1. Introduction

Conducting aerial surveys is one of the core functions of the Ministry of Environment and Tourism. The surveys are essential management tools, allowing for informed decision making.

The survey of northwestern Namibia was conducted over three periods, from 27 September to 10 October 2005, 19 to 28 October 2005 and 7 to 17 November 2005 using the Ministry's two aircraft, a Cessna 206 (V5-PRO) and a Cessna 182 (V5-ISE).

2. Survey Design and Methodology

The survey was originally planned to cover an area of 102156 km² (Figure 1), but delays and staff and equipment constraints resulted in only 31144 km² of the area being counted (Figure 2). The survey area was first stratified according to the boundaries of the parks and conservancies in the area, then these areas were divided into mountainous and not-so-mountainous areas. Some of the very large blocks were then cut into 20km wide slices to make surveying easier[1].

Survey intensity for each block was decided based on the expected distribution of animals. Transects in each block were selected at the required transect spacing. At a strip width of 500m, transect intervals were 1.25 km for 40% intensity, 2.5km for 20% and 5 km for 10%. A summary of the block data is presented in Table 1.

[1] Practical experience has shown that 20 km should be the maximum length of a transect else the observers lose concentration.

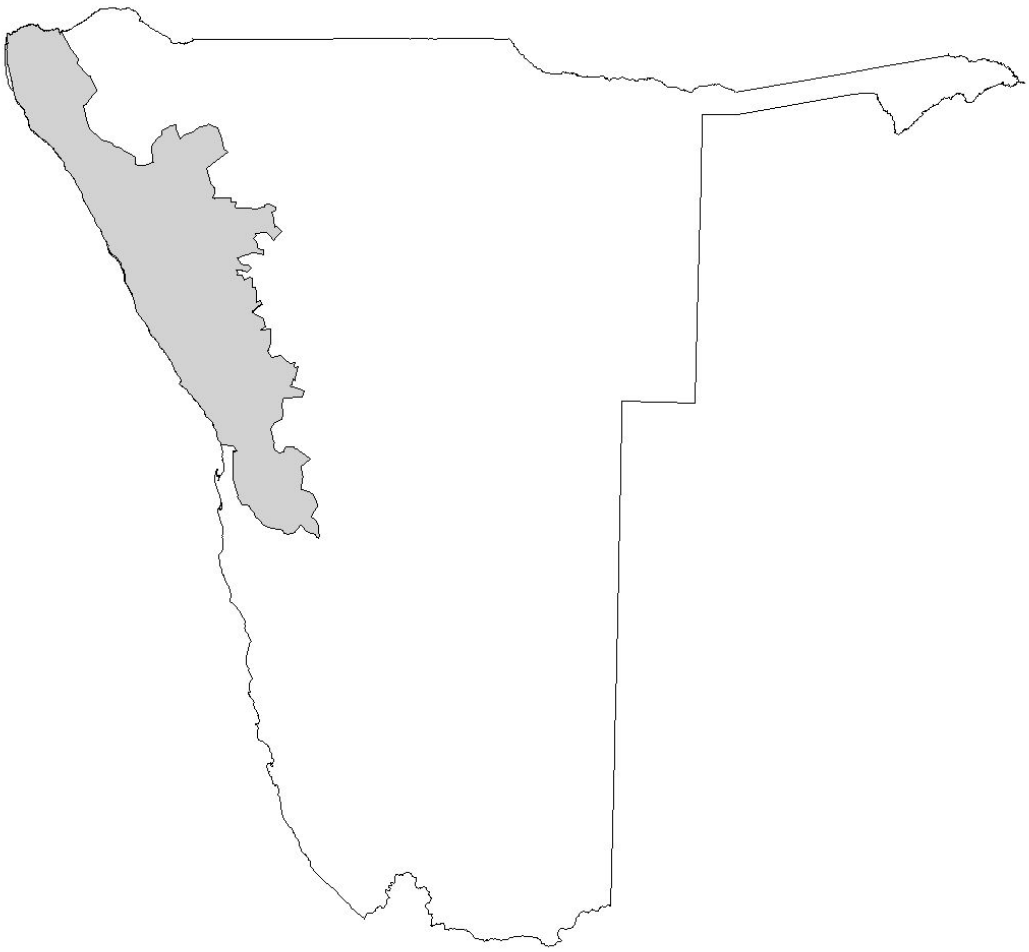

Figure 1: Location of the survey area.

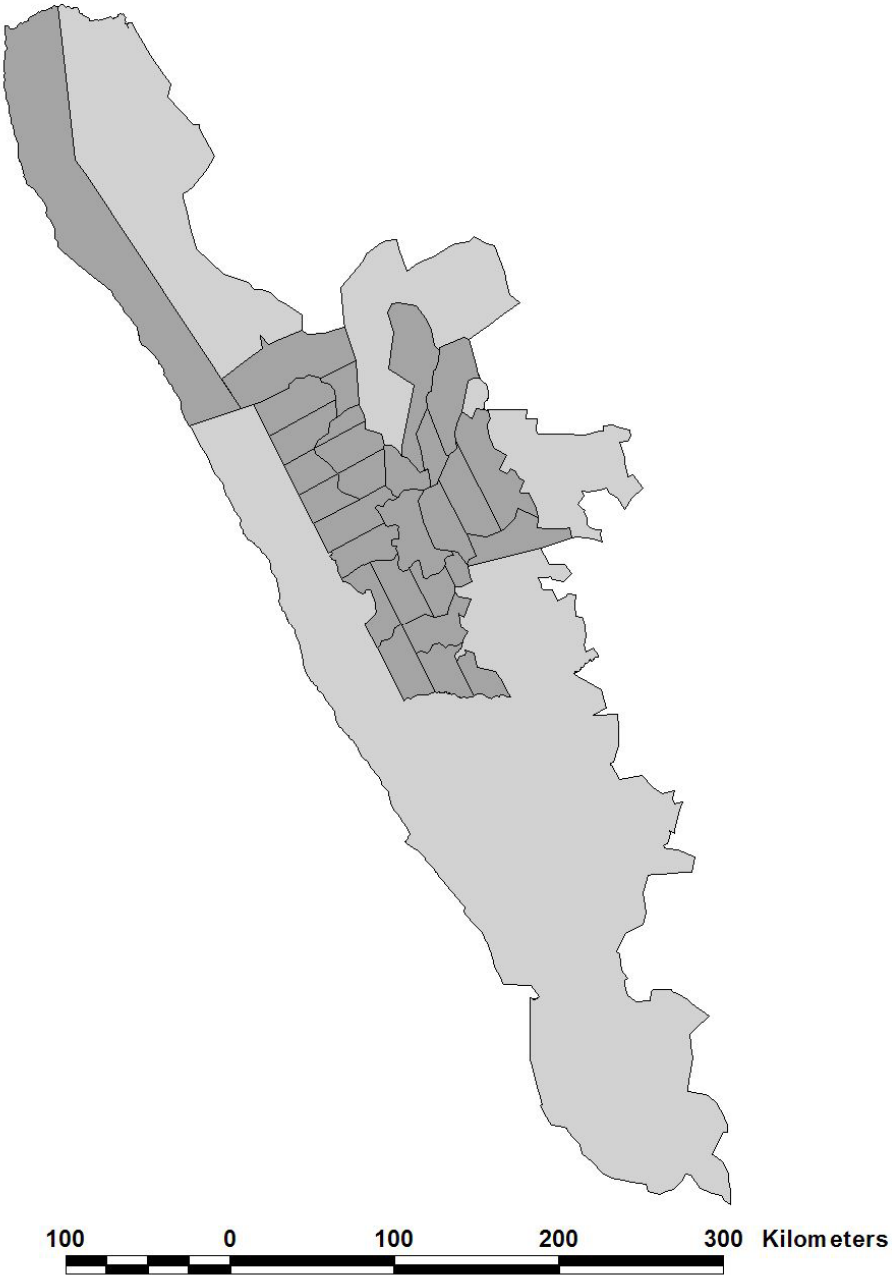

Figure 2: Actual area surveyed (dark grey) in relation to the originally planned area.

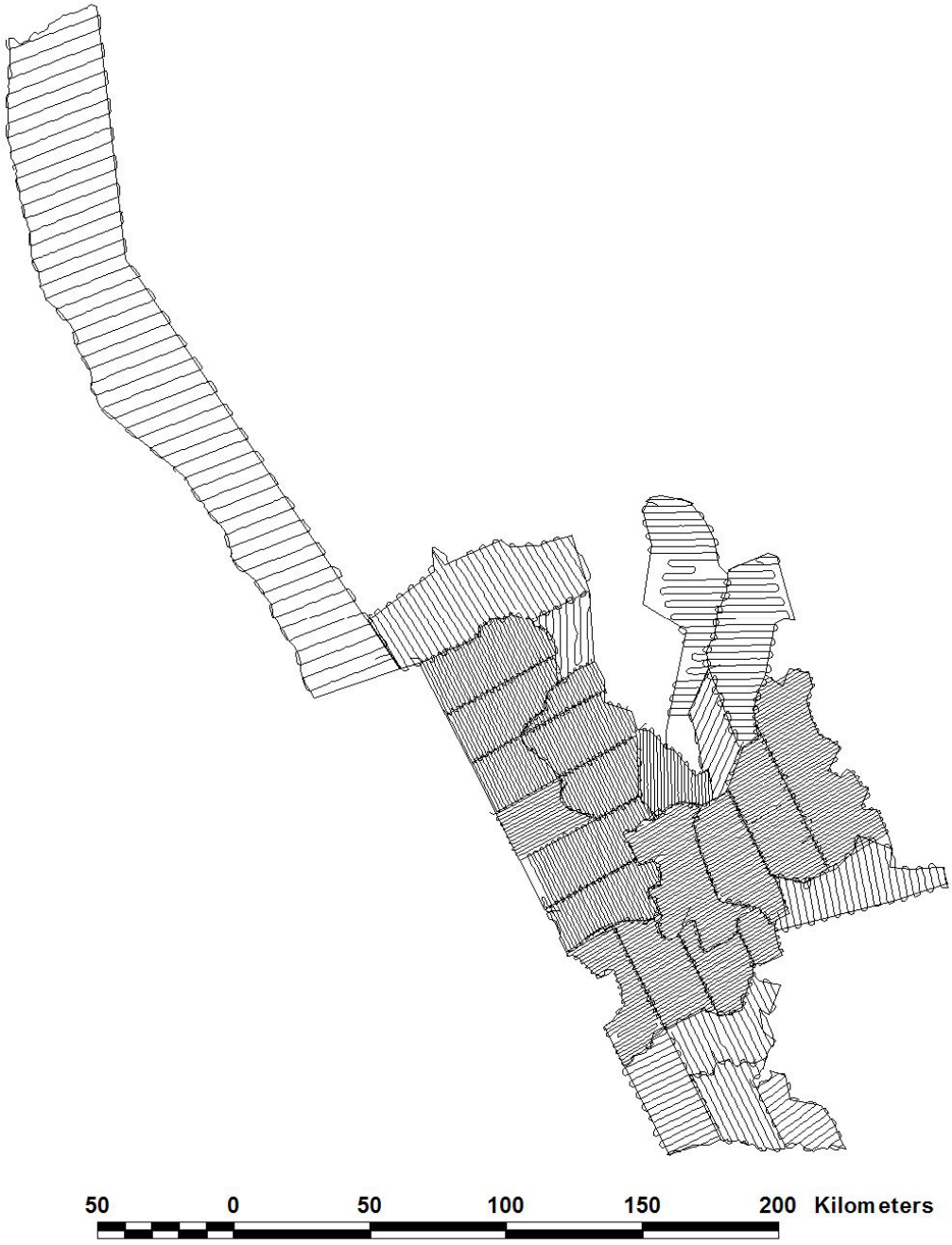

Figure 3: Actual flight paths for the 2005 North West aerial Survey.

Table 1: Summary of data for the North West survey blocks.

Name	Area (km²)	Block Search Time (min)	Block Area Searched (km²)	Block Search Rate (km²/min)	Percentage of Block Searched
NW01	8710.587	471	731.9	1.6	8.40%
NW22	2047.495	221	576.6	2.6	28.16%
NW23	419.687	40	88.7	2.2	21.13%
NW28	1630.327	128	405.0	3.2	24.84%
NW35	1246.158	126	315.1	2.5	25.28%
NW36	477.390	54	124.0	2.3	25.97%
NW37	934.456	194	519.2	2.7	55.56%
NW38	744.456	158	251.2	1.6	33.75%
NW39	471.399	99	157.7	1.6	33.45%
NW40	524.105	98	164.6	1.7	31.41%
NW41	276.036	60	177.7	3.0	64.36%
NW42	694.192	140	451.3	3.2	65.01%
NW43	564.978	117	346.9	3.0	61.40%
NW44	882.001	163	326.0	2.0	36.96%
NW45	725.834	168	231.9	1.4	31.95%
NW46	518.171	110	257.4	2.3	49.68%
NW52	1524.651	301	661.7	2.2	43.40%
NW53	999.283	199	449.3	2.3	44.96%
NW54	844.606	172	471.1	2.7	55.78%
NW55	1131.853	239	1005.1	4.2	88.81%
NW56	489.956	105	231.3	2.2	47.22%
NW57	772.981	174	301.3	1.7	38.97%
NW58	659.875	141	234.4	1.7	35.53%
NW59	221.511	42	176.7	4.2	79.77%
NW60	964.790	102	263.8	2.6	27.34%
NW68	777.155	80	341.4	4.3	43.93%
NW69	665.435	71	164.9	2.3	24.79%
NW70	779.121	84	178.5	2.1	22.90%
NW71	445.898	51	76.8	1.5	17.22%
Total	**31144.388**	**4108**	**9681.6**	**2.4**	**31.09%**

The survey was designed to calibrate the observers at a strip width of 250 metres on either side of the aircraft, following standard procedures. The boundaries of the strips on either side of the aircraft were delimited by a pair of streamers fixed to the lift struts of the wing. The calculated strip width (Norton-Griffifths 1978), for each observer is presented in Appendix 1.

The aircraft used in the survey were each equipped with two Garmin GPS 12 XL models. This ensured accurate navigation along the pre-determined transects, which had been downloaded as route files. Two observers called out the sightings of animals within the demarcated strips. The front seat recorder noted waypoints for each sighting, which included the species and number. The recorder also noted the height *above ground level* from the radar altimeter to allow for the calculation of the average height for each survey block, and additionally recorded the start and end times of each transect. The waypoint and flight data

were downloaded to a personal computer using Ozi Explorer® software, after each flying session.

The localities of each sighting were plotted on maps using the Geographical Information System, ArcView® and ArcView Spatial Analyst® was used to generate density maps (Figure 4).

Figure 4: All sightings recorded during the 2005 North West aerial survey.

Jolly's method number 2 for unequal-sized sampling blocks was applied to the data. A spreadsheet model (Emslie 2002) was developed to calculate total population size, 95% confidence limits and the range for each species per stratum at 95% confidence limits. The

equations as per Krebs (1999) were used. If the confidence limits were larger than 100%, the actual number of animals seen within the block was taken as the lower limit of the 95% range.

3. Results

Overall estimates of numbers of the most important species are summarised in Table 2. These species are those that can be counted through aerial survey sampling techniques with a reasonable degree of accuracy and precision. Table 2 includes population estimates, their 95% range, the actual number seen, and the densities for the whole of the area surveyed.

Table 2: Summary of estimates and density of all species for the entire survey area.

	Species	No Seen*	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
Am	Springbok	4116	4116	5335	6957	627336.7	1622	30.4%	0.171
Db	Black Rhino Mountain	25	25	29	51	113.1	22	74.8%	0.001
Ezh	Zebra	2787	2787	3491	4272	145301.4	781	22.4%	0.112
Gc	Giraffe	248	248	345	461	3215.6	116	33.7%	0.011
La	Elephant	169	169	210	374	6432.5	164	78.2%	0.007
Og	Oryx	2531	2826	4452	6078	630128.1	1626	36.5%	0.143
Sc	Ostrich	545	545	814	1096	19030.6	283	34.7%	0.026
	Cattle	4898	5535	8553	11571	2171208.9	3018	35.3%	0.275
	Donkey	454	454	605	795	8592.1	190	31.4%	0.019
	Goats	15320	17617	25312	33007	14117255.5	7695	30.4%	0.813
	Horses	236	236	303	436	4255.5	134	44.1%	0.010
	Sheep	587	587	741	1558	158961.7	817	110.2%	0.024

* includes animals seen outside the counting strip, but within the block (applies to all tables hereafter).

Table 3: Summary of estimates and density for northern Skeleton Coast Park.

	Species	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
Am	Springbok	15	15	70	226	6080.1	156	221.8%	0.008
Db	Black Rhino	0							
Ezh	Mountain Zebra	0							
Gc	Giraffe	0							
La	Elephant	0							
Og	Oryx	531	531	1577	3030	528110.6	1453	92.2%	0.181
Sc	Ostrich	27	27	85	220	4516.9	134	157.4%	0.010
Ts	Kudu	0							

Table 4: Summary of estimates and density for Palmwag Concession.

	Species	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
Am	Springbok	1350	1350	1509	2178	84242.2	669	44.4%	0.259
Db	Black Rhino	18	18	20	42	89.3	22	107.6%	0.003
Ezh	Mountain Zebra	1273	1273	1322	1836	49555.4	513	38.8%	0.227
Gc	Giraffe	77	77	93	146	533.4	53	57.5%	0.016
La	Elephant	45	45	49	88	292.2	39	81.2%	0.008
Og	Oryx	736	736	824	1123	16780.2	299	36.2%	0.142
Sc	Ostrich	194	194	235	357	2801.8	122	51.9%	0.040
Ts	Kudu	20	20	20	45	112.4	24	120.8%	0.003
	Cattle	12							
	Donkey	0							
	Goats	50							
	Horses	0							
	Sheep	0							

Table 5: Summary of estimates and density for Etendeka Concession.

	Species	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
Am	Springbok	1330	1330	1430	2309	177512.9	879	61.4%	2.760
Db	Black Rhino	7	7	9	19	23.8	10	114.5%	0.017
Ezh	Mountain Zebra	412	412	474	860	34185.6	386	81.3%	0.915
Gc	Giraffe	54	54	60	103	432.4	43	72.8%	0.115
La	Elephant	5	5	6	22	57.3	16	249.0%	0.012
Og	Oryx	131	131	151	248	2165.3	97	64.3%	0.291
Sc	Ostrich	1	1	1	4	2.3	3	249.5%	0.002
Ts	Kudu	32	32	39	69	206.5	30	76.3%	0.076
	Cattle								
	Donkey								
	Goats	200							
	Horses								
	Sheep								

Table 6 to Table 17 summarise the estimates and summary data for selected species seen in each block. Figure 5 to Figure 16 present distribution and density maps, based on all sightings, for each species.

Table 6: Summary of estimates and density of springbok.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01	15	15	70	226	6080.1	156	221.80%	0.008
NW22	74	74	144	256	2996.5	112	77.53%	0.070
NW23	45	45	119	473	22379.6	354	296.66%	0.284
NW28								
NW35	3	3	7	32	146.2	25	331.95%	0.006
NW36	341	341	774	1977	282971.6	1203	155.51%	1.621
NW37	102	102	111	176	1017.7	64	57.90%	0.119
NW38	122	122	140	364	11978.0	223	159.56%	0.188
NW39	219	219	266	654	34501.8	387	145.55%	0.565
NW40	45	45	60	146	1581.4	85	141.09%	0.115
NW41	8	8	10	26	62.3	16	159.14%	0.037
NW42	436	436	411	561	5421.5	150	36.61%	0.592
NW43	208	208	233	473	13649.3	240	103.01%	0.413
NW44	167	167	222	449	12545.9	226	101.83%	0.252
NW45	43	43	54	174	3484.3	119	219.97%	0.075
NW46	1330	1330	1430	2309	177512.9	879	61.44%	2.760
NW52	11	11	14	38	147.3	24	174.45%	0.009
NW53	37	37	46	125	1508.5	78	169.43%	0.046
NW54	261	261	328	664	27693.8	336	102.69%	0.388
NW55	302	342	381	419	362.7	38	10.11%	0.337
NW56	143	143	166	296	4047.2	130	78.43%	0.338
NW57	118	118	148	328	7914.8	180	121.19%	0.192
NW58	14	14	17	57	377.8	39	226.03%	0.026
NW59								
NW60	29	29	73	204	4103.9	132	181.03%	0.075
NW68	24	24	61	106	444.4	44	72.69%	0.079
NW69								
NW70	18	18	45	184	4378.3	140	313.34%	0.057
NW71	1	1	2	14	28.6	11	461.39%	0.006
Total	**4116**	**4116**	**5335**	**6957**	**627336.7**	**1622**	**30.40%**	**0.171**

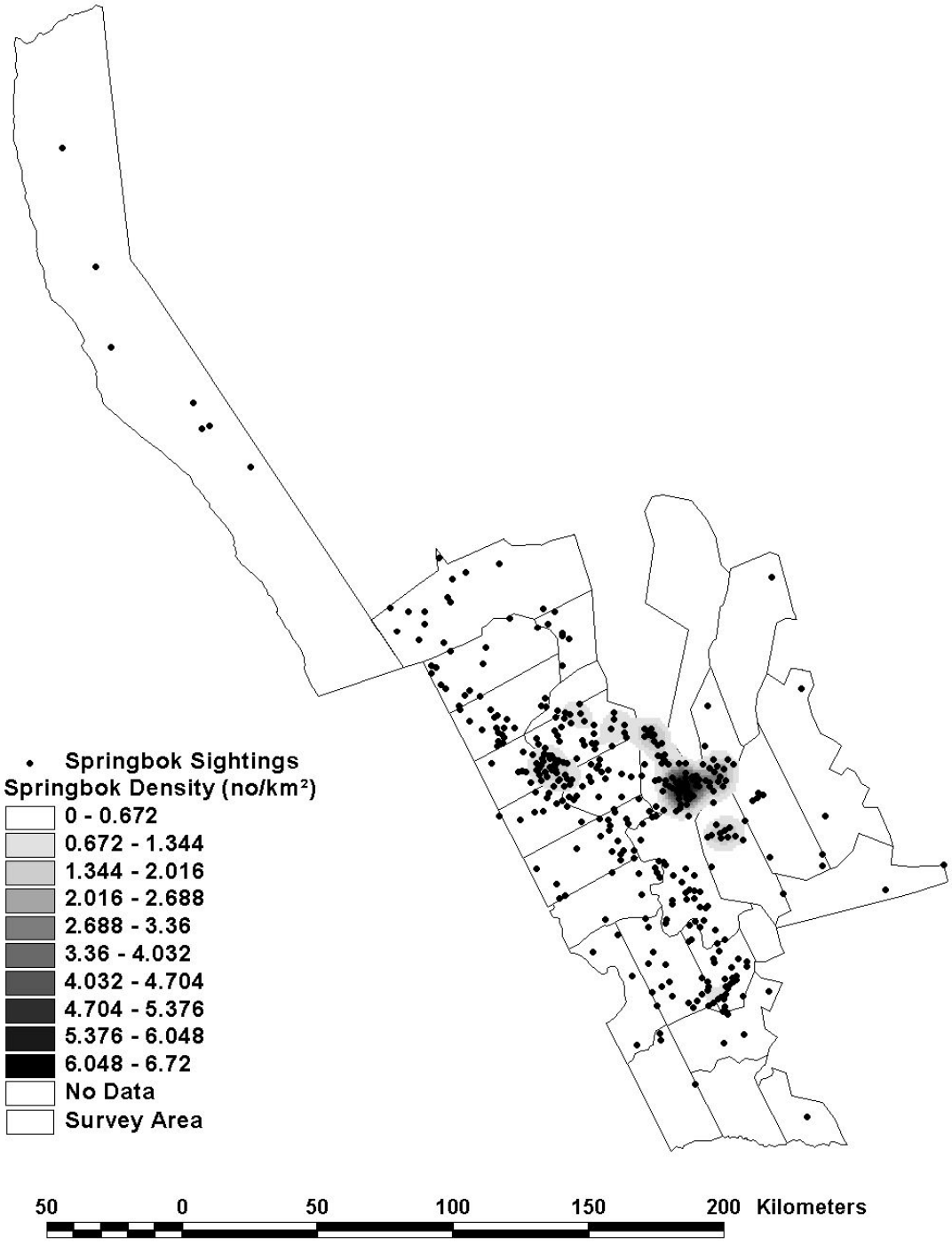

Figure 5: Distribution and density of springbok.

Table 7: Summary of estimates and density of black rhino.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22								
NW23								
NW28								
NW35								
NW36								
NW37								
NW38	1	1	1	6	6.0	5	399.55%	0.002
NW39	8	8	10	27	63.6	17	164.84%	0.021
NW40	2	2	1	7	6.8	6	416.03%	0.003
NW41								
NW42	3	3	4	9	6.7	5	139.79%	0.005
NW43	4	4	4	9	6.2	5	135.62%	0.007
NW44								
NW45								
NW46	7	7	9	19	23.8	10	114.54%	0.017
NW52								
NW53								
NW54								
NW55								
NW56								
NW57								
NW58								
NW59								
NW60								
NW68								
NW69								
NW70								
NW71								
Total	**25**	**25**	**29**	**51**	**113.1**	**22**	**74.77%**	**0.001**

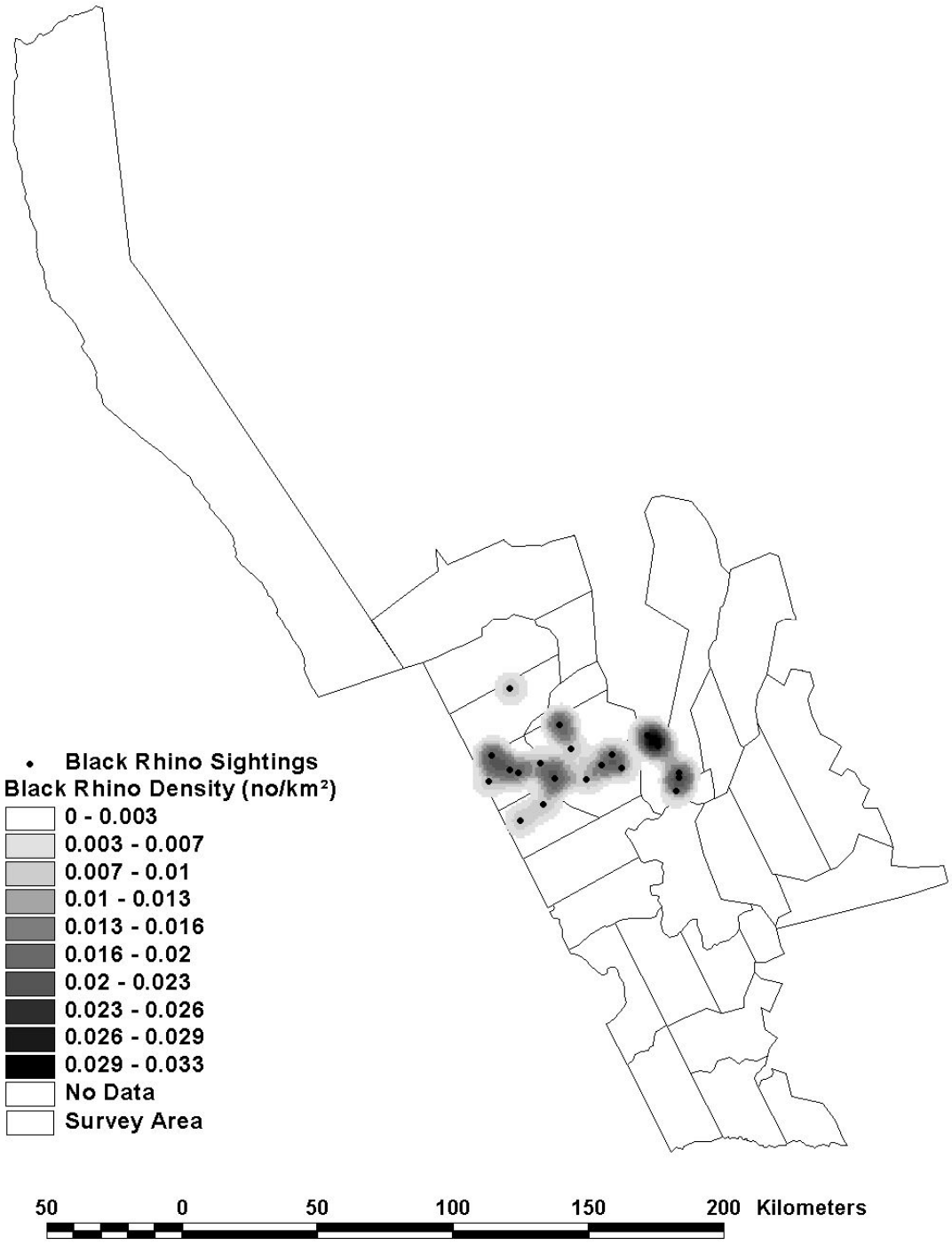

Figure 6: Distribution and density of black rhino.

Table 8: Summary of estimates and density of mountain zebra.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22								
NW23	82	82	196	488	15209.4	292	148.72%	0.467
NW28	5							
NW35	18	18	45	115	1176.8	70	156.95%	0.036
NW36	137	137	308	643	21923.6	335	108.73%	0.645
NW37	68	68	86	130	468.5	44	50.84%	0.092
NW38	106	106	123	267	4989.0	144	117.69%	0.165
NW39	106	106	124	344	11126.6	220	177.96%	0.262
NW40	52	52	52	168	2905.4	116	220.66%	0.100
NW41	76	76	97	130	265.0	33	34.54%	0.350
NW42	402	402	304	409	2657.3	105	34.67%	0.437
NW43	208	208	209	318	2790.3	109	51.90%	0.370
NW44	168	168	218	466	14963.0	247	113.24%	0.248
NW45	87	87	110	306	9390.3	196	178.48%	0.151
NW46	412	412	474	860	34185.6	386	81.32%	0.915
NW52	6	6	8	24	69.1	17	219.09%	0.005
NW53	35	35	44	90	529.7	47	106.13%	0.044
NW54	340	340	427	696	17739.2	269	63.09%	0.505
NW55	374	431	464	497	266.7	33	7.11%	0.410
NW56								
NW57	35	35	44	112	1123.6	68	153.95%	0.057
NW58	3	3	4	18	47.6	14	374.36%	0.006
NW59	11	11	14	41	163.9	27	196.84%	0.062
NW60	8	8	20	69	571.2	49	244.82%	0.021
NW68	34	34	87	151	936.4	65	74.48%	0.112
NW69	3	3	8	35	142.9	27	354.63%	0.011
NW70								
NW71	11	11	27	115	1660.4	87	319.76%	0.061
Total	**2787**	**2787**	**3491**	**4272**	**145301.4**	**781**	**22.36%**	**0.112**

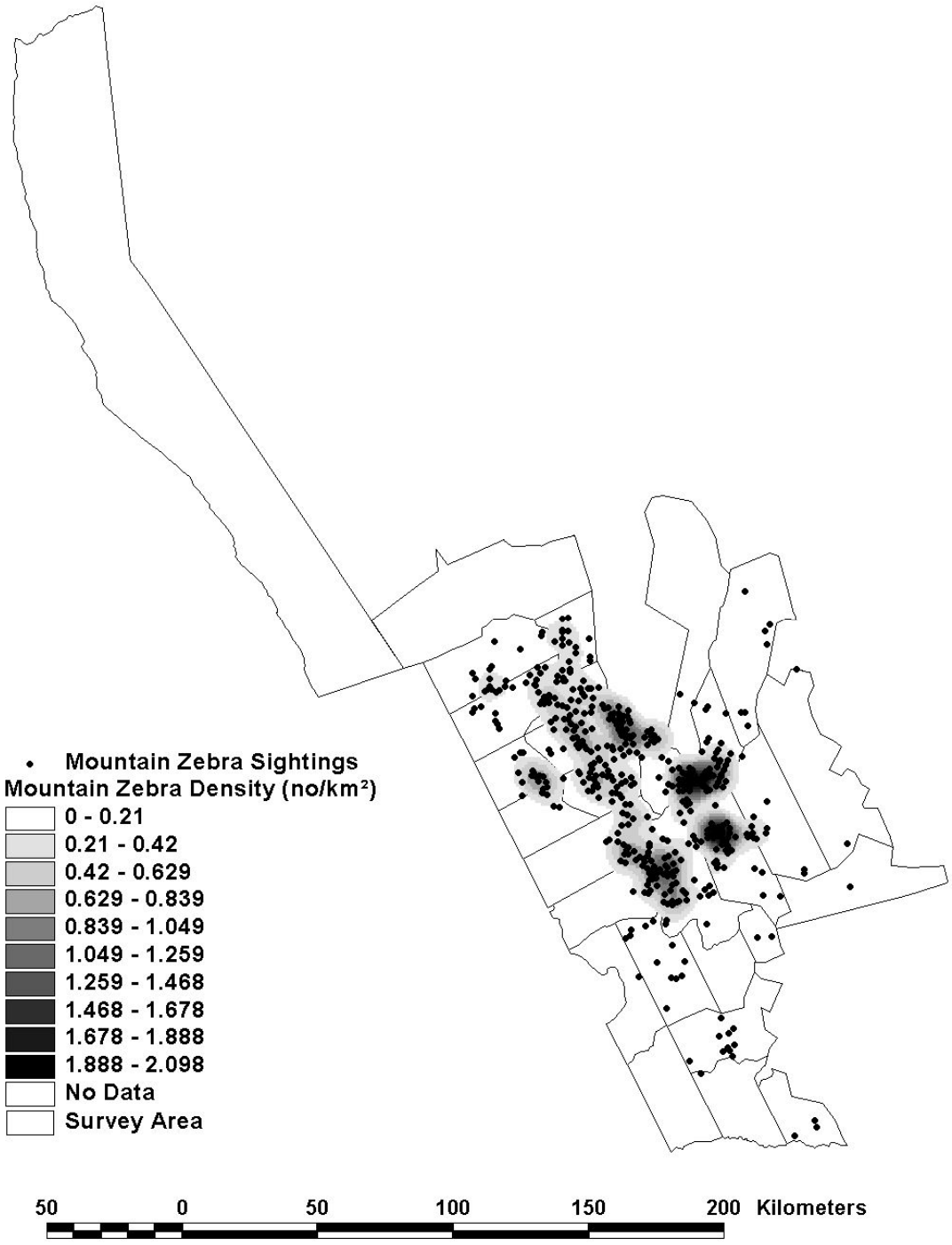

Figure 7: Distribution and density of mountain zebra.

Table 9: Summary of estimates and density of giraffe.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22	7	7	17	37	94.8	20	114.23%	0.008
NW23								
NW28								
NW35	8	8	20	68	542.6	48	239.78%	0.016
NW36	26	26	61	129	900.2	68	111.92%	0.127
NW37	29	29	37	71	295.5	35	94.68%	0.039
NW38	2	2	3	13	24.1	10	400.59%	0.003
NW39								
NW40								
NW41	10	10	13	26	44.9	14	108.00%	0.046
NW42	16	16	20	37	71.2	17	85.50%	0.029
NW43	11	11	14	31	66.3	17	120.70%	0.025
NW44	9	9	7	18	31.5	11	170.33%	0.008
NW45								
NW46	54	54	60	103	432.4	43	72.78%	0.115
NW52	28	28	33	65	254.1	32	96.94%	0.022
NW53	26	26	33	70	351.6	38	116.40%	0.033
NW54	11	11	14	27	44.2	13	97.30%	0.016
NW55	7	7	9	11	0.9	2	21.92%	0.008
NW56								
NW57								
NW58	3	3	4	18	46.6	14	370.29%	0.006
NW59								
NW60								
NW68								
NW69	1	1	3	11	15.0	9	344.54%	0.004
NW70								
NW71								
Total	**248**	**248**	**345**	**461**	**3215.6**	**116**	**33.71%**	**0.011**

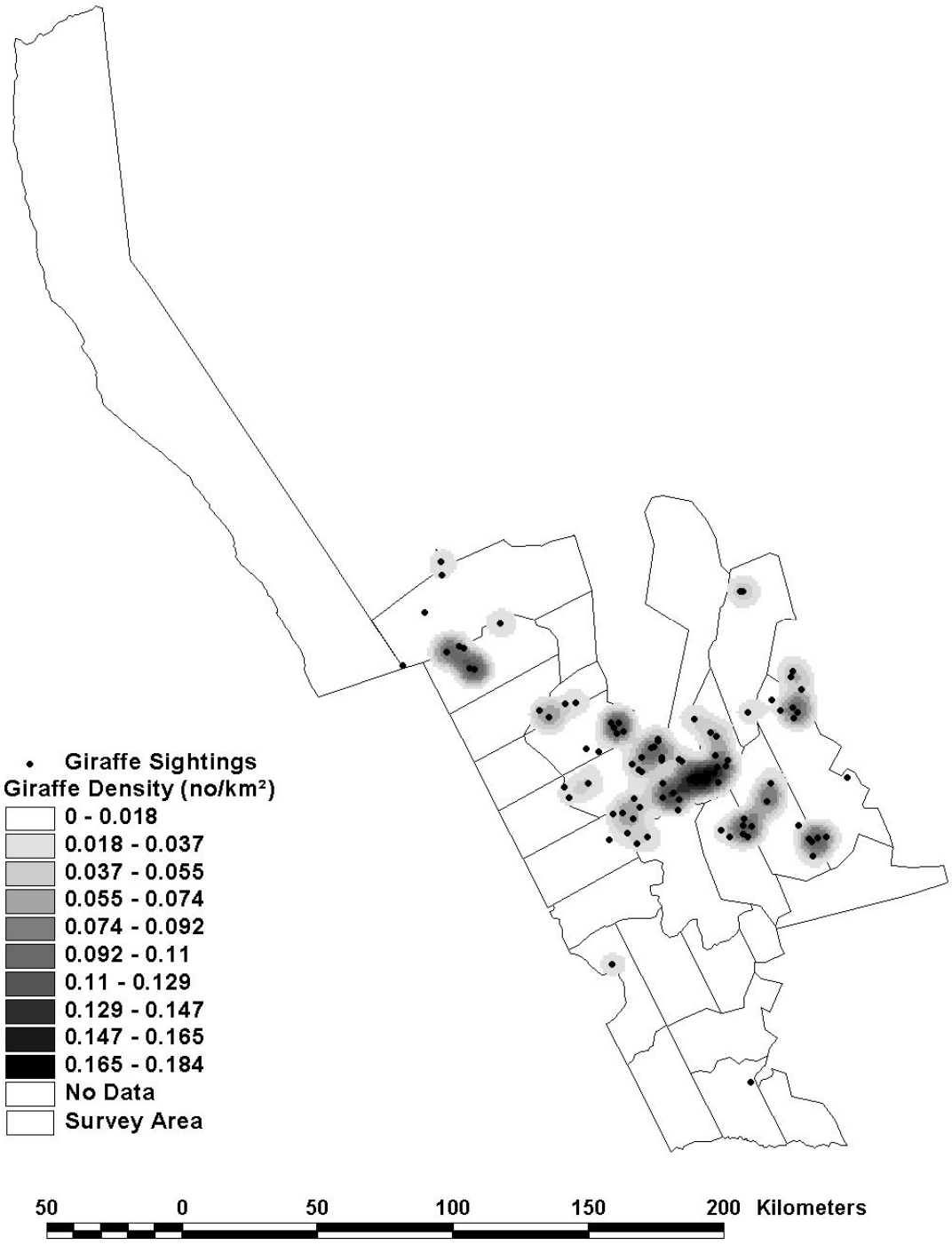

Figure 8: Distribution and density of giraffe.

Table 10: Summary of estimates and density of elephant.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22	6	6	12	34	115.1	22	176.27%	0.006
NW23								
NW28	10	10	25	98	1262.3	73	289.00%	0.015
NW35	20	20	50	177	3848.6	127	255.44%	0.040
NW36								
NW37	9	9	11	22	30.1	11	97.30%	0.012
NW38	1	1	1	6	5.9	5	398.04%	0.002
NW39								
NW40								
NW41	21	21	27	56	200.5	29	108.73%	0.097
NW42	1	1	1	3	0.7	2	139.79%	0.002
NW43								
NW44	12	12	7	21	48.8	14	212.07%	0.008
NW45	1	1	1	6	6.2	5	397.78%	0.002
NW46	5	5	6	22	57.3	16	249.01%	0.012
NW52	25	25	11	35	140.0	24	207.90%	0.007
NW53	24	24	30	82	654.7	52	172.08%	0.030
NW54	1	1	1	4	1.6	3	205.33%	0.001
NW55	12	12	15	20	6.5	5	34.09%	0.013
NW56	13	13	1	4	2.2	3	244.90%	0.003
NW57	3	3	3	11	16.4	8	325.51%	0.003
NW58								
NW59	3	3	4	15	26.3	11	289.33%	0.017
NW60	2	2	3	9	9.1	6	246.83%	0.003
NW68								
NW69								
NW70								
NW71								
Total	**169**	**169**	**210**	**374**	**6432.5**	**164**	**78.18%**	**0.007**

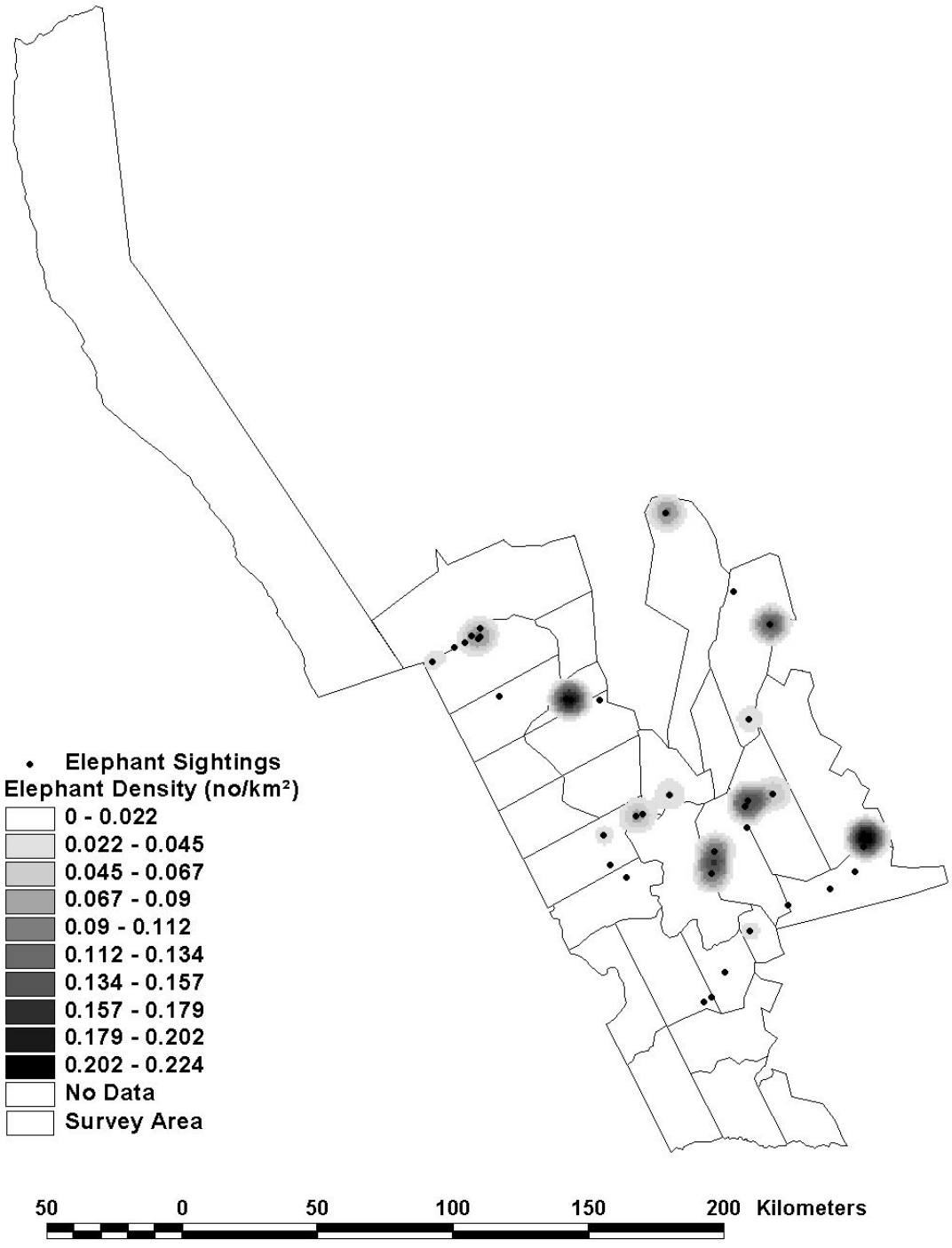

Figure 9: Distribution and density of elephant.

Table 11: Summary of estimates and density of oryx.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01	531	531	1577	3030	528110.6	1453	92.16%	0.181
NW22	191	191	423	709	19678.2	286	67.78%	0.206
NW23	48	48	109	409	16116.2	300	276.31%	0.259
NW28	2	2	6	17	32.4	12	208.22%	0.003
NW35	13	13	32	94	901.4	62	190.19%	0.026
NW36	149	149	315	708	30152.7	393	124.57%	0.661
NW37	60	60	68	105	321.4	36	53.03%	0.073
NW38	57	57	71	185	3095.6	114	159.39%	0.096
NW39	97	97	117	217	2278.1	100	84.85%	0.249
NW40	63	63	73	150	1318.3	78	107.35%	0.138
NW41	27	27	34	69	283.4	35	100.55%	0.124
NW42	113	113	105	156	629.1	51	48.98%	0.151
NW43	105	105	120	192	1237.7	72	60.40%	0.212
NW44	154	154	198	366	6893.1	168	84.60%	0.225
NW45	30	30	38	92	723.5	54	143.67%	0.052
NW46	131	131	151	248	2165.3	97	64.33%	0.291
NW52	16	16	20	66	520.1	46	225.36%	0.013
NW53	34	34	43	107	1006.6	64	150.62%	0.043
NW54	126	126	157	255	2369.8	98	62.72%	0.186
NW55	171	203	216	228	40.1	13	5.94%	0.191
NW56	133	133	151	257	2686.7	106	70.24%	0.308
NW57	160	160	194	333	4732.2	139	71.81%	0.250
NW58	46	46	57	144	1841.5	87	151.88%	0.087
NW59	5	5	5	19	46.7	14	288.88%	0.023
NW60	37	37	93	190	2244.3	97	104.93%	0.096
NW68	19	19	48	80	230.4	32	66.12%	0.062
NW69	1	1	3	12	16.0	9	355.55%	0.004
NW70	8	8	20	49	185.0	29	144.93%	0.025
NW71	4	4	10	45	271.8	35	355.78%	0.022
Total	**2531**	**2826**	**4452**	**6078**	**630128.1**	**1626**	**36.52%**	**0.143**

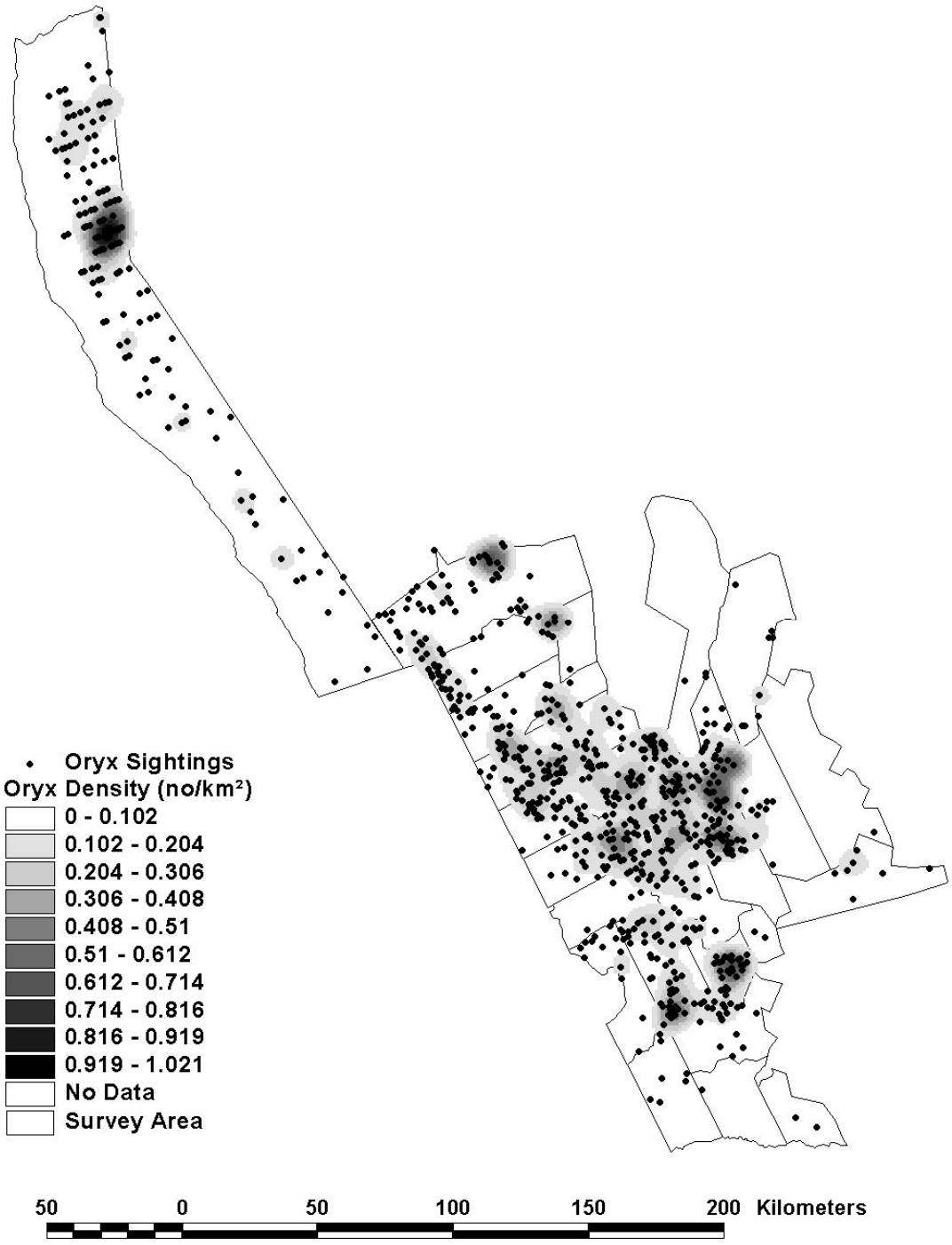

Figure 10: Distribution and density of oryx.

Table 12: Summary of estimates and density of ostrich.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01	27	27	85	220	4516.9	134	157.43%	0.010
NW22	23	23	57	104	525.0	47	81.84%	0.028
NW23	33	33	82	248	4889.8	165	201.29%	0.196
NW28	9	9	25	55	217.8	30	120.04%	0.015
NW35	5	5	12	33	100.2	21	164.83%	0.010
NW36	4	4	10	28	62.1	18	183.79%	0.020
NW37	11	11	14	24	23.4	10	70.25%	0.015
NW38	40	40	49	118	1144.6	69	141.65%	0.066
NW39	41	41	52	97	467.9	45	87.23%	0.110
NW40	27	27	24	66	385.7	42	174.18%	0.046
NW41	2	2	3	5	1.9	3	110.01%	0.009
NW42	10	10	13	23	25.2	10	81.29%	0.018
NW43	14	14	18	34	64.9	17	93.84%	0.031
NW44	29	29	39	80	420.7	41	107.38%	0.044
NW45	20	20	25	58	267.6	33	131.07%	0.035
NW46	1	1	1	4	2.3	3	249.50%	0.002
NW52	1	1	1	5	2.6	3	255.85%	0.001
NW53	10	10	8	18	25.7	10	136.34%	0.008
NW54	50	50	58	121	988.9	64	110.10%	0.068
NW55	32	35	40	45	5.9	5	12.21%	0.036
NW56	56	56	37	72	288.7	35	92.87%	0.076
NW57	30	30	38	83	491.0	45	118.73%	0.049
NW58	22	22	27	68	410.2	41	149.88%	0.041
NW59	16	16	16	40	126.1	24	146.10%	0.074
NW60	3	3	8	18	26.3	11	140.07%	0.008
NW68	4	4	10	17	9.5	6	63.66%	0.013
NW69	3	3	8	27	70.2	19	248.60%	0.011
NW70	10	10	25	77	604.2	52	209.51%	0.032
NW71	12	12	30	145	2865.4	115	385.05%	0.067
Total	**545**	**545**	**814**	**1096**	**19030.6**	**283**	**34.71%**	**0.026**

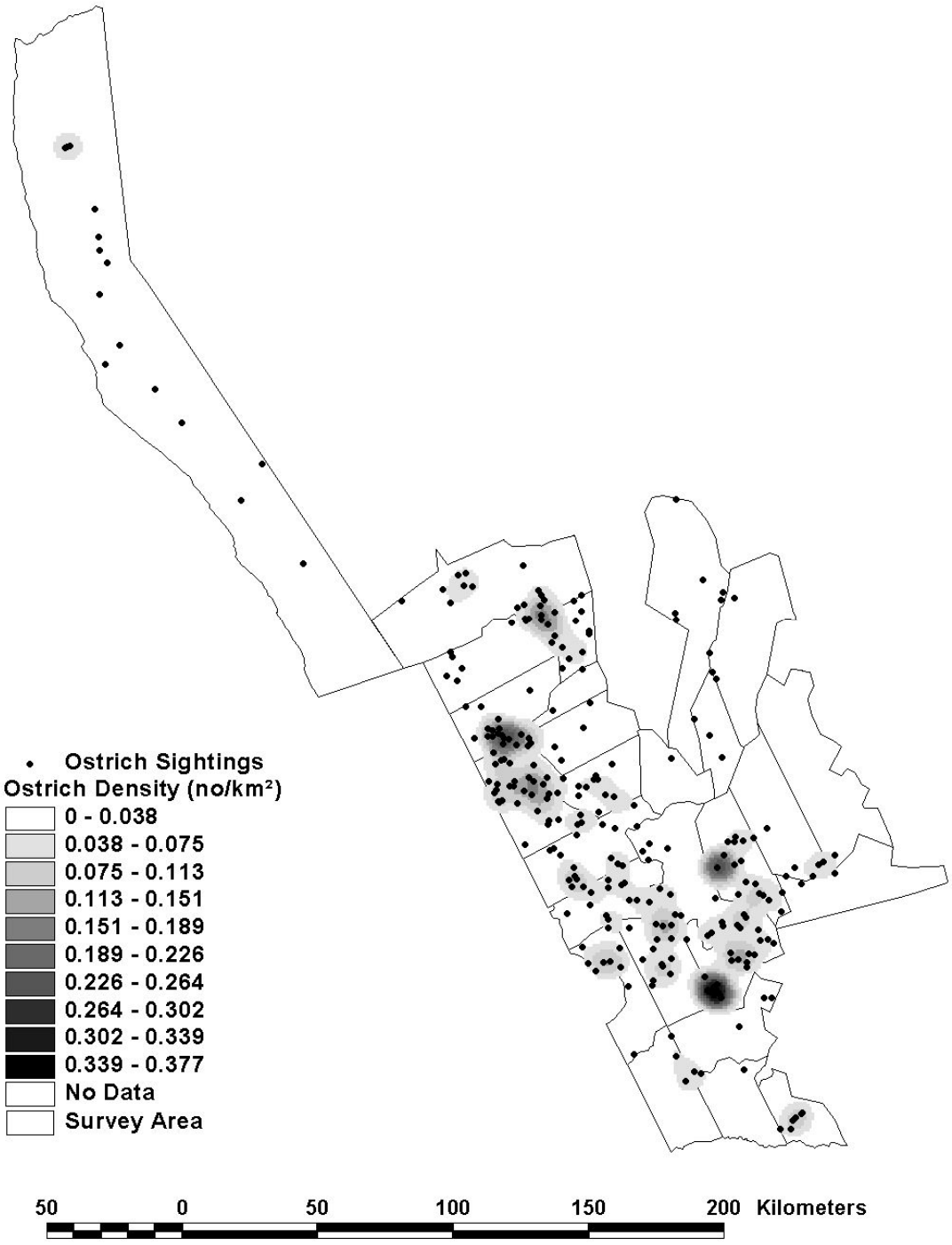

Figure 11: Distribution and density of ostrich.

Table 13: Summary of estimates and density of cattle.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22	264	264	656	1266	89262.5	610	92.96%	0.321
NW23	42	42	111	375	12477.1	264	237.33%	0.265
NW28	792	792	1869	3207	429455.3	1338	71.60%	1.146
NW35	862	862	1954	4330	1341538.3	2377	121.66%	1.568
NW36	156	156	376	1108	104695.6	732	194.68%	0.788
NW37								
NW38								
NW39								
NW40								
NW41								
NW42	12							
NW43								
NW44								
NW45								
NW46								
NW52	1578	1578	1864	2515	105737.8	650	34.88%	1.223
NW53	787	787	985	1461	55467.7	476	48.30%	0.986
NW54	90	90	113	223	2941.9	110	97.06%	0.134
NW55	60	64	76	87	33.8	12	15.54%	0.067
NW56	6	6	7	26	80.3	18	244.91%	0.015
NW57	33	33	41	165	3707.4	123	296.60%	0.054
NW58								
NW59	35	35	44	171	3585.7	127	289.33%	0.198
NW60	138	138	346	633	19408.5	286	82.73%	0.359
NW68	43	43	110	222	2816.9	112	102.14%	0.141
NW69								
NW70								
NW71								
Total	**4898**	**5535**	**8553**	**11571**	**2171208.9**	**3018**	**35.28%**	**0.275**

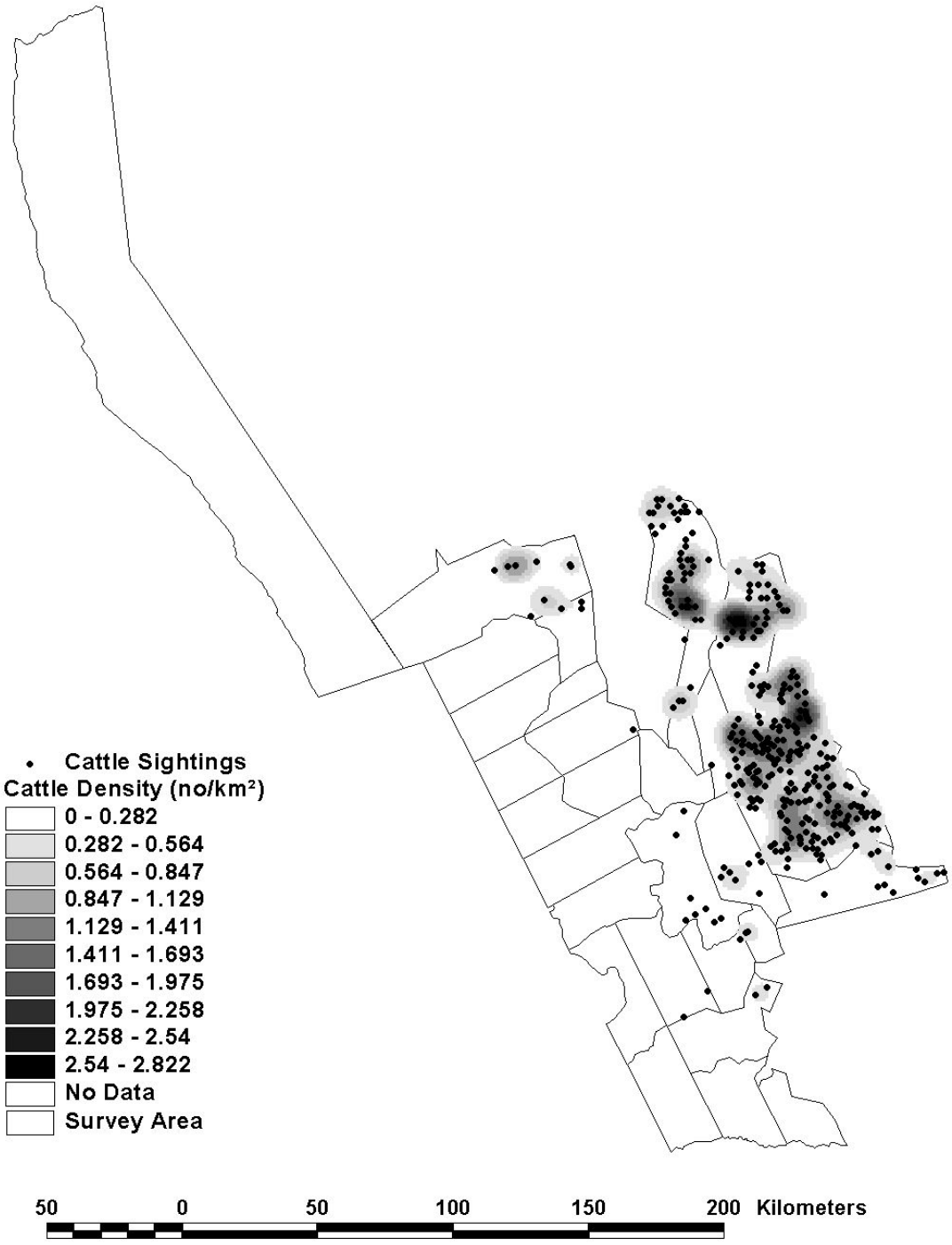

Figure 12: Distribution and density of cattle.

Table 14: Summary of estimates and density of donkeys.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22	12	12	30	60	217.8	30	101.01%	0.015
NW23	4	4	11	41	160.7	30	282.77%	0.025
NW28	4	4	11	36	151.4	25	225.18%	0.007
NW35	2	2	5	21	63.0	16	326.89%	0.004
NW36								
NW37								
NW38								
NW39								
NW40								
NW41								
NW42								
NW43								
NW44								
NW45								
NW46								
NW52	258	258	326	481	5951.9	154	47.28%	0.214
NW53	93	93	116	193	1422.0	76	65.44%	0.117
NW54	26	26	33	78	515.1	46	140.59%	0.039
NW55	44	49	55	62	11.4	7	12.31%	0.049
NW56	8	8	10	25	52.8	15	148.92%	0.020
NW57								
NW58								
NW59								
NW60	3	3	8	21	46.1	14	185.47%	0.008
NW68								
NW69								
NW70								
NW71								
Total	**454**	**454**	**605**	**795**	**8592.1**	**190**	**31.38%**	**0.019**

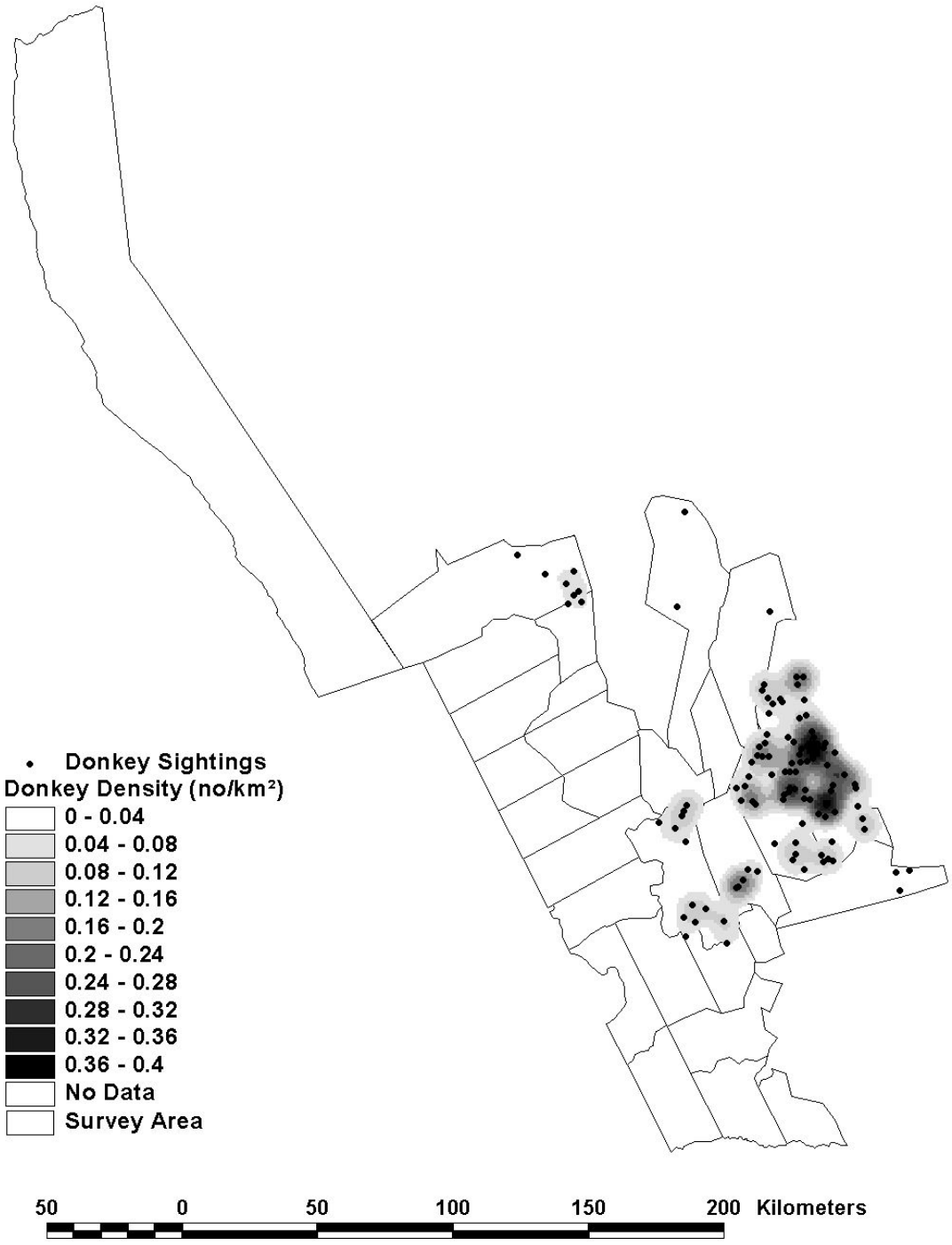

Figure 13: Distribution and density of donkeys.

Table 15: Summary of estimates and density of goats.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22	1752	1752	4355	8649	4421513.2	4294	98.59%	2.127
NW23	375	375	994	4237	1880916.9	3244	326.36%	2.368
NW28	1193	1193	3297	6436	2362357.3	3139	95.19%	2.022
NW35	989	989	2165	5362	2426571.0	3196	147.62%	1.738
NW36	214	214	519	1462	173700.1	943	181.62%	1.087
NW37								
NW38								
NW39								
NW40								
NW41								
NW42	50							
NW43								
NW44								
NW45								
NW46	200							
NW52	5463	5463	6910	9369	1510874.5	2458	35.58%	4.532
NW53	2395	2395	2999	4707	714724.6	1709	56.97%	3.001
NW54	376	376	467	840	34059.5	373	79.90%	0.553
NW55	924	924	1165	1255	1964.7	90	7.69%	1.030
NW56	590	590	735	1785	264723.3	1051	142.99%	1.500
NW57	9	9	11	41	213.1	29	260.71%	0.015
NW58								
NW59	230	230	288	848	69792.0	560	194.25%	1.302
NW60	530	530	1330	2364	253269.1	1035	77.82%	1.378
NW68	30	30	76	184	2576.3	107	140.01%	0.098
NW69								
NW70								
NW71								
Total	**15320**	**17617**	**25312**	**33007**	**14117255.5**	**7695**	**30.40%**	**0.813**

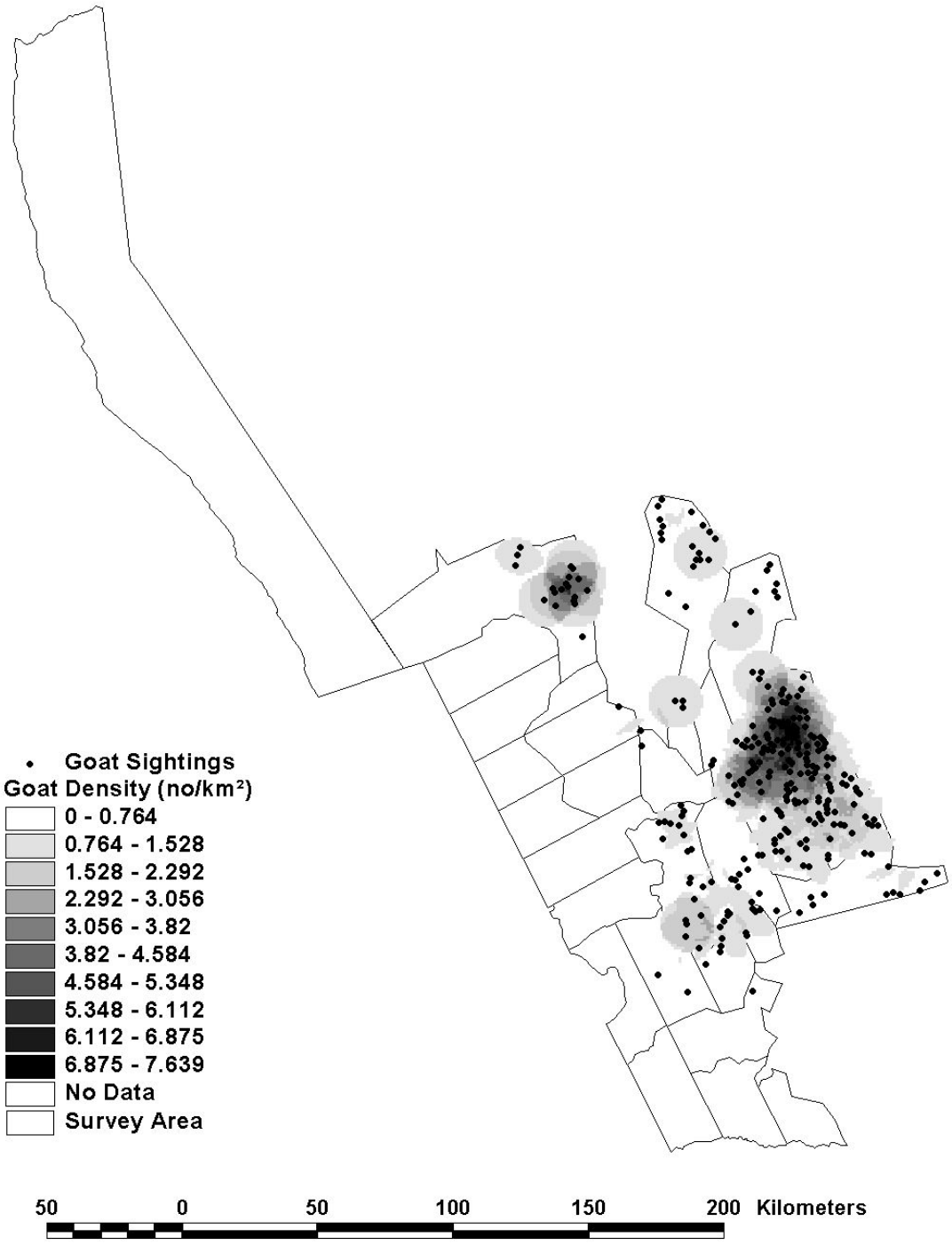

Figure 14: Distribution and density of goats.

Table 16: Summary of estimates and density of horses.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22								
NW23								
NW28	1	1	3	11	15.4	8	287.36%	0.002
NW35								
NW36								
NW37								
NW38								
NW39								
NW40								
NW41								
NW42								
NW43								
NW44								
NW45								
NW46								
NW52	141	141	178	282	2709.9	104	58.37%	0.117
NW53	74	74	93	166	1318.6	73	79.20%	0.093
NW54	8	8	10	30	100.0	20	201.36%	0.012
NW55	1	1	1	2	0.0	0	34.09%	0.001
NW56	8	8	10	29	85.7	19	189.79%	0.020
NW57								
NW58								
NW59								
NW60								
NW68	3	3	8	18	25.8	11	140.01%	0.010
NW69								
NW70								
NW71								
Total	**236**	**236**	**303**	**436**	**4255.5**	**134**	**44.13%**	**0.010**

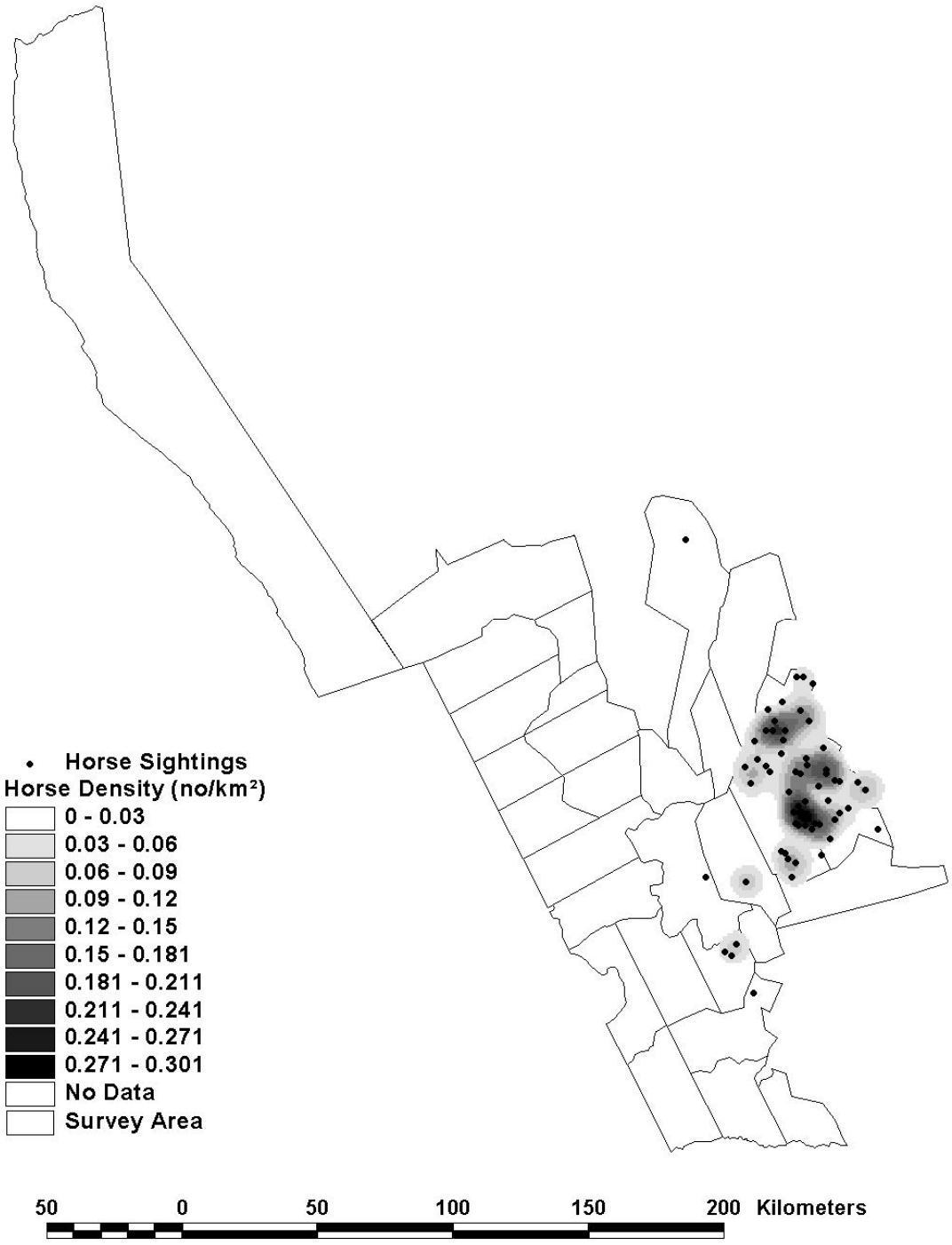

Figure 15: Distribution and density of horses.

Table 17: Summary of estimates and density of sheep.

Block	No Seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
NW01								
NW22								
NW23								
NW28								
NW35								
NW36								
NW37								
NW38								
NW39								
NW40								
NW41								
NW42								
NW43								
NW44								
NW45								
NW46								
NW52	451	451	570	1303	134248.7	733	128.45%	0.374
NW53	90	90	113	429	24524.9	316	280.85%	0.113
NW54	9	9	11	34	126.9	23	201.58%	0.013
NW55	37	37	47	62	61.2	16	33.88%	0.041
NW56								
NW57								
NW58								
NW59								
NW60								
NW68								
NW69								
NW70								
NW71								
Total	**587**	**587**	**741**	**1558**	**158961.7**	**817**	**110.18%**	**0.024**

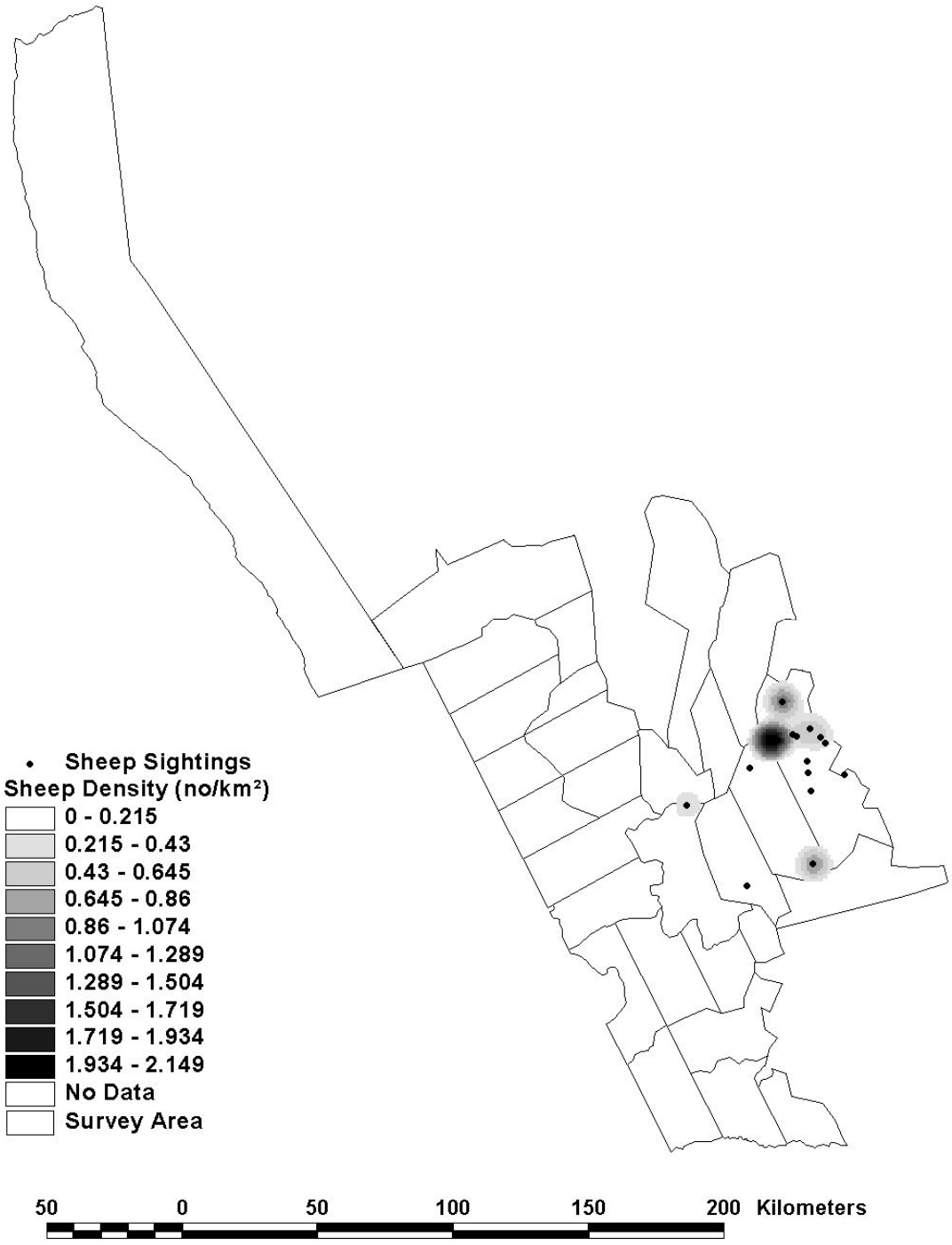

Figure 16: Distribution and density of sheep.

4. Discussion

This survey was undertaken a lot later than intended. In future, the survey should be done in June and July as this is apparently the time of the year when the animals congregate in the more open areas. This is the same time that the conservancies do their game counts and it would hence make comparisons between the two counts more easy.

Appendix I: Observer Calibration

Crew ISE

Andries Kheibehab

	Height	In	Out	Width	O-I + 1
	300	10	20	10	11
	300	11	23	12	13
	400	15	30	15	16
	200	9	21	12	13
	300	8	30	22	23
	300	12	30	18	19
	360	10	30	20	21
	200	5	16	11	12
Average	**295**				**16**
					16.27119
	Calibrated strip width (m)				**163**

Battlefield Nghishekwa

	300	7	29	22	23
	300	12	28	16	17
	200	9	27	18	19
	300	13	28	15	16
	360	7	29	22	23
	200	6	26	20	21
Average	**277**				**20**
					21.51
	Calibrated strip width (m)				**215**
	Total strip width for ISE crew				**378**

Crew PRO

Gabriel Shatumbu

	Height	In	Out	Width	O-I + 1
	290	4	27	23	24
	300	5	29	24	25
	300	4	28	24	25
	300	4	30	26	27
	300	4	24	20	21
	300	4	26	22	23
	300	4	28	24	25
	300	4	29	25	26
	310	4	26	22	23
	300	4	26	22	23
	300	4	27	23	24
	310	4	29	25	26
	300	4	26	22	23
	290	5	27	22	23
	290	4	25	21	22
	300	4	29	25	26
Average	**299.375**				**24.13**
	Calibrated strip width (m)				**242**

Johannes Kapner

	300	5	22	17	18
	300	5	21	16	17
	300	5	23	18	19
	300	5	23	18	19
	300	5	21	16	17
	300	6	22	16	17
	310	4	20	16	17
	300	5	22	17	18
	300	4	22	18	19
	310	5	20	15	16
	300	5	23	18	19
	290	5	22	17	18
	290	6	23	17	18
	300	4	20	16	17
Average	**300**				**17.78571**
	Calibrated strip width(m)				**178**
	Total strip width for PRO crew				**420**

Appendix II: Survey Cost

The table below gives an analysis of the survey cost.

Item	Cost N$
S&T	
Overtime	
Vehicles[2]	
Plane[3]	
Other	
Total	

[2] Only the cost of fuel and emergency repairs.
[3] Only the cost of avgas and landing fees.

Appendix III: Survey Participants

Pilots: Martin du Plessis, Dr Nad Brain
Recorders: Wayne Handley, Alwyn Engelbrecht, Ebeb Naude
Observers: Gabriel Shatumbu, Johannes Kapner, Battlefield Nghishekwa, Andries Kheibehab
Data Management and ground support: Holger Kolberg