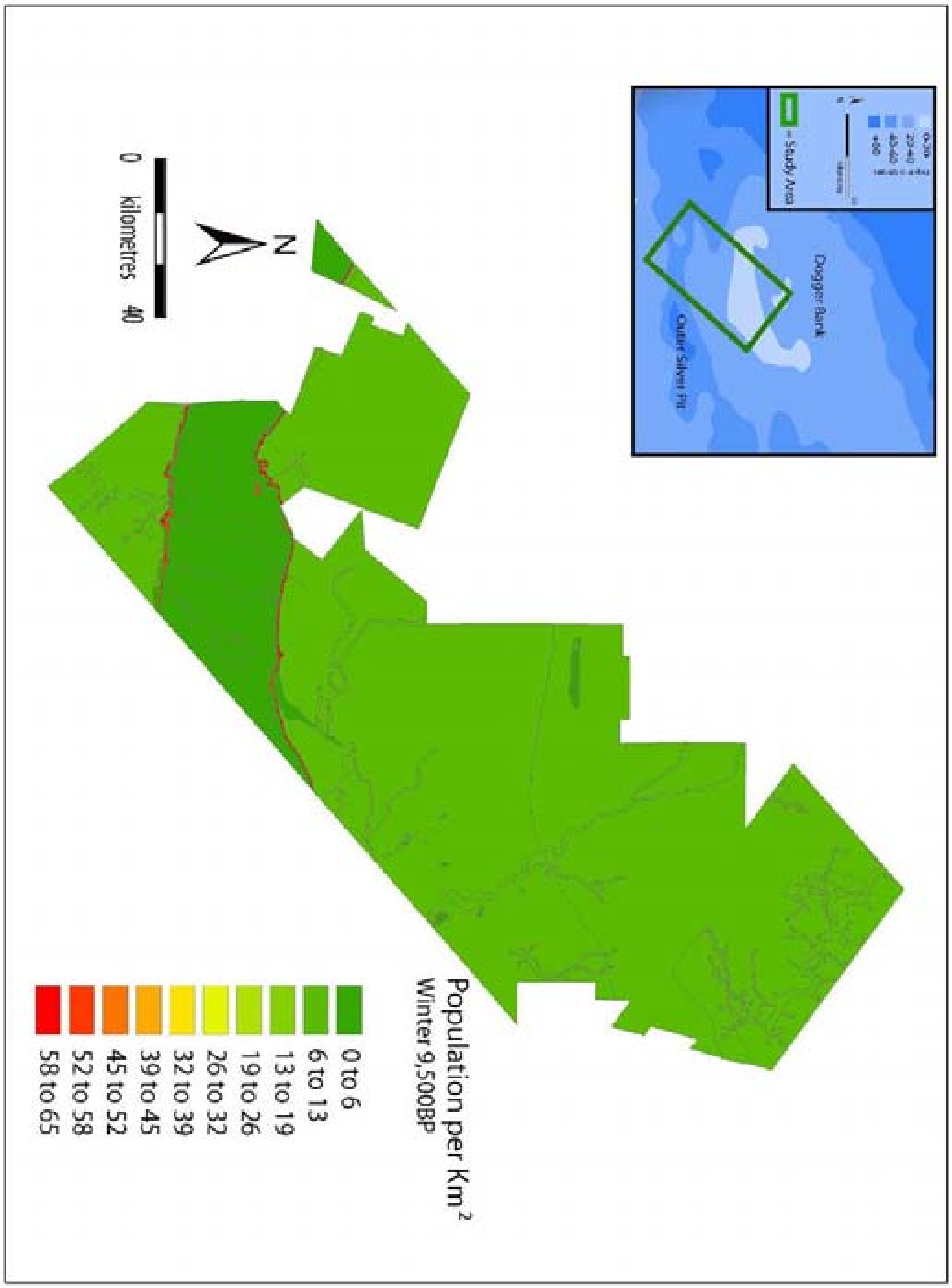

Figure 9.31 Population density map for the winter (9,500BP)

9.9 Population Density 9,000BP

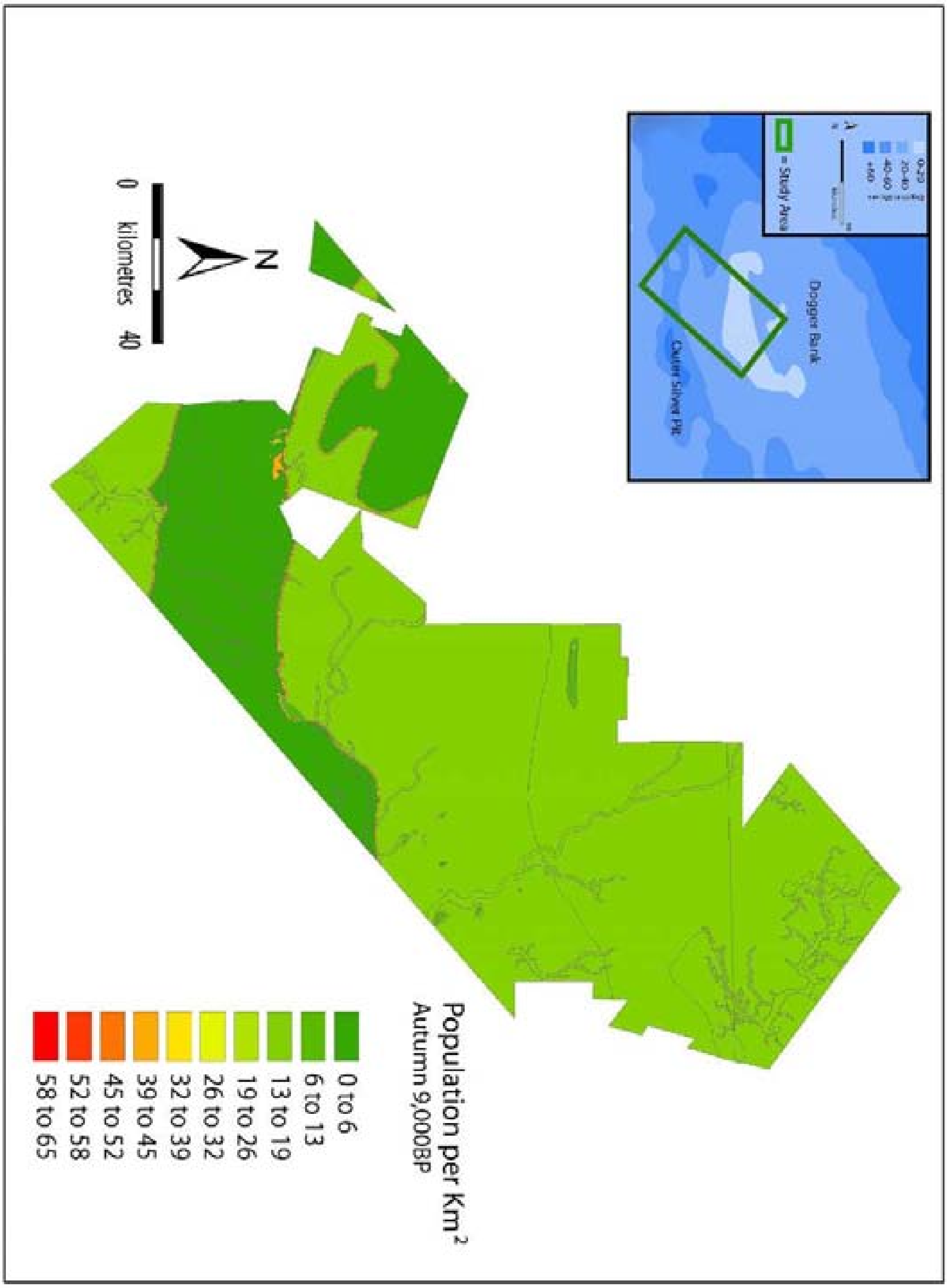

Figure 9.32 Population density map for the autumn (9,000BP)

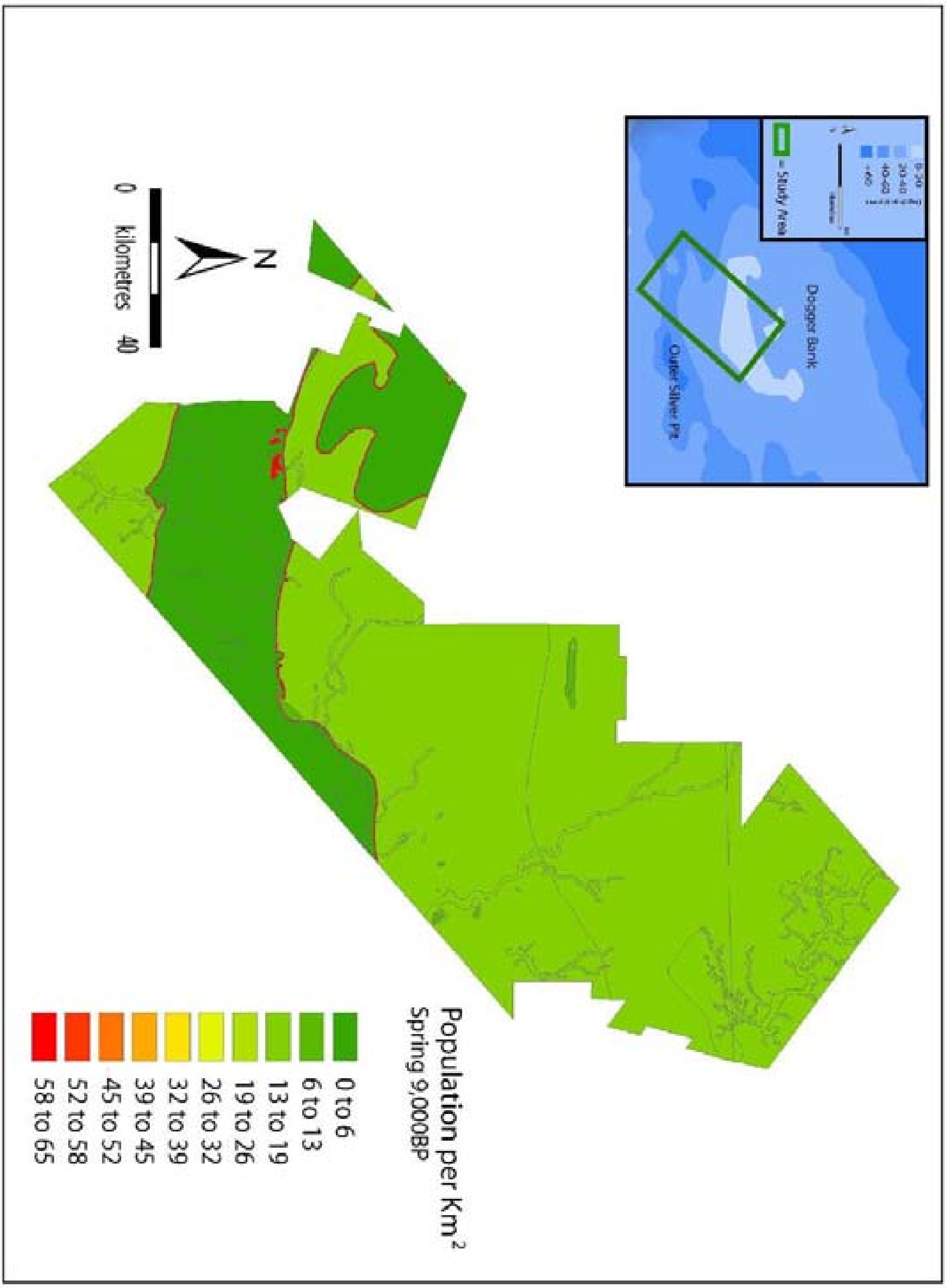

Figure 9.33 Population density map for the spring (9,000BP)

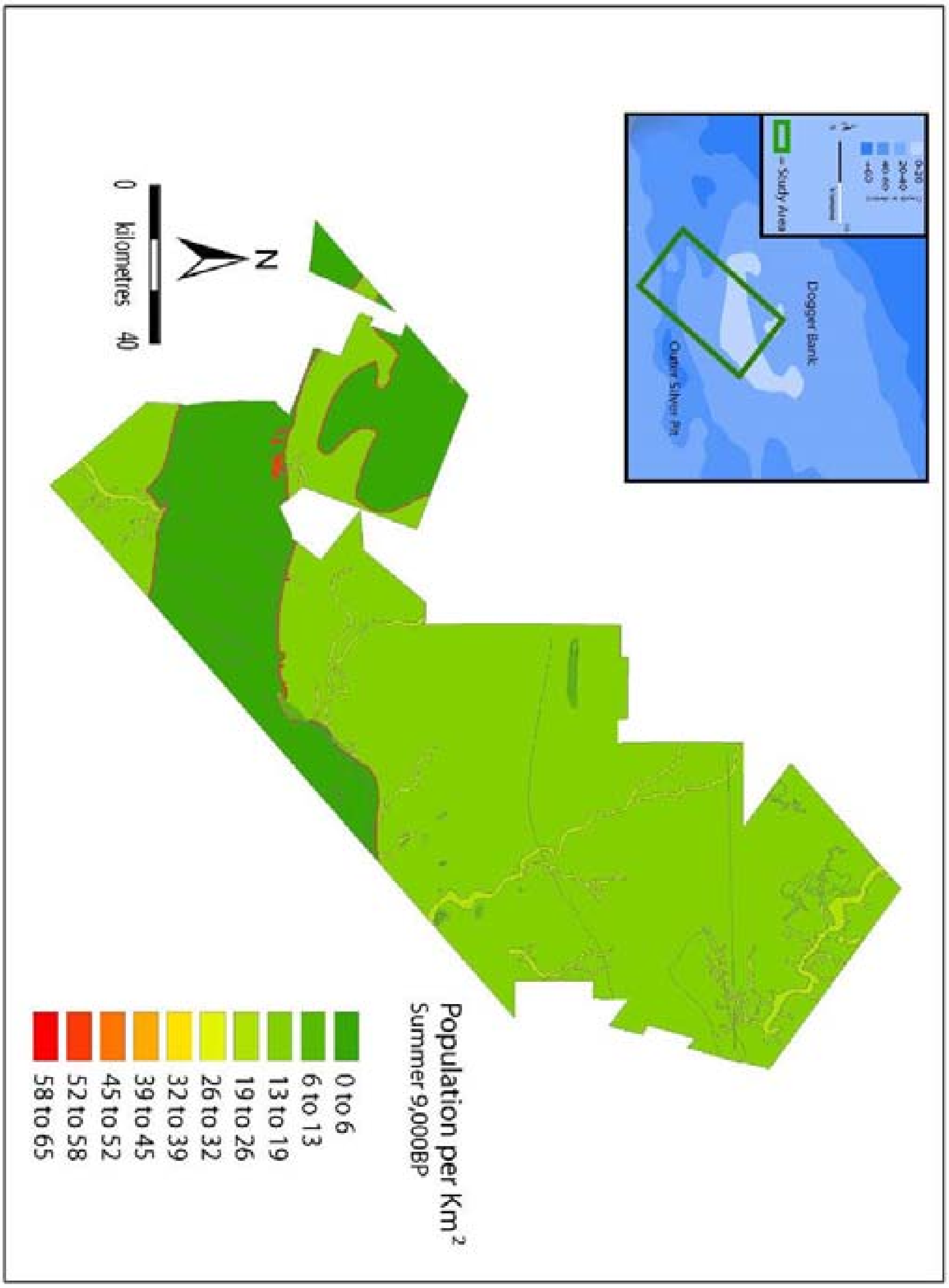

Figure 9.34 Population density map for the summer (9,000BP)

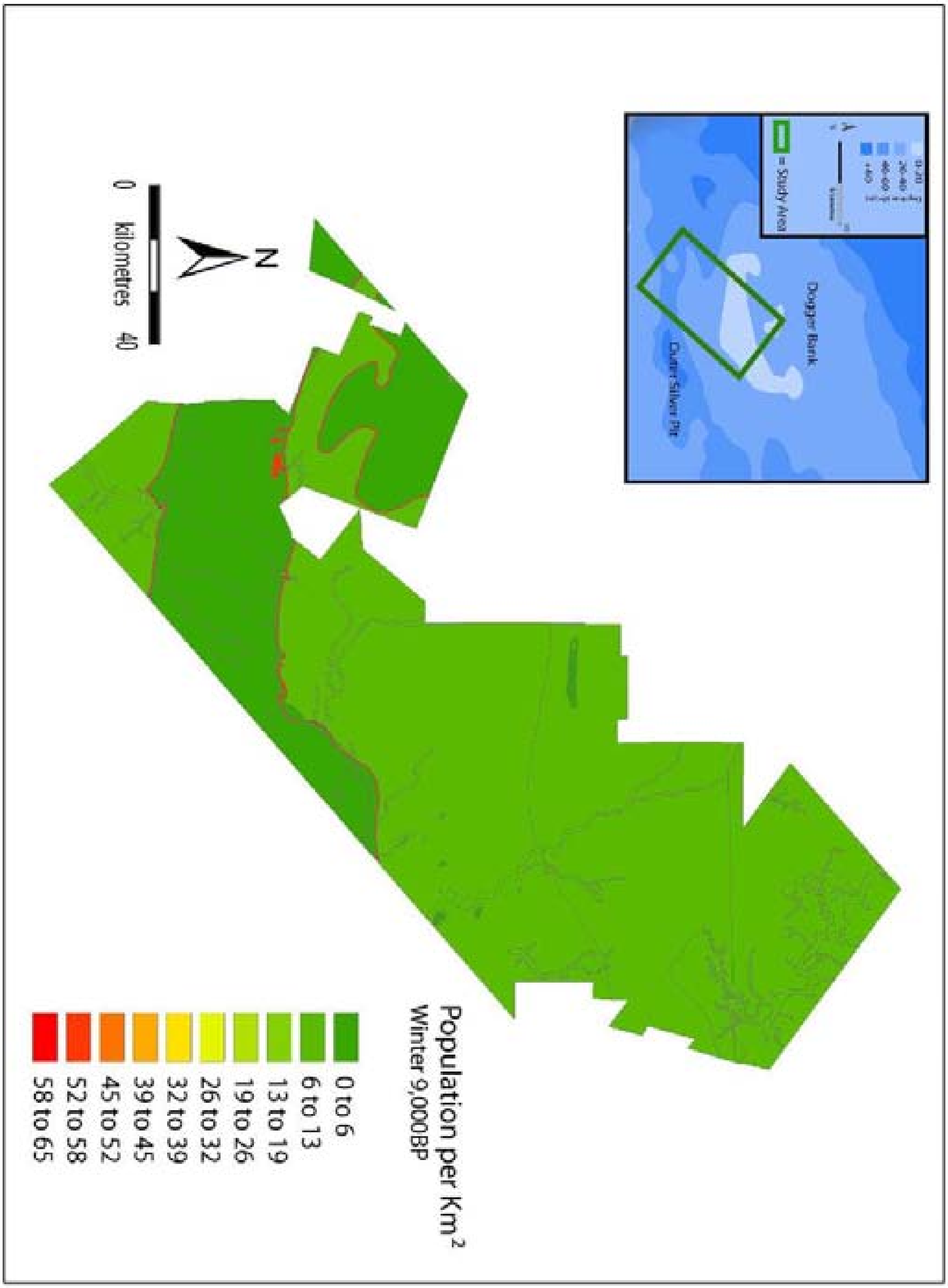

Figure 9.35 Population density map for the winter (9,000BP)

9.10 Population Density 8,500BP

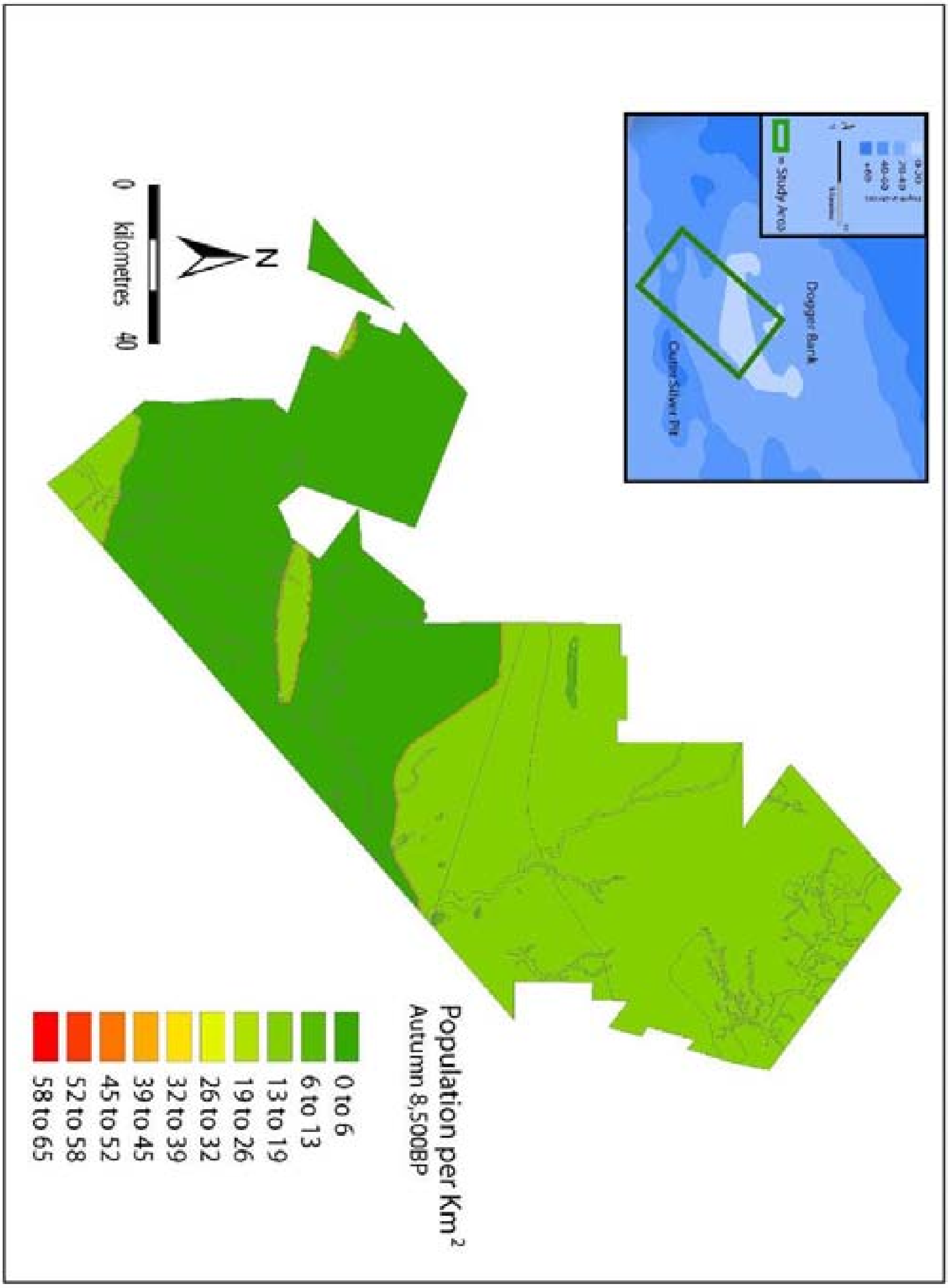

Figure 9.36 Population density map for the autumn (8,500BP)

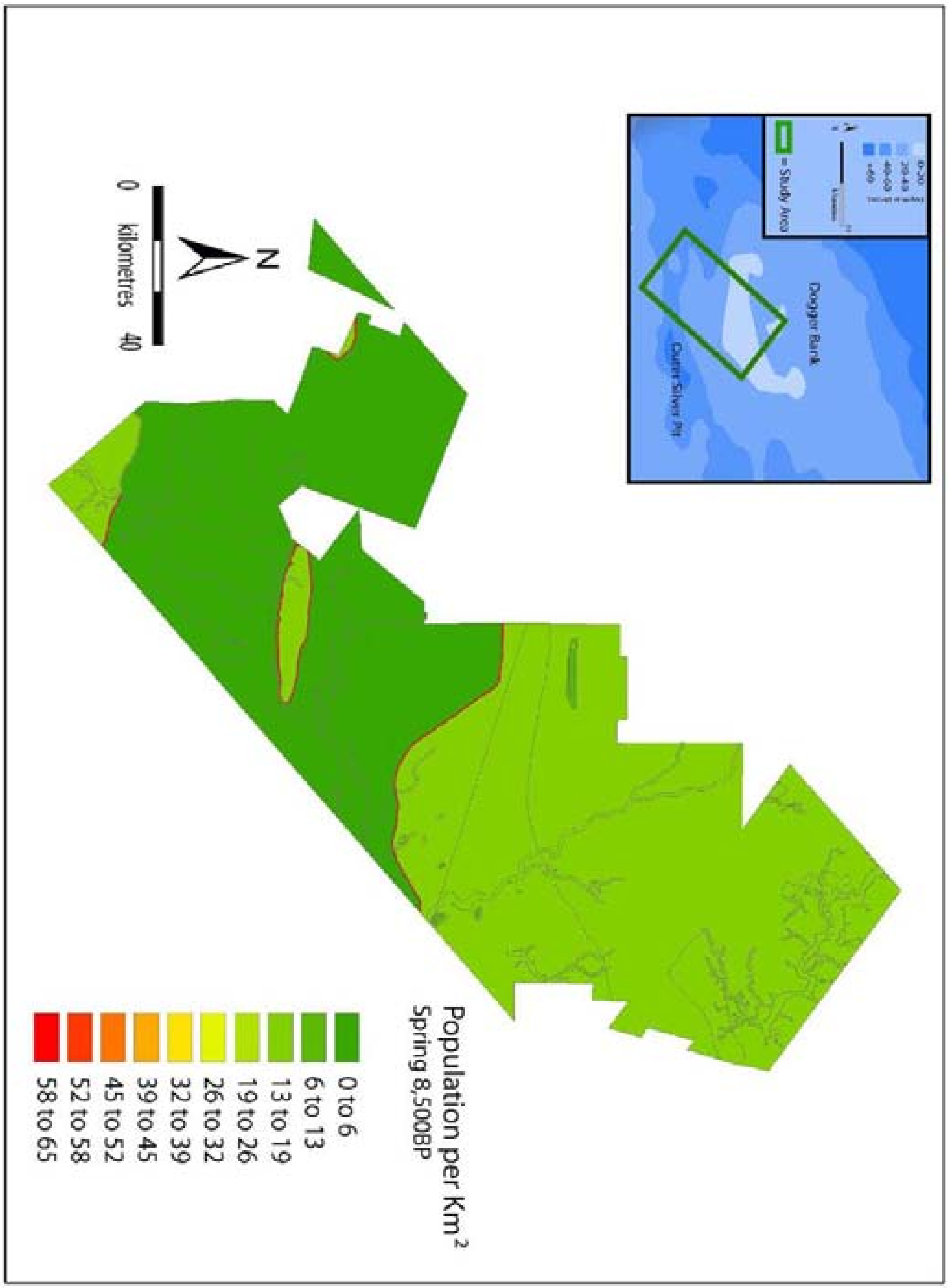

Figure 9.37 Population density map for the spring (8,500BP)

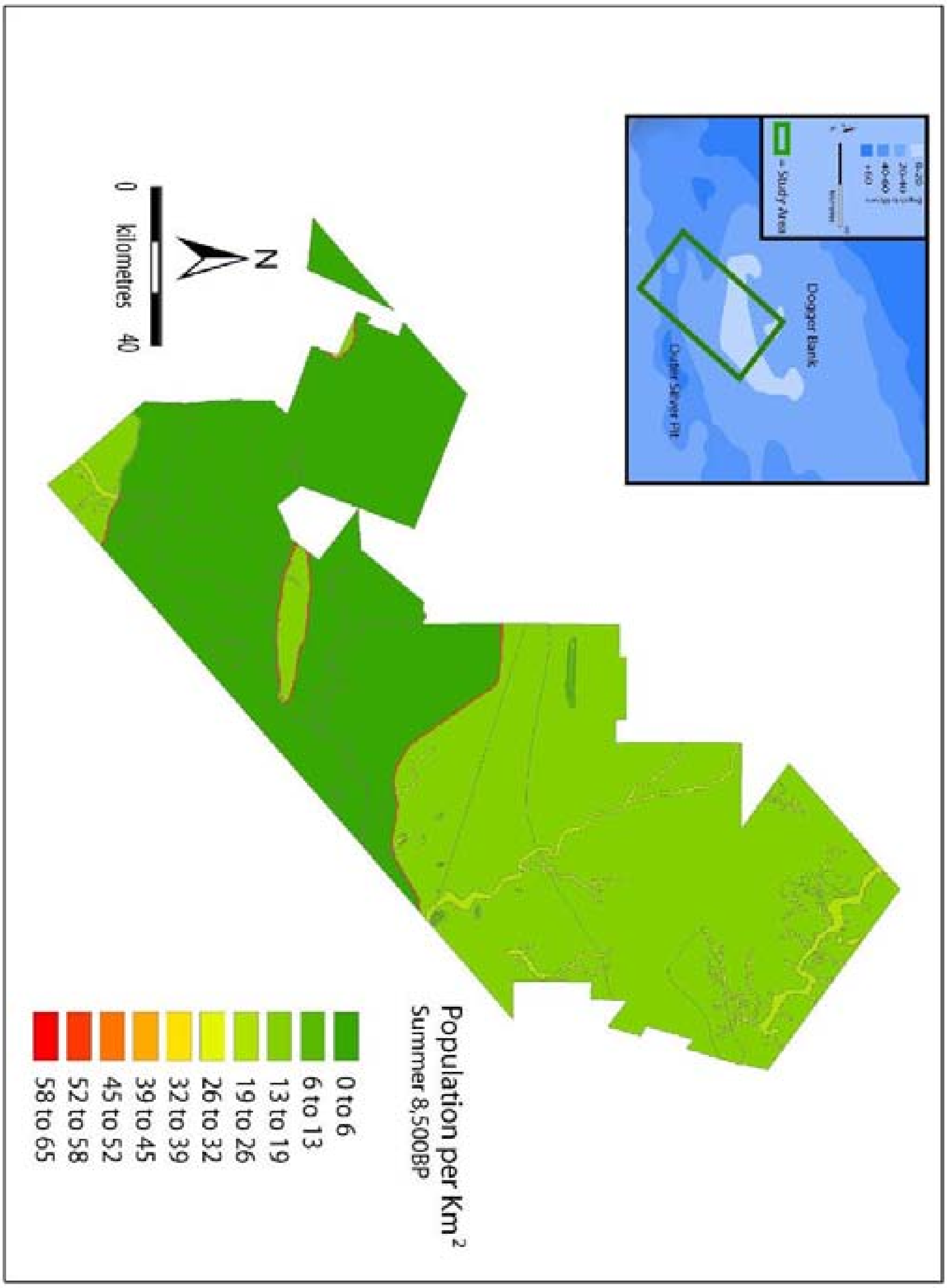

Figure 9.38 Population density map for the summer (8,500BP)

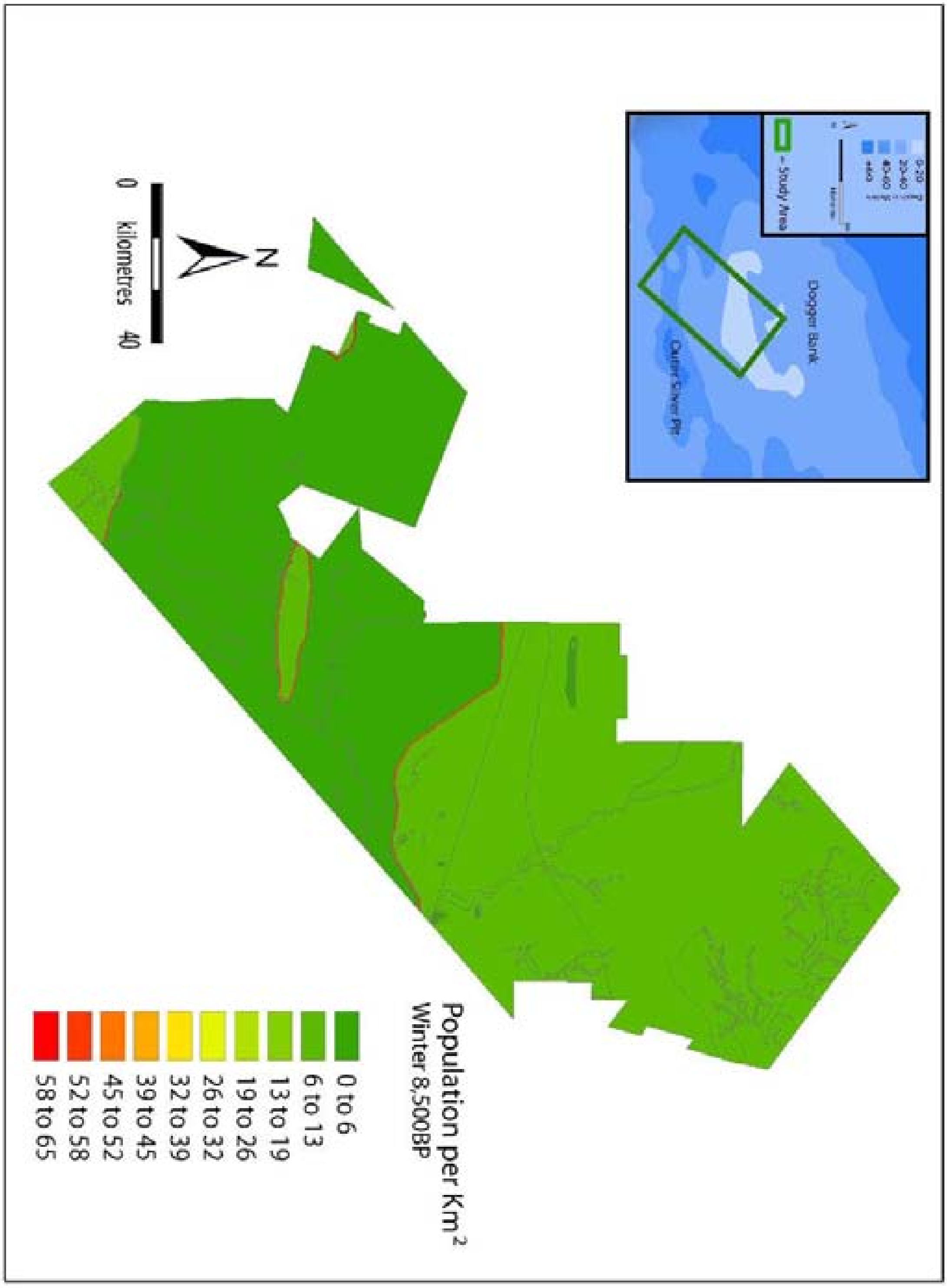

Figure 9.39 Population density map for the winter (8,500BP)

9.11 Population Density 8,000BP

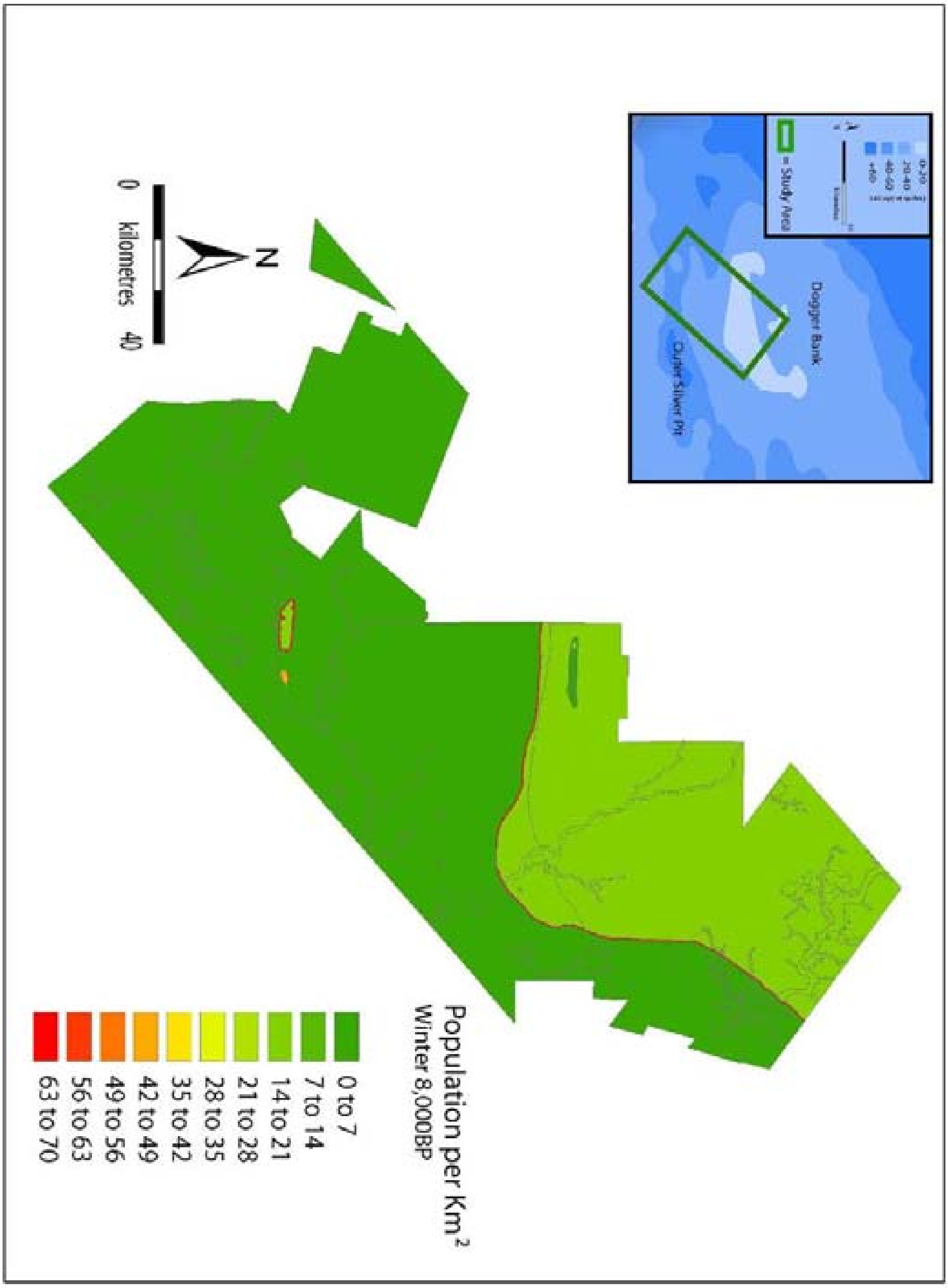

Figure Population density map for the winter (8,000BP)

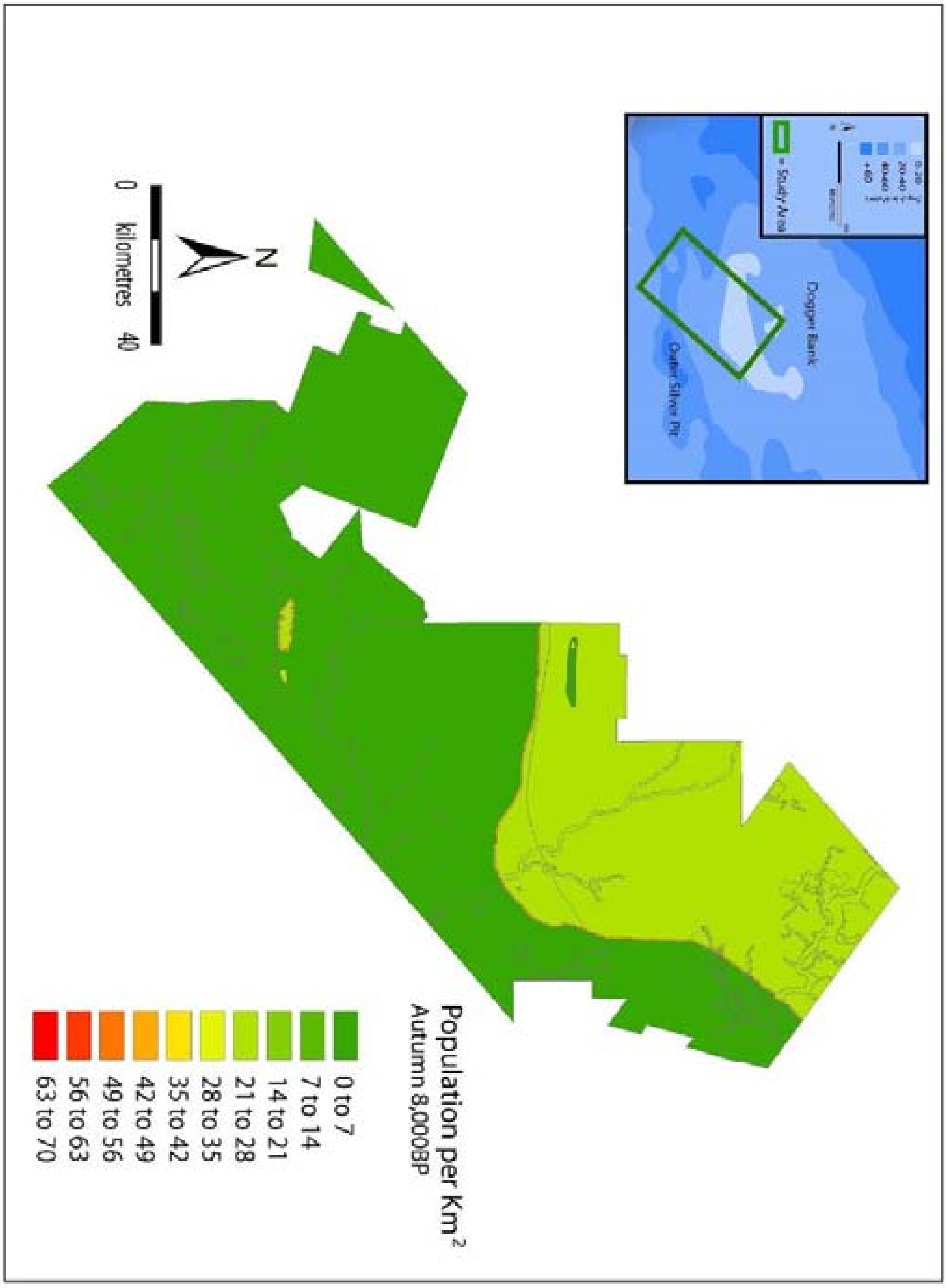

Figure 9.39 Population density map for the autumn (8,000BP)

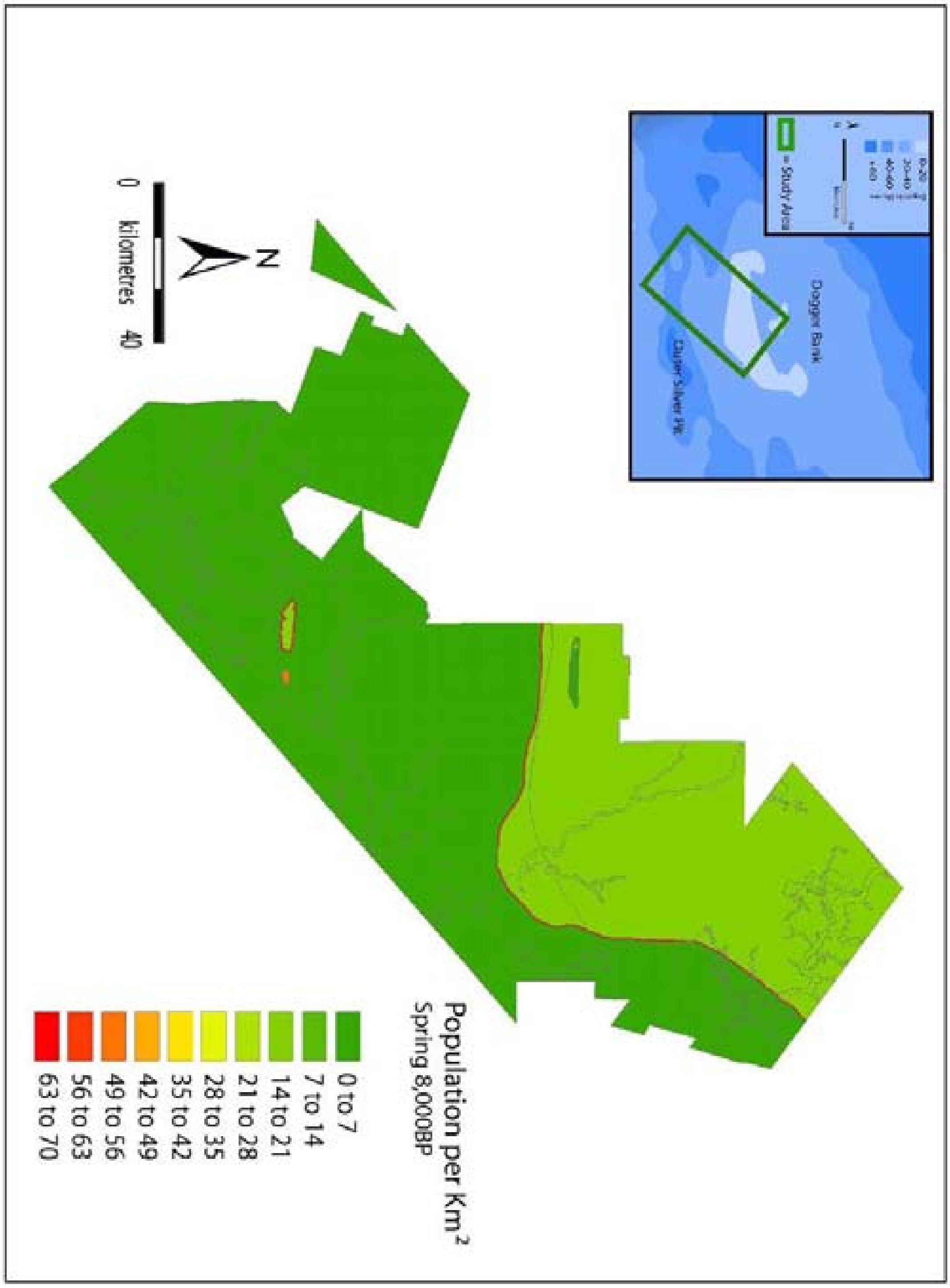

Figure 9.40 Population density map for the spring (8,000BP)

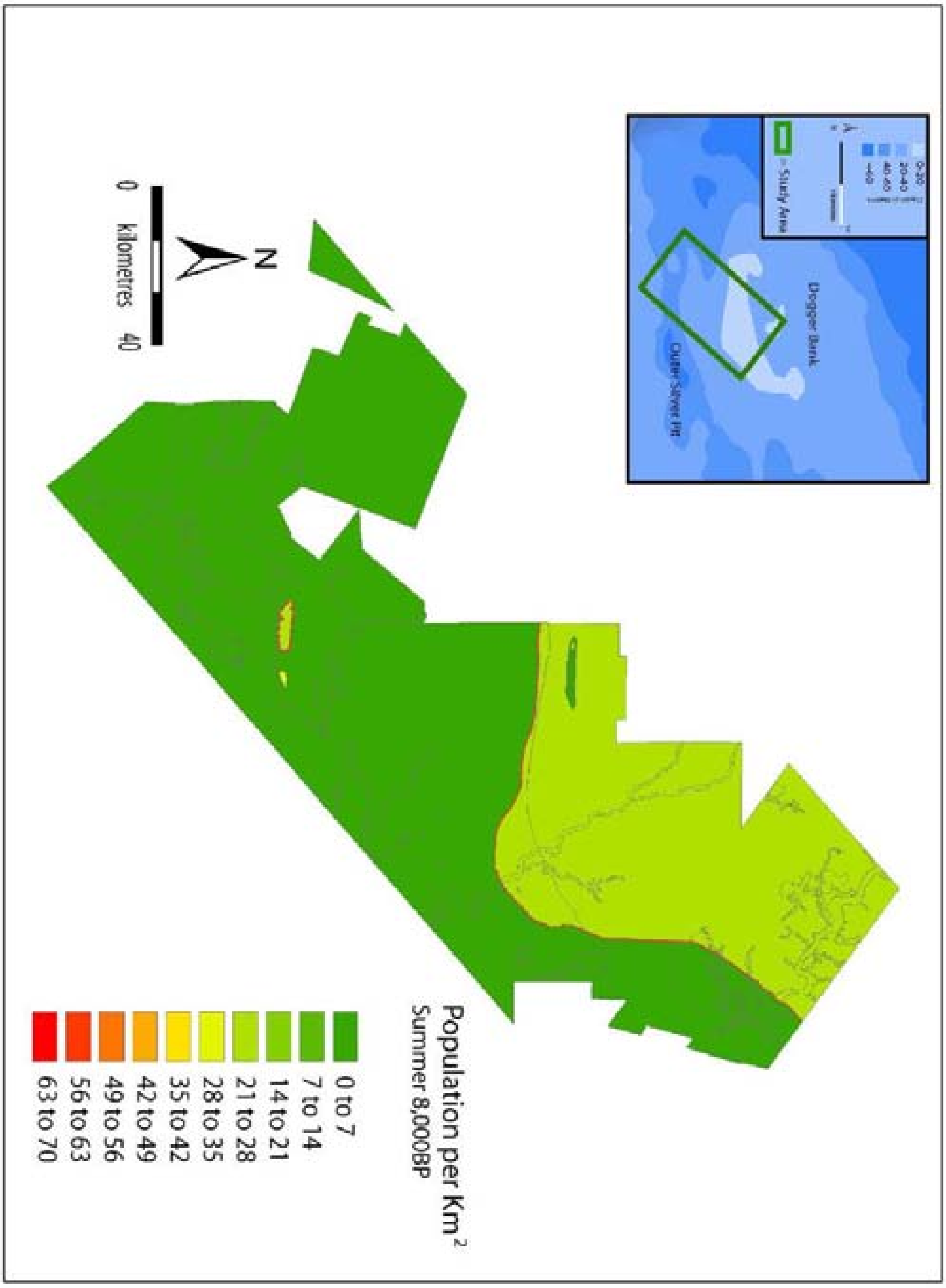

Figure 9.41 Population density map for the summer (8,000BP)

9.12 Population Density 7,500BP

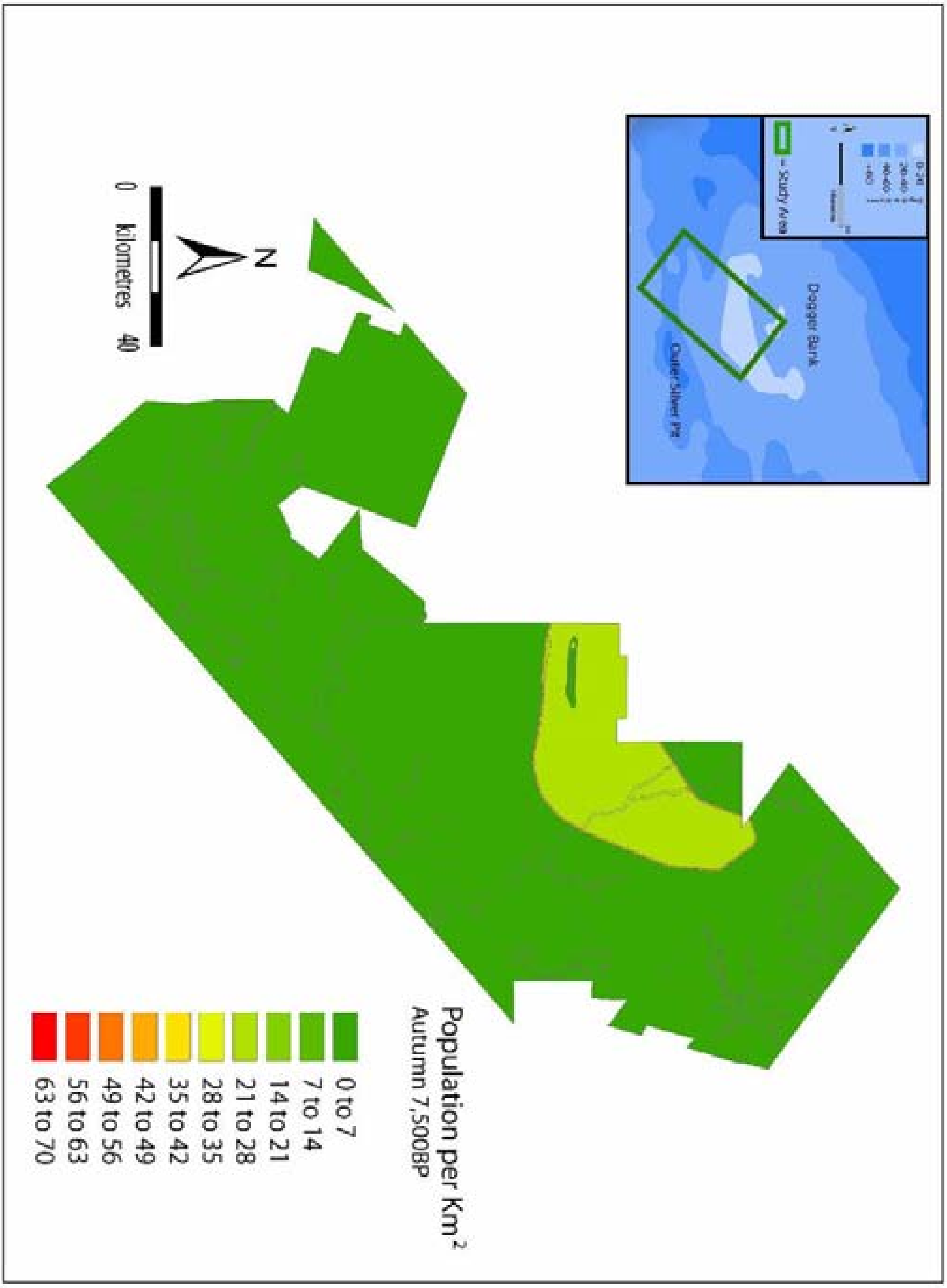

Figure Population density map for the autumn (7,500BP)

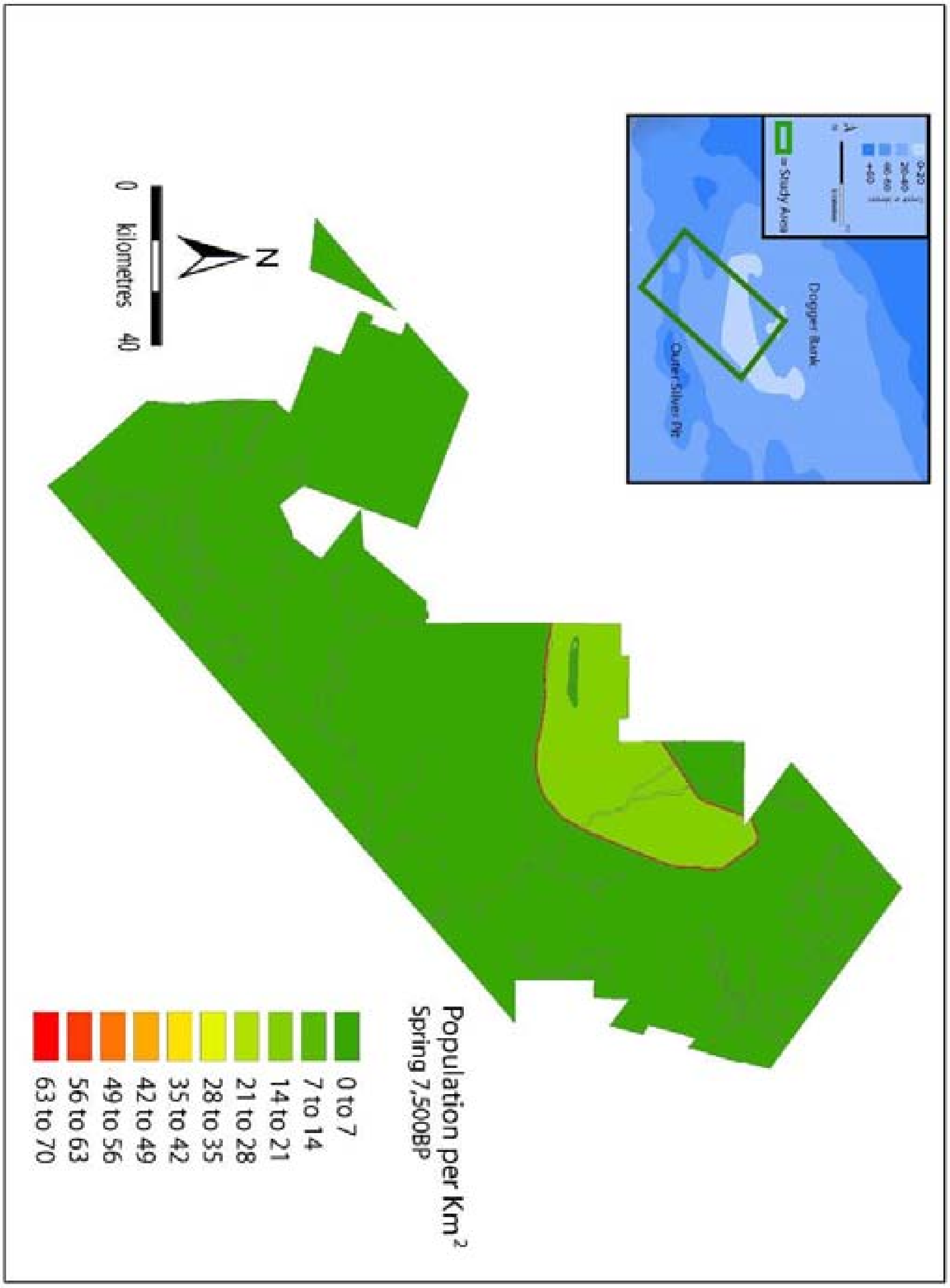

Figure 9.42 Population density map for the spring (7,500BP)

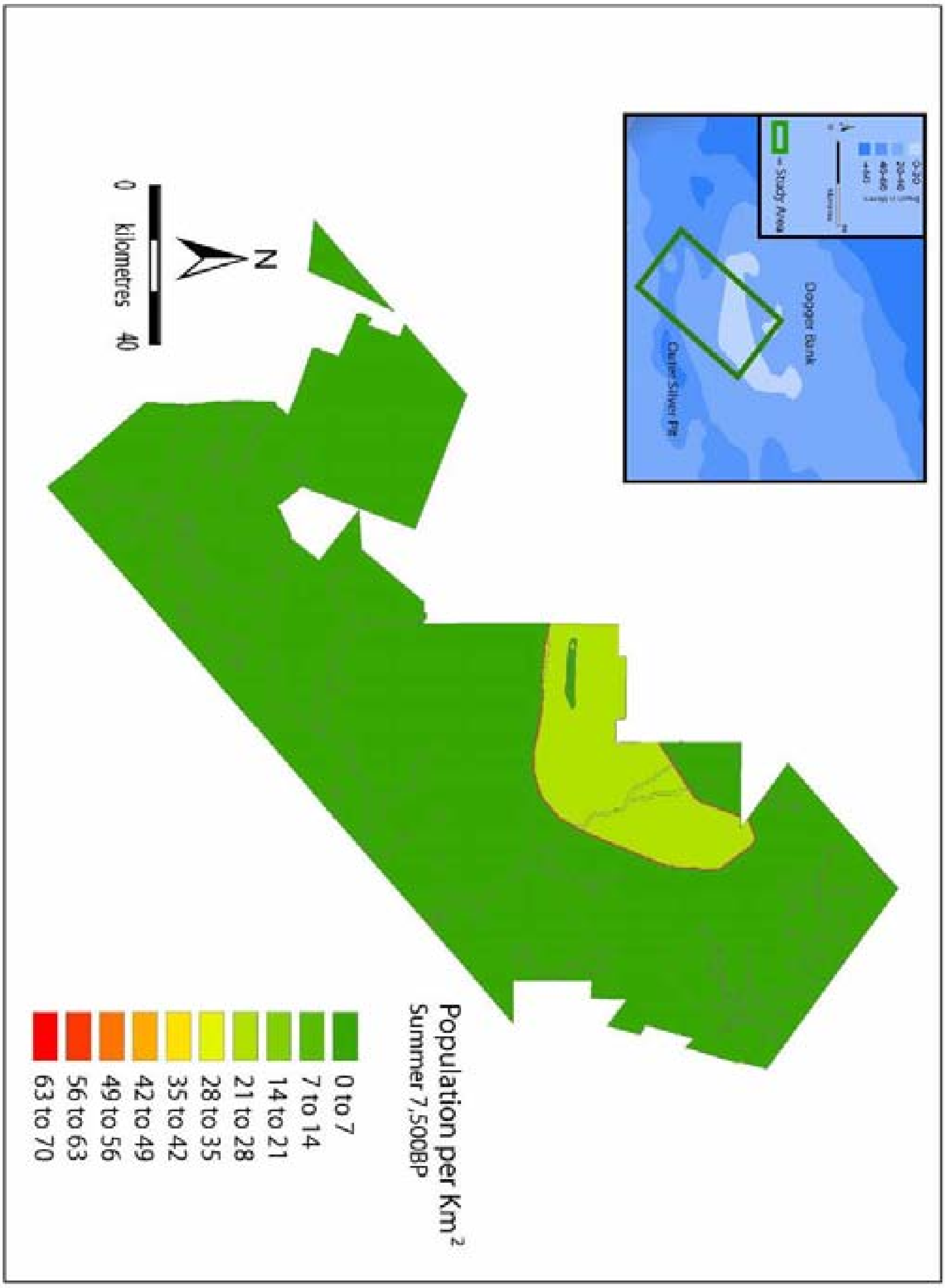

Figure 9.43 Population density map for the summer (7,500BP)

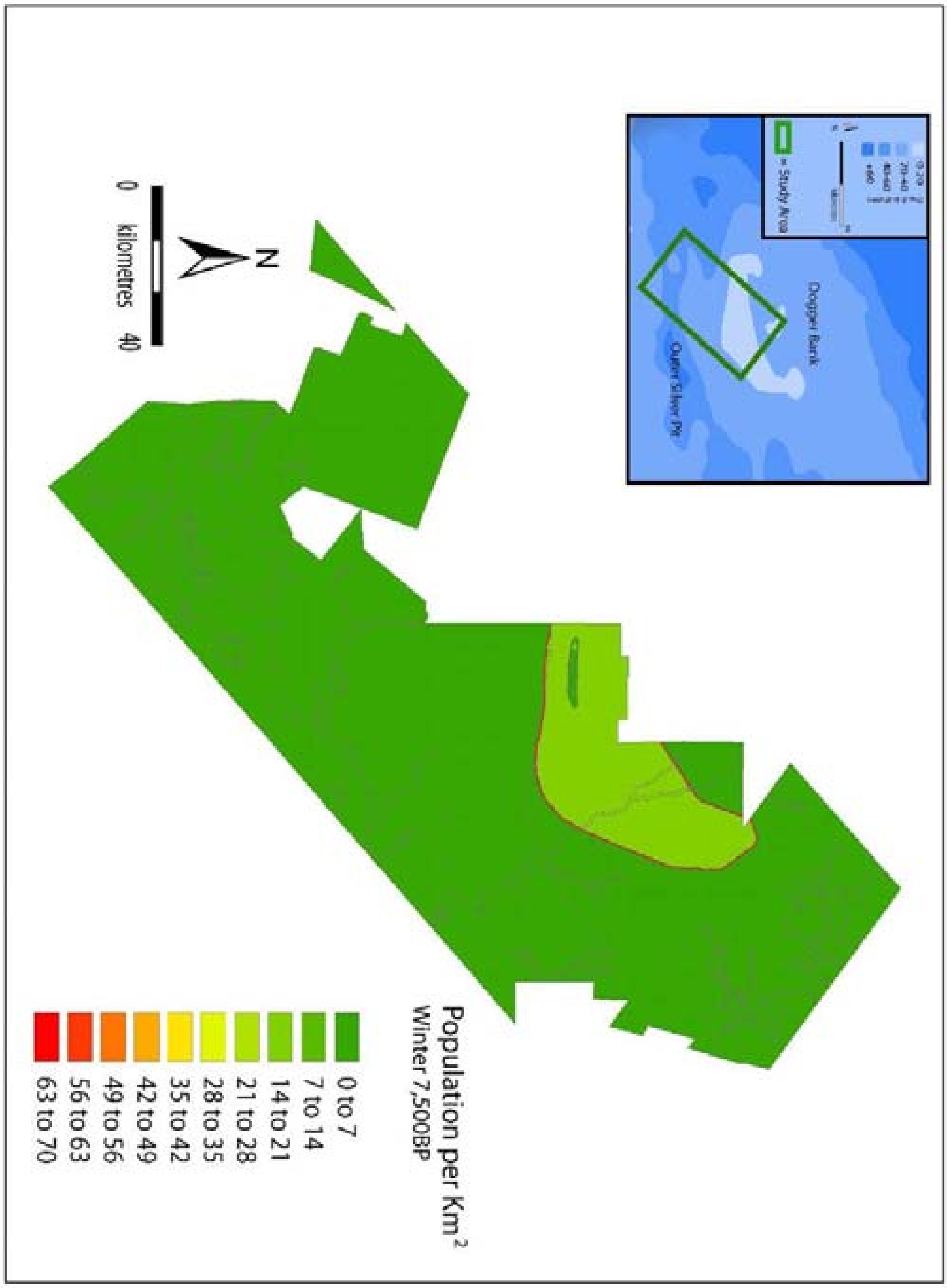

Figure 9.44 Population density map for the winter (7,500BP)

9.13 Population Density Catchment Analysis

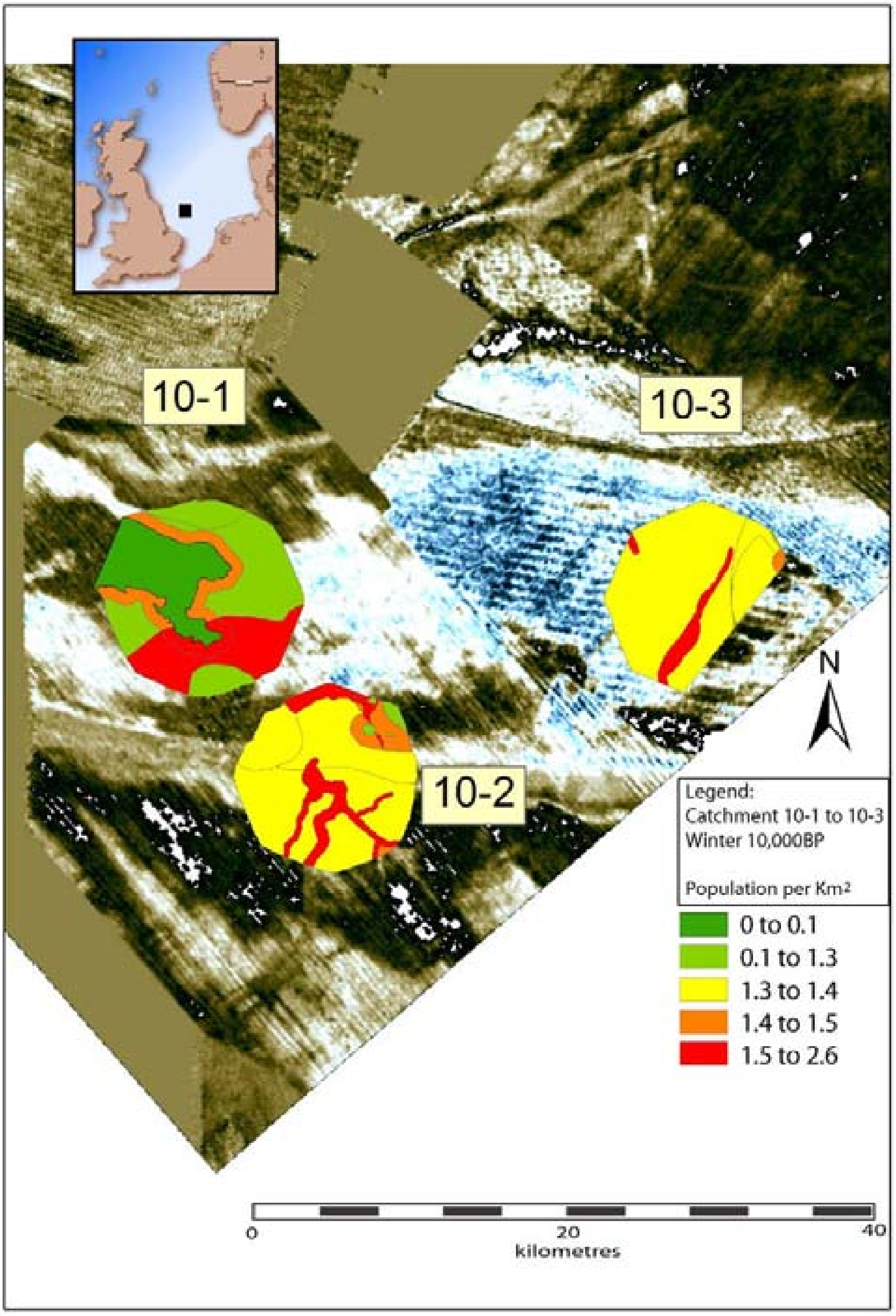

Figure 9.45 Population density map for the all catchment analysis at winter 10,000BP

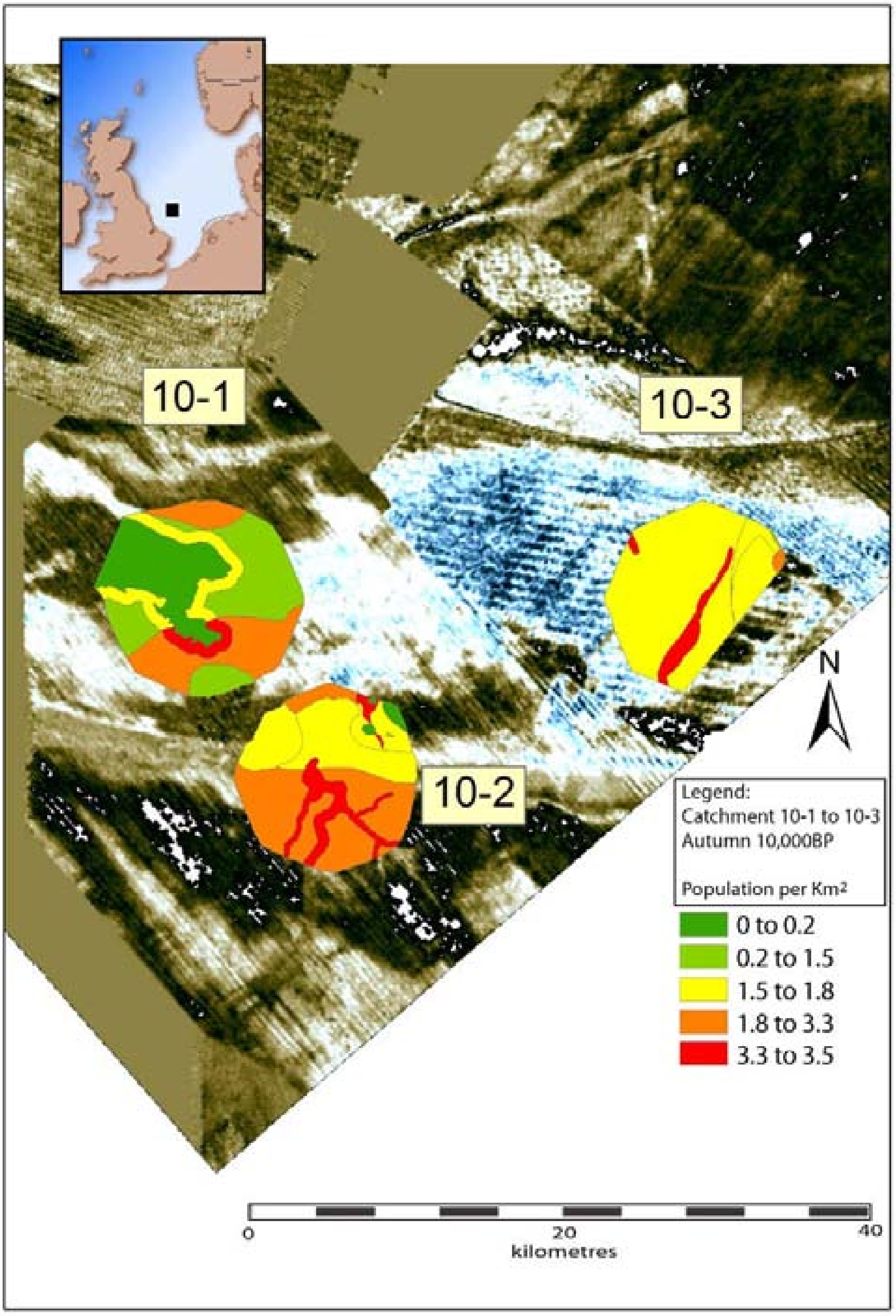

Figure 9.46 Population density map for the all catchment analysis at Autumn 10,000BP

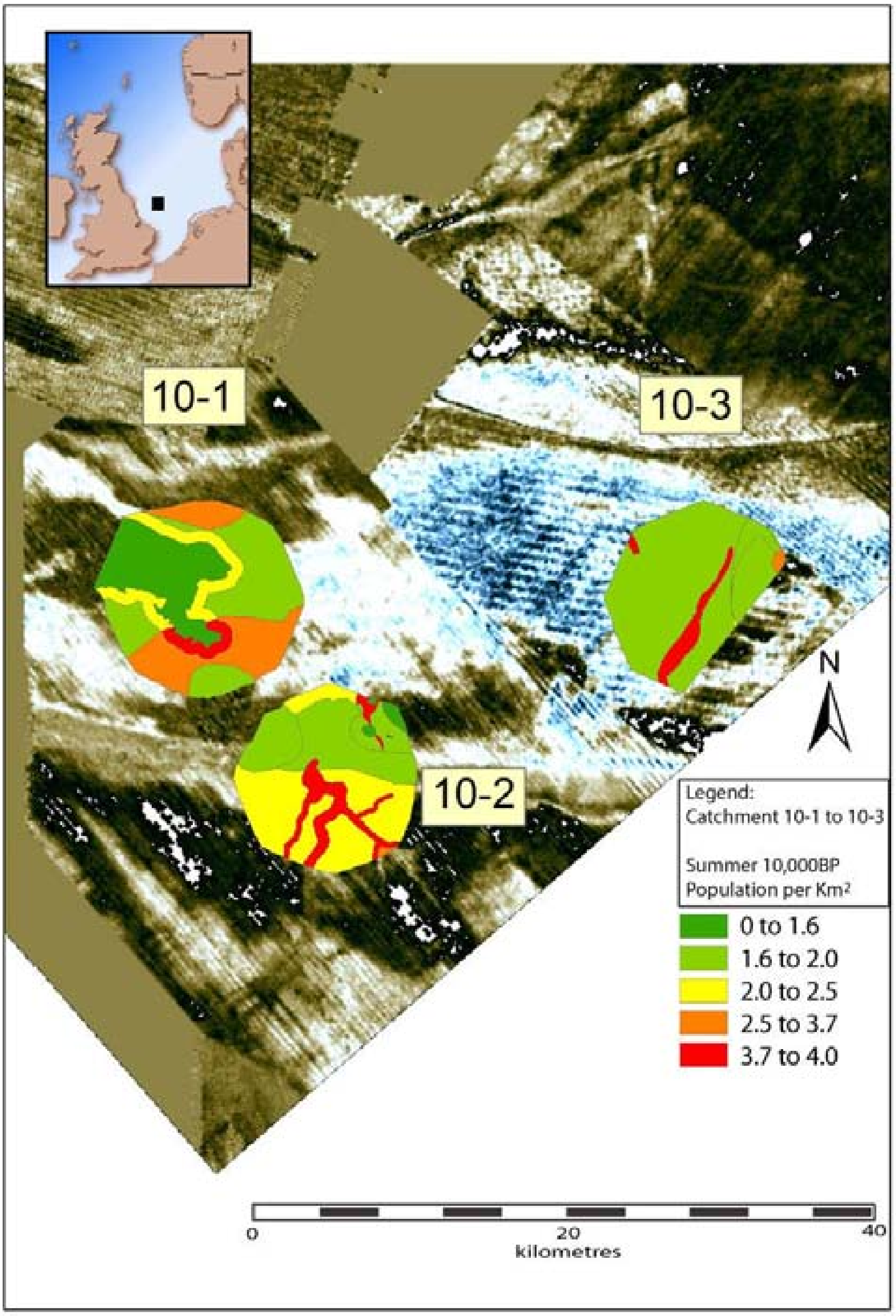

Figure 9.47 Population density map for the all catchment analysis at summer 10,000BP

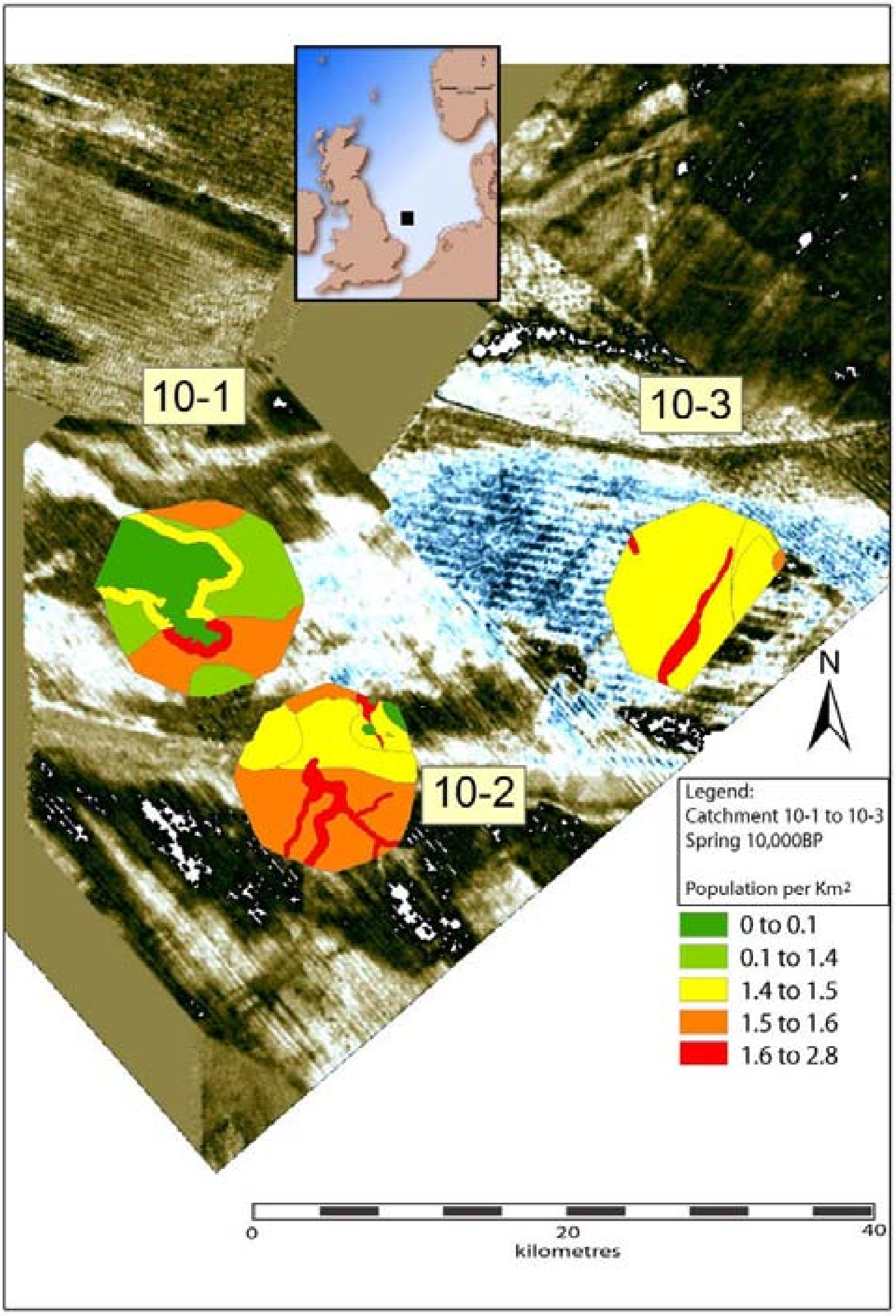

Figure 9.48 Population density map for the all catchment analysis at spring 10,000BP

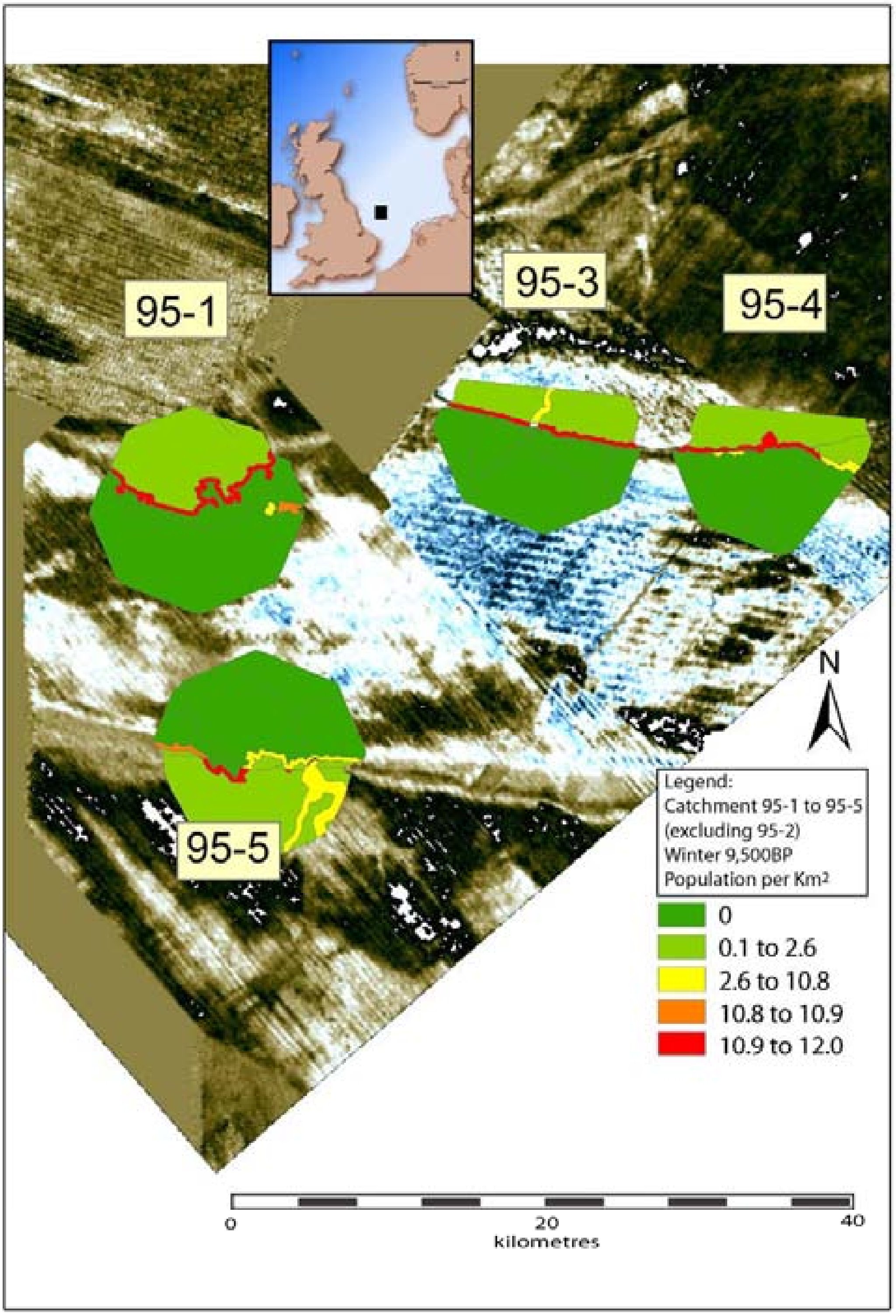

Figure 9.49a Population density map for catchment analysis at winter 9,500BP

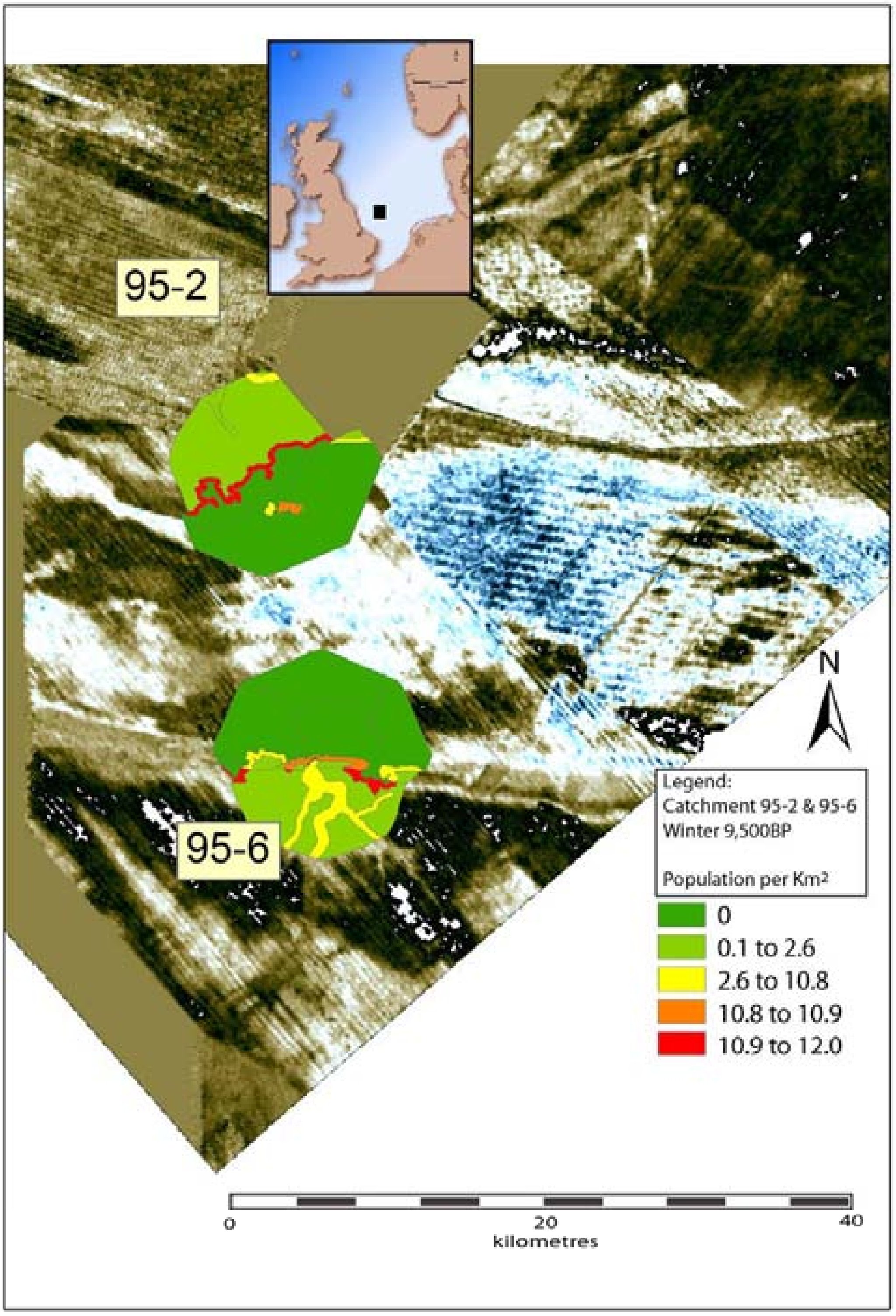

Figure 9.49b Population density map for catchment analysis at winter 9,500BP

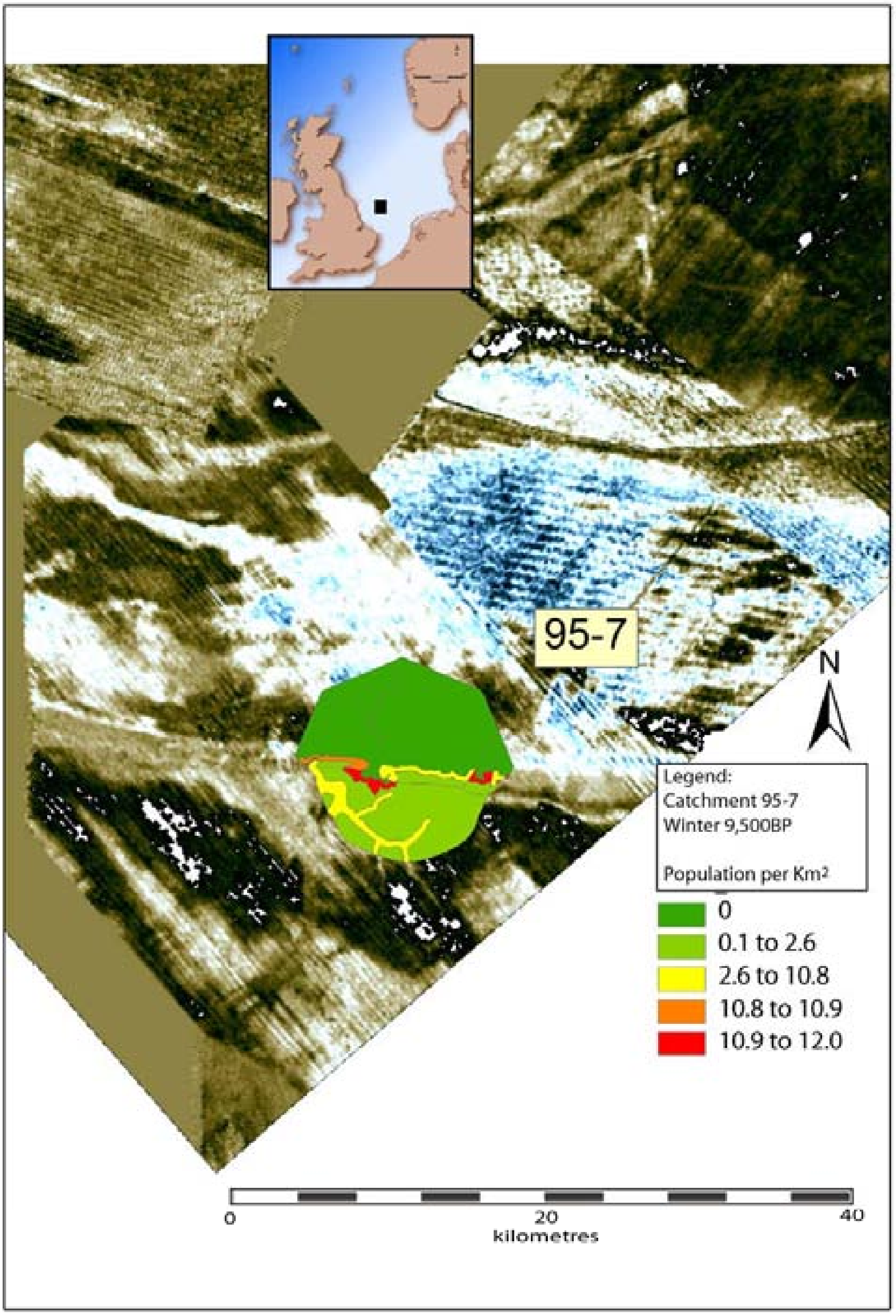

Figure 9.49c Population density map for catchment analysis at winter 9,500BP

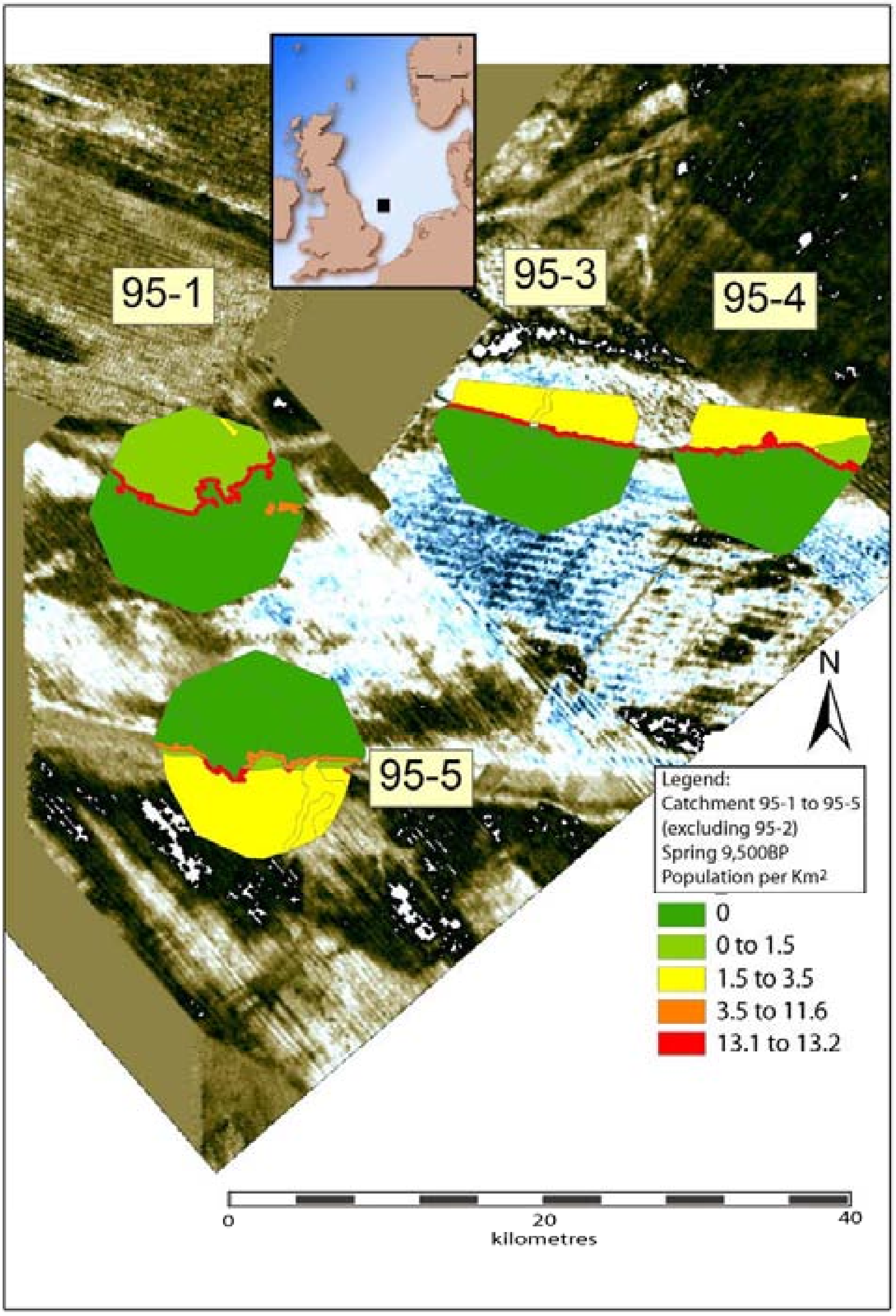

Figure 9.50a Population density map for catchment analysis at spring 9,500BP

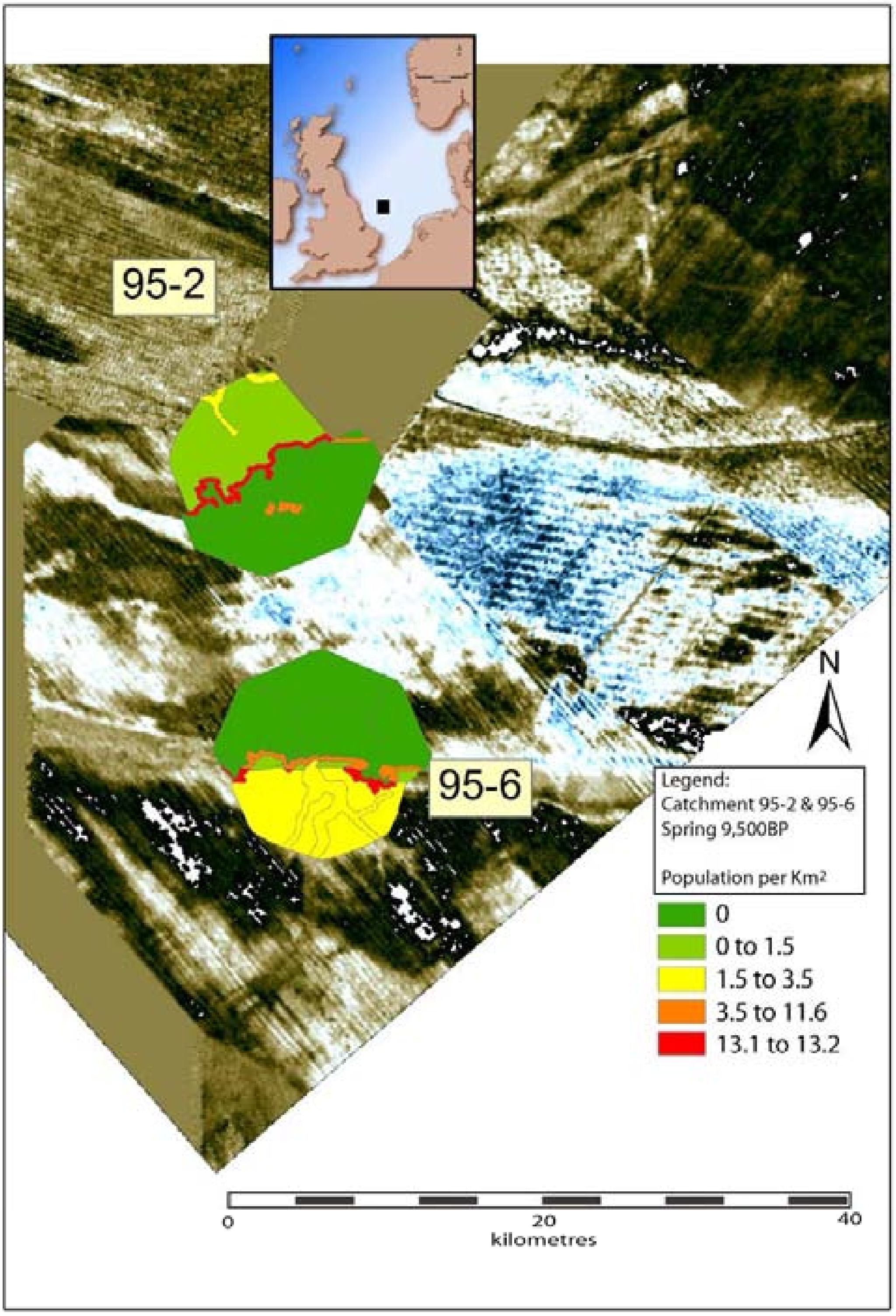

Figure 9.50b Population density map for catchment analysis at spring 9,500BP

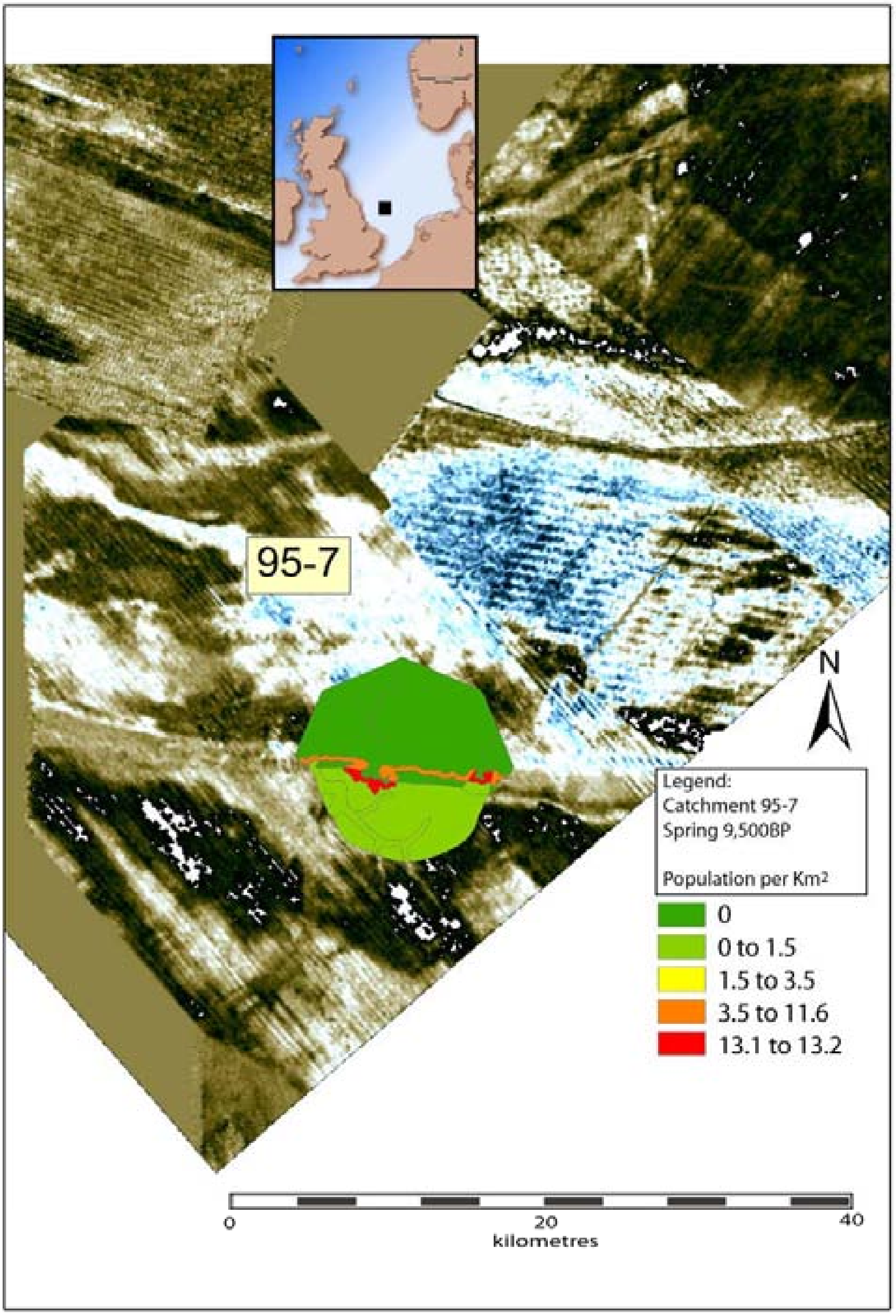

Figure 9.50c Population density map for catchment analysis at spring 9,500BP

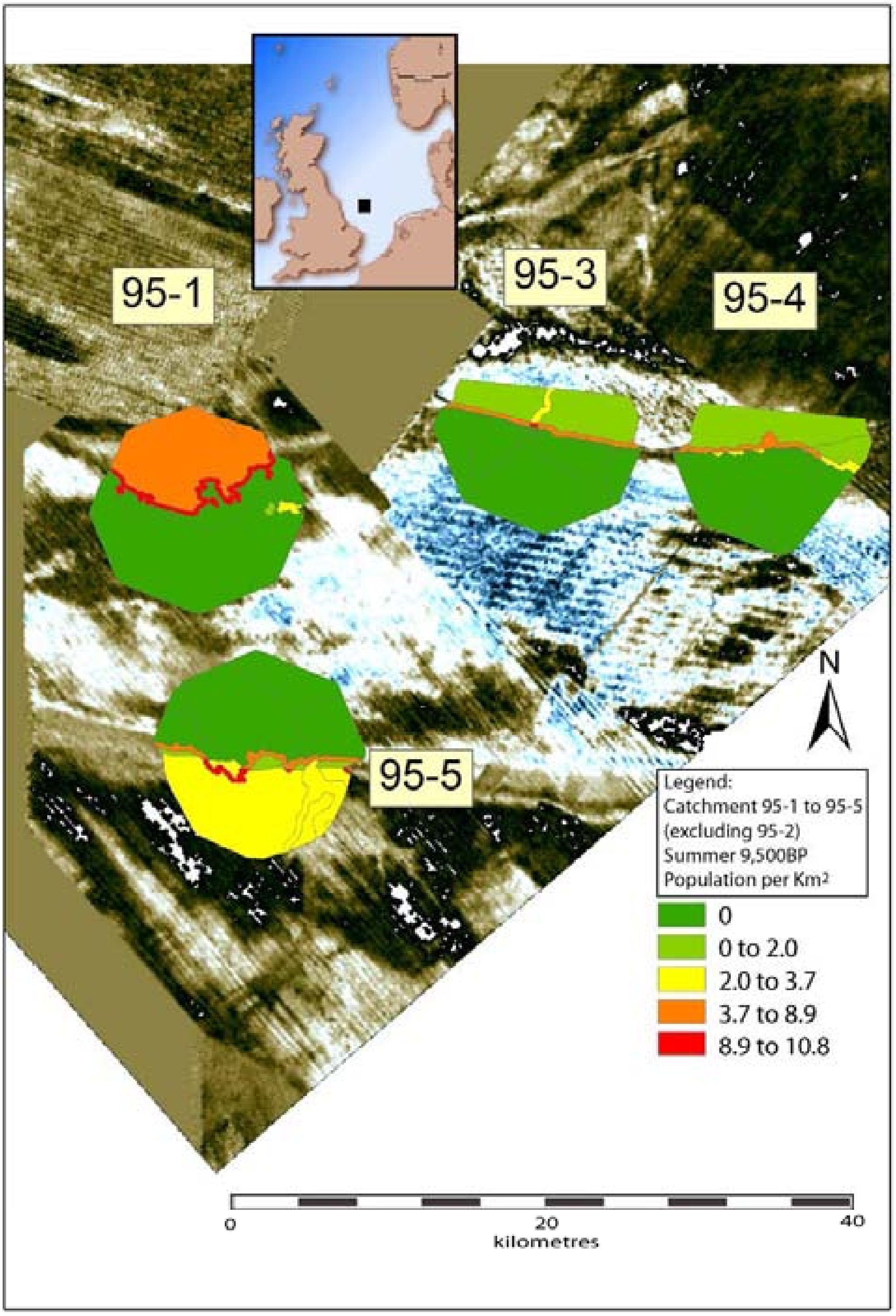

Figure 9.51a Population density map for catchment analysis at summer 9,500BP

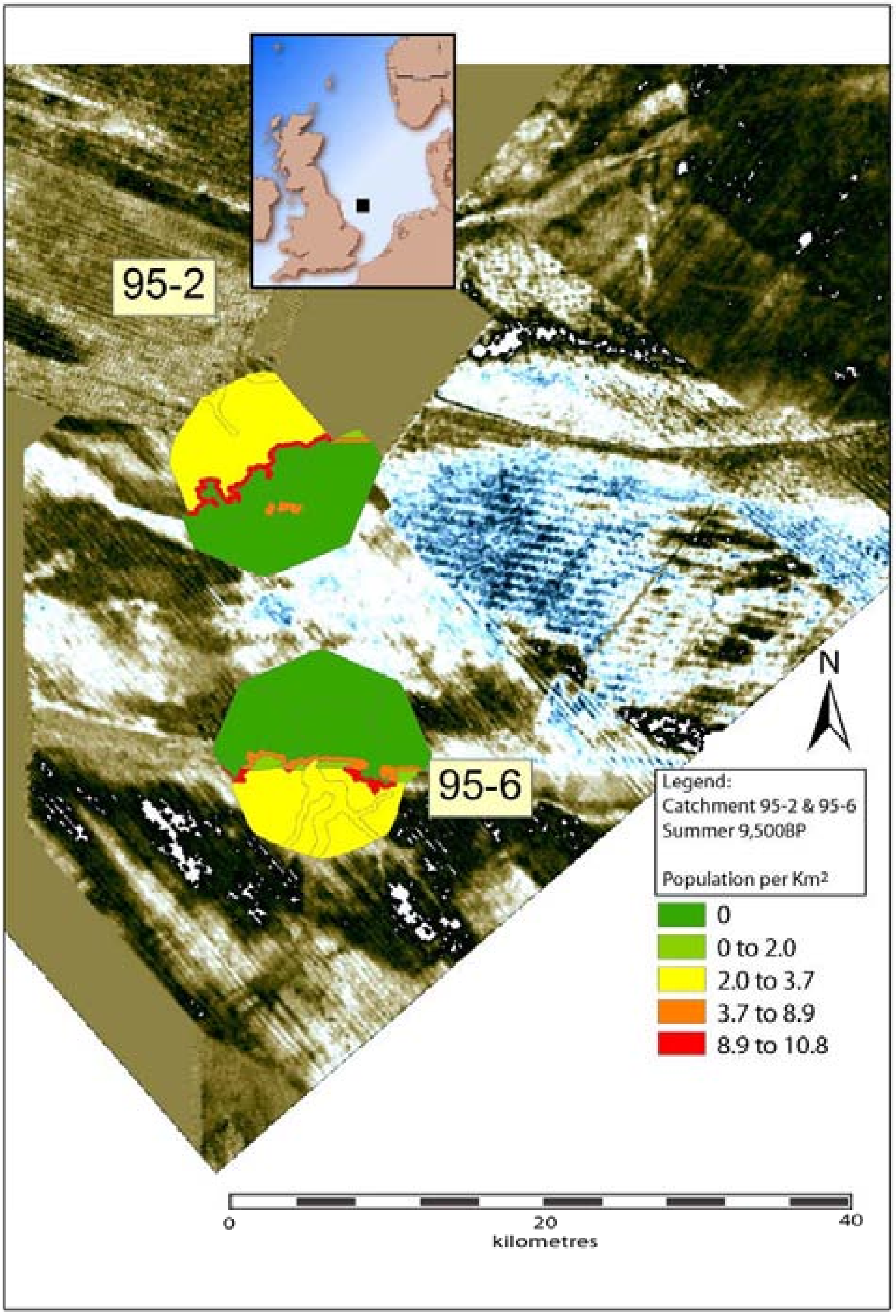

Figure 9.51b Population density map for catchment analysis at summer 9,500BP

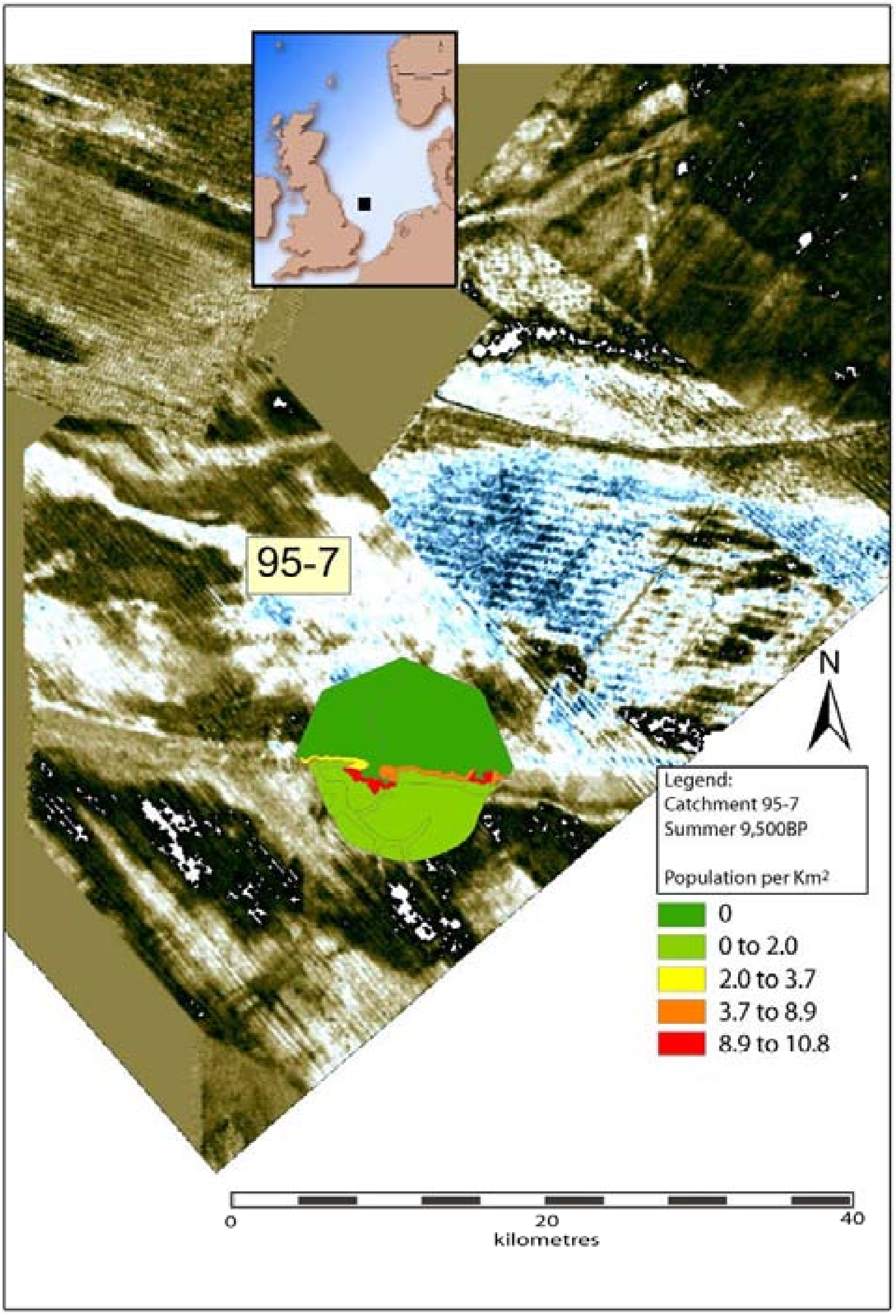

Figure 9.51c Population density map for catchment analysis at summer 9,500BP

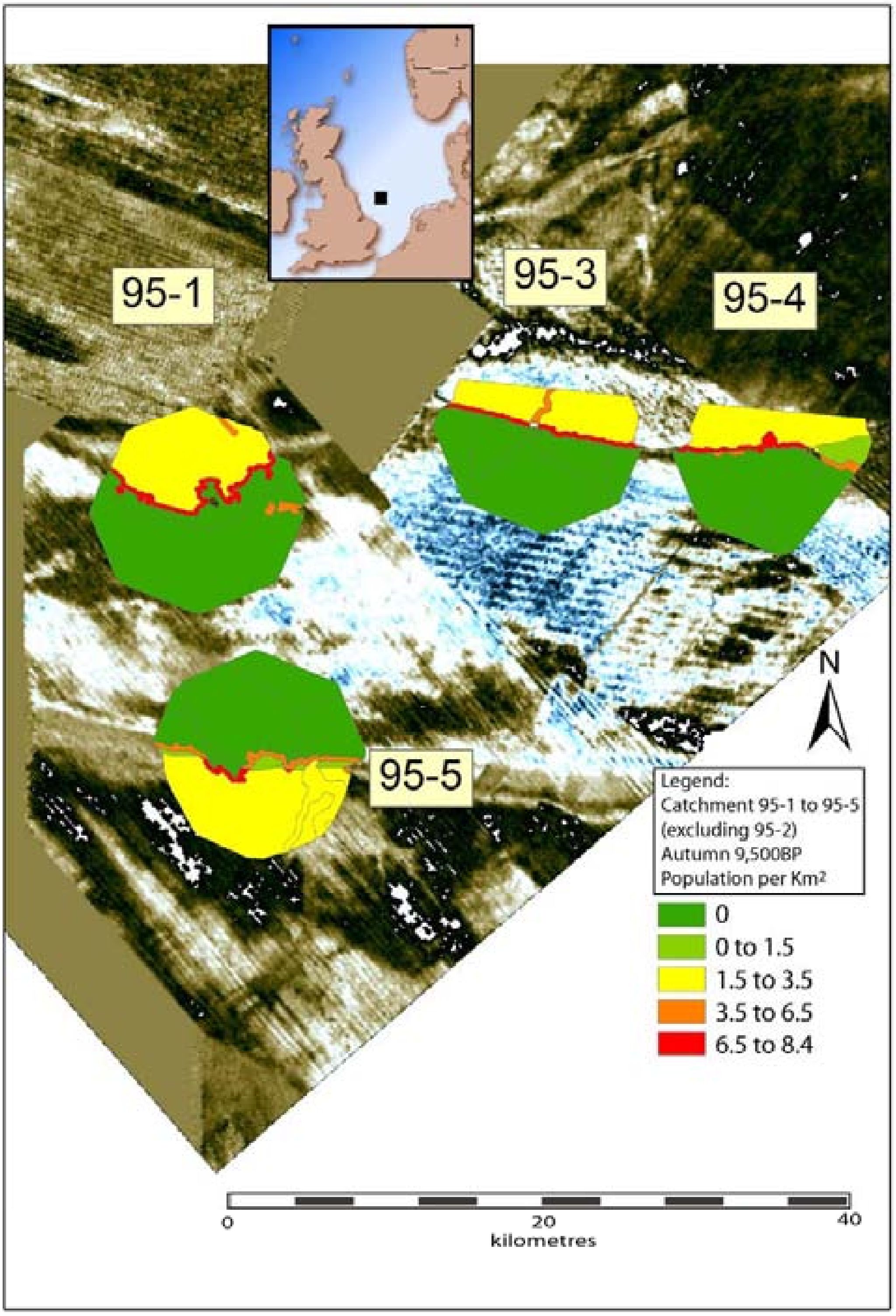

Figure 9.52a Population density map for catchment analysis at autumn 9,500BP

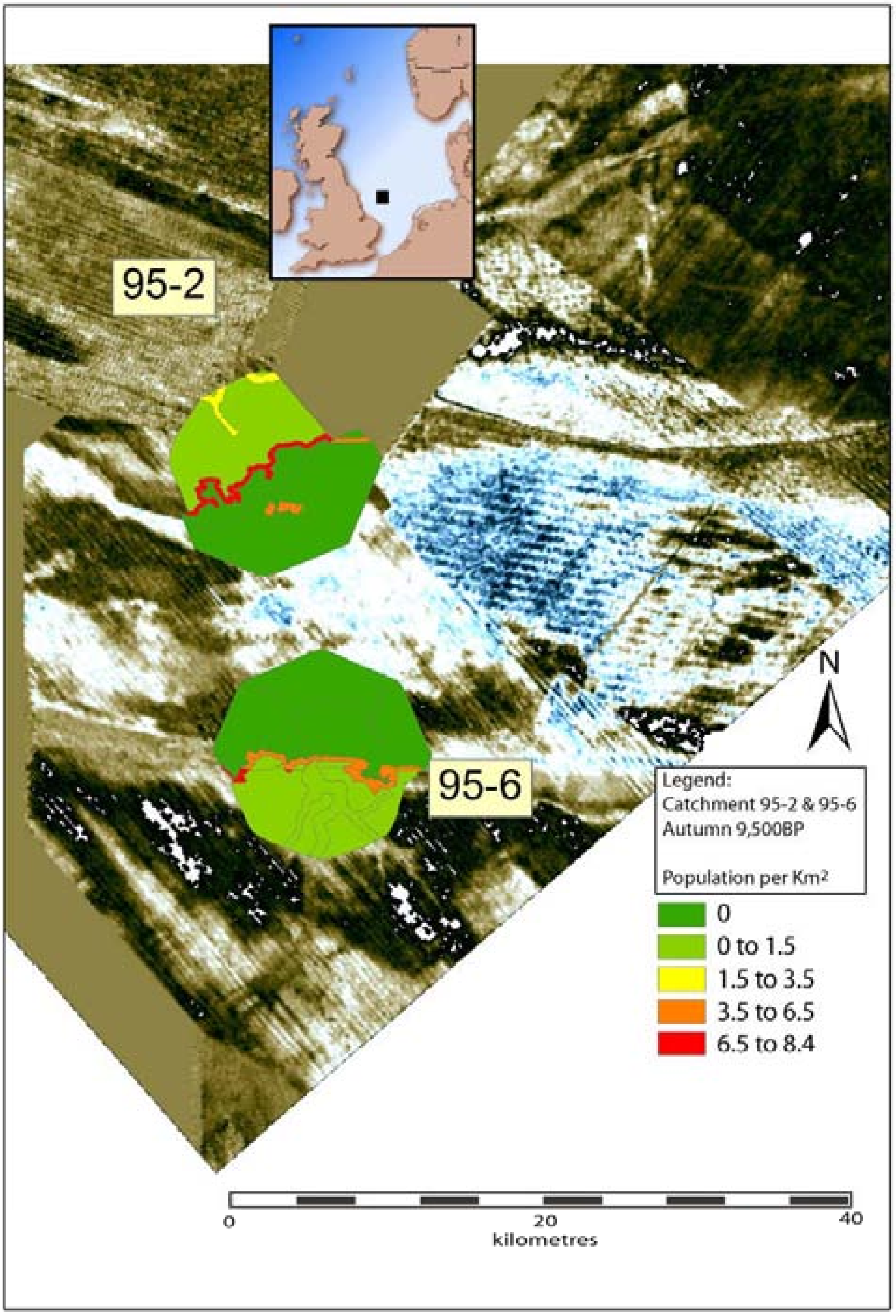

Figure 9.52b Population density map for catchment analysis at autumn 9,500BP

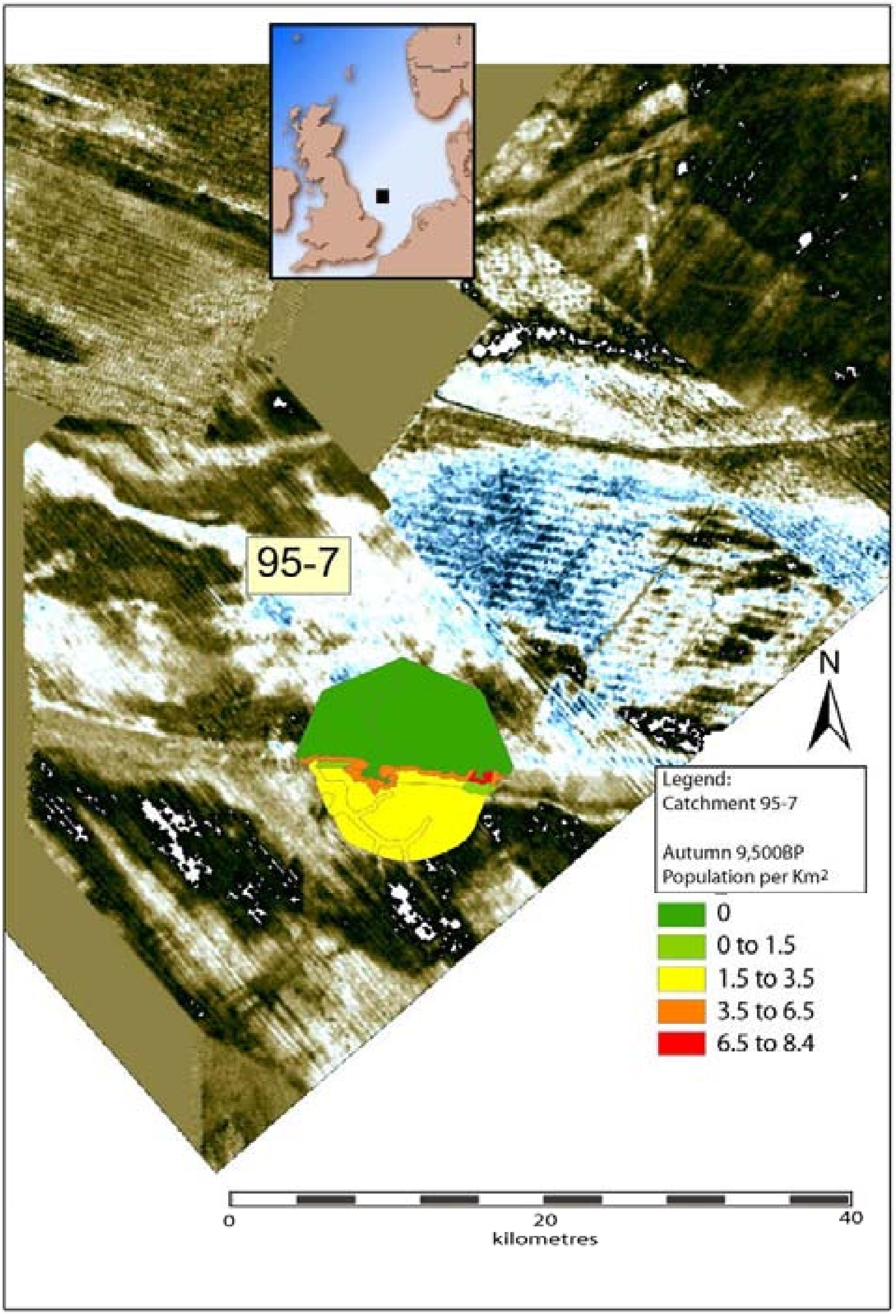

Figure 9.52c Population density map for catchment analysis at autumn 9,500BP

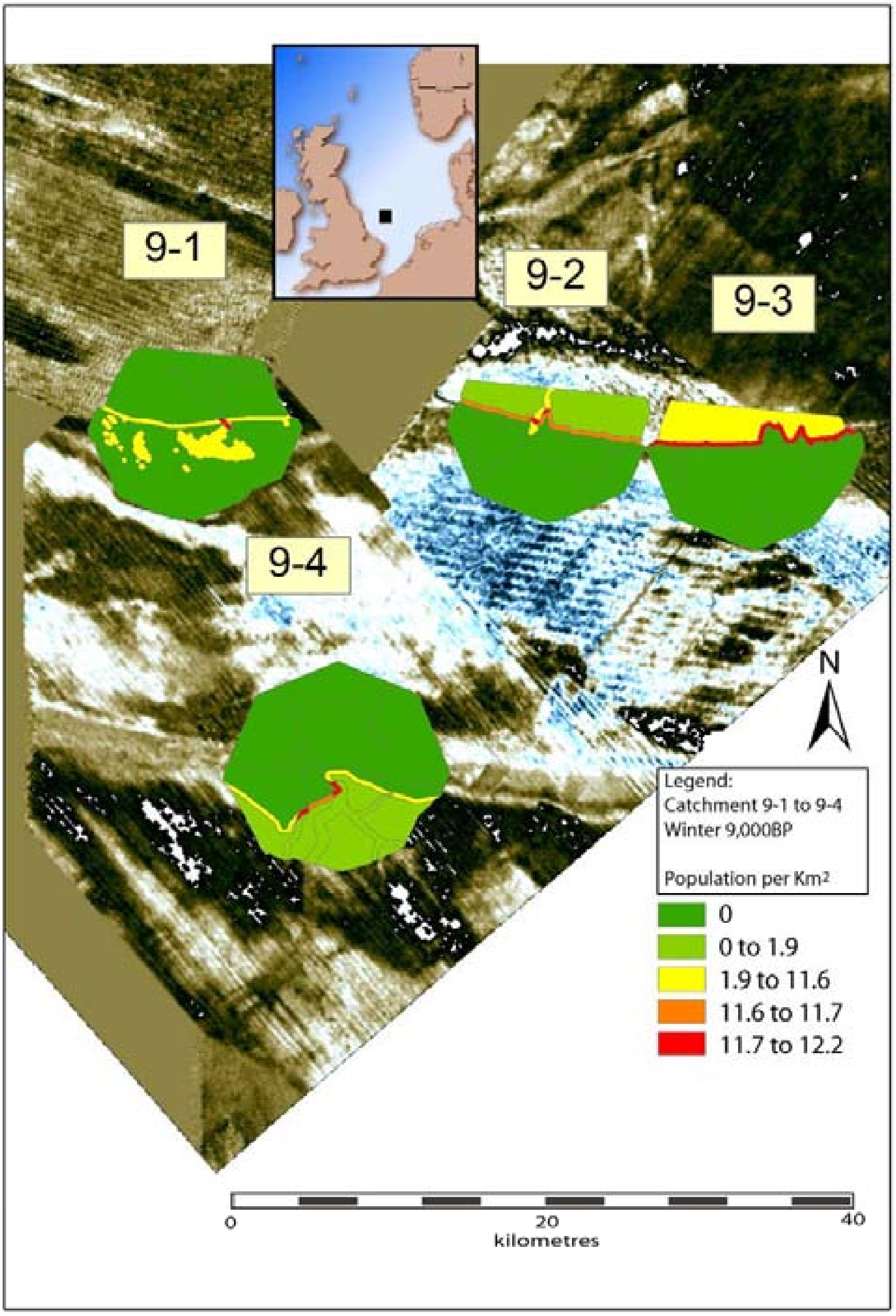

Figure 9.53a Population density map for catchment analysis at winter 9,000BP

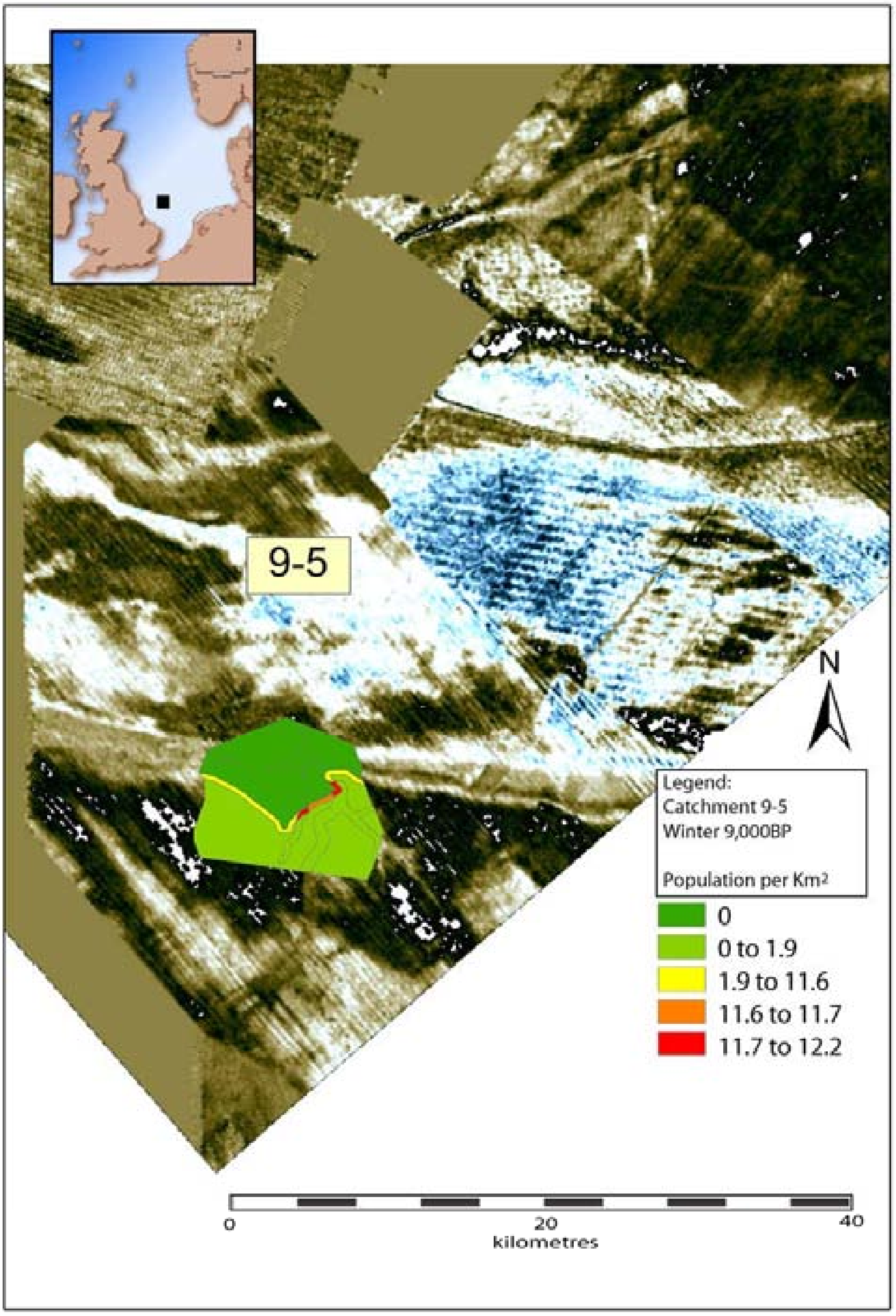

Figure 9.53b Population density map for catchment analysis at winter 9,000BP

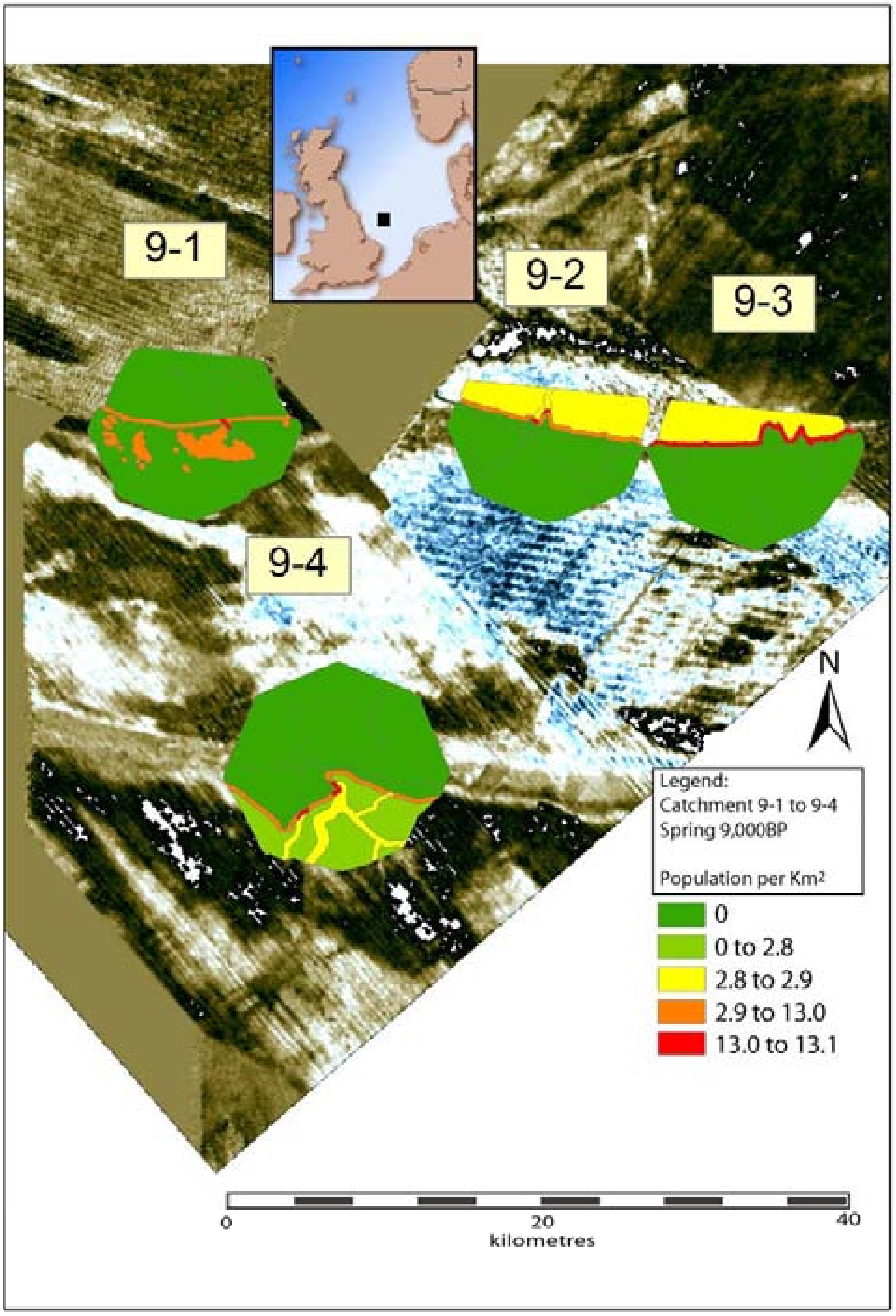

Figure 9.54a Population density map for catchment analysis at spring 9,000BP

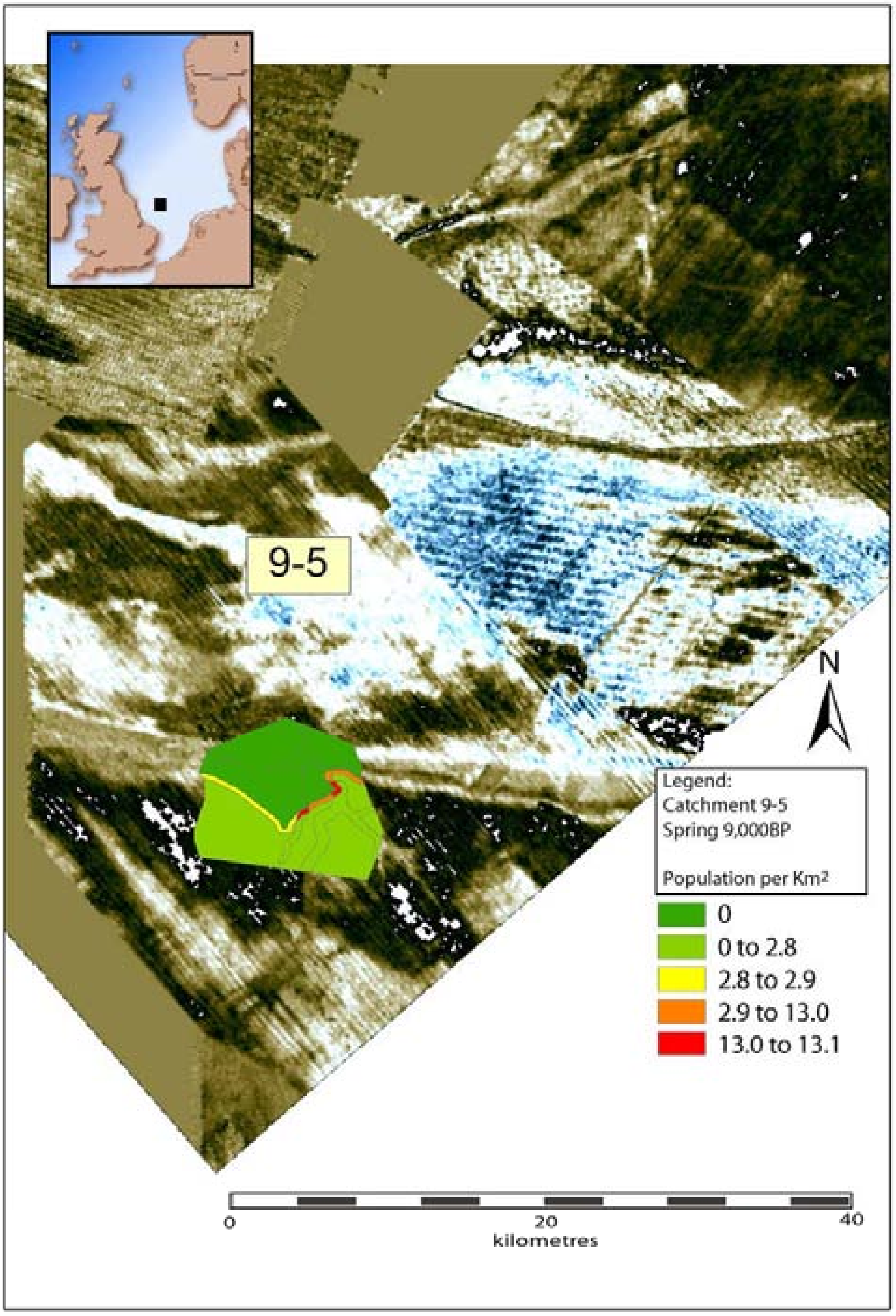

Figure 9.54b Population density map for catchment analysis at spring 9,000BP

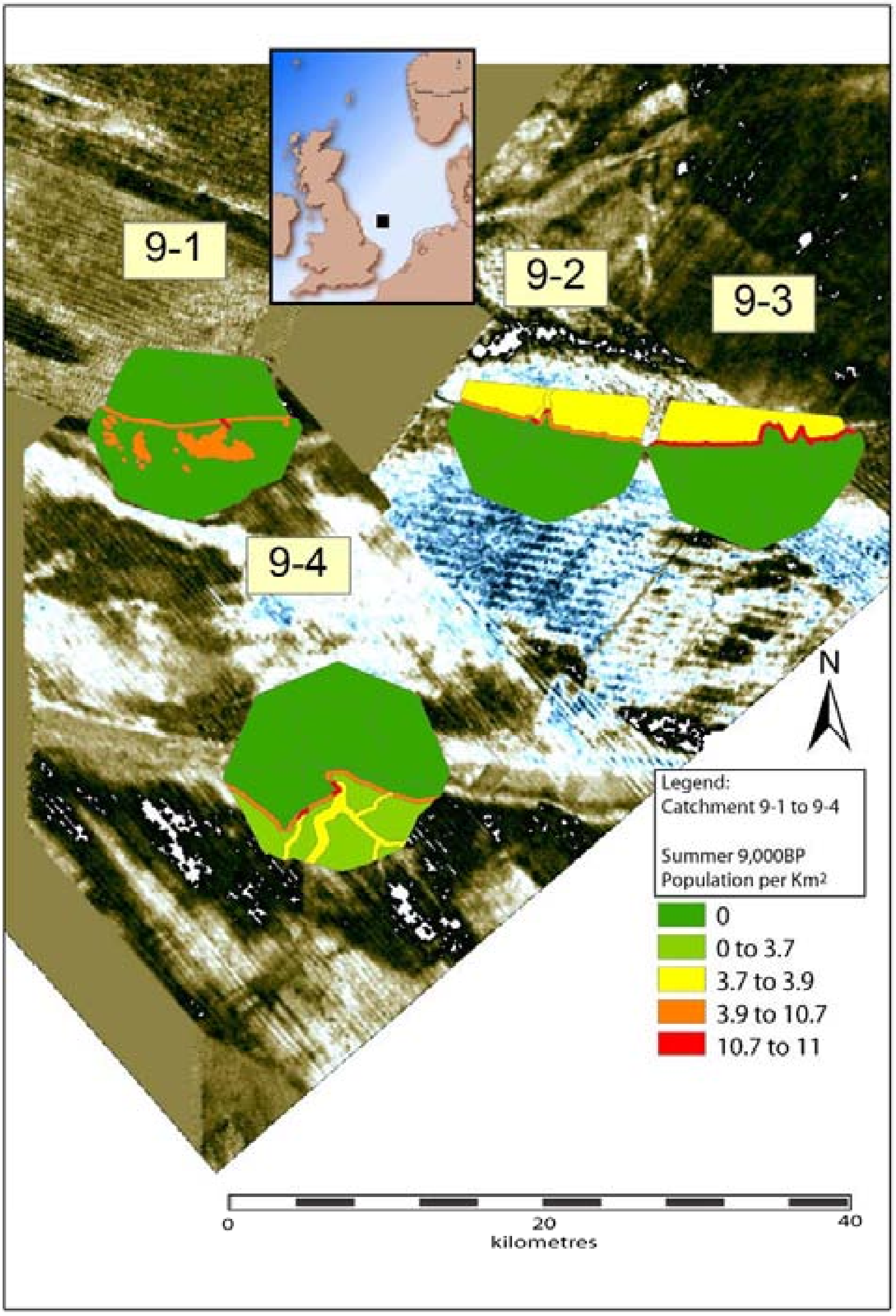

Figure 9.55a Population density map for catchment analysis at summer 9,000BP

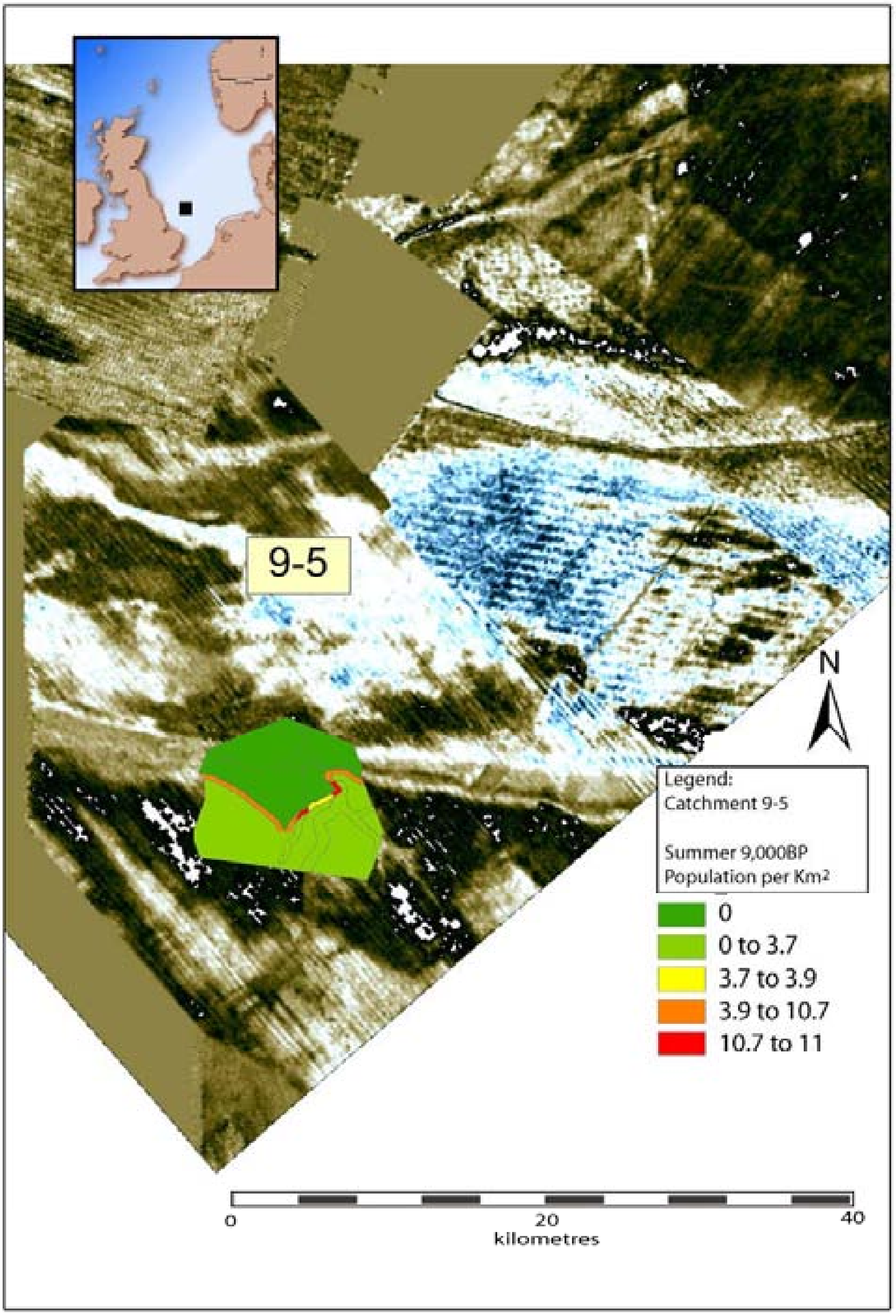

Figure 9.55a Population density map for catchment analysis at summer 9,000BP

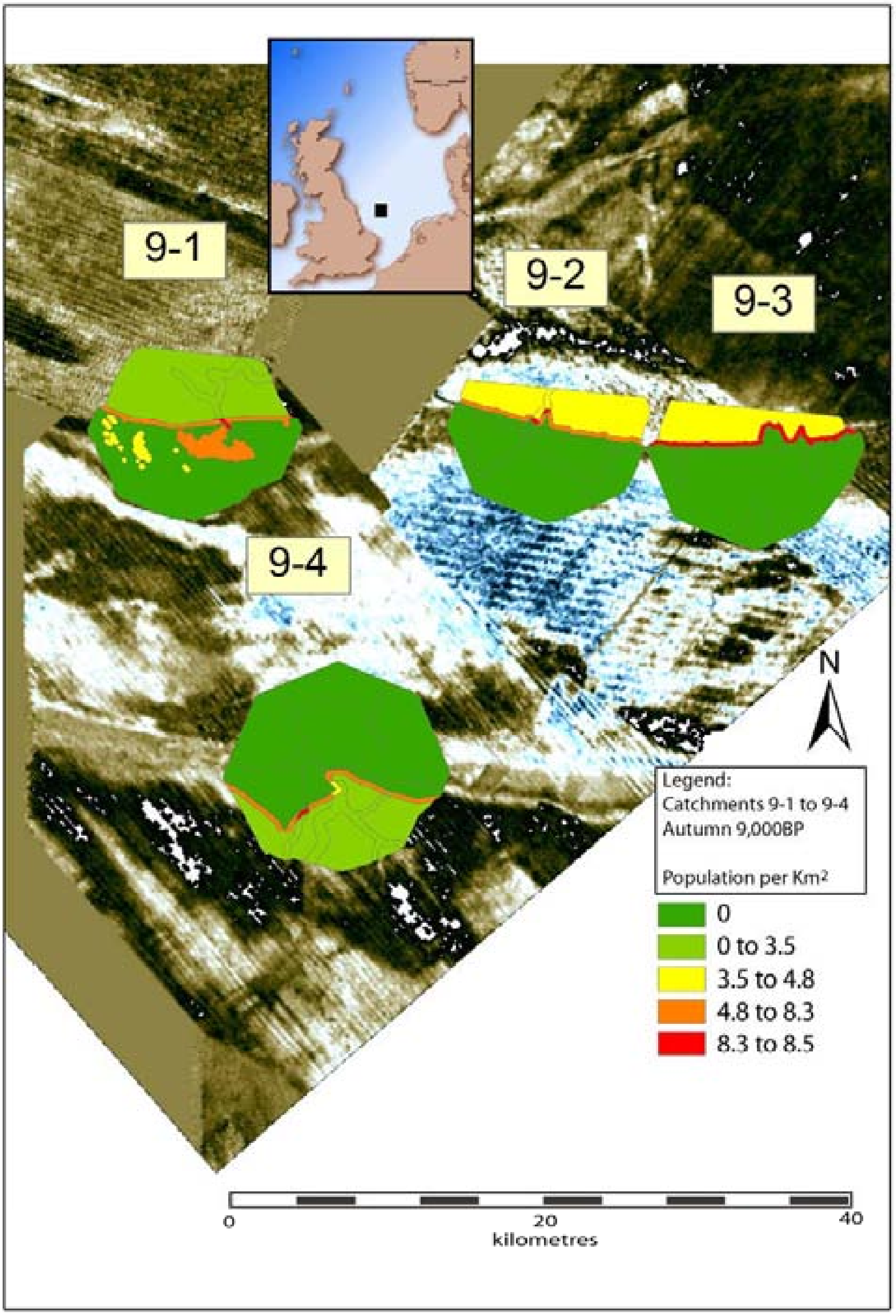

Figure 9.56a Population density map for catchment analysis at autumn 9,000BP

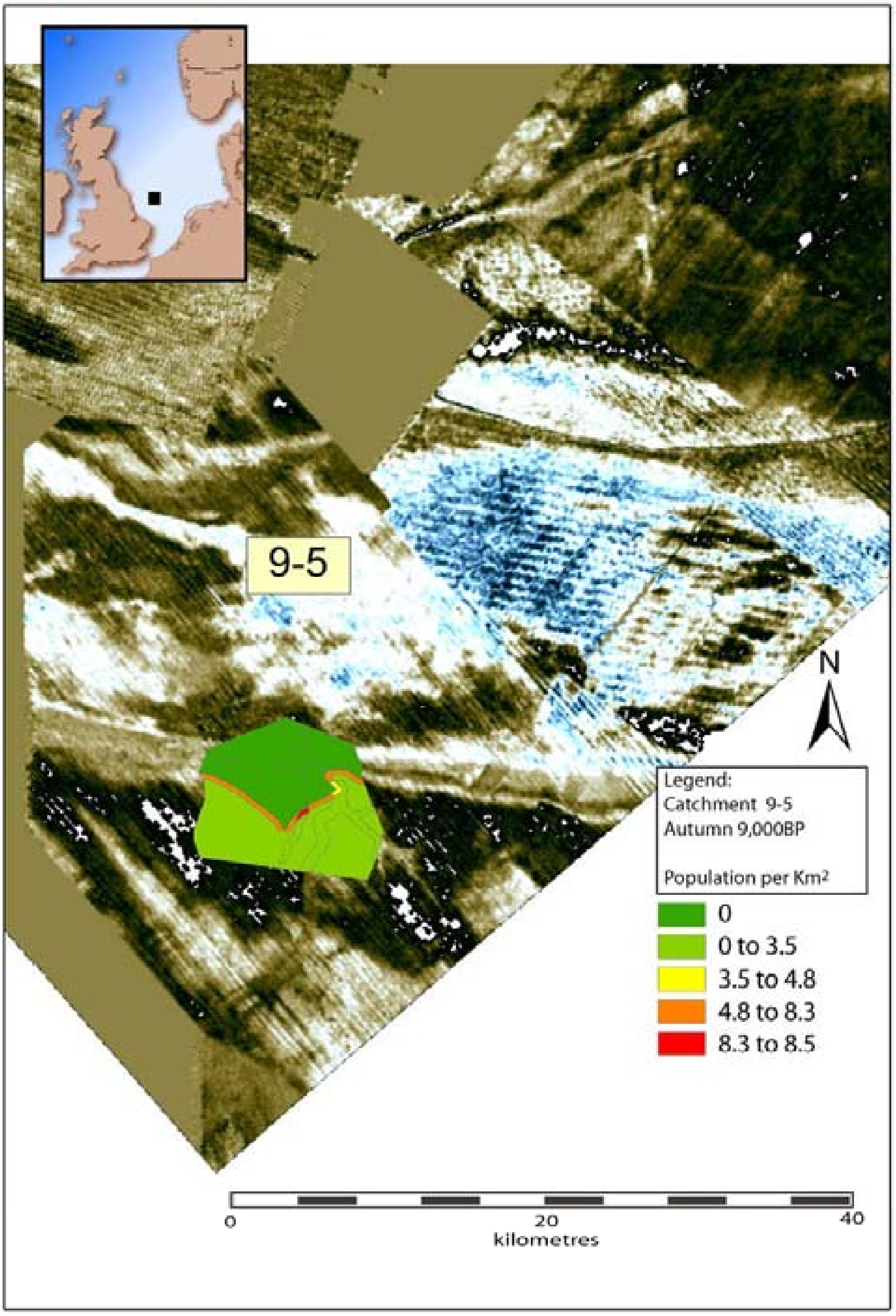

Figure 9.56b Population density map for catchment analysis at autumn 9,000BP

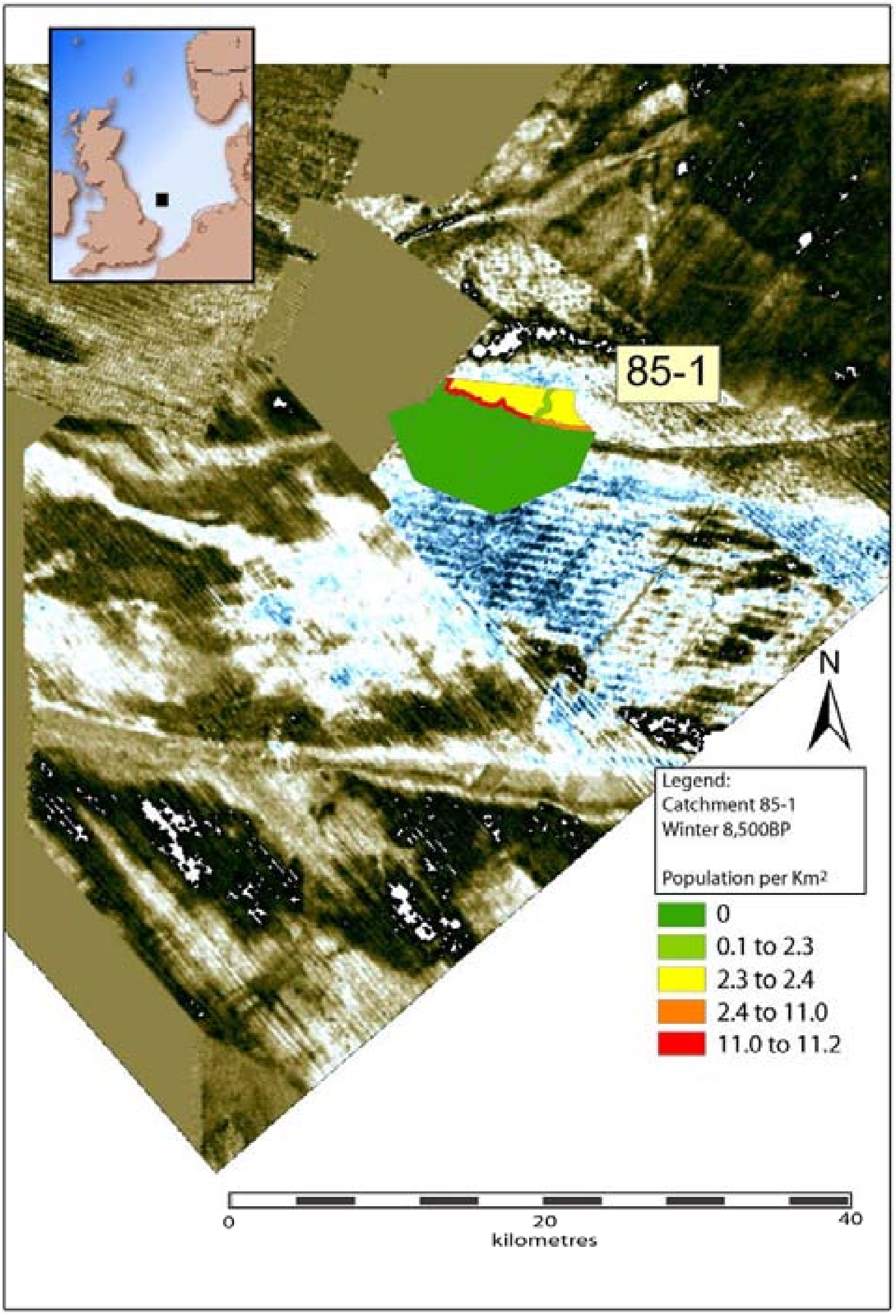

Figure 9.57a Population density map for catchment analysis at winter 8,500BP

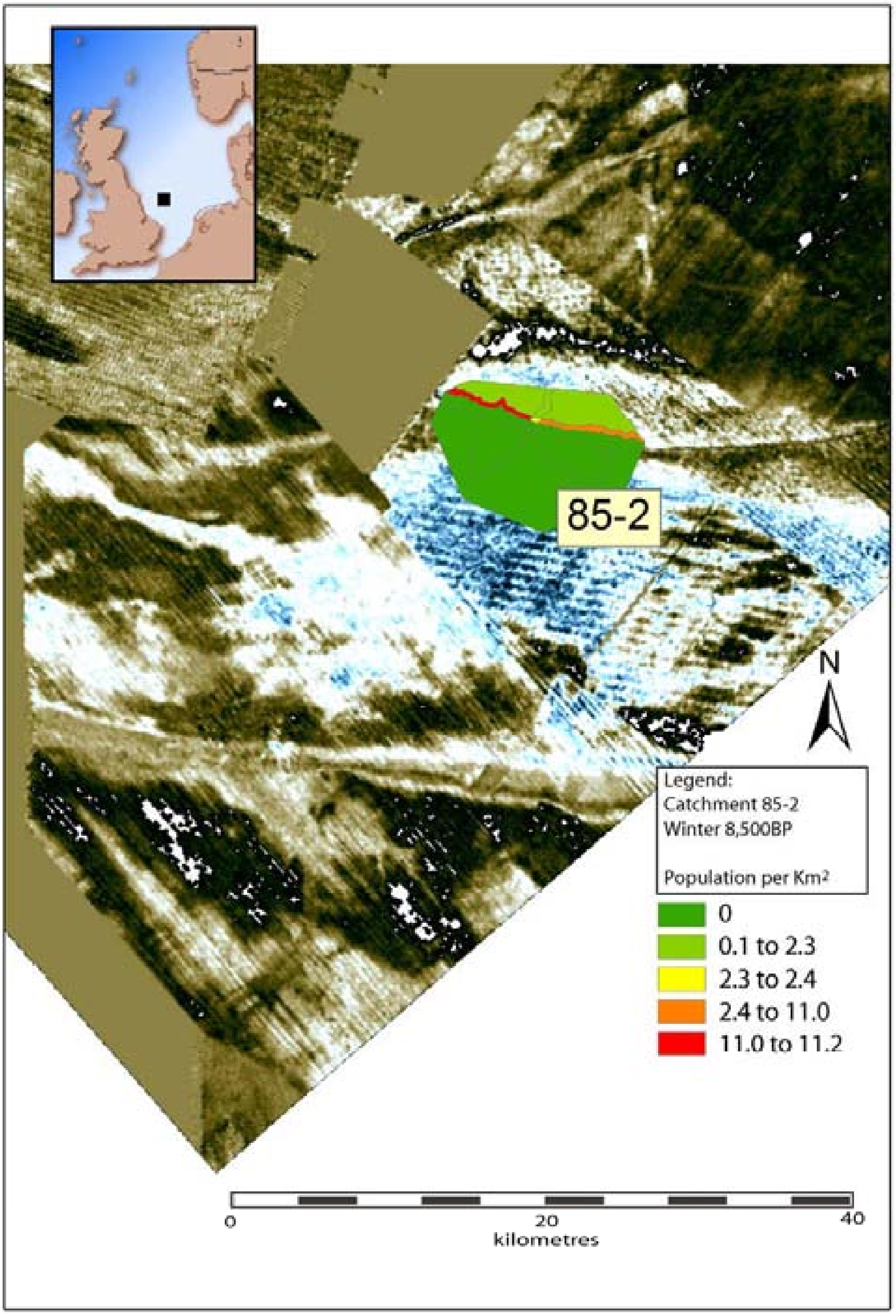

Figure 9.57b Population density map for catchment analysis at winter 8,500BP

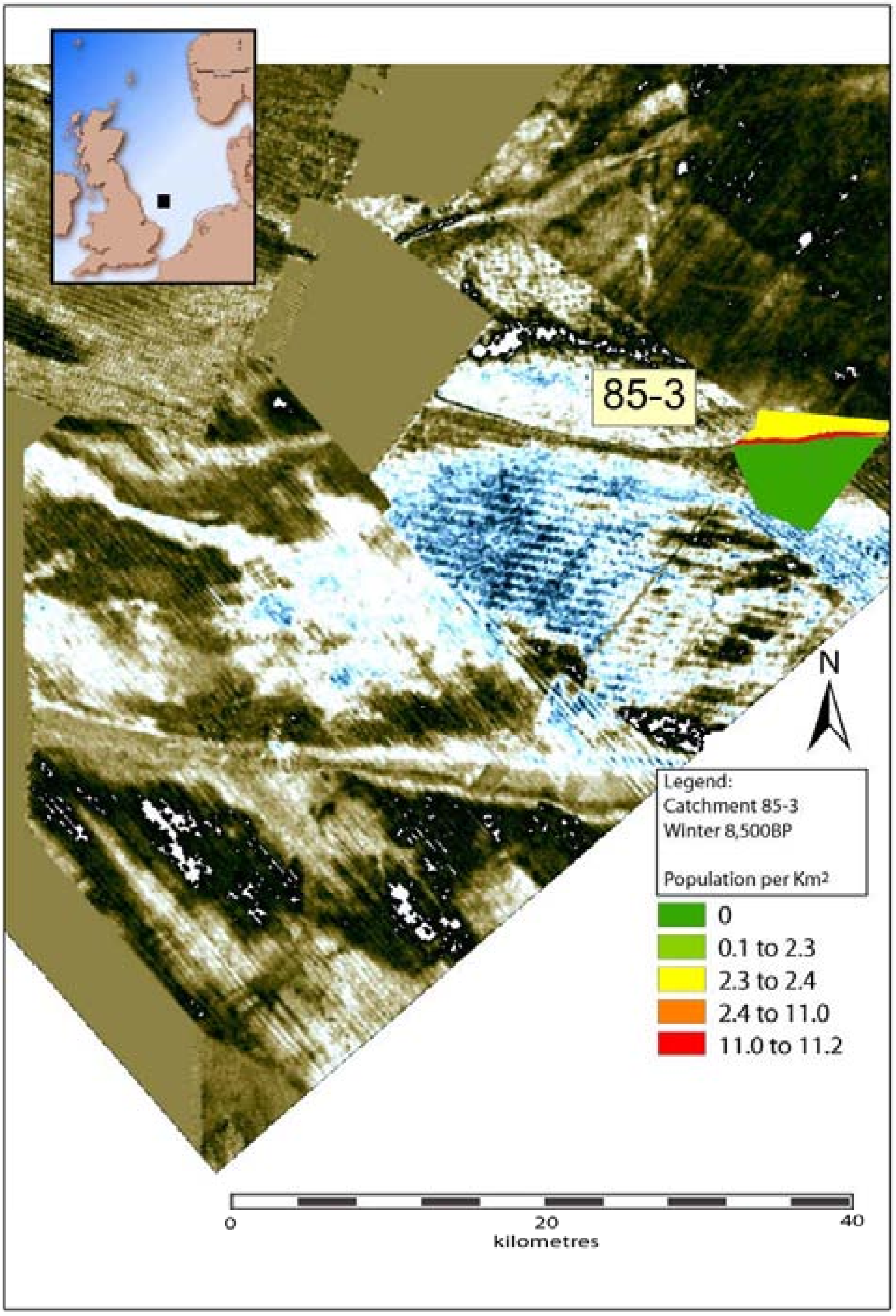

Figure 9.57c Population density map for catchment analysis at winter 8,500BP

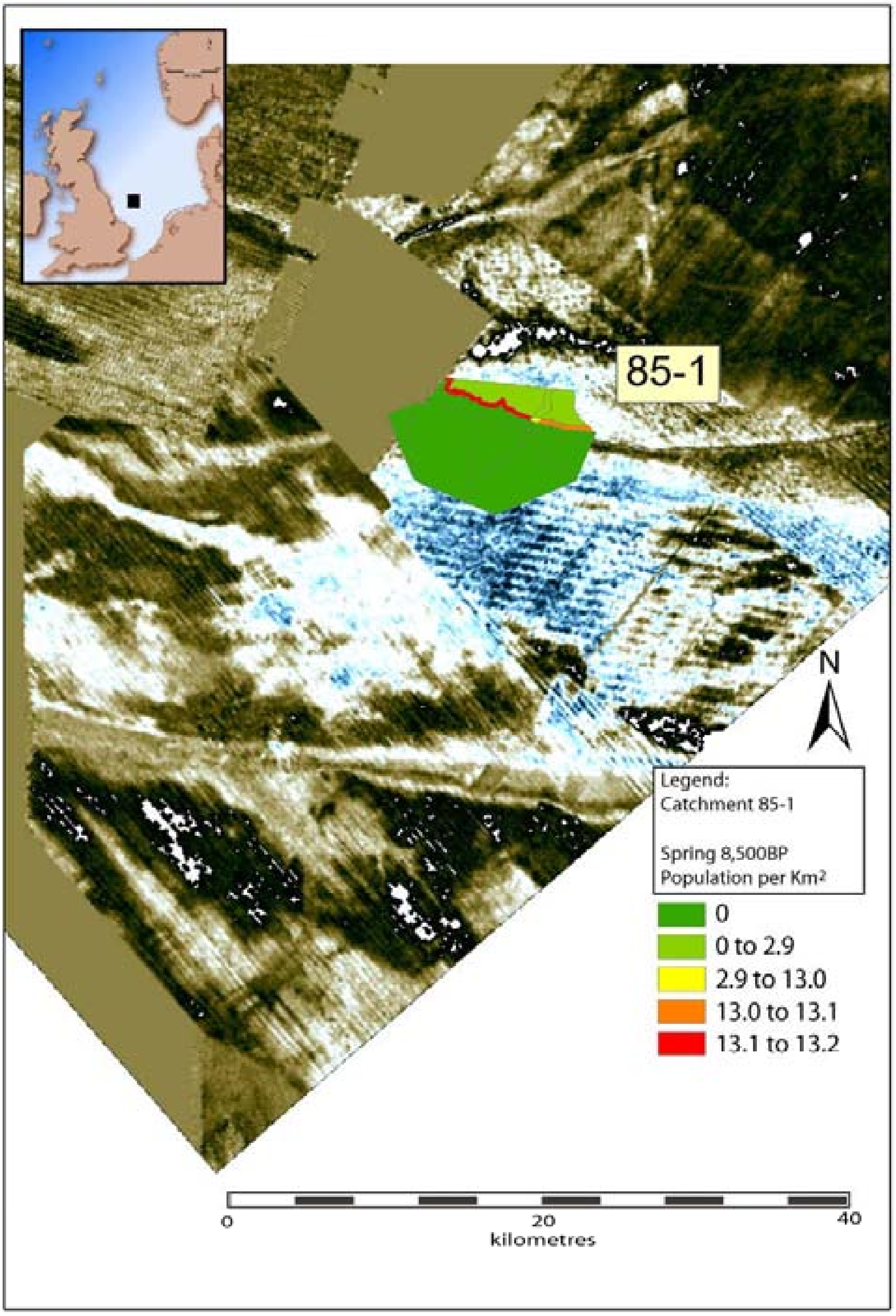

Figure 9.58a Population density map for catchment analysis at spring 8,500BP

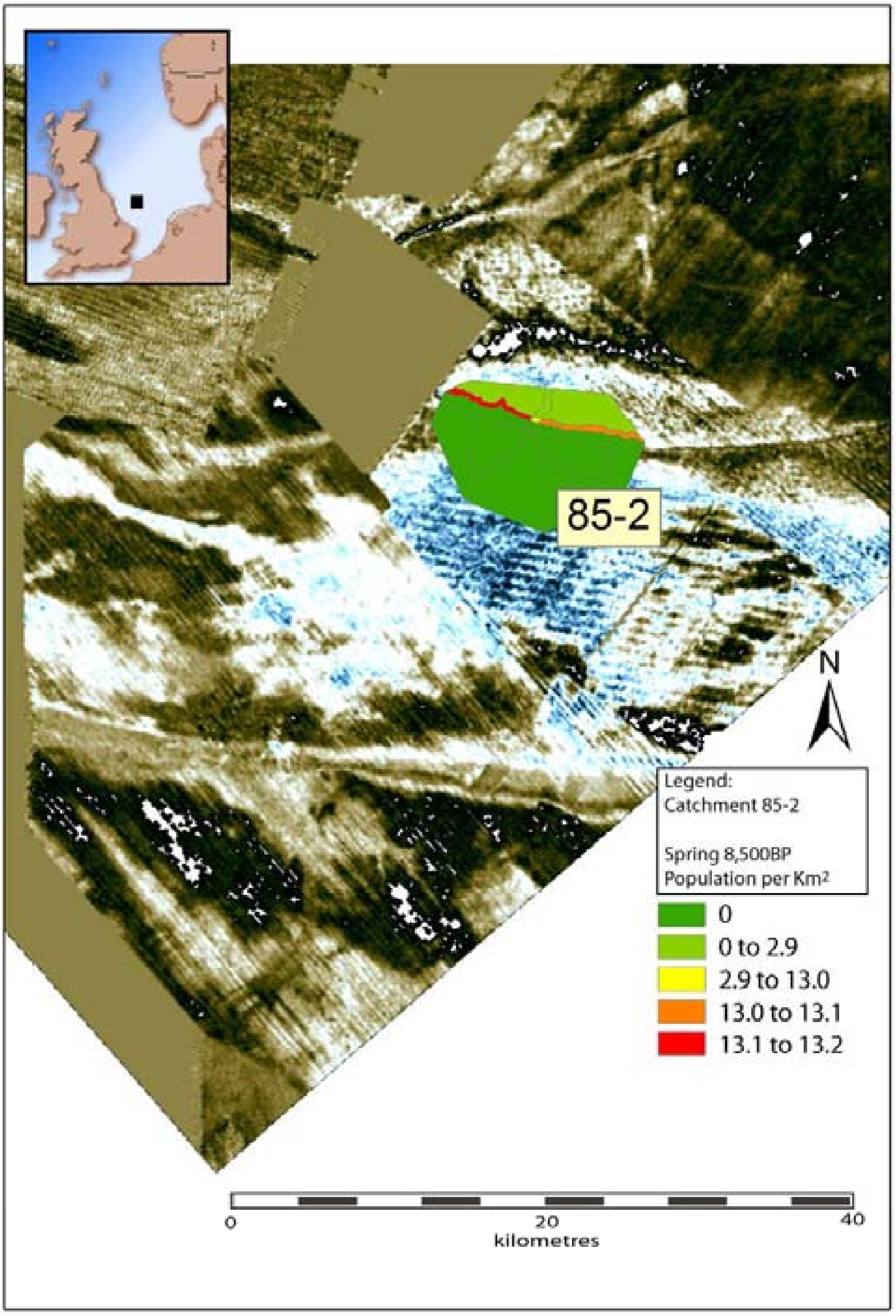

Figure 9.58b Population density map for catchment analysis at spring 8,500BP

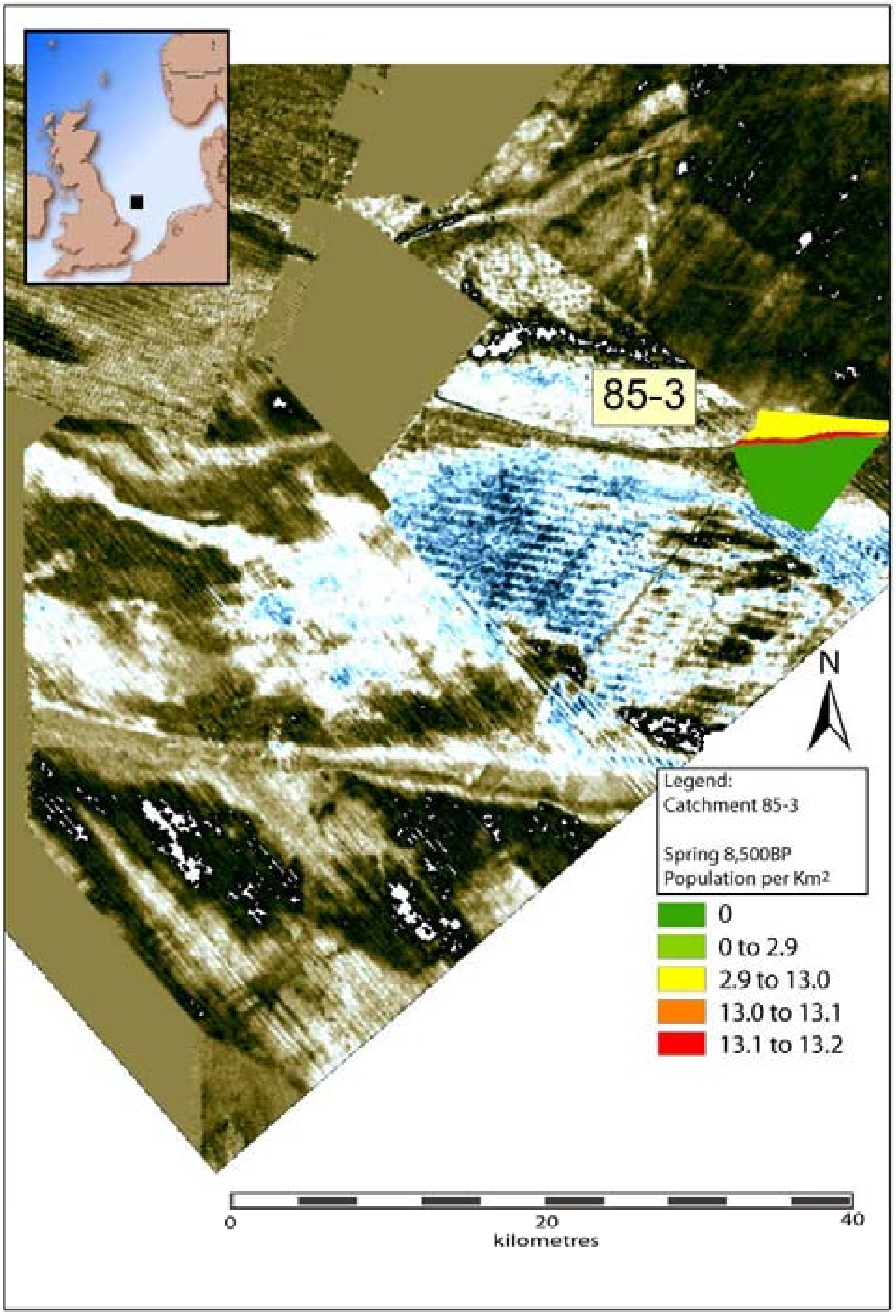

Figure 9.58c Population density map for catchment analysis at spring 8,500BP

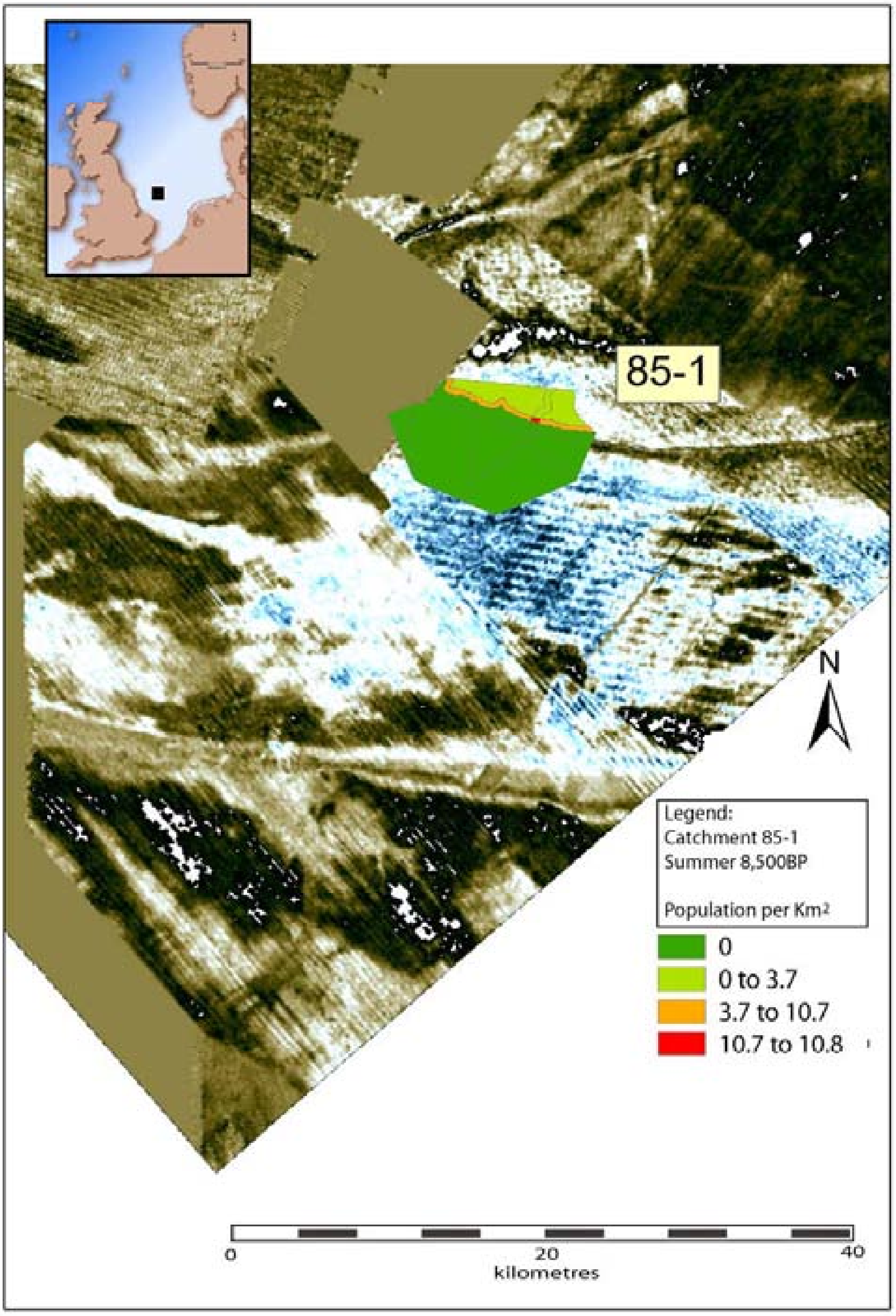

Figure 9.59a Population density map for catchment analysis at summer 8,500BP

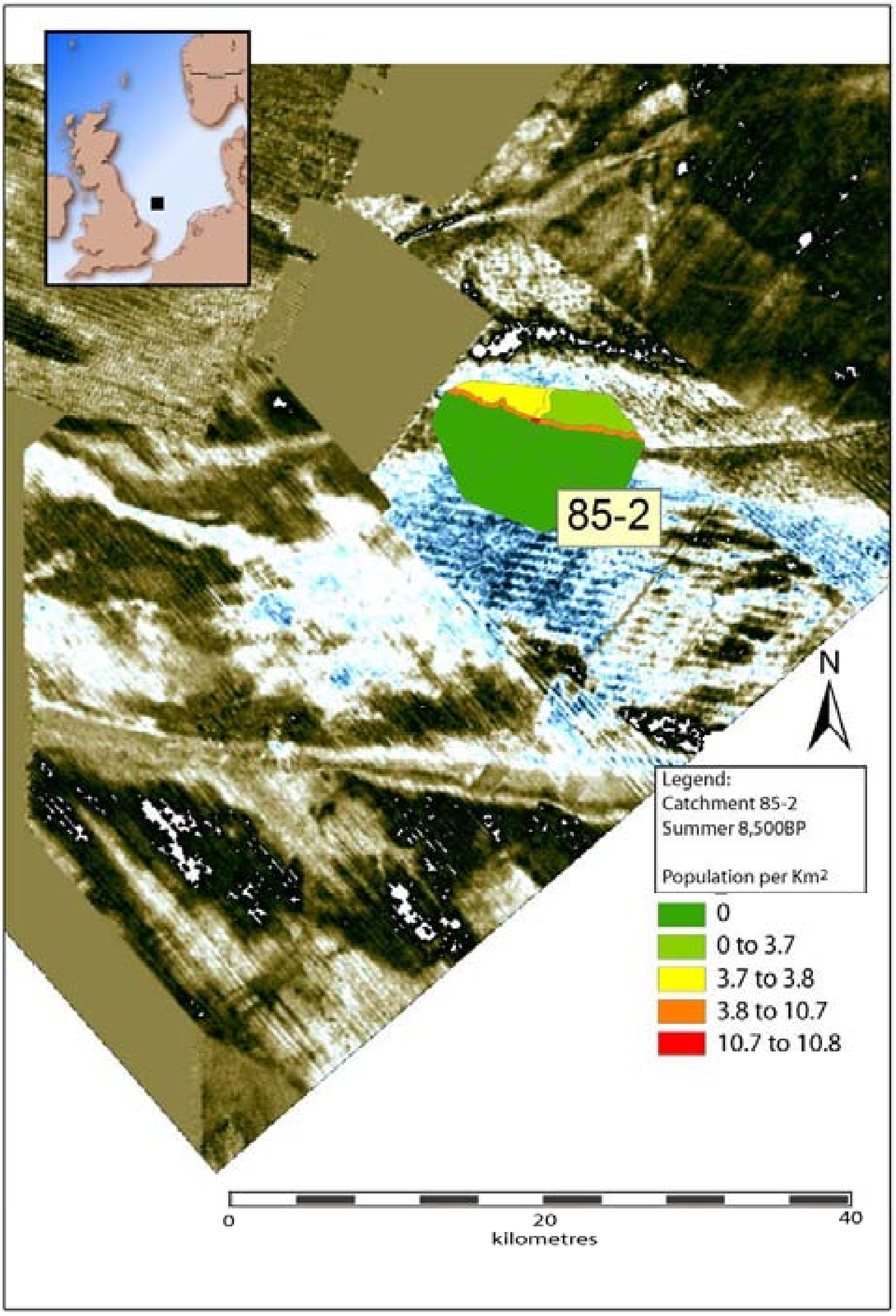

Figure 9.59b Population density map for catchment analysis at summer 8,500BP

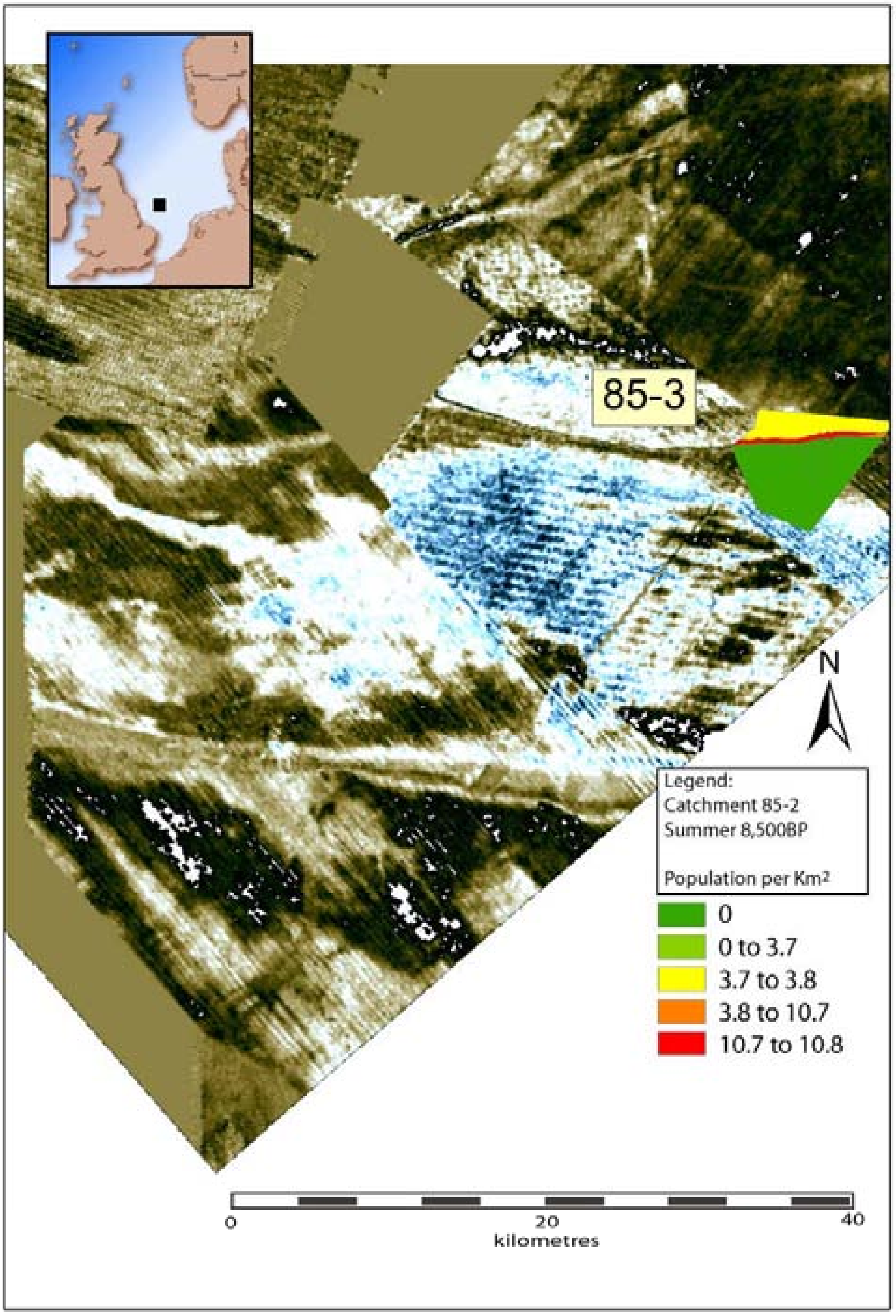

Figure 9.59c Population density map for catchment analysis at summer 8,500BP

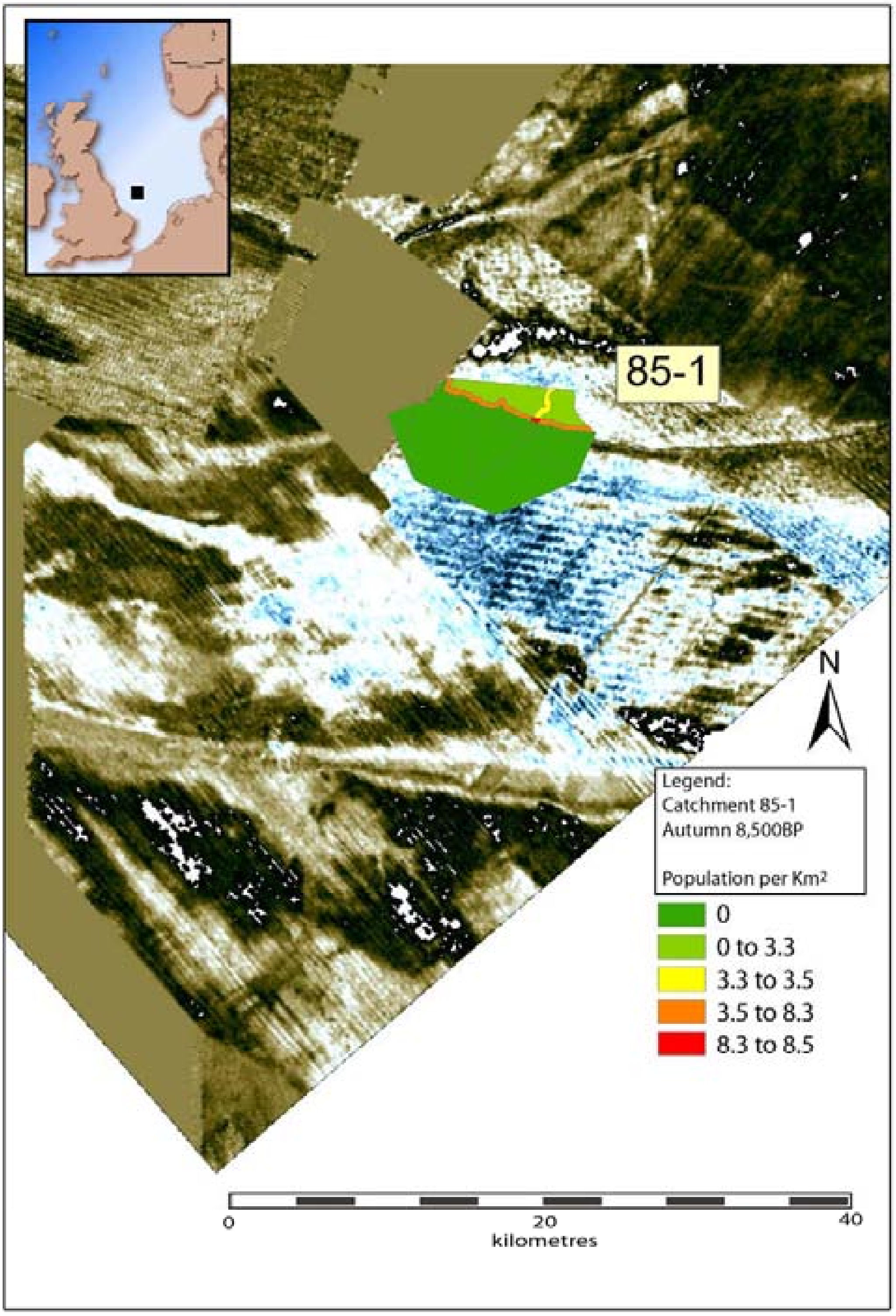

Figure 9.60a Population density map for catchment analysis at autumn 8,500BP

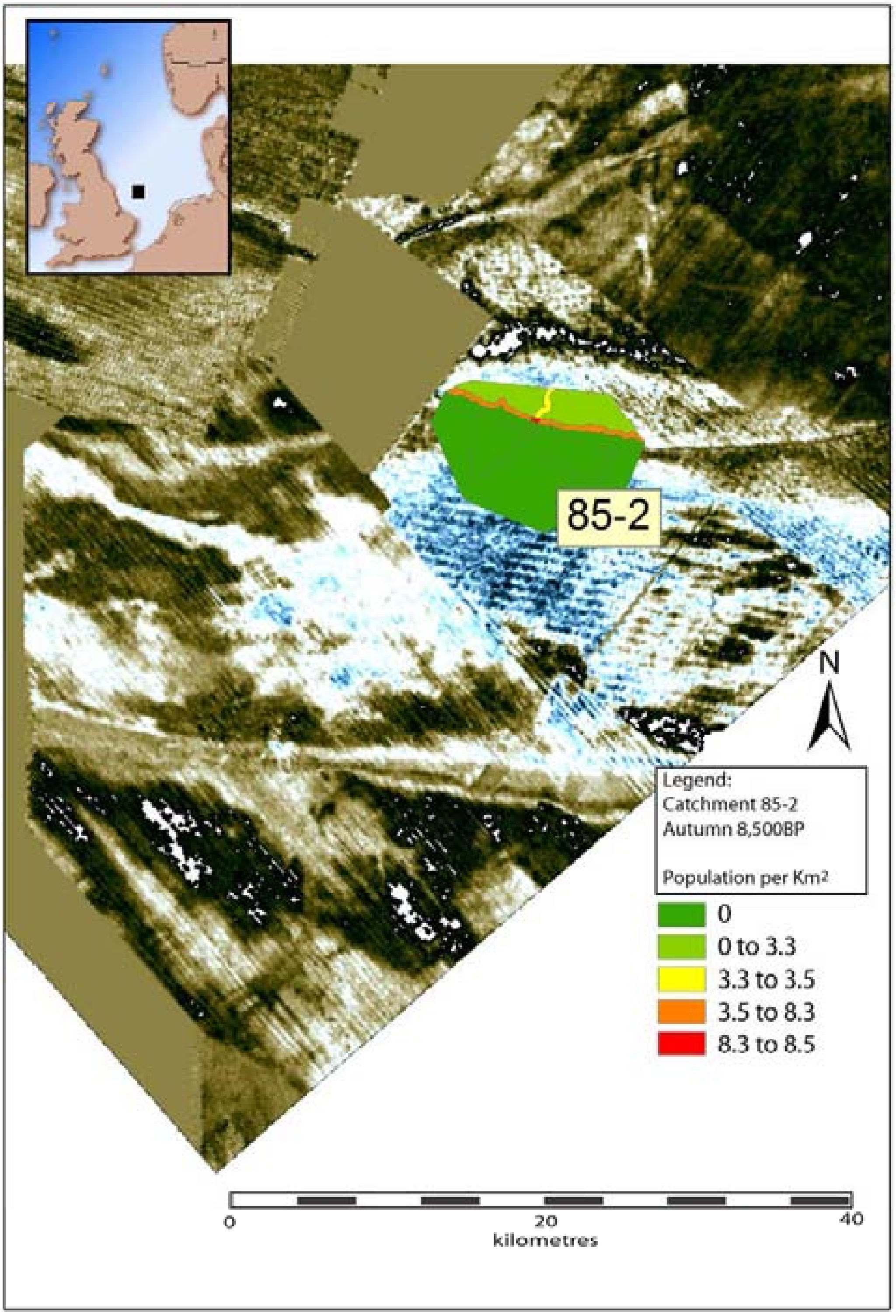

Figure 9.60b Population density map for catchment analysis at autumn 8,500BP

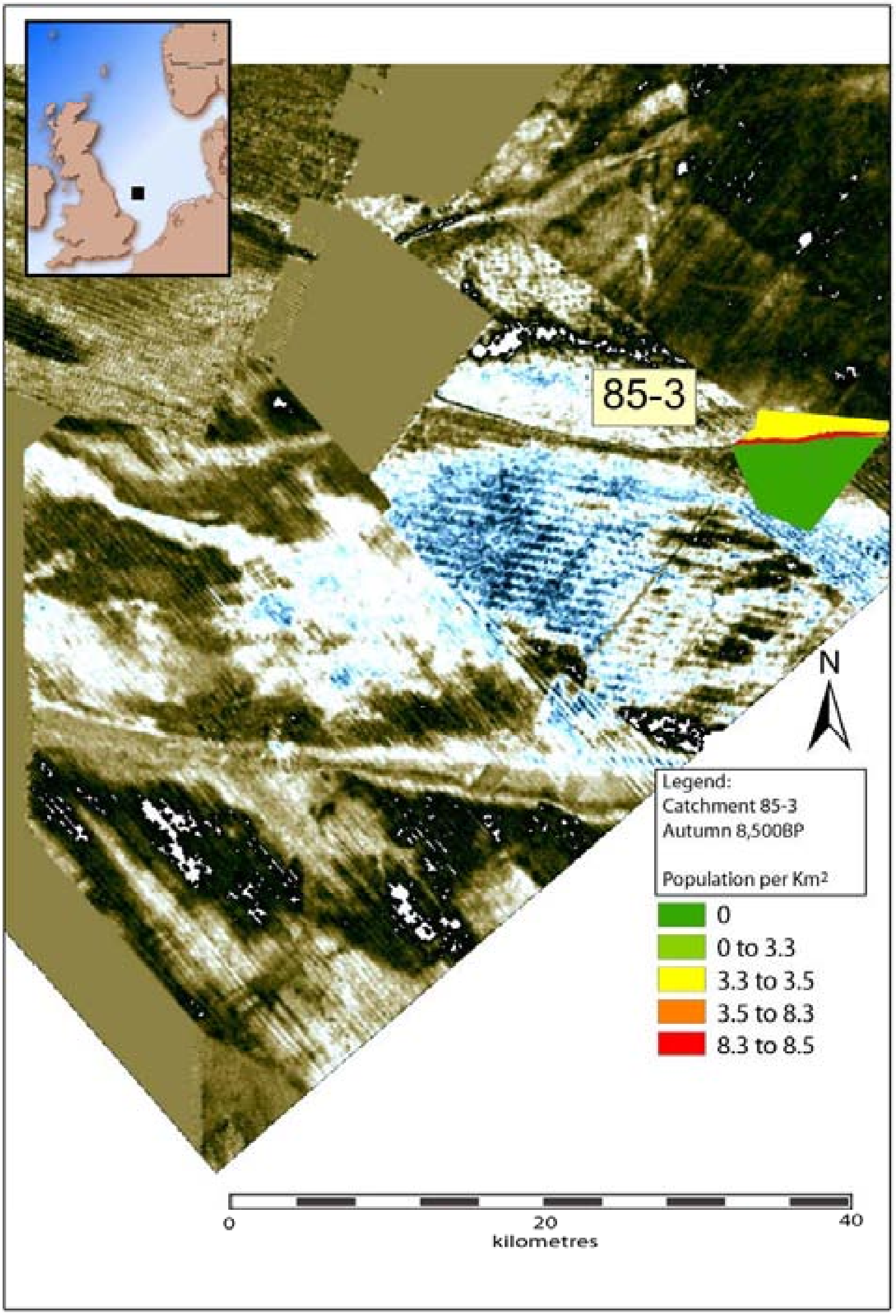

Figure 9.60c Population density map for catchment analysis at autumn 8,500BP

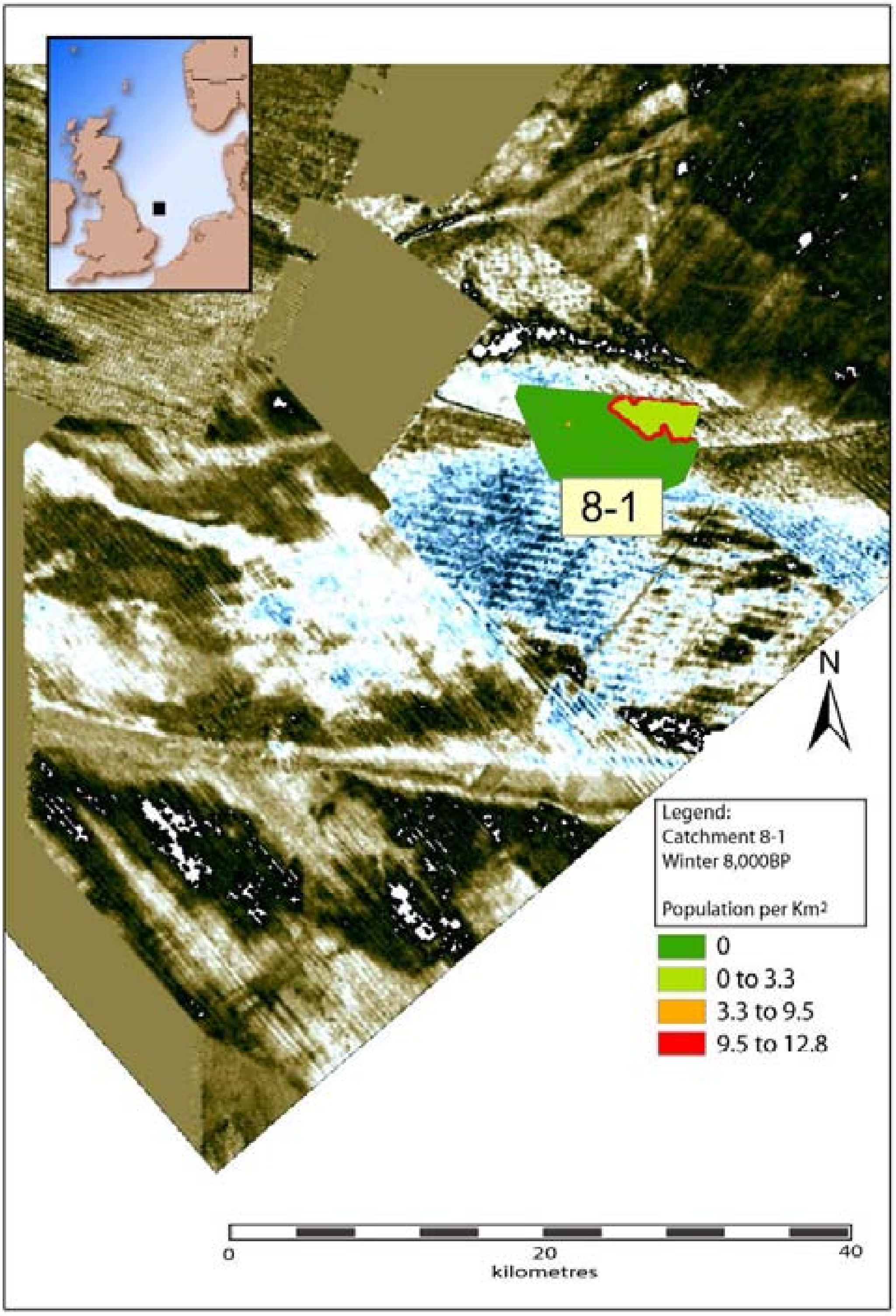

Figure 9.61a Population density map for catchment analysis at winter 8,000BP

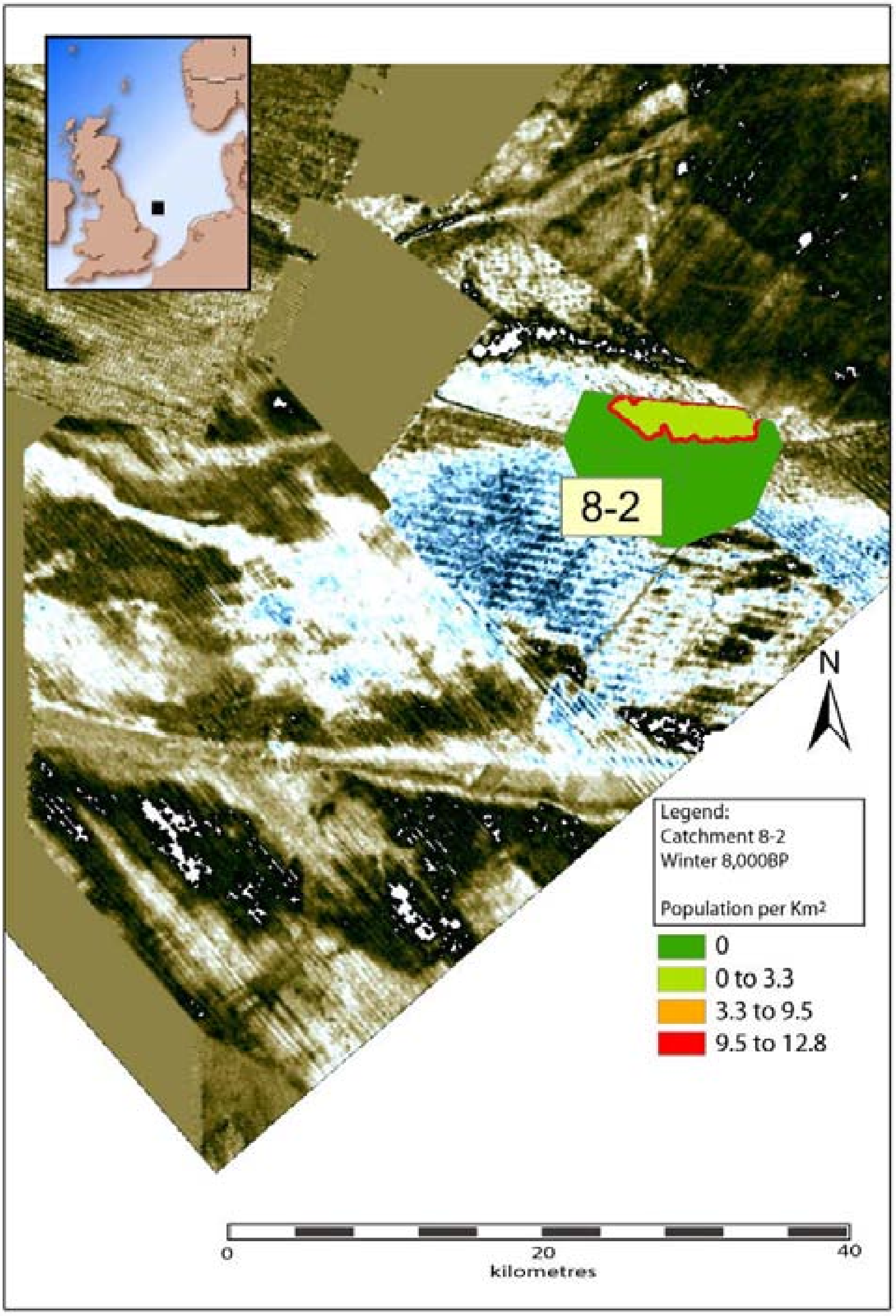

Figure 9.61b Population density map for catchment analysis at winter 8,000BP

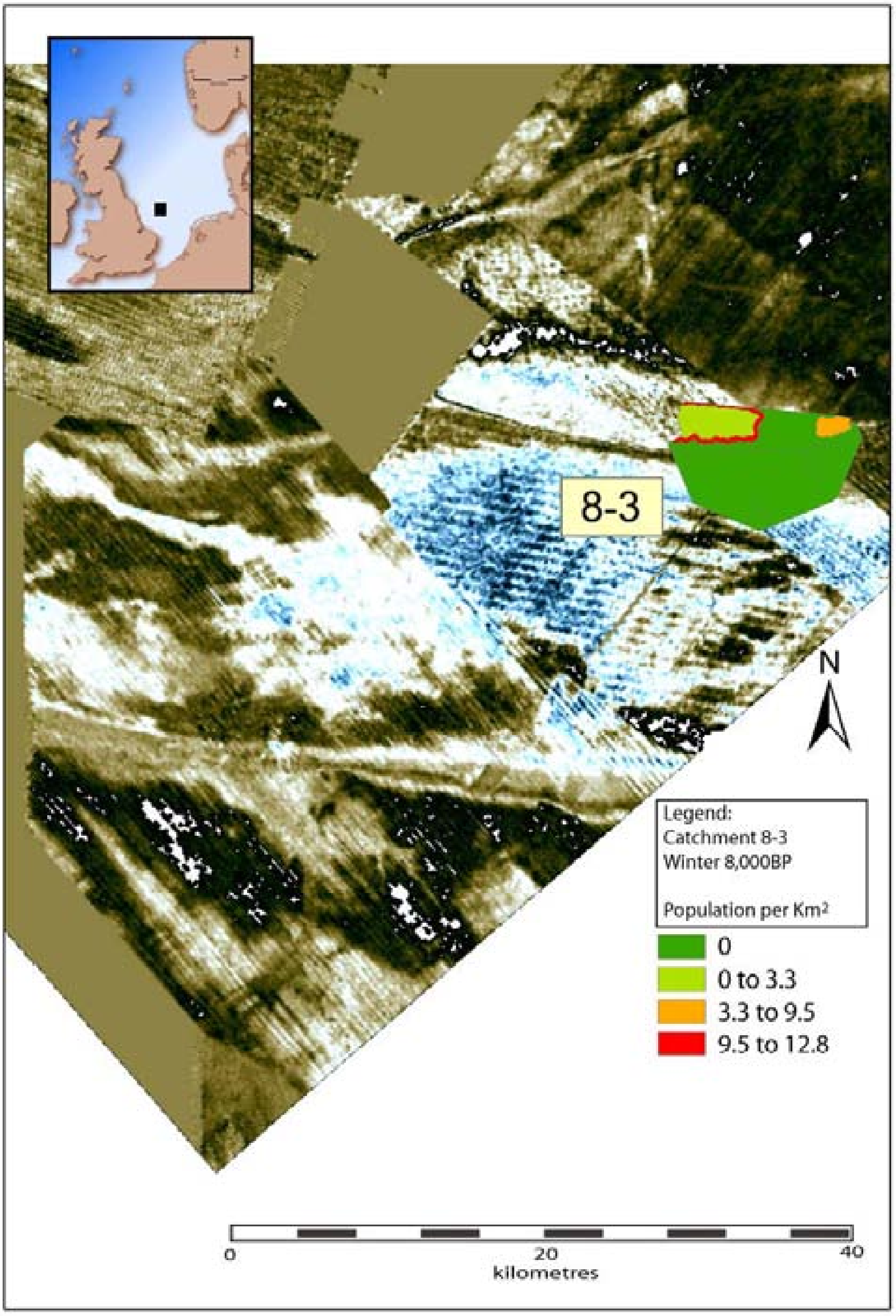

Figure 9.61c Population density map for catchment analysis at winter 8,000BP

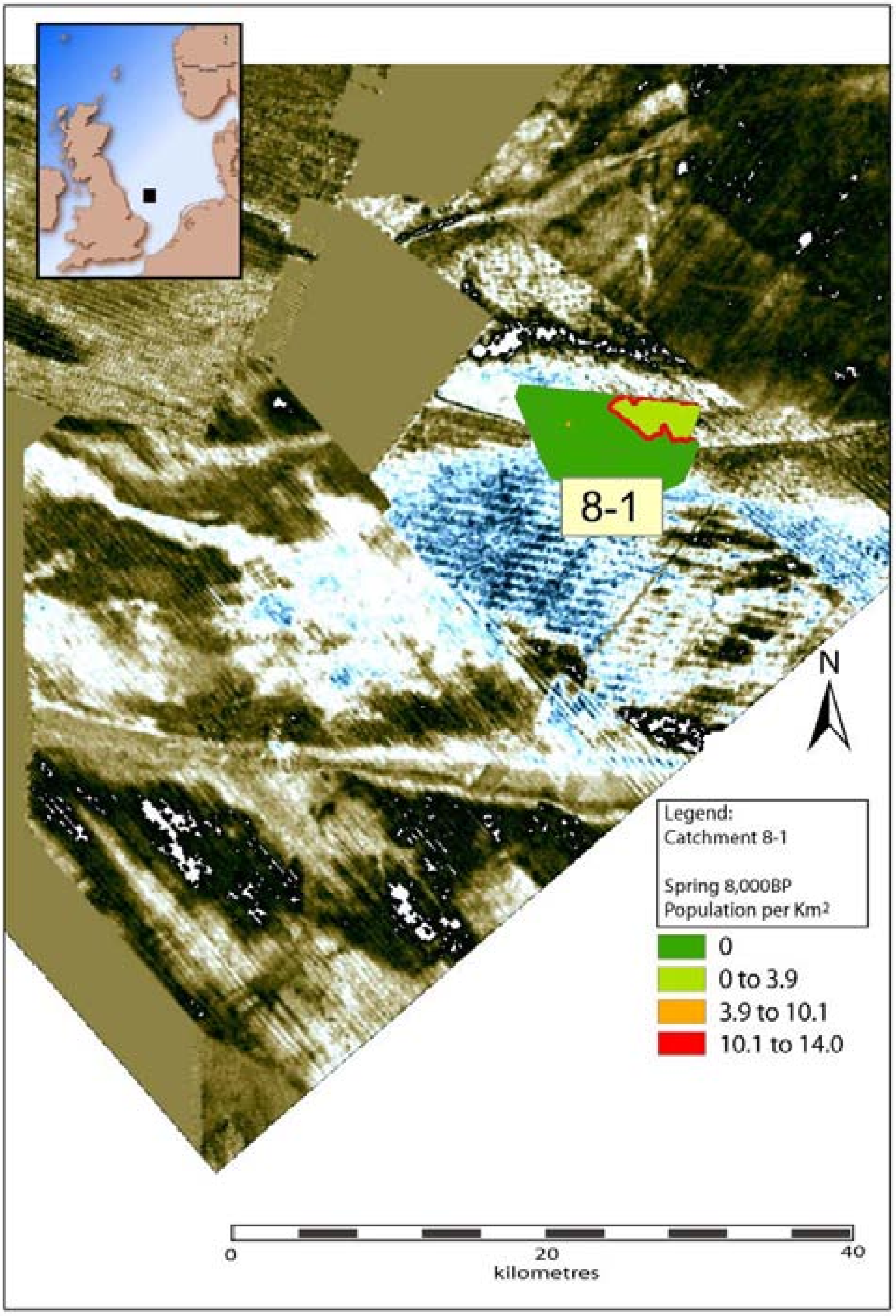

Figure 9.62a Population density map for catchment analysis at spring 8,000BP

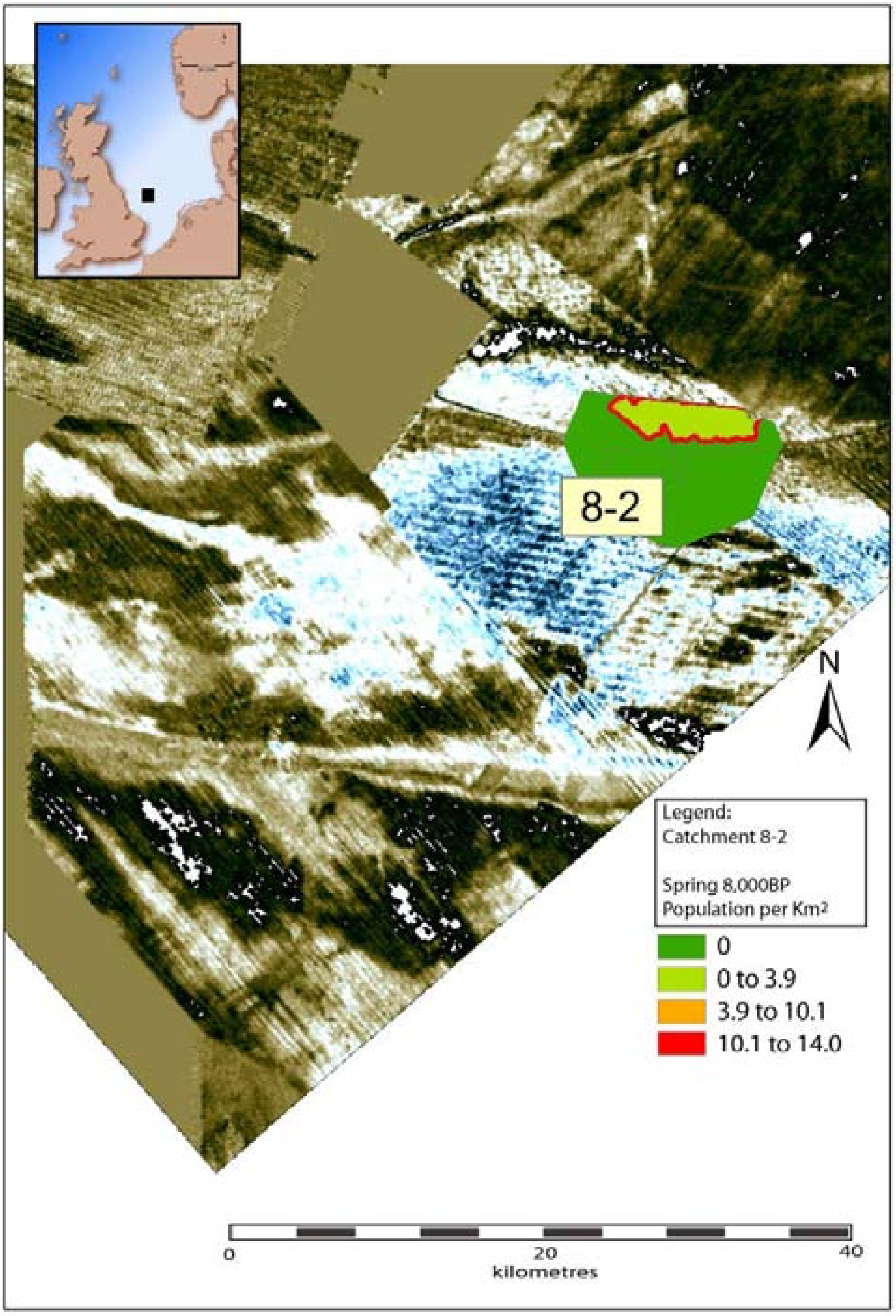

Figure 9.62b Population density map for catchment analysis at spring 8,000BP

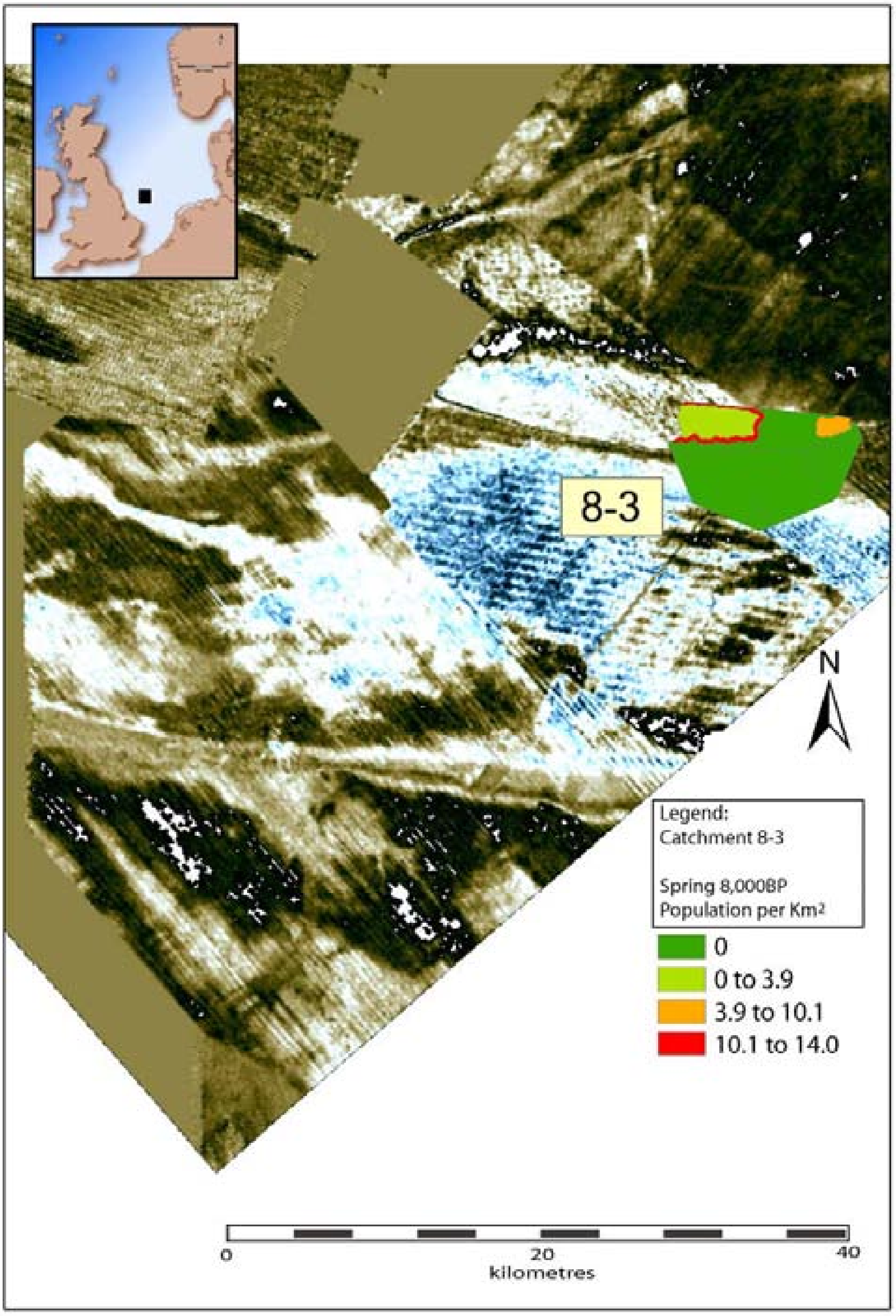

Figure 9.62c Population density map for catchment analysis at spring 8,000BP

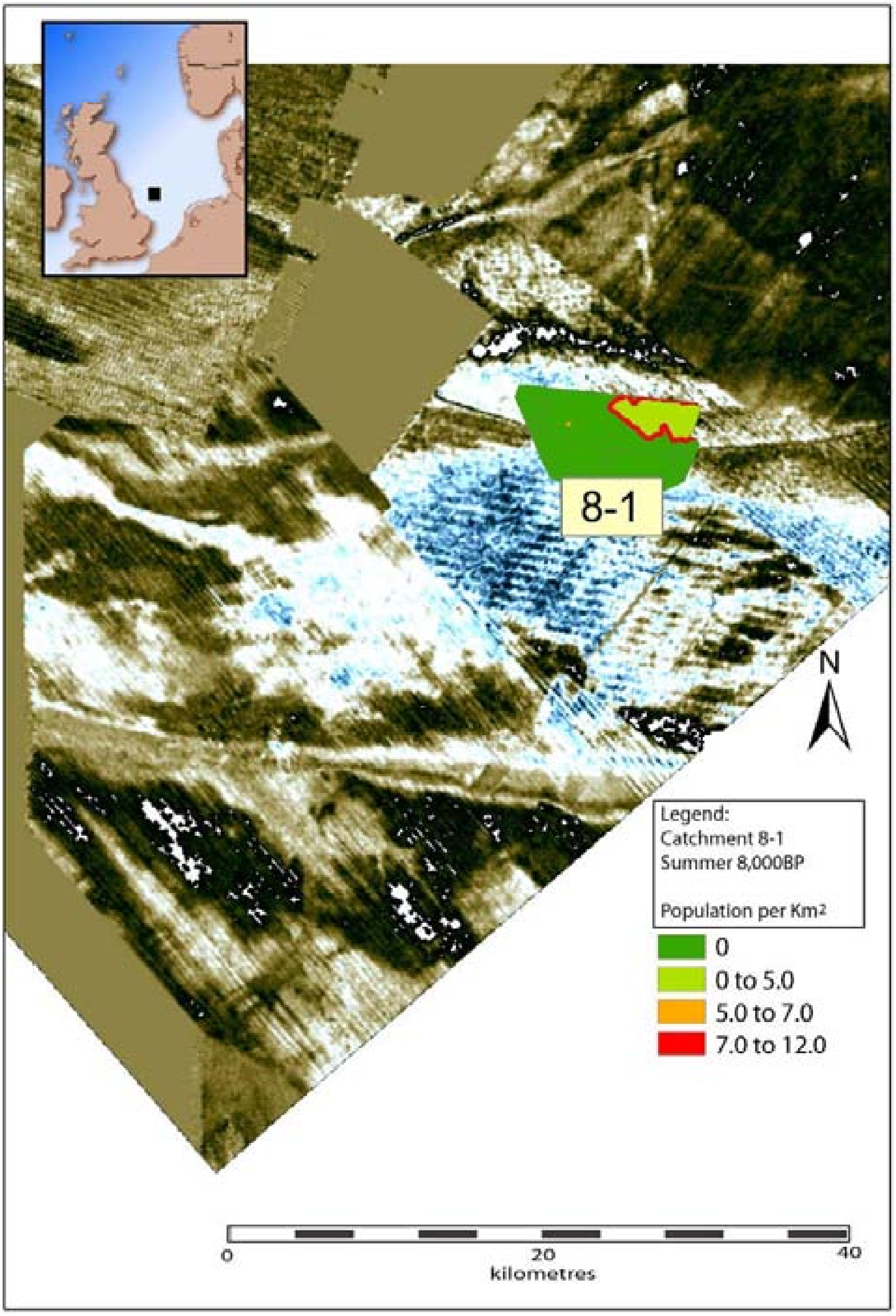

Figure 9.63a Population density map for catchment analysis at summer 8,000BP

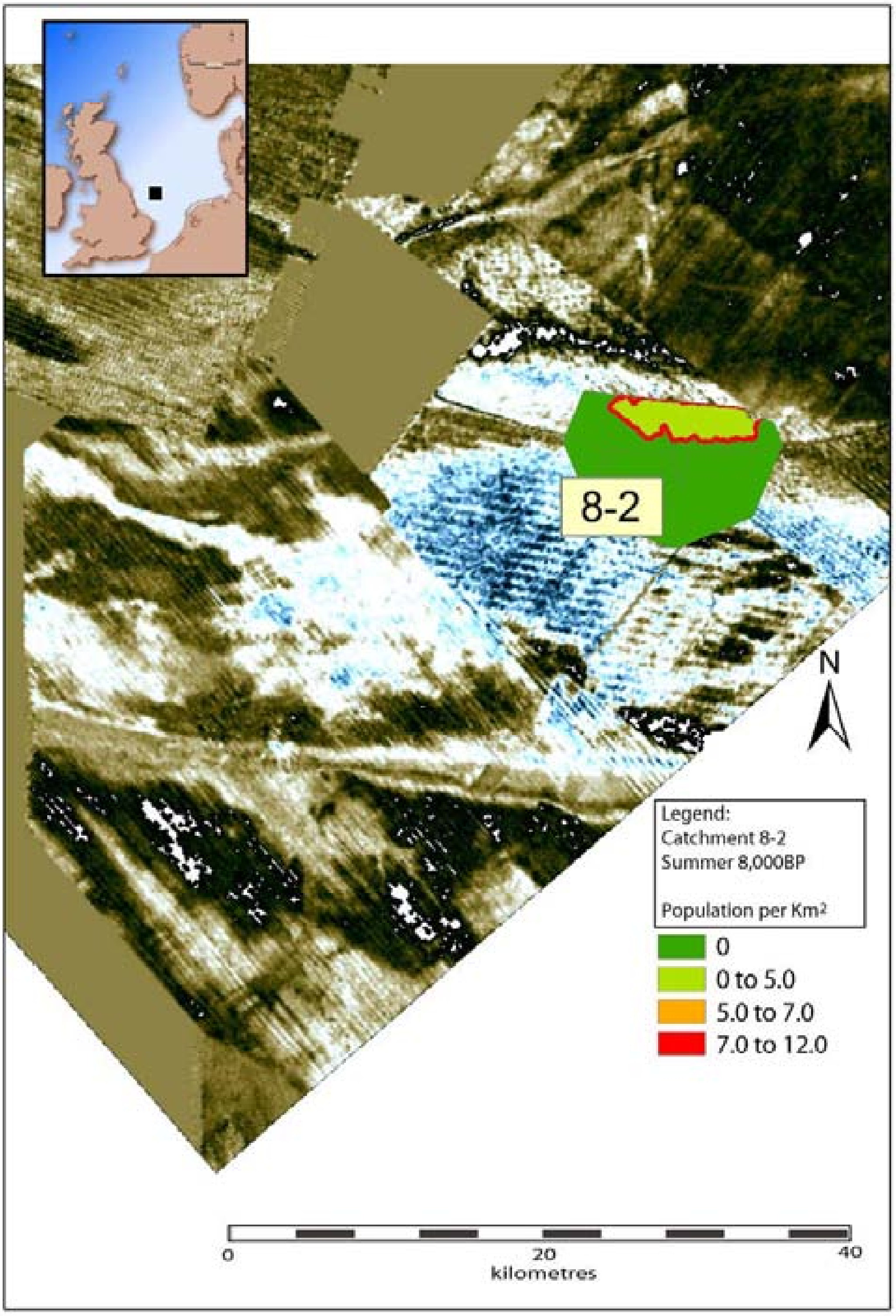

Figure 9.63b Population density map for catchment analysis at summer 8,000BP

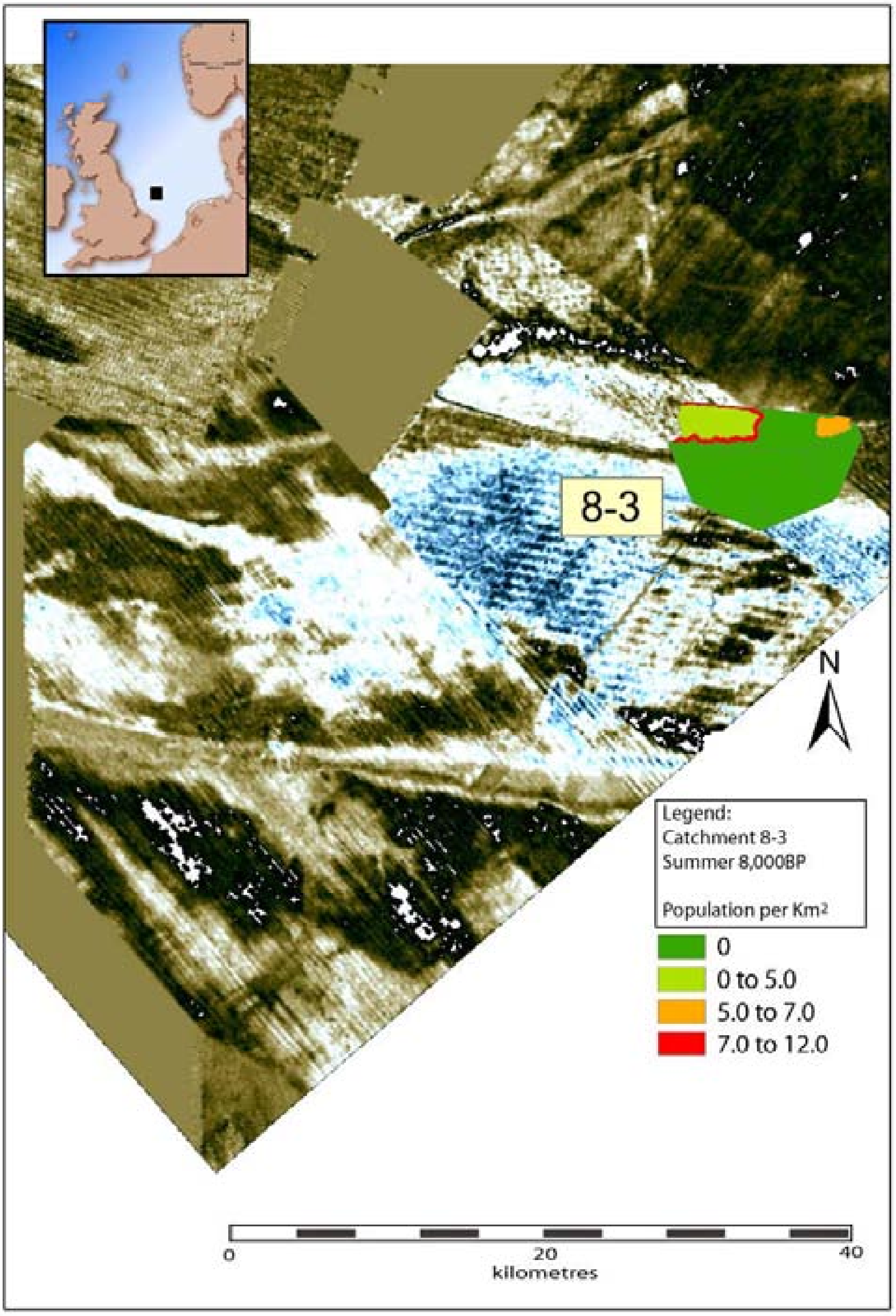

Figure 9.63c Population density map for catchment analysis at summer 8,000BP

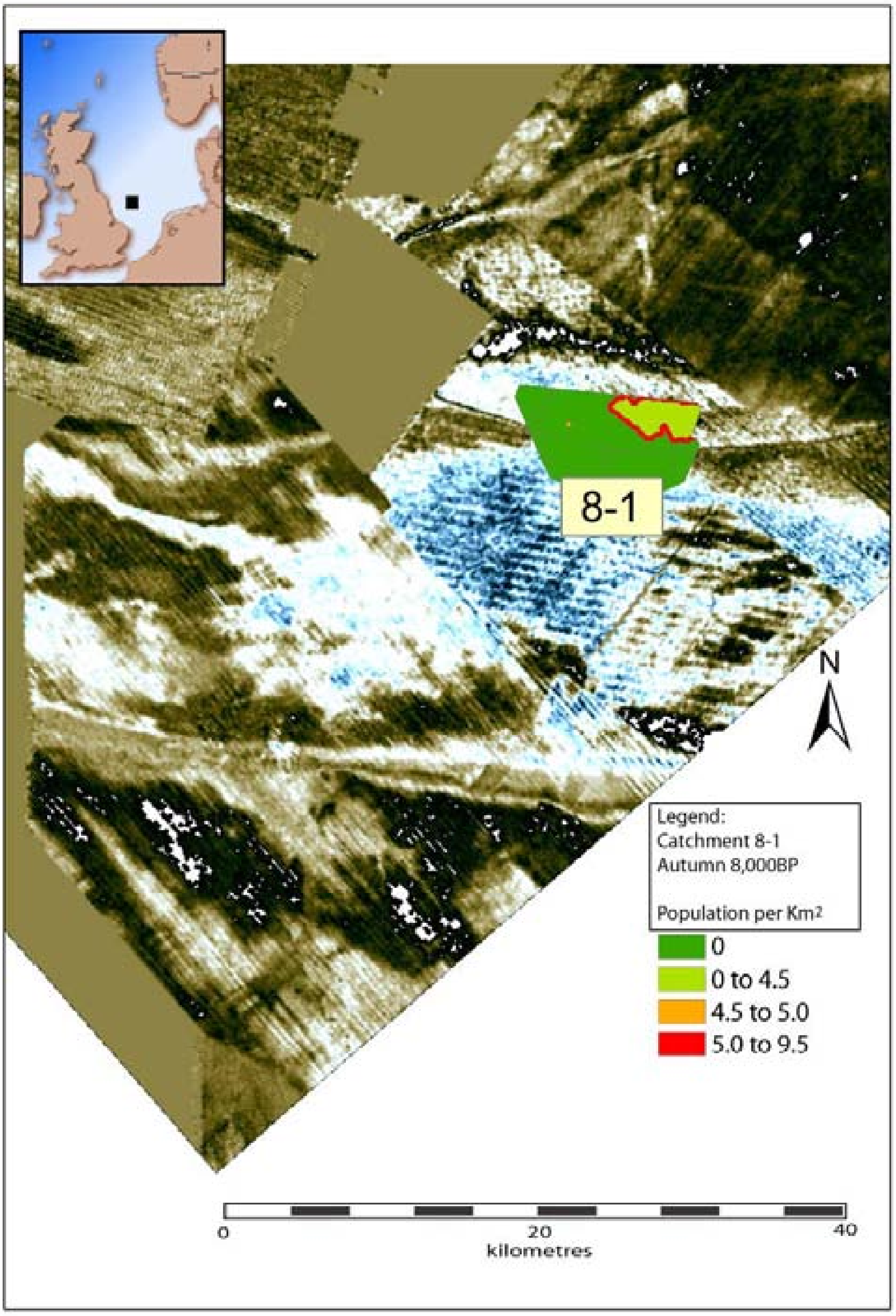

Figure 9.64a Population density map for catchment analysis at autumn 8,000BP

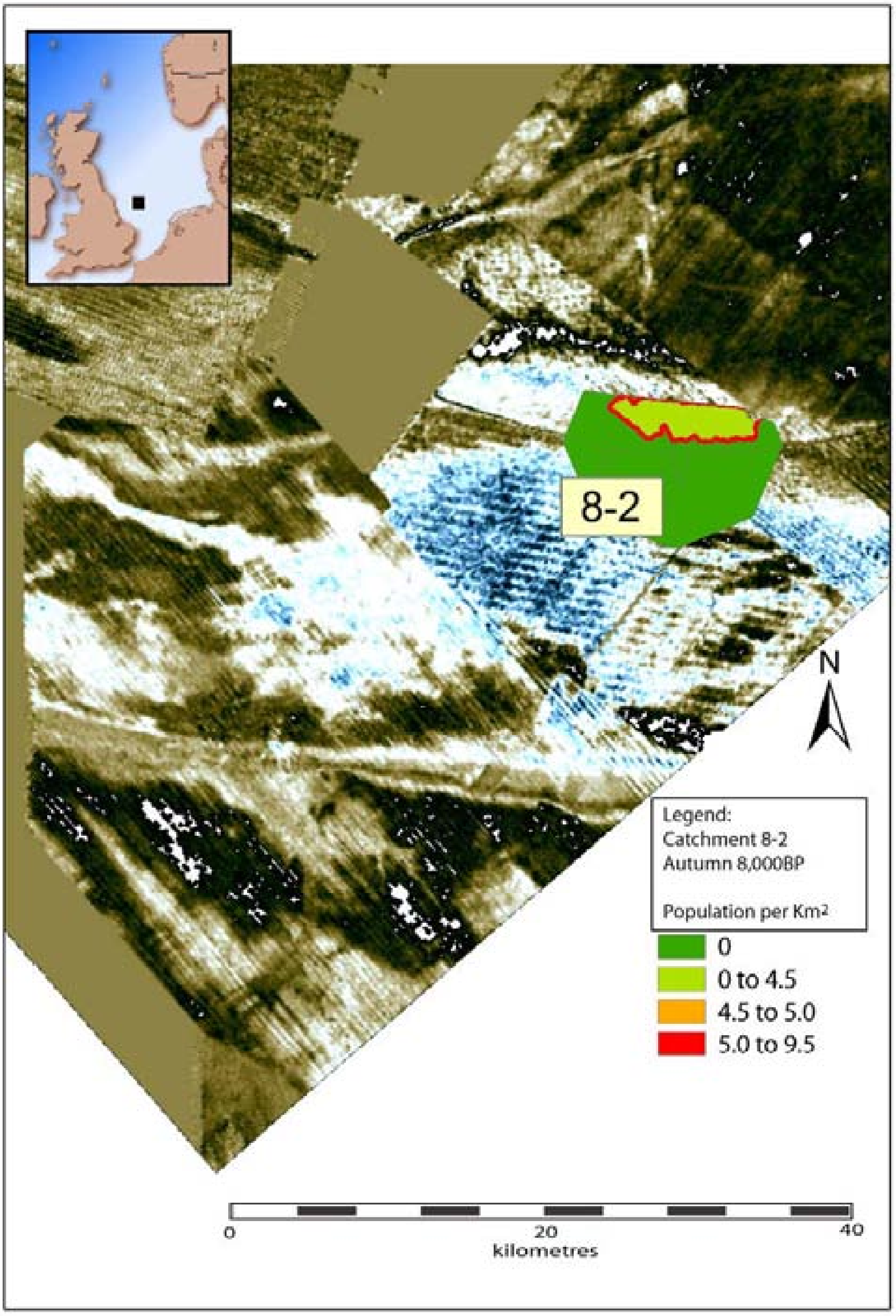

Figure 9.64b Population density map for catchment analysis at autumn 8,000BP

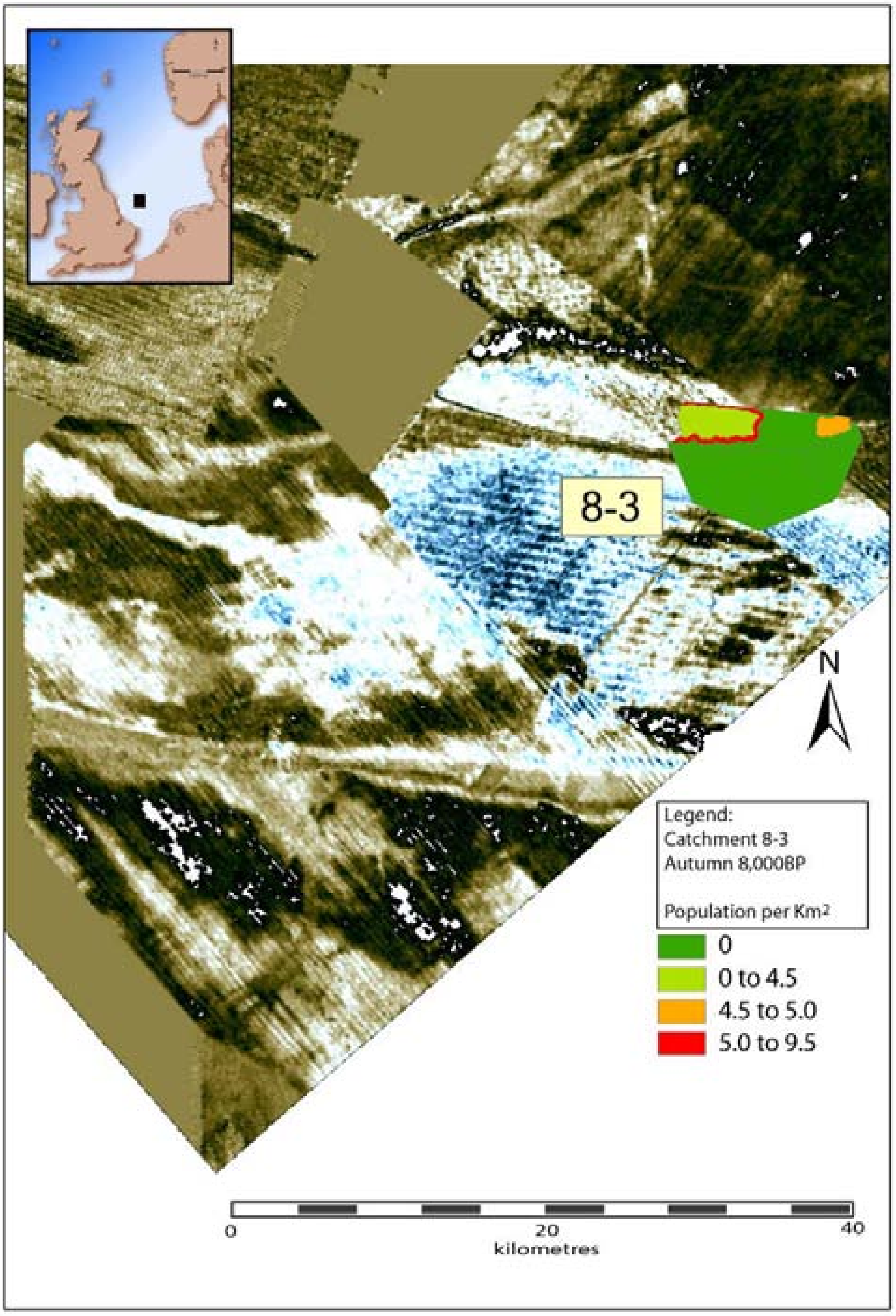

Figure 9.64c Population density map for catchment analysis at autumn 8,000BP

Appendix 3
An Atlas of the palaeolandscape of the southern North Sea: A Context for this Thesis

10.1 Introduction

This thesis preceded the North Sea Palaeolandscapes Project (NSPP) and acted as a pilot for developing the initial methodology for that study. This thesis further developed the modelling associated with hunter gatherer use of the original pilot study, and within an area of c. 6000km2. However, the landscape interpretation provided within the thesis represents only a small part of the larger mapped landscape. Published separately (Fitch et al 2007), the primary results of the NSPP are presented here to assist the reader and to provide a larger context for the thesis data. The NSPP mapping utilised the top 0.5s of the SNS Mega Survey. This was provided by PGS Ltd for research purposes and was analysed as part of an English Heritage Marine Aggregates Levy Sustainability grant. The thesis data is from the same source as the Mega Survey data utilised by the NSPP study and is directly comparable to the data used within this thesis. The NSPP results for the whole of the NSPP study area are presented in Figure 10.1 to 10.4. For presentation purposes the detail of the analysis has been presented as four quadrants reflecting the underlying BGS geological maps.

10.2 North Western Quadrant

10.2.1 Description

The landscape of the northwestern quadrant displays strong geological influence. This in part is due to the thin Pleistocene sediment cover within the area, which allows underlying geological relief to influence the overlying Holocene landscape (Lumsden 1986a). In addition to this, four active salt domes in this region are associated with graben collapse features and these form dominant structures within the landscape. The first of these circular structures (Figure 10.5 A) appears as a depression in the south of this quadrant. It features an upstanding lip on the west of this structure, and was formed by an outcrop of solid geology that remained upstanding after the collapse of the salt dome graben. In the Holocene, this structure would have created low hills of only a few metres in height. These would have partially surrounded the main graben collapse, which would have created a lower area, possibly containing a marshy area.

The second structure (Figure 10.5 B) appears in close proximity to the previous feature. The expression of this structure is very slight, and it is possible that this had little visible impact on the landscape. This is also suggested by the identification of a fluvial feature that appears to run directly across the feature.

A third structure, (Figure 10.5 C), is located at the mouth of the OSP depression. This structure is surrounded by relatively flat land. However, this graben collapse structure forms a slight, but distinct, depression in this area. The graben collapse is surrounded by slight rises formed by upstanding geology. This area is also likely to have contained a marshy depression during the Mesolithic period, with the upstanding lip forming a slight, but visible, rise in the ground level. The location of this depression close to the edge of the OSP suggests that during inundation, this structure may have bounded a channel joining the OSP to the wider marine environment.

The fourth, and final, structure is smaller than the others. However this crestal collapse differs in being surrounded by a clear ring of upstanding geology (Figure 10.5 D). The outer ring is disturbed in places by geological faulting associated with the main graben collapse. The upstanding nature of this ring is clearly demonstrated by an adjacent fluvial feature that is clearly channelled around the structure (Figure 10.7). This circular structure, however, possesses several interesting properties.

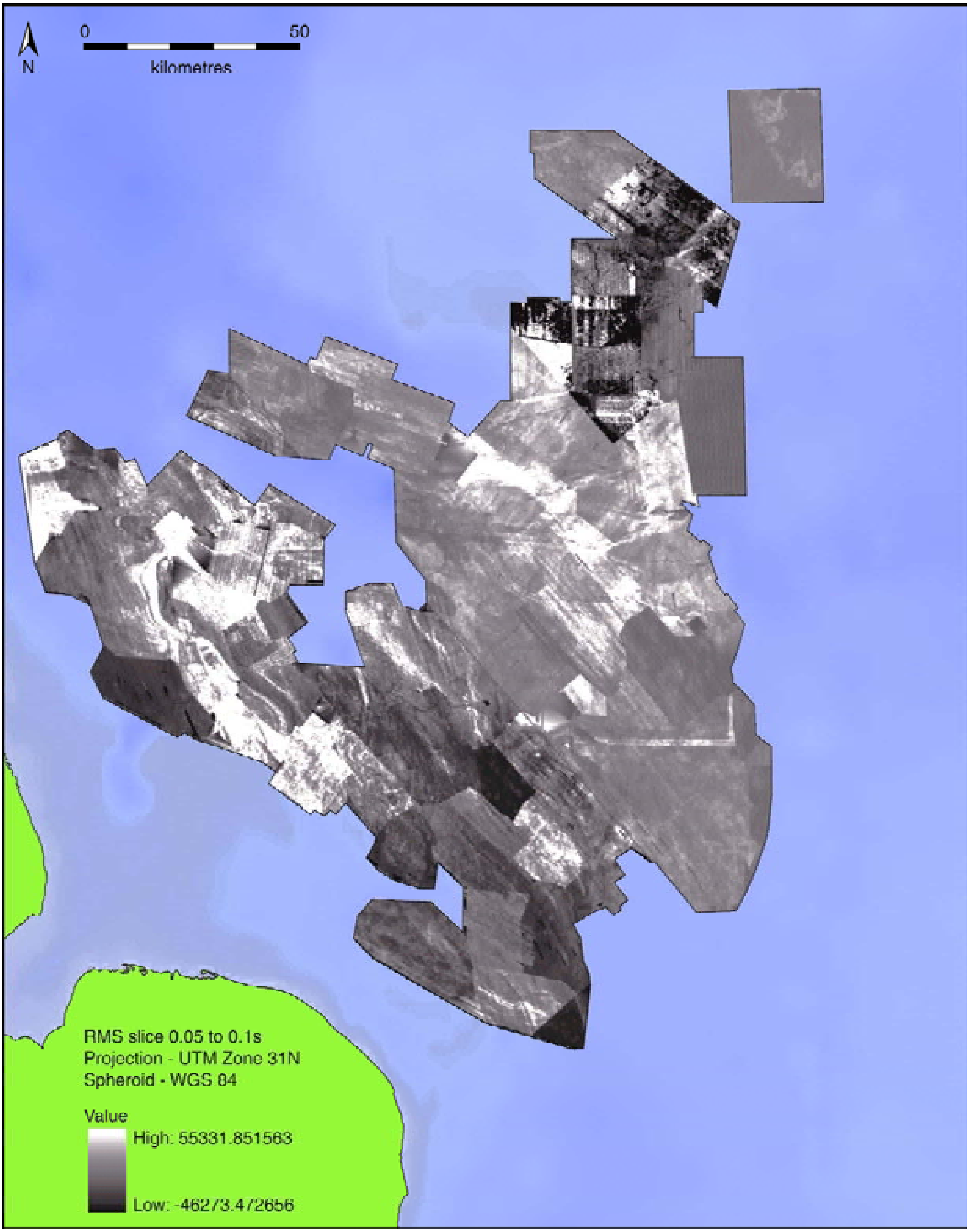

Figure 10.1 An RMS timeslice covering the whole of the project study area

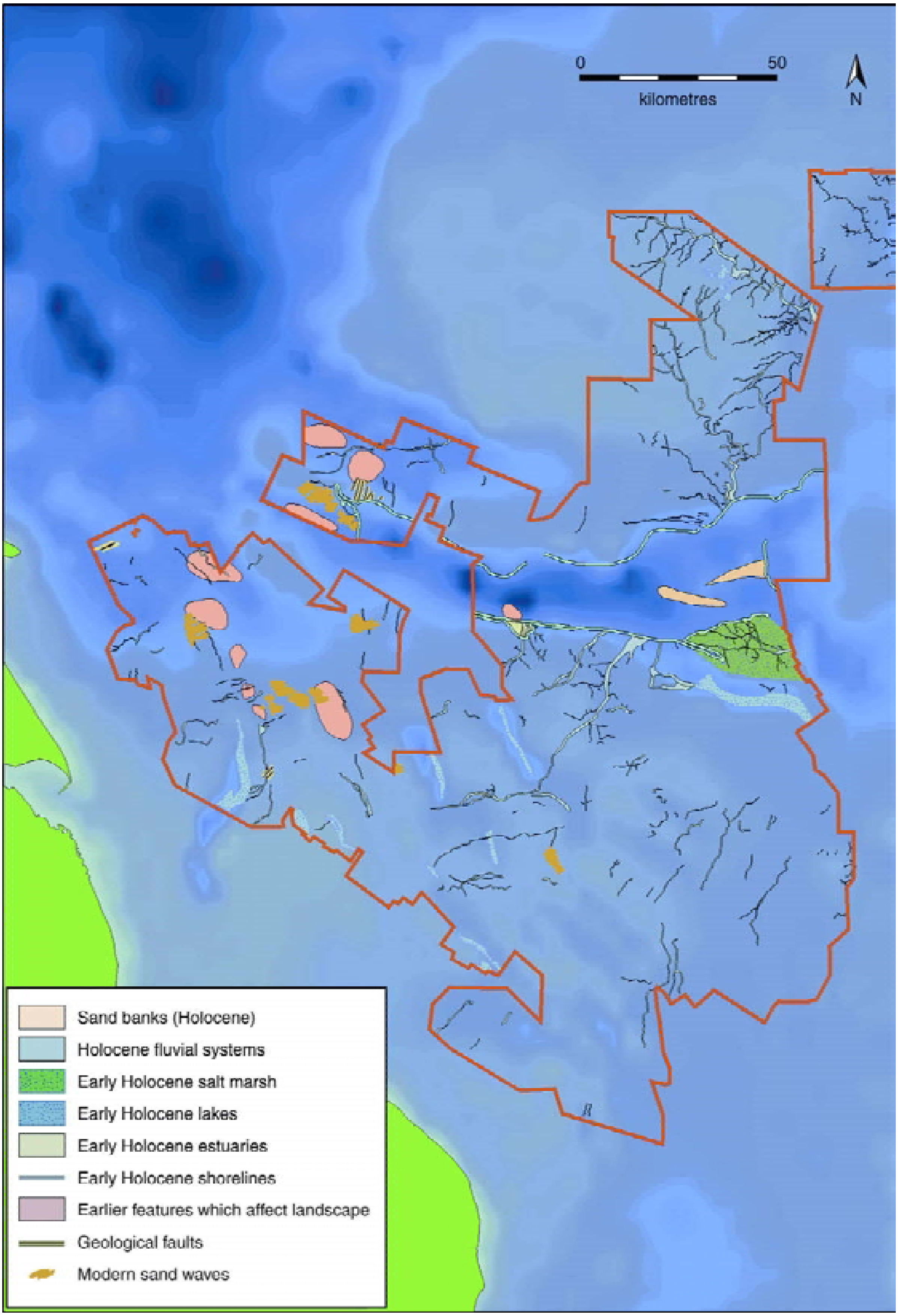

Figure 10.2 Primary features identified within the Holocene landscape of the southern North Sea

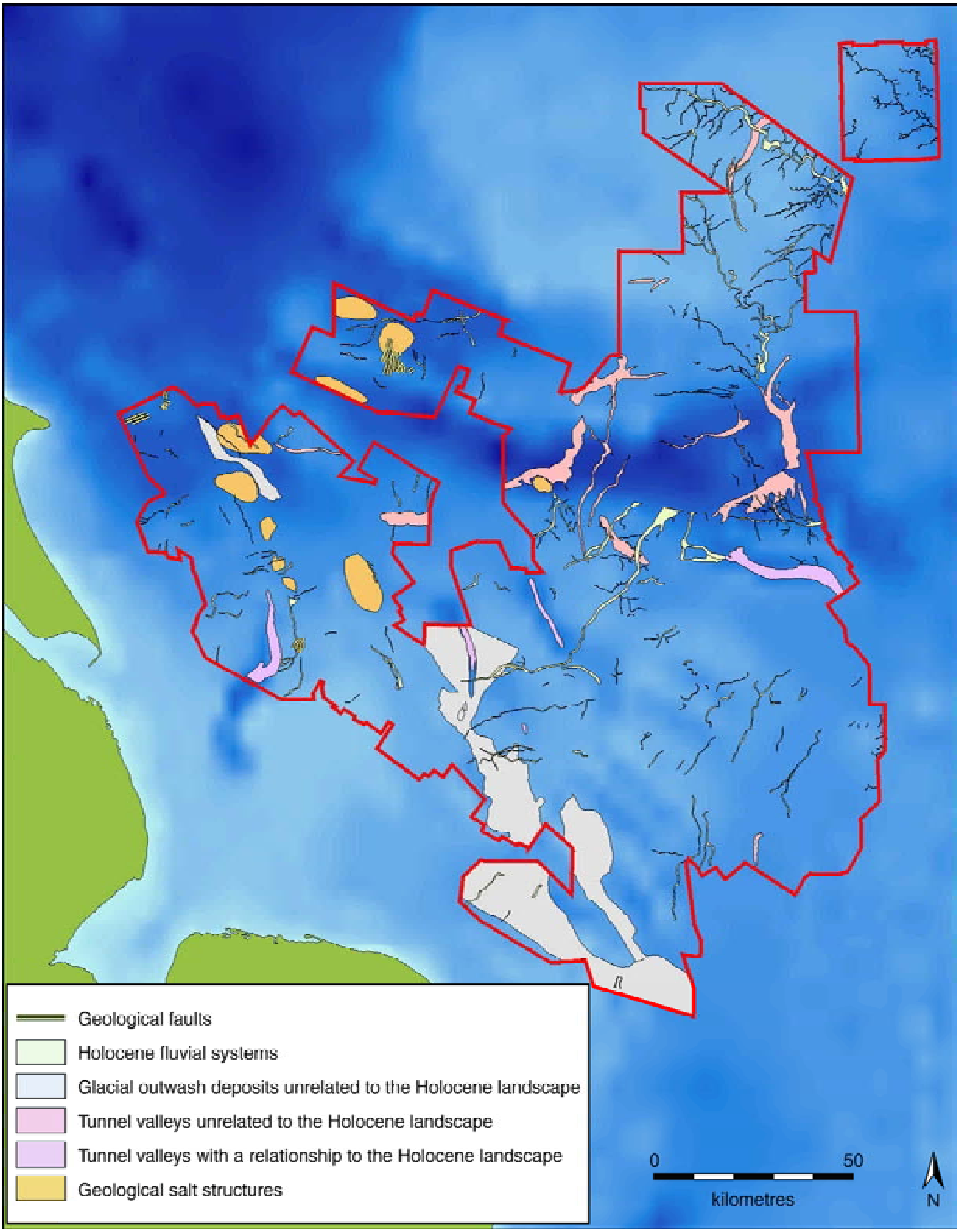

Figure 10.3 Pre-Holocene features recorded during mapping

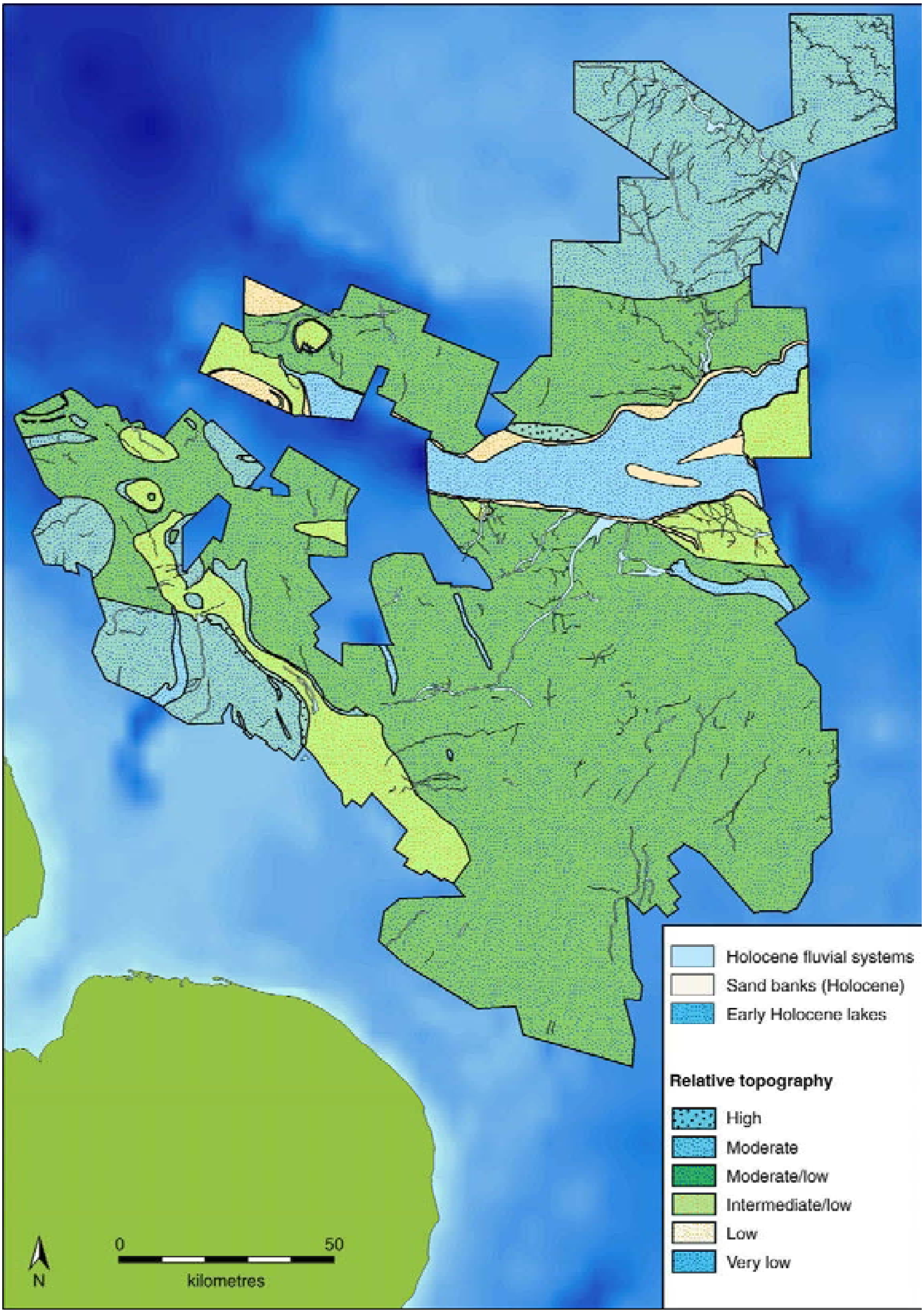

Figure 10.4 General map of all recorded Holocene landscape features including general topographic interpretation

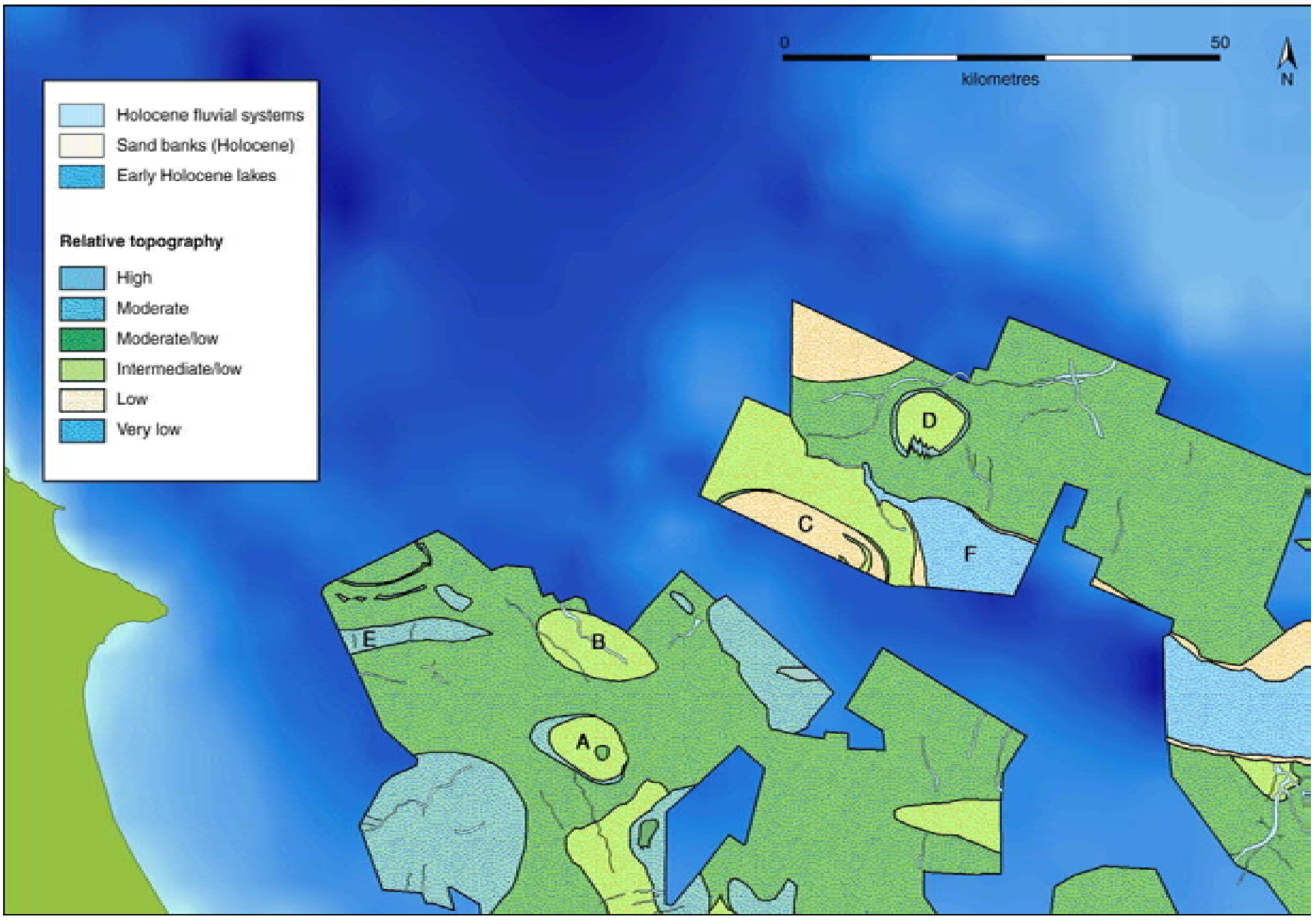

Figure 10.5 The Holocene landscape and features within the northwestern quadrant

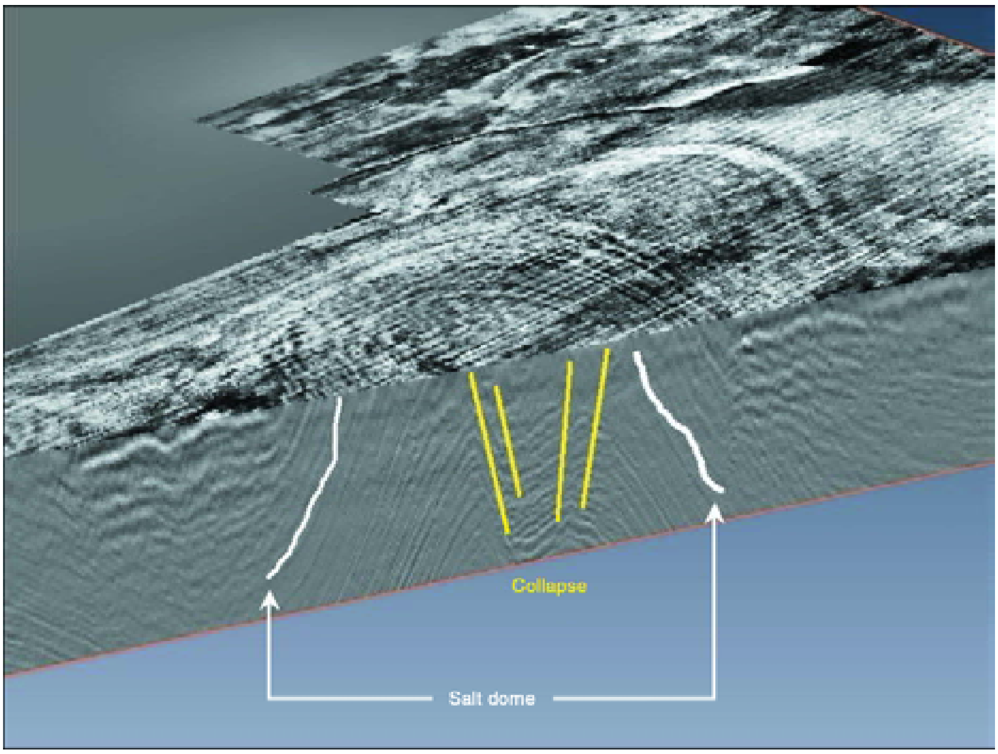

Figure 10.6 Vertical slice through salt dome exhibiting graben collapse

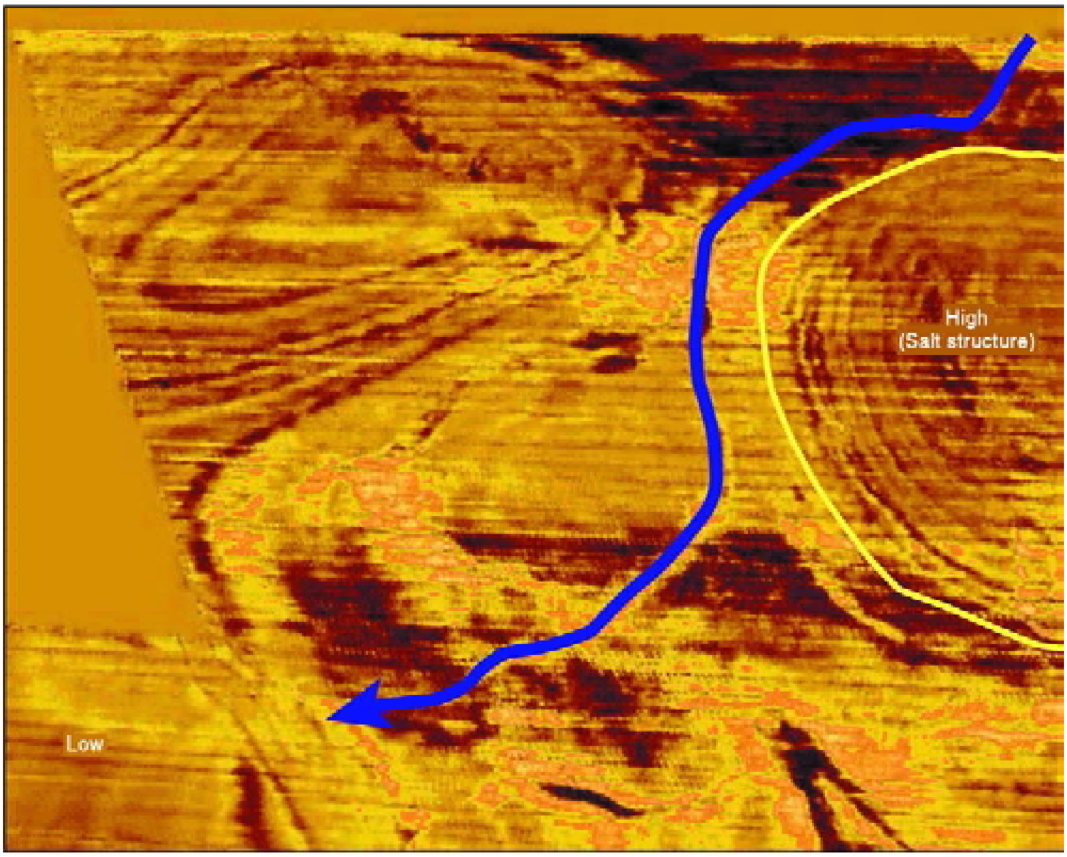

Figure 10.7 The major fluvial channel (blue) can be clearly seen to deviate to respect the topographic rise formed during the Holocene by the underlying salt structure

It may be that the basin is surrounded by solid geology which, given the right conditions, may have retained water. If this is so, two possibilities are suggested. The first is that this structure retained water and formed a lake that was surrounded by low hills. If so this would have formed a highly attractive environment for hunter-gatherers. Another option is that it may have contained a general marshy or wetland area, if the faulting and/or geological permeability prevented significant water build up. Unfortunately, neither scenario can be advanced with certainty. Indeed, as the water table was raised prior to inundation a marshy area may well have become a lake over time.

The fact that these salt structures formed enough of a topographic expression to produce regional highs and lows strongly suggests that at least some salt structures within this region were active during the Late Pleistocene and Early Holocene. This evidence is not inconsistent with observations of recent salt movements in the North Sea (Holford et al. 2007). The large Dogger Bank earthquake recorded in 1931 indicates that the area is still active (BGS 2007).

The underlying geology is also evident in other areas of the quadrant. To the far west, several prominent features may also be observed (Figures 10.5E and 10.8). One is directly correlated with the Flamborough Head disturbance, which appears on BGS mapping as being directly exposed on the seabed. The flanks of this feature are covered by a very thin veneer of Pleistocene material. This would have represented a significant Holocene landscape feature and appeared as a dominating, but low, ridge extending from the present coastline out into the North Sea. Given the thin sediments within this region it is unlikely that extensive archaeological sediments are preserved in the area.

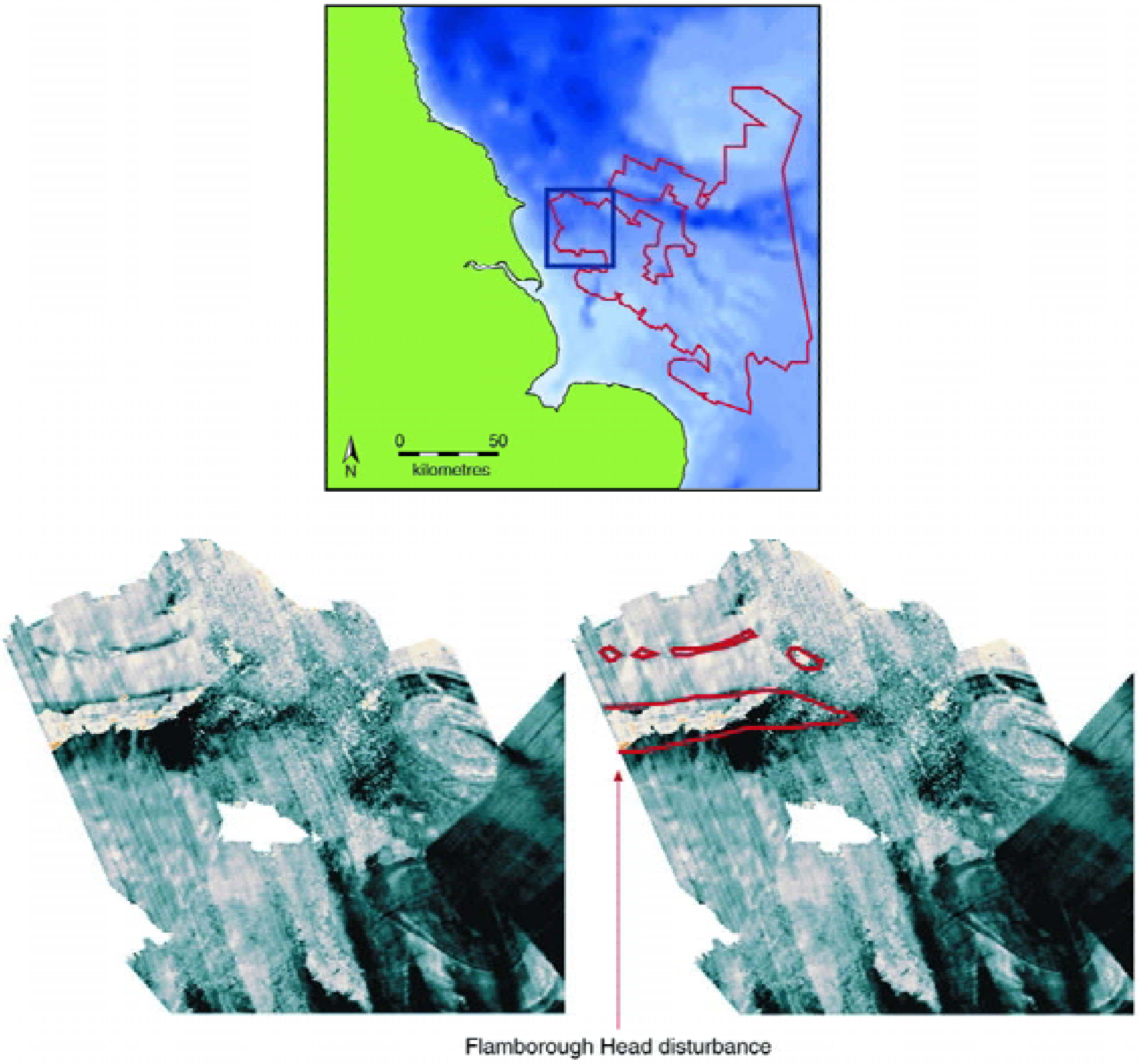

Figure 10.8 Seismic relief image of the Flamborough Head disturbance, note the visible positive relief it imparts to the Holocene landscape

Further south, the Holocene landscape would have risen as it drew nearer to the present shoreline. Within this area a series of small, fragmentary and truncated fluvial features can be observed. Their patchy nature is almost certainly a reflection of post inundation erosion (Flemming 2002, Cameron 1992). The poor resolution of these features may also be due to noise caused by the shallow water column in this area.

The dominant feature in the northeast of this quadrant is the western end of the OSP (Figure 10.5 F and Figure 10.9). A distinct fluvial feature can be seen running west north west from the OSP towards the topographic depression in between Flamborough Head and the Dogger Bank. This feature may be a channel flowing from, or even feeding, the lake that must have filled the OSP during the early Holocene. This channel was certainly active prior to the inundation of this region c. 9.5 Ka BP (Shennan 2000). A similar channel was advocated by Coles (1998) in her map of the region, although at the time no evidence was available to support such a proposal. In any case, the presence of such a channel suggests that the OSP contained a significant freshwater body prior to marine inundation that would have been very attractive to hunter gathers.

With respect of the OSP itself, it is clear that the bulk of this structure has suffered from Early Holocene marine erosion (Figure 10.10). Large scour marks are clearly visible within the depression, and the seismic data clearly shows truncation of deposits. This observation suggests that any lacustrine deposits that remain within this feature are likely to be intermittent. Coastlines at the edges of the Outer Silver Pit are characterised by a strong response and appear as distinct boundaries. Tidal scour marks are also visible and reflect differences in tidal flow. Although no clear dating evidence is available, isostatic models suggest that this coastline was active at around 9,500 BP (Shennan 2000).

10.2.2 Other Features

10.2.2.1 Solid Geology

The underlying bedrock, along with associated faults, is seen clearly within the upper timeslices of the data. Although there are clear indications that the solid geology of this region is near the surface, not all of this need have a topographic expression. Indeed the BGS maps for this region record that late Pleistocene cover in this region is very thin over much of the area (Laraminie 1989). This allows the strongly reflective bedrock to swamp the signal of all but the largest of Holocene features. Thus it is likely that this area may contain features that could not be identified during mapping. This observation must also be tempered by the observation that it is possible that active erosion may have effectively truncated the Holocene deposits and features within in this area. The remaining features in the offshore regions (<-10m) are therefore likely to be incised enhancing their survival and detection.

10.2.2.2 Recent Geological Features

A series of linear features can be discerned in the centre of the study area, near the outflow of the OSP Lake. Their position in the upper sections of the seismic section and their structure revealed that these features were reflections of large sand waves on the seabed surface that are of recent origin (Lumsden 1986b).

10.3 North Eastern Quadrant

10.3.1 Description

The northeastern quadrant of the survey area has provided one of the most complete pictures of the emergent landscape of the SNS. This area was mapped as part of a pilot study prior to this project, and the results of that work have been confirmed and enhanced during this larger exercise (Fitch et. al. 2005). The level nature of this landscape largely reflects the presence of deep Late Pleistocene sediments within the region. The area possesses a topographic high over the area of the Dogger Bank that gently descends into the lower lying plain surrounding the OSP. One minor topographic high can be observed in the southwest of this quadrant, located approximately over the Outer Well Bank (Figure *10.11* B, Laraminie 1989). This topographic high is related to a facies change within the Late Pleistocene deposits, and is due to a change in depositional environment during the Late Pleistocene (Laramine 1989). However the dominant topographic feature in the area remains the *OSP*, which forms a significant depression in the south of the quadrant (Figure 10.11 C*).*

Within this quadrant the predominant trend of all the fluvial systems is to the southeast. These drain the area of the Dogger Bank, to the north, and converge on the OSP, (Figure 10.11 D, A). All of the Holocene fluvial features can be seen to be incised into the underlying Late Pleistocene Dogger Bank Formation. This relationship demonstrates that these features are likely to have been latest Pleistocene or Early Holocene in date. The majority of these features are highly developed sinuous systems with a high stream order. The geographic location of these systems, in relation to the early Holocene topography, suggests that they were sub-aerially exposed for a longer period than most of the survey area and that the systems are better developed as a consequence. A number of abandoned meanders can be observed, in association with a developed main central channel, and these join the coast via a well-formed estuary. The latter feature can just be seen through heavy striping within the dataset.

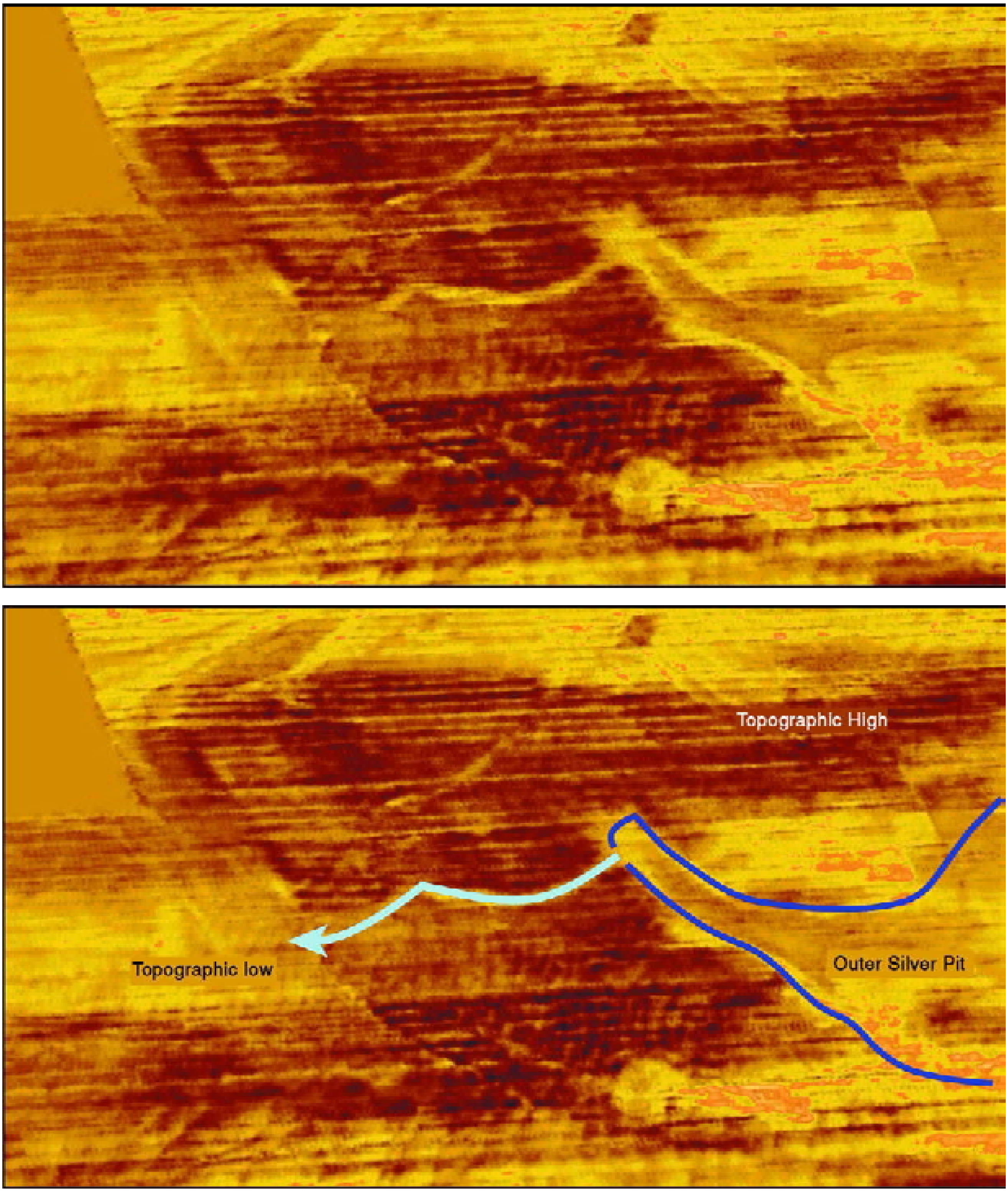

Figure 10.9 Western end of the OSP lake showing outflow channel and associated topographic highs and lows

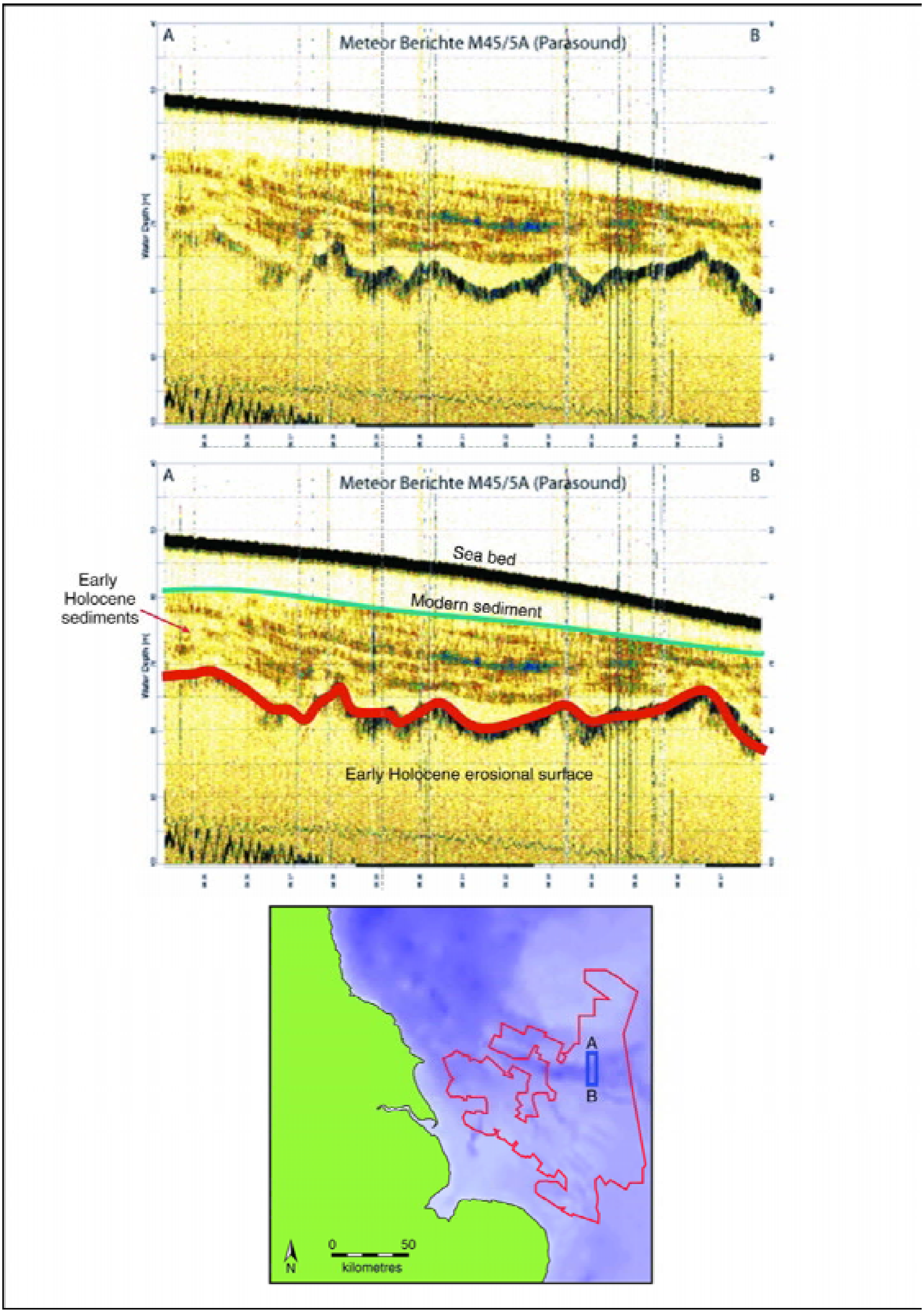

Figure 10.10 A seismic line across the OSP. Pronouced scouring (red line) occured during the early Holocene marine transgression of the area . The surface is overlain by later early Holocene marine sands and muds. (Data provided by the University of Bremen)

The abandonment of channels is presumably a response to changes in the fluvial regime. In this case, the most likely cause is a response to regional sea-level rise. The final landscape features in this quadrant that require description are a series of bulbous basins that occur next to a prominent fluvial system referred to as the "Shotton River" (Figure 10.11 E, Fitch et. al. 2005). Initially recorded during the pilot project these basins have been interpreted as wetlands or lakes. The correlation between these features and an underlying tunnel valley within the seismic dataset suggests that the earlier depression may have been filled with impermeable glacial fill material leading to lake or marsh formation. Again, such wetland systems could have been gathering points for hunter gatherer groups within the landscape and provided a wide variety of hunting and gathering opportunities.

As the fluvial systems progress down to the OSP, clear coastlines are observed framing the OSP itself (between B and D (Figure 10.11). These are characterised by a strong response and are often accompanied on the seaward side by tidal scour marks. A number of rivers meet the coastline in this area, widen and form small estuaries (Figure 10.12). The coast (or lakeside) is clearly defined, located between the -40 metre and -50 metre contours and coincide with the contemporary outline topography of the OSP.

If we utilise the sea level curves provided by Jelgersma (1979), Shennan (2000) and Peltier (2004) then an approximate age between 9,500 BP and 8,500 BP is suggested. Unfortunately, the profusion of sea level curves for this region, combined with the difficulties of relating such models to the real world (Bell et al. 2006), demands that an accurate age for this shoreline awaits the recovery of suitable, dateable material.

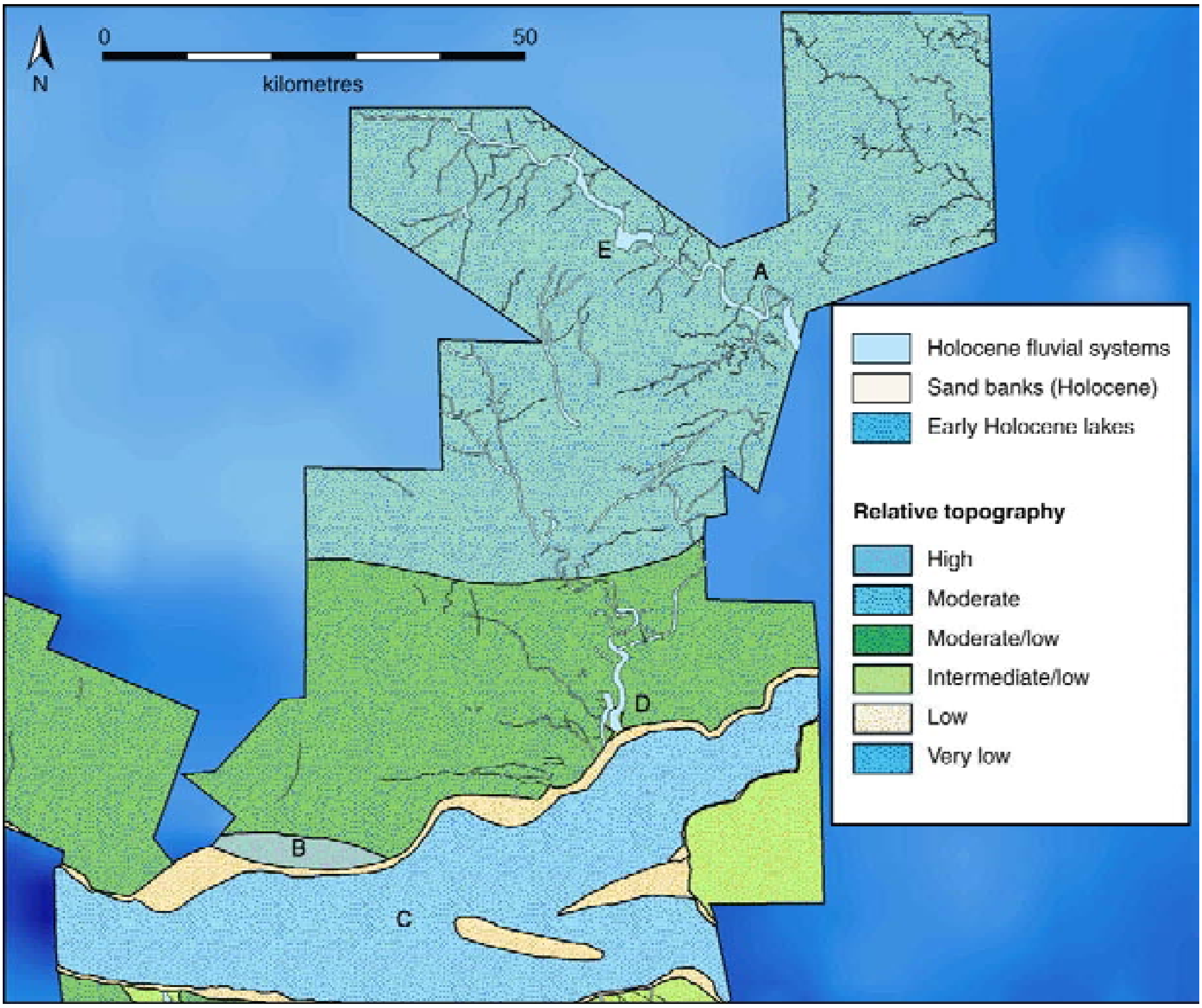

Figure 10.11 The Holocene landscape and features within the northeastern quadrant

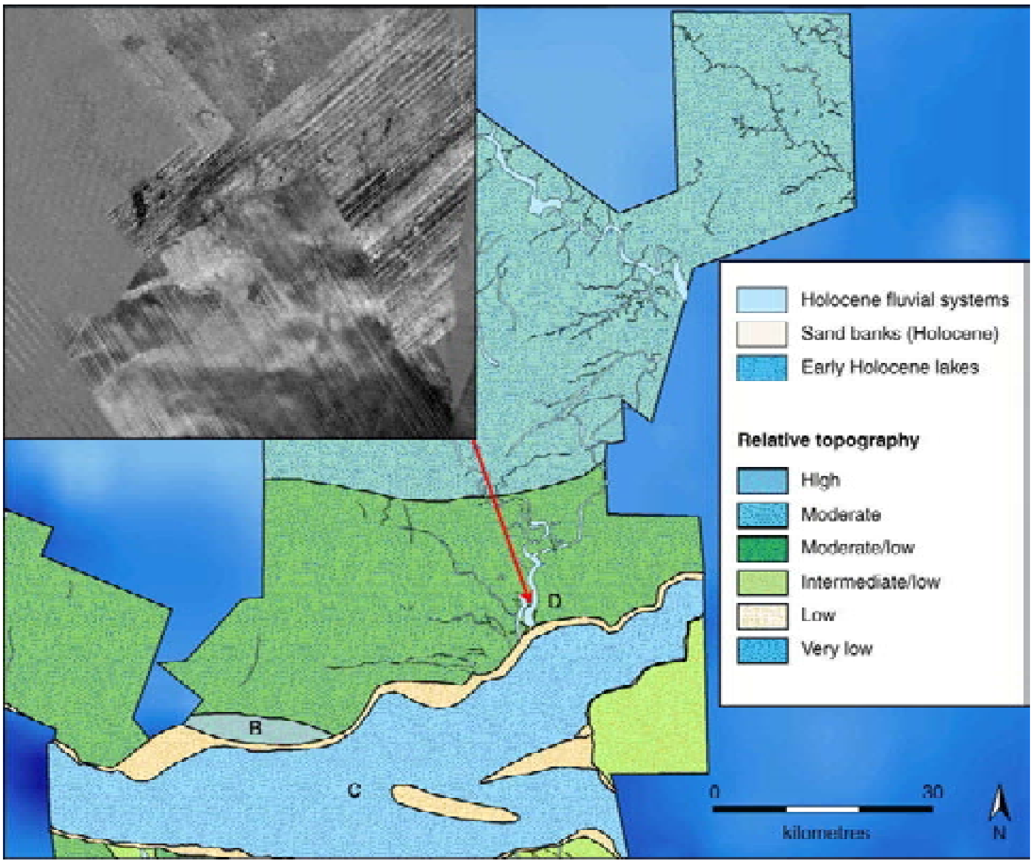

Figure 10.12 The junction of rivers and coastline can clearly be seen in the inset seismic image. The river channels can be observed to widen and form small estuaries

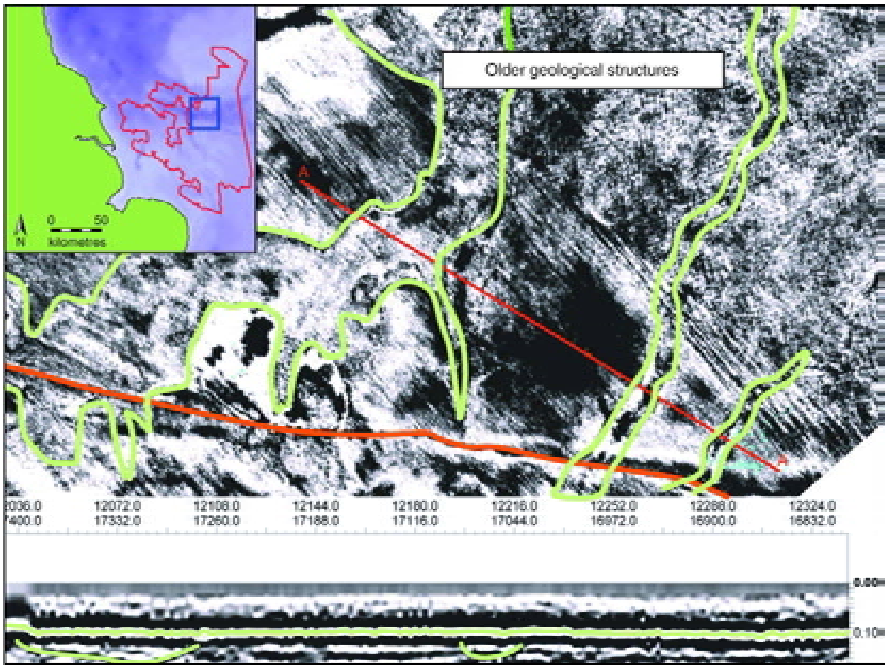

Figure10.13 A series of tunnel valleys (green outline) crossing the OSP and observed to underlie the Holocene landscape (coastline marked in orange)

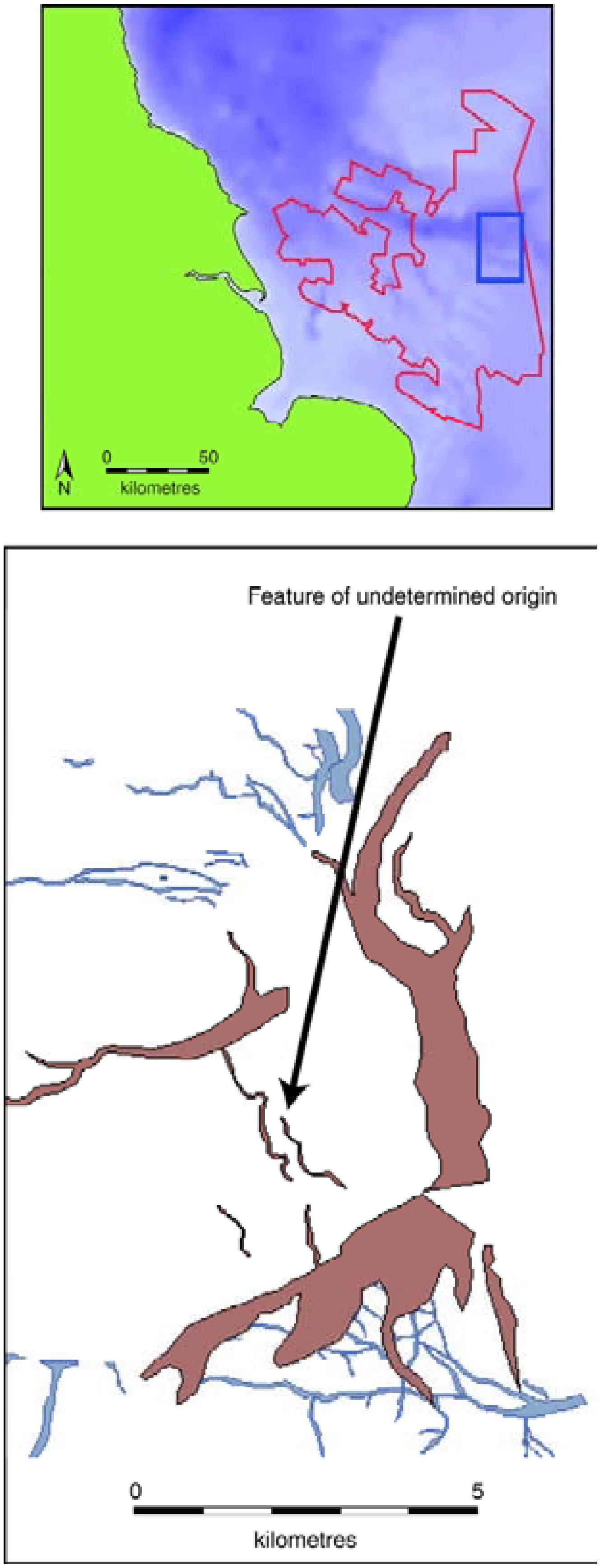

Figure 10.14 The location of one of the small structures that resembles a palaeochannel. The origin of these features remains to be determined

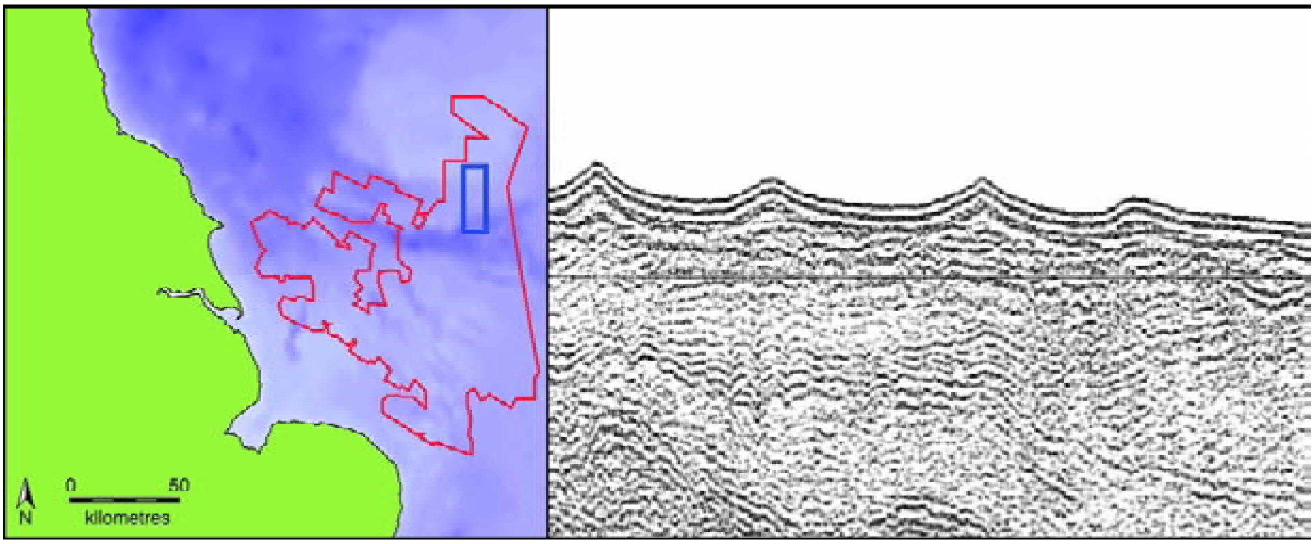

Figure 10.15 Modern Sandwaves directly overlying the Holocene landscape

However, this area would have provided a diverse and productive environment for the occupants of the landscape. The OSP during this period would have hosted a variety of intertidal and estuarine environments within which food would have been relatively abundant.

Two large prominent ridges can be observed in the southern central section of the quadrant (near C in Figure 10.11). These elongate ridge features, have already been discussed in an earlier paper in this volume and were interpreted as moribund sand banks that formed in as estuarine environment during the early Holocene marine transgression (see Briggs et al. this volume; Shennan 2000). From this it is inferred that the tidal range of the OSP was probably macro-tidal and the tidal currents conveyed in the estuary were relatively strong.

10.3.2 Other Features

10.3.2.1 Solid Geology

A series of tunnel valleys can be clearly be observed underlying the Holocene landscape and crossing the OSP within this quadrant (Figure10.13). These features do not appear to have any topographic expression, but are visible due to the absence of the Later Pleistocene deposits in this depression. These are directly related to features observed on BGS mapping ascribed to the Middle Pleistocene Swarte Bank Formation (Laramine 1989). Due to time and focus constraints only those features that were significant to the interpretation of the Holocene landscape were digitised.

There are, however, a number of small features that resemble a series of palaeochannels. These are located within the Outer Silver Pit, incised into Lower to Middle Pleistocene deposits, and are covered by recent sediment (Figure 10.14).

It is likely that these formed small extensions of tunnel valleys located within this area; although it is equally possible that these are remnants of a more recent palaeolandscape. Unfortunately the origin of these features could not be determined utilising the available data, and the mode of formation and age of these structures remains undetermined.

10.3.2.2 Recent Geological Features

No features of recent geological origin were observed in the seismic data within this region, however 2D BGS seismic lines do show that minor sand structures are located in this area (Figure 10.15).

10.4 South East Quadrant

10.4.1 Description

Few major topographic features were identified within the area (Figure 10.16) and the majority of the surface area within the quadrant was determined to be extremely flat (Figure 10.17). Although the significant data striping present in the southeast of this quadrant hindered interpretation (Figure 10.18), data quality is reasonable elsewhere, and little significant landscape variation is discernable. The southern margin of the OSP is visible in the northern most part of the quadrant (Figure 10.16 B), along with associated intertidal features. A significant depression, which retains a bathymetric expression today, can be observed to the north. However, the majority of the fluvial features within this region run across a large and relatively flat plain. The seismic signal in this area generates a "mottled" appearance, the origin of which is uncertain (Figure 10.18). A few minor fluvial channels can be observed within this mottled zone (Figure 10.16 A). Although detailed interpretation within this area is problematic the area, although undistinguished in topographic terms, may contain significant archaeological potential. The BGS mapping for this region, for example, records an extensive coverage of the archaeologically important early Holocene Elbow Formation over the plain.

Where fluvial features can be defined within this quadrant they can be divided into two groups. The first group is located to the northwest of the quadrant and flow from the southwest to the northeast (Figure 10.16 C). These features run directly across Holocene floodplains but have little observed sinuosity. The project was unable to resolve the channels located within these floodplains. However, given the topography, it is likely that the channels have a higher degree of sinuosity than is visible within the data. Adjacent to the coast, a clearly defined and developed estuary can be seen at the termination of the fluvial channels (near Figure 10.16 B). The character of these estuaries suggests that their formation has been controlled by a series of inundations during a period of rising sea level.

The second group of features is located in the southeast of the quadrant and trend southwest - southeast. They may flow towards a location, suggested by Coles (1998), to contain a deep-water channel (Figure 10.16 A, D). Unfortunately, the noise within this region is enough to hinder the resolution of these features. In one area, near that studied by Praeg (1997), a clear and well-developed sinuous channel system can be discerned. This suggests that if the issue of noise could be overcome, possibly following access to newer surveys, the route of these channels could be resolved.

The most significant landscape feature within the quadrant is the large depression that forms Markham's Hole (Figure 10.16 E and Figure 10.19). Located in the northeast of the quadrant, this large, partially in-filled valley retains a bathymetric expression. The seismic data actually reveals that this feature is much deeper than the bathymetry suggests (Figure 10.19).

BGS cross-sections for the area, along with 2D seismic data made available to the project, suggests the existence of significant deposits within this structure. These deposits can be directly related to the Late Pleistocene Botney Cut Formation and are directly overlain by sediments of recent origin. A channel system attached to the end of this tunnel valley, which is incised into the Late Pleistocene Boulders Bank Formation, can be observed to terminate at the Early Holocene coastline. These relationships suggest that this feature dates to the Late Pleistocene or Early Holocene, and strongly suggests that this feature may have been a drainage channel for this depression. The depression may have contained a lake during the early Holocene. This interpretation is supported by the BGS mapping for the area that records the presence of Late Weichselian to Holocene glacio-lacustrine deposits throughout this depression (Brown 1986).

Further to the north, in an area bound by Markham's Hole, the Botney Cut and the OSP, are a series of channels traversing a low-lying area (Figure 10.16 F). The area itself is clearly defined but does not possess any specific characteristic other than the presence of these channels. This might suggest a delta system (Figure 10.20) however there are no structures visible in the seismic data to support this interpretation. Its relatively flat prospect and position, adjacent to one of the OSP marine inlets, suggests that the area might have been a salt marsh for part of its history at least. The channels appear to show two distinct formation phases. A primary, slightly larger, channel may be older, whilst a series of smaller channels may form a network over and around this structure at a slightly later date. Once again, this sequence may be the consequence of rising sea levels.

The OSP coastline is still well pronounced in this area, although the basin appears to widen as it nears the area of the postulated salt marsh. The coastline is characterised by a strong seismic response although tidal scour marks, which are clearly visible elsewhere, are not clearly defined in this area. This might reflect a difference in tidal flow at this point. A deeply incised inlet can be seen in the intertidal area, adjacent to the postulated salt marsh. The origin of this feature is a partially filled glacial tunnel valley, which was inundated during the marine transgression at around 9,500 BP.

10.4.2 Other Features

10.4.2.1 Recent Geological Features

In the west of the study area are a series of very small linear features. Their position, high in the seismic column and their structure revealed that these features are reflections of large sand waves on the seabed surface and are of recent origin.

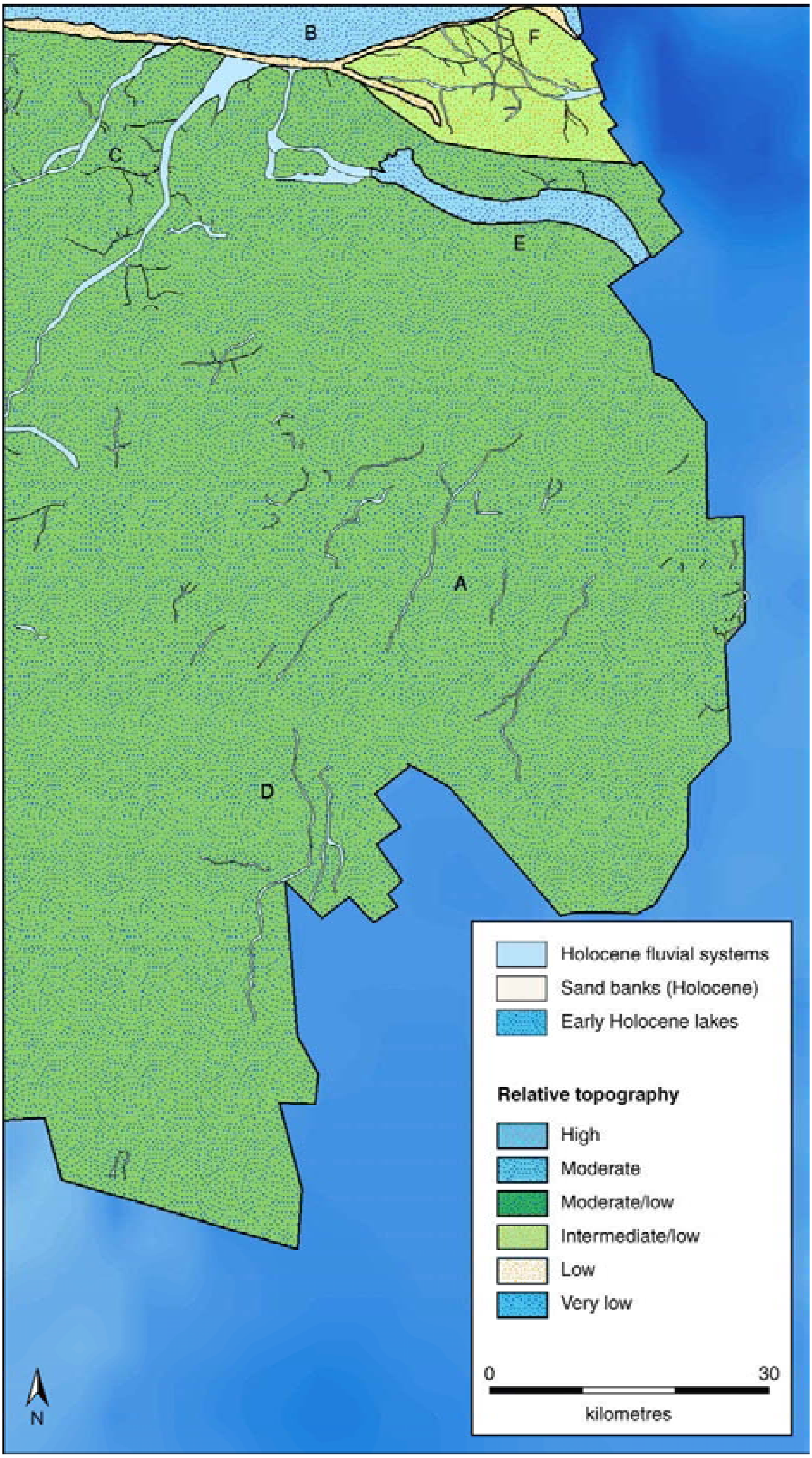

Figure 10.16 The Holocene landscape and features within the southeastern quadrant

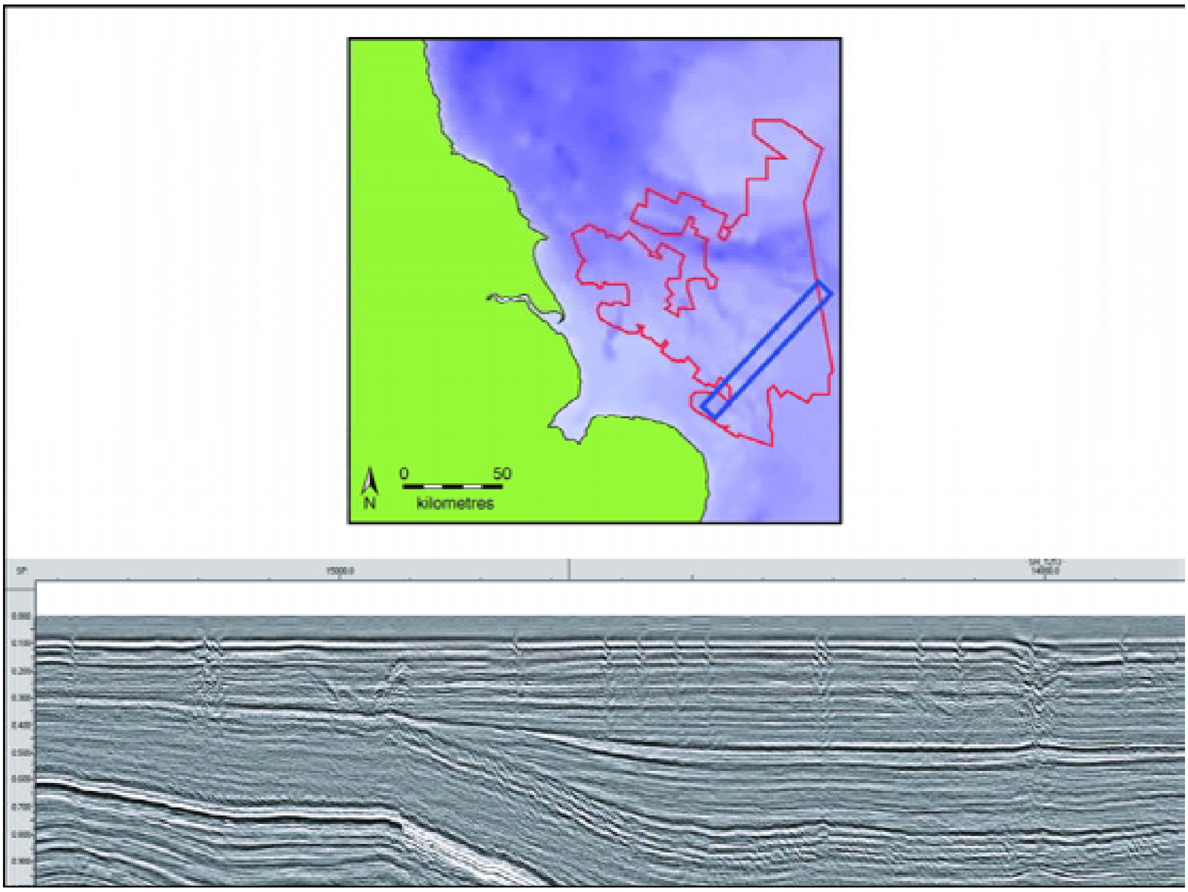

Figure 10.17 Seismic line across the southeastern quadrant. Little landscape variation can be discerned in this area

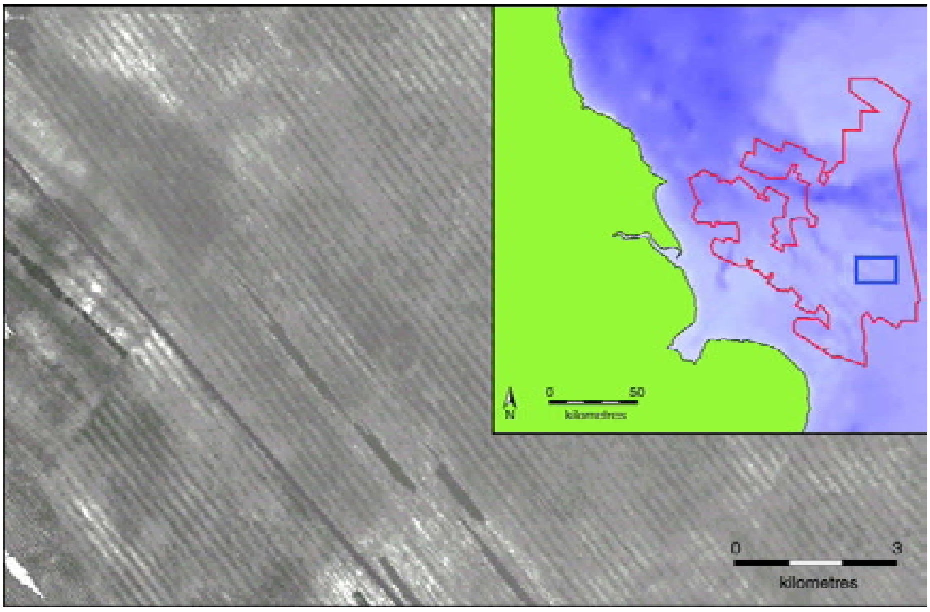

Figure 10.18 A representative image of "mottling" within the seismic data. Whilst minor channels can be discerned, the clarity of the interpretation is hindered.

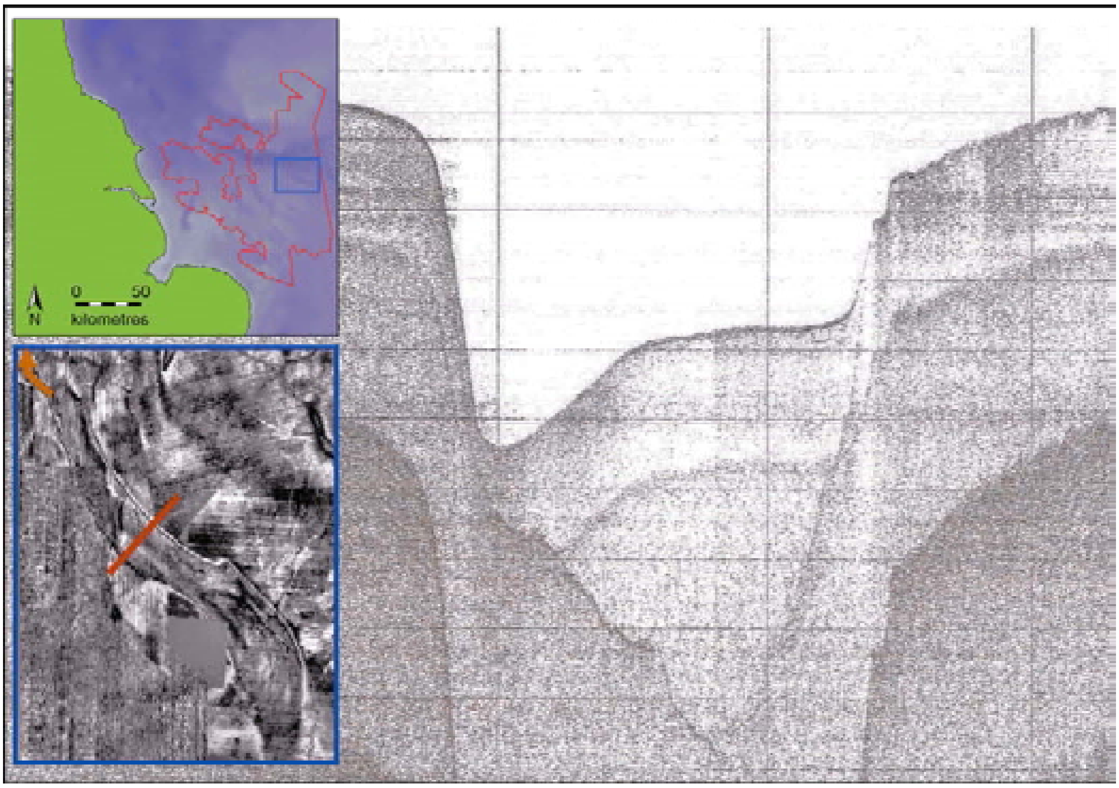

Figure 10.19 Cross section (BGS line 80-01-05) over Markham's Hole. This clearly shows the deep incision of this feature (location marked by red line on inset). The inset timeslice of this feature shows the location of the outflow channel (marked orange)

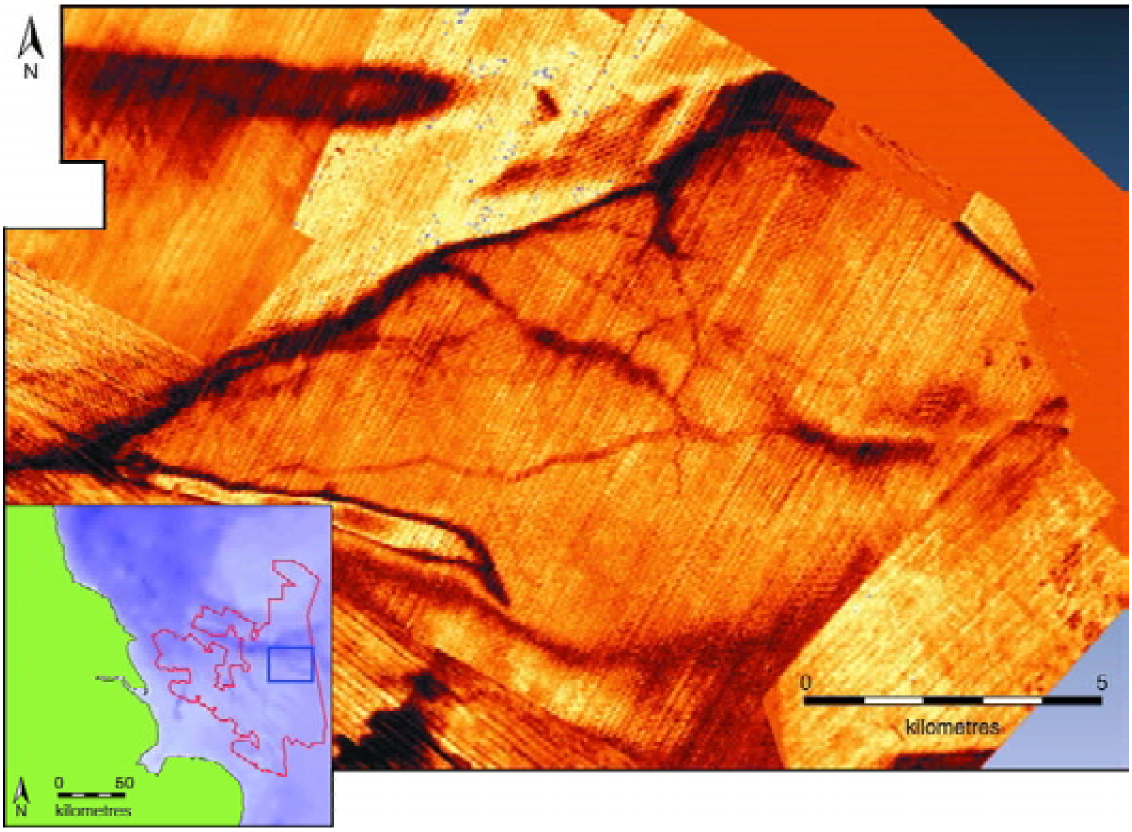

Figure 10.20 Seismic timeslice image of the palaeochannels within an area interpreted as a salt marsh

10.5 South Western Quadrant

10.5.1 Description

The landscape which has been observed within the seismic data for this quadrant reflects the variable influence of the underlying geology upon the observed siesmic signal. Areas in which the geological influence is weak are generally associated with the presence of deep Late Pleistocene deposits. However, the overall character of this landscape is as a relatively gentle plain sloping from the modern coastline onto a lower plain in the north and west of the quadrant (Figure 10.21).

Beginning in the east of the quadrant, the results suggest a relatively flat lying terrain, with a number of large, interspersed depressions. These depressions represent unfilled tunnel valleys that may have contained lakes due to their pre-existing low lying topography and basin-like nature. This is supported in part by the presence of lacustrine deposits relating to the Late Plesitocene and Early Holocene within sediments recovered from some of these depressions (Cook 1991). However later erosional events makes the calculation of the full lacustrine extent problematic (Cook 1991). The smaller of these basins probably corresponds to the Well Hole (Figure 10.21 A). However, the shape of this feature only partially corresponds to the feature observable within the 3D seismic data. A cross section through this feature was provided by an additional high-resolution 2D digital line (93-01-81) provided by the BGS (Figure 10.22). This 2D line reveals a partly eroded deposit, which directly overlies the erosion surface but is beneath modern sediments. Similar results are recorded on the BGS maps for the area, which describe the deposits within this feature as pertaining to the Botney Cut Formation. This deposit dates from the latest Pleistocene/earliest Holocene and is associated with a glacio-lacustrine origin. Given that no obvious outflow is observed, this tunnel valley presumably formed a lake within the surrounding flat lying landscape.

The other major depression within this plain corresponds to the Sole Pit (Figure 10.21 B). The available high-resolution 2D seismic data reveals that the base of this pit has also suffered significant erosion, removing any deposits of Late Pleistocene/Early Holocene age. Minor deposits of this material do occur on the flanks of this feature. It is suggested that this feature would have formed a similar lacustrine feature to 10.21 A. Holocene erosion within this feature ensures that confirmation of such an interpretation is likely to be problematic.

Further to the west of the quadrant, significant landscape features reflect the influence of underlying solid geology (Figure 10.21 C). This is indicated by the clarity of solid geological structures within the seismic data and their influence upon the early Holocene landscape. The seismic data indicates a slight, but significant, depression located in the south-western corner of the quadrant. This is bounded on either side by low but significant scarp slopes. Geological beds pushed to near-surface positions by the crests of deep underlying salt structures form these slopes. The result of this process would have been a landscape comprising a broad, low valley bounded on either side by gentle slopes. Given that the majority of fluvial features observed within the area appear to drain into this valley (Figure 10.21 C, D), it is suggested that this area formed a low lying wetland plain, occupied by fluvial systems. Within the valley, one large up-standing feature can be observed (Figure 10.21 E). This indicates the presence of an underlying salt dome that has gently raised the geological beds within this area. This would have formed a low hill within a relatively flat area. Such a hill might represent an important locale for hunter-gatherers. Aside from potential for settlement, game could have been observed from this vantage point as it migrated up the valley (e.g. Fischer 2004, 34).

Slightly to the north is a salt dome (right of Figure 10.21 D) where the break of slope coincides, again, with underlying geological formations. A rise is located within the north of this feature and relates to the peak of the underlying salt dome. This feature is considered as indicative of a relatively raised area in comparison to the valley. This would have formed a distinctive topographic high within the contemporary landscape.

The large depression associated with the Inner Silver Pit is located to the southwest of the hill mentioned above (Figure 10.21 F). The seismic data is, unfortunately, heavily striped in this area. Despite this, the broad outline of the feature can be determined and available geological mapping for the area suggests that the depression is heavily incised and that all sediment has been removed from within the bulk of the feature. Whilst BGS mapping indicates an absence of Botney Cut Formation deposits in the area it is possible that patches of sediments may remain within the Inner Silver Pit. Whilst it is impossible to determine if this depression formed a lake or wetland during the early Holocene, the feature is so pronounced today that it is extremely unlikely that it had no topographic expression during the early Holocene. On that basis, it seems reasonable to suggest that the feature would have contained a lacustrine environment of some sort. A series of palaeochannels can be seen to emerge from this feature (between F and C on Figure 10.21). Unfortunately, noise within the data renders it impossible to determine if these features are related to the Holocene or earlier landscapes.

The southwestern quadrant is associated with three principal groups of fluvial systems. The first, located in the northwestern area (Figure 10.21 G), may be equated to those described in the northwest quadrant. They comprise a series of small, truncated channels that appear to be generally poorly preserved. Although some larger sections provide a clearer response their fragmentary nature is almost certainly a product of erosion. The second group includes those features that are a continuation of channel systems observed in the southeastern quadrant (Figure 10.21 H). These also drain towards the northeast, and a few abandoned meander bends are associated with these channels. They appear large and well developed and a cross section through one indicates a substantial sedimentary profile (Figure 10.23). Given the size and significance of these riverine features, they may well have provided an important route through the landscape, and to and from the coast (Barton and Roberts 2004, 352).

The third group of features is located in the far northeastern corner of the quadrant, adjacent to the coastline (Figure 10.21 I). These features are similar to those observed in the northeastern quadrant and display dendritic tributaries with well-developed floodplains.

This group displays evidence for change in sea level indicated by the abandonment of part of the channel and the overlying formation of an associated estuary or tidal flat. The estuary has a clear bathymetric expression within the BGS Digbath250 dataset, which suggests that any archaeological deposits may be near the surface. This area could well represent a location with significant potential for future palaeoenvironmental sampling.

10.5.2 Other Features

10.5.2.1 Fluvio-Glacial features

A series of channel structures were observed to lie beneath Holocene features (Figure 10.23). In the west of the quadrant, and near the location of the later depression at Figure 10.21 B, a large fluvio-glacial outwash plain may also be observed beneath the Holocene land surface (Figure 10.24). Although this has little observed impact upon the overlying Holocene landscape, the feature may have archaeological significance as it may contain deposits relating to the earlier Palaeolithic occupation of this landscape.

10.5.2.2 Recent Geological Features

Four main sets of sand ridges were observed in the west of the study area. These sand ridges cluster as a series of parallel lines and are reflected in the upper sections of the seismic column. These are interpreted as large seabed, sand waves of recent origin.

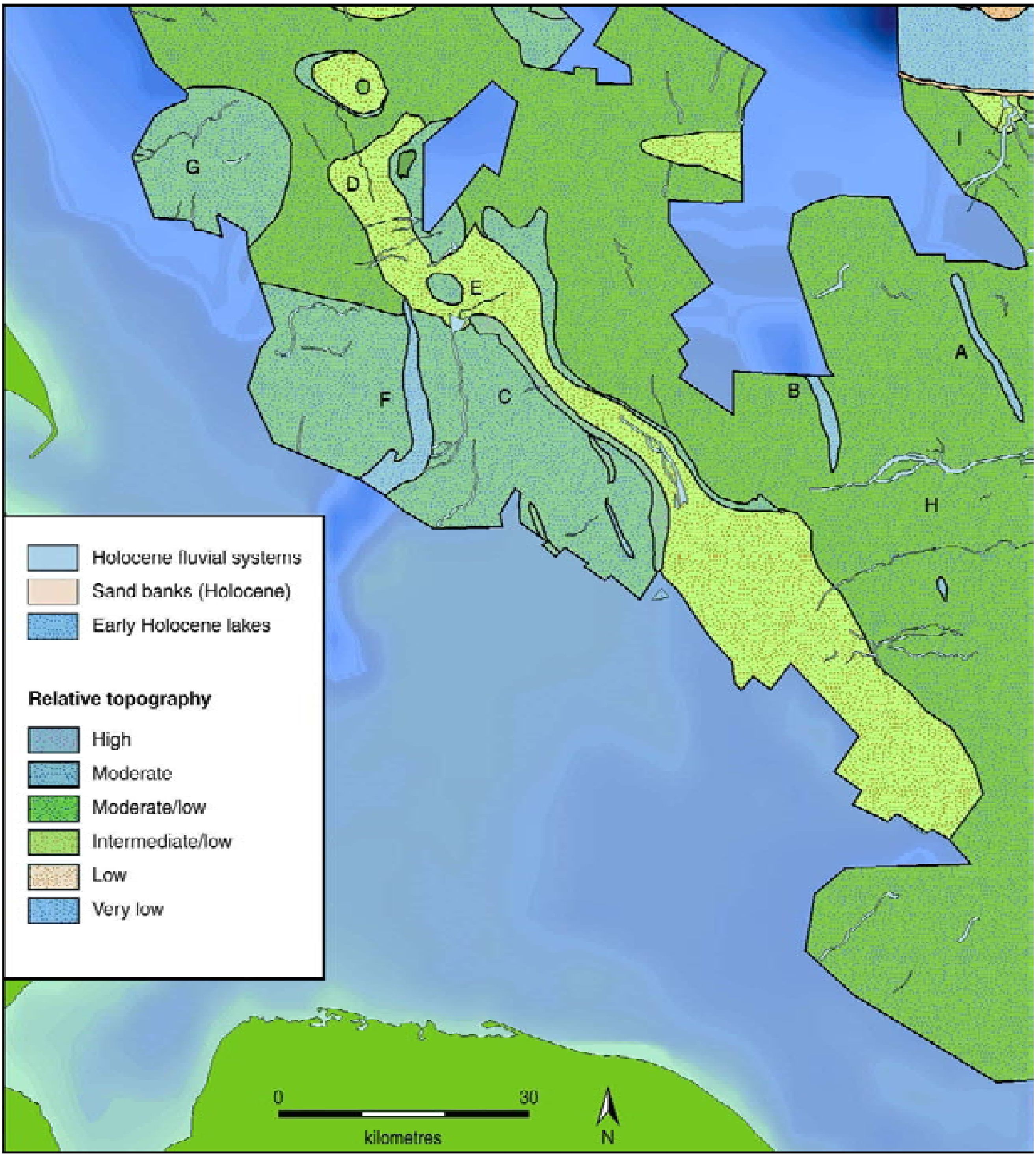

Figure 10.21 The Holocene landscape and features within the southwestern quadrant

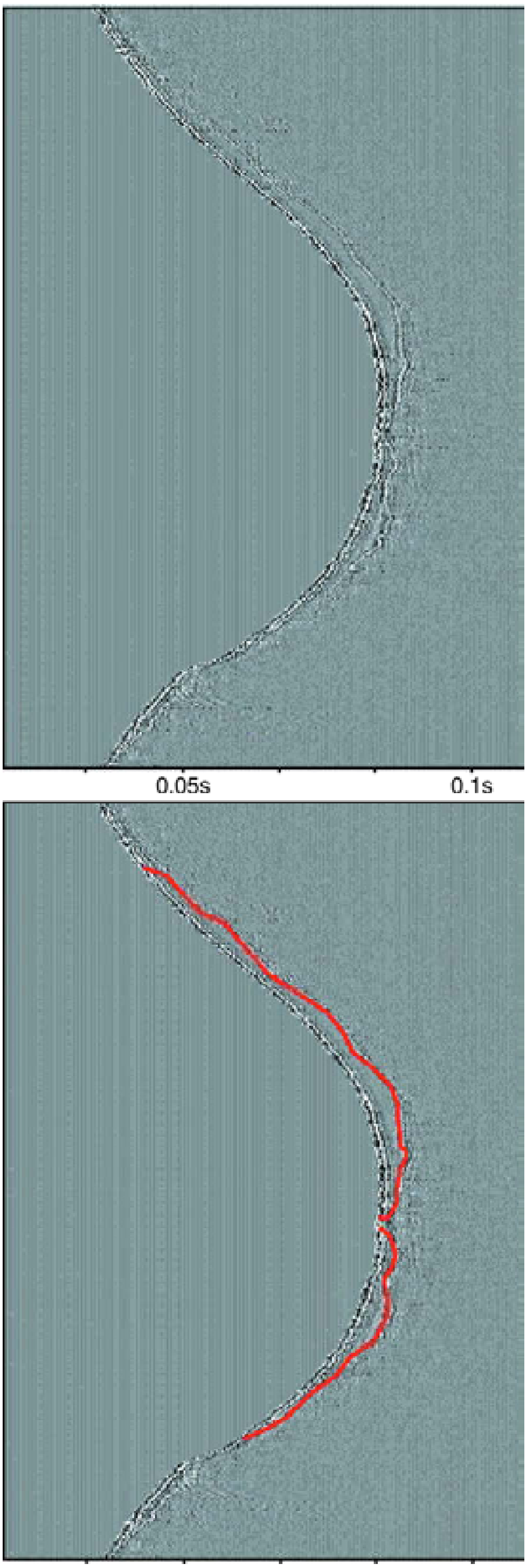

Figure 10.22 Cross section through Well Hole (BGS Line 93-01-81. Note the preservation of the Botney Cut Formation (base marked red on interpreted section)

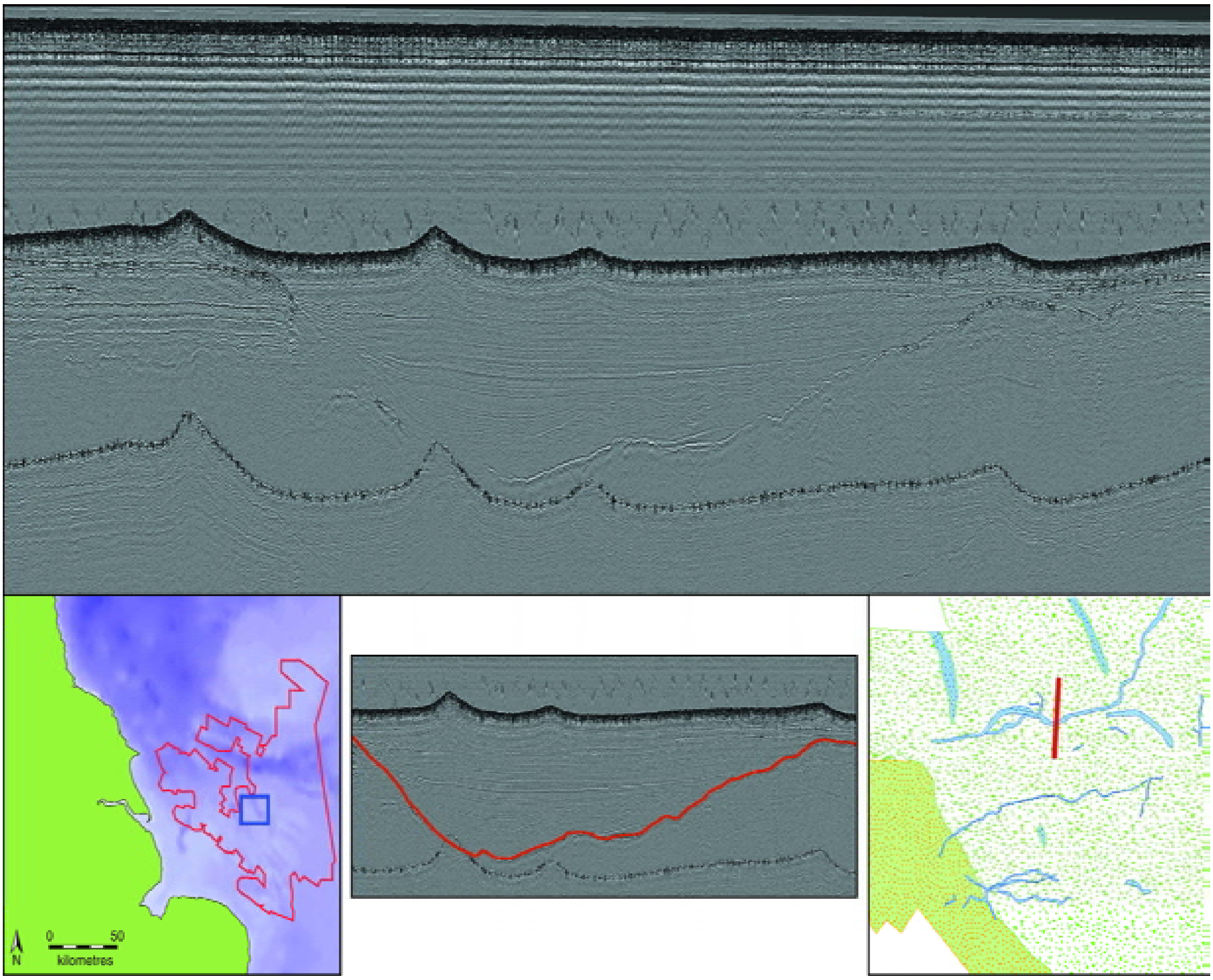

Figure 10.23 Cross section through the large channels in the southwestern quadrant. (BGS Line 93-01-74A)

10.6 Conclusions

The mapping and recording of such an extensive archaeological landscape has been a daunting task. The primary statistics relating to the extent of features recorded during the project is provided in Table .

Table 10.1 Basic quantitative data relating to identified landscape features

Coastline Length Observed	**691 km**
Marine Area Observed	**1791 km^2**
Lakes/Wetlands Observed	**24**
Salt Marsh Area	**309 km^2**
Intertidal Zone area observed	**293 km^2**
Major Estuaries Observed	**10**
Total Fluvial Stream Length	**1612 km**
Fluvial Related Features Observed	**305**
Number of Stream Segments	**719**
Total Area covered by Fluvial Features	**526 km**
Mean Strahler Order	**1.52**
Mean Shrever Order	**3.64**
Average Angle of Stream Join	**68 degrees**

In considering the results of the NSPP mapping exercise it should be stressed that the interpretation provided here is historic in several senses. The 3D seismic data was acquired over a period of 20 years at least. The PGS Mega survey does not, therefore, represent a snap shot of any single period of time and the information presented here may not represent the full effect of modern changes to the preserved elements of the landscape. However, the effects of burial and erosion across such a vast landscape are likely to be relatively small given the time period under consideration. As such, the general thrust of this chapter remains valid and the data can, with some caution, be used in support of larger archaeological synthesis and for management purposes. However, it is clear that the results of this mapping will require future ground truthing. Coring is required to provide samples for palaeoenvironmental study and dating, whilst higher resolution survey might usefully be considered to resolve specific issues or enhance interpretation.

In conclusion, it seems reasonable to stress that the quantitative data and associated mapping presented here represents a quantum shift in respect of our knowledge of the Holocene landscapes of the North Sea. The study has revealed a hunter gatherer landscape that is, currently, without parallel in Europe and, moreover, may prove to be an optimum area of settlement during the Early Holocene. Interpretation of this landscape in terms of habitation potential and sediment survival will undoubtedly affect our understanding of the regional archaeology of all the countries bounding the survey area.

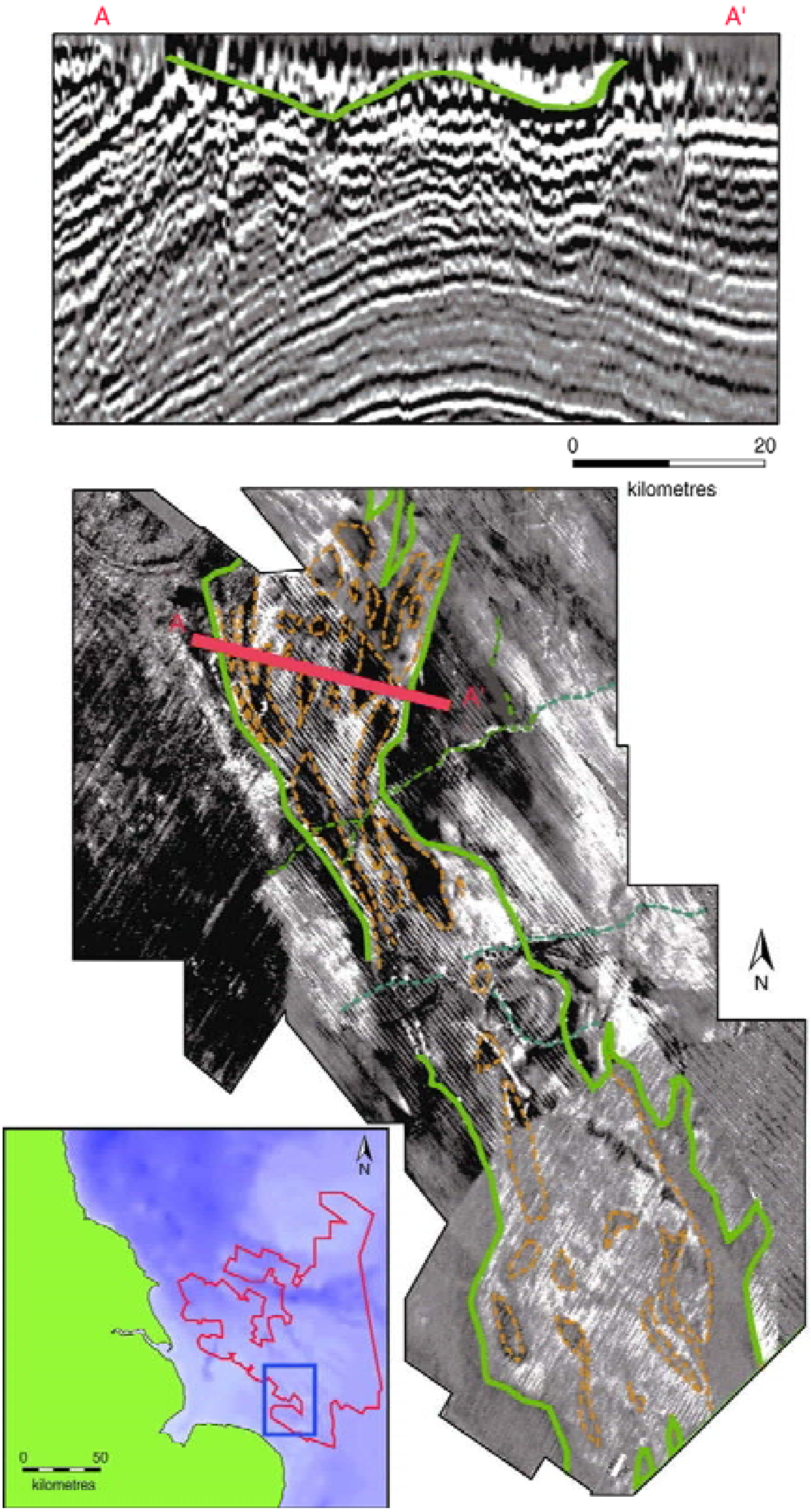

Figure 10.24 An image showing the complex structure of a glacial outwash plain. A cross section through this feature (Line A-A') shows that this feature is located deep beneath the seabed (marked on in green)

Appendix 3

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<u>APPENDIX 4</u>

WHOLE STUDY AREA MODEL OUTPUT TABLES AND CATCHMENT ANALYSIS OUTPUT TABLES

(Note: Due to the tables size this is provided as a digital appendix in a CD ISO image.)