Range Size, Distribution, and Seasonal Activity Levels of Western Diamondback Rattlesnakes at the Arizona-Sonora Desert Museum

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Resident Rattlesnakes

The Desert Museum's grounds are home to several rattlesnake species.

When a rattlesnake is seen by visitors or staff, it may be moved to a less-frequented location.

ASDM's herpetology department also uses radio telemetry to track the movements of a few resident diamondbacks, *Crotalus atrox*.

Color-coded Crotalids

The rattles of newcomers are painted with a unique "bar code" of color bands for future identification.

Rattle-marking began in 1991; some marked snakes have been encountered repeatedly over many years.

The radio telemetry tracking project uses both long-term residents and first-time captures as data sources.

Surgical Implantation

The body cavity of each participant in the radio telemetry tracking project is implanted with a AA battery-sized transmitter, connected to a thin, foot-long antenna wire just beneath the skin.

In addition, nickel-sized data recorders store information about temperature.

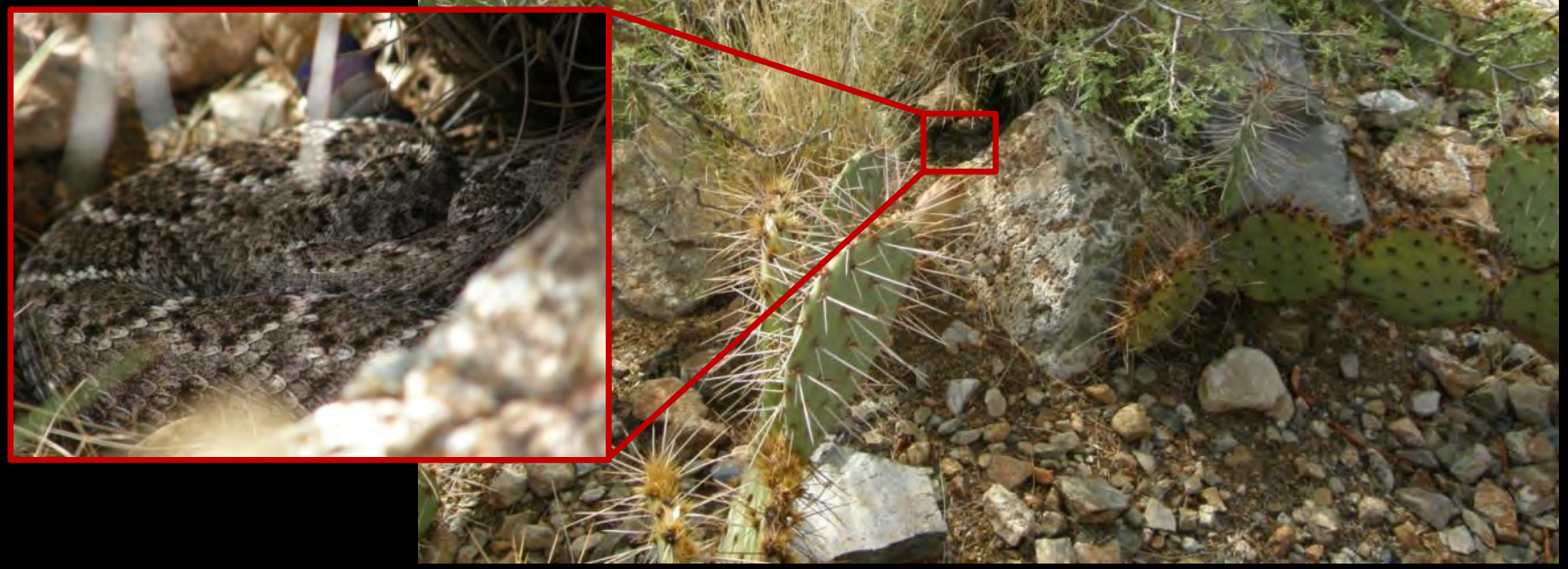
Needles” in a 100-acre “Haystack”

After implantation by the museum’s veterinarian, snakes are released to travel where they choose.

Museum personnel periodically use a portable receiver and directional antenna to monitor their movements.

Blending In

Rattlesnakes are typically secretive and well-camouflaged, often hiding under vegetation.



They Can Run, but Can't Hide

Even if a snake is underground, the transmitter's signal gives it away.

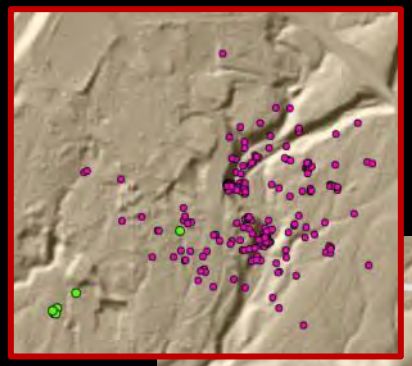
Once it has been located, the XY coordinates and other data are recorded.

From Excel to ArcMap: 2000+ Survey Entries

Mapped points were edited for outliers and other errors.

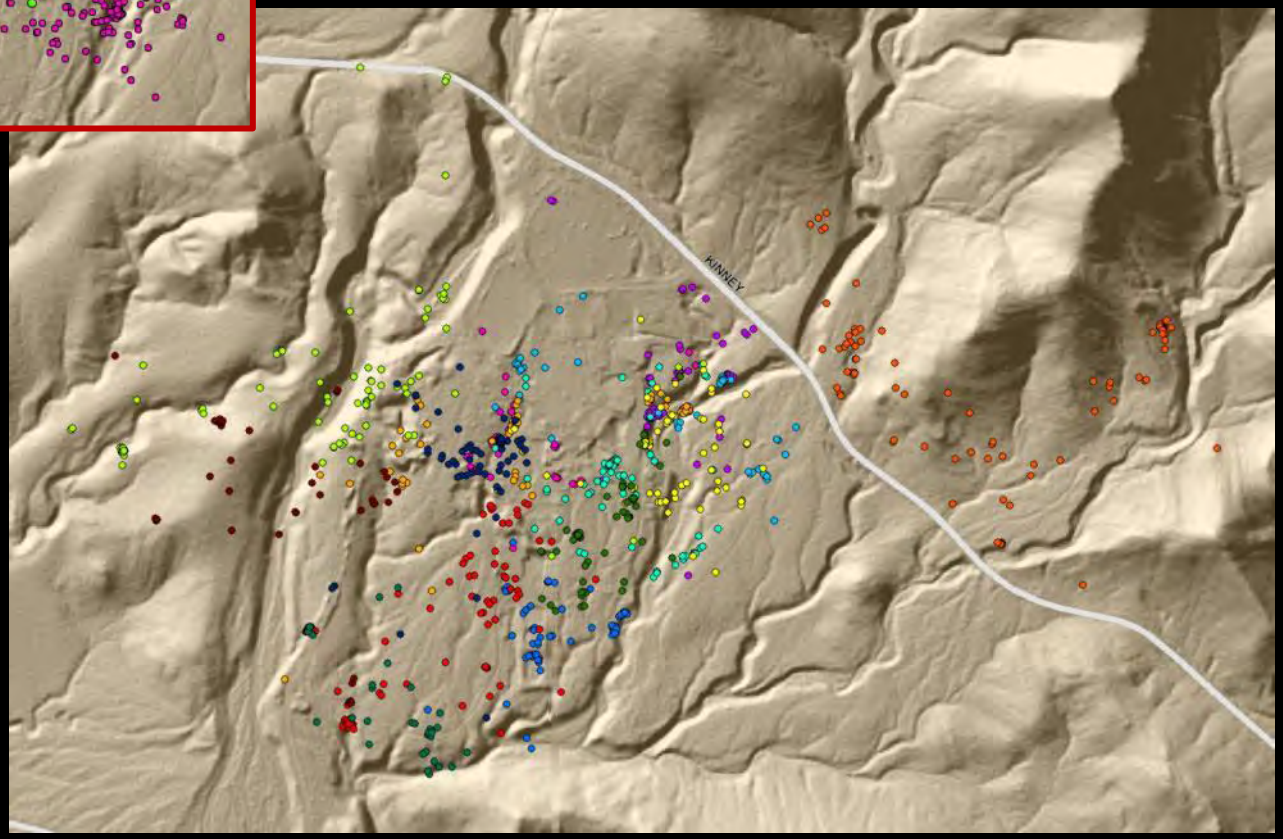
Comparing Apples to Apples

The time span for participation in the study varied from just a few weeks to a few years.



To normalize this variation, 14 snakes with at least one year of data were separated into a subgroup.

From these, new feature classes were generated from initial years of data, yielding 14 more-or-less uniform groups of first-year point clusters.

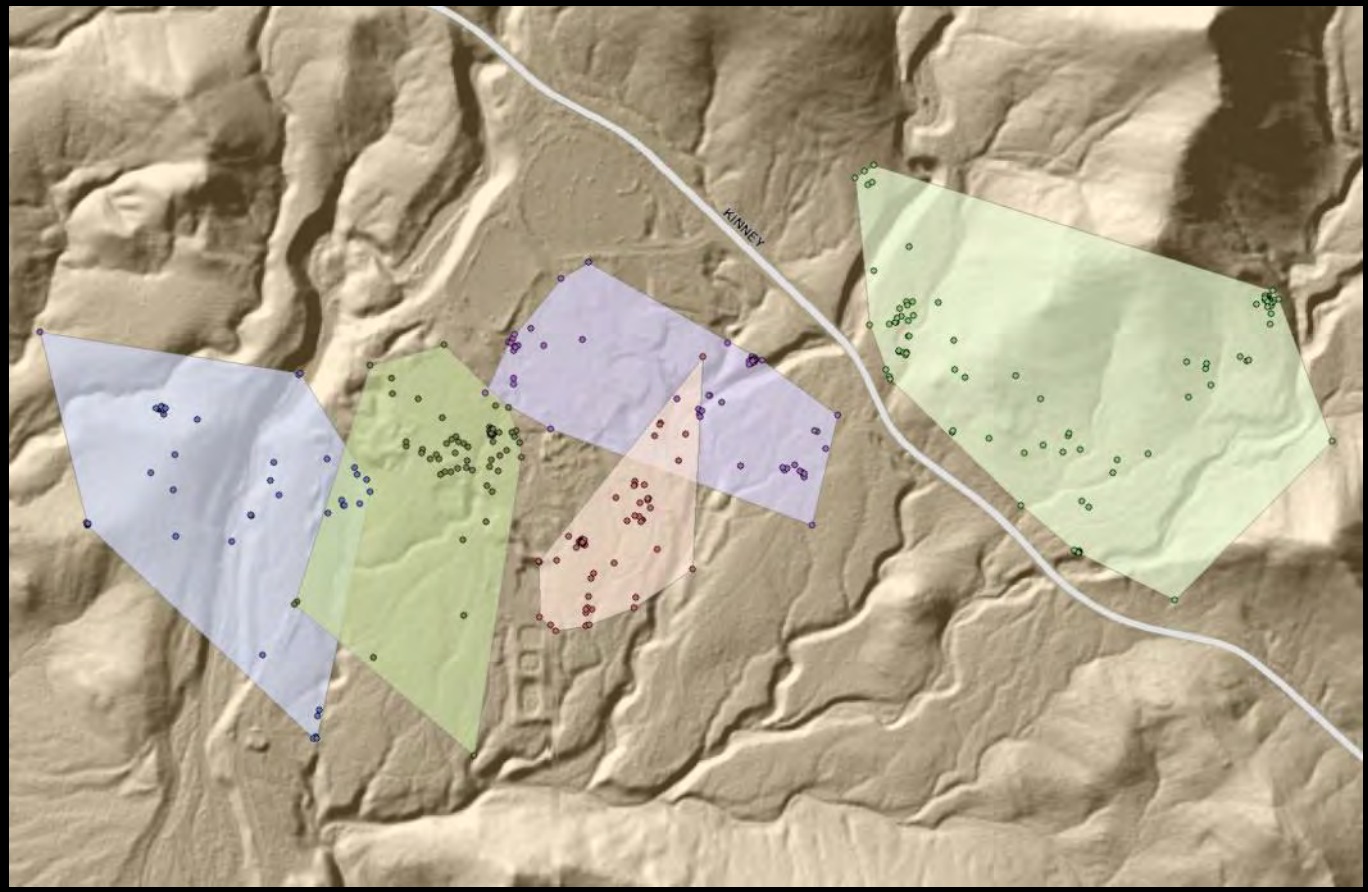


Finding Each Snake's Home Range

Convex Hull Tool:

The first tool used for estimating home ranges was the Convex Hull.

Like a rubber band stretched around pins in a map, this tool draws simple polygons around point clusters.

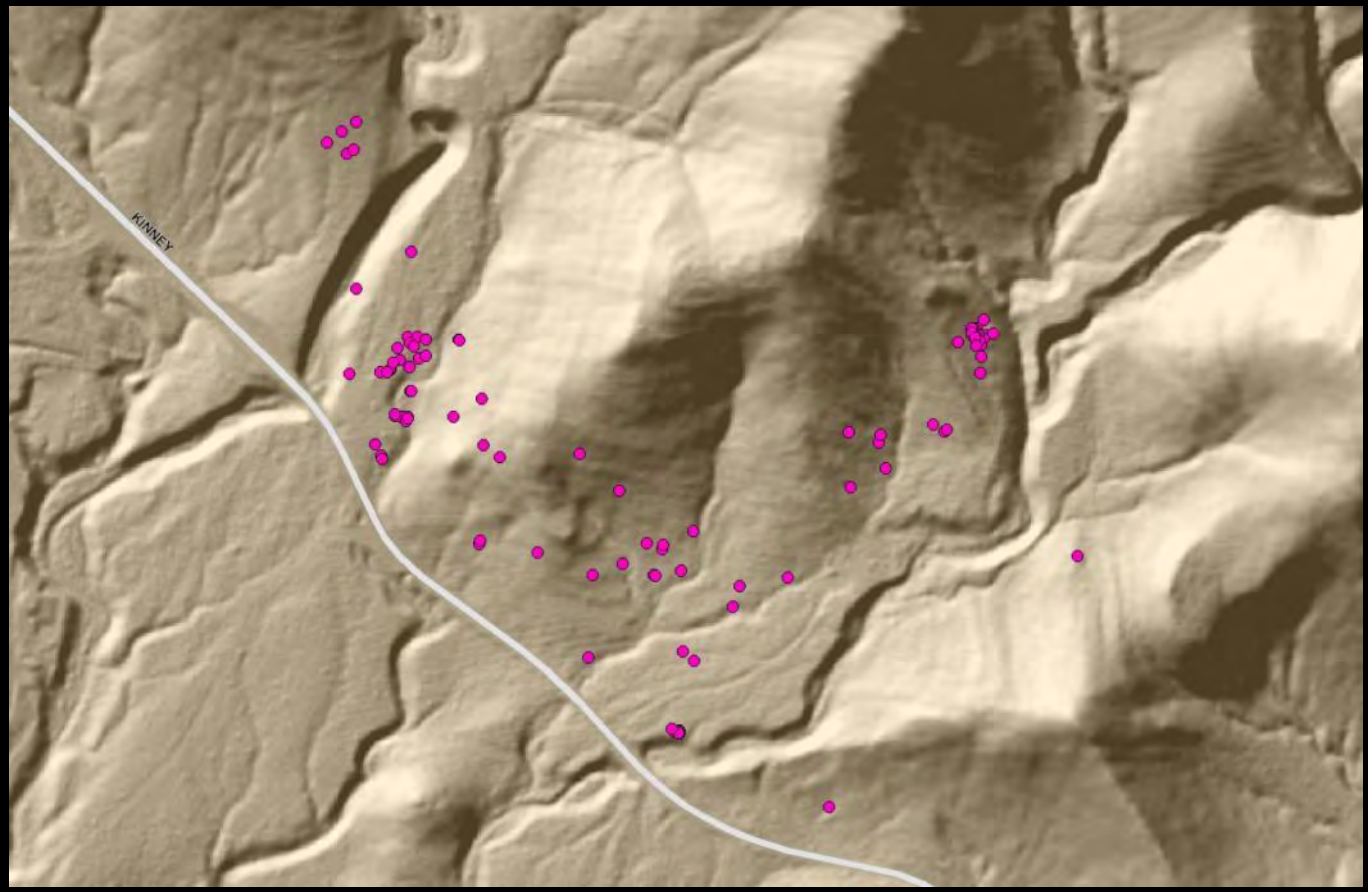


Finding Each Snake's Home Range

Convex Hull Tool:

Since it uses just the outermost points to create polygons, Convex Hull tends to oversimplify shapes.

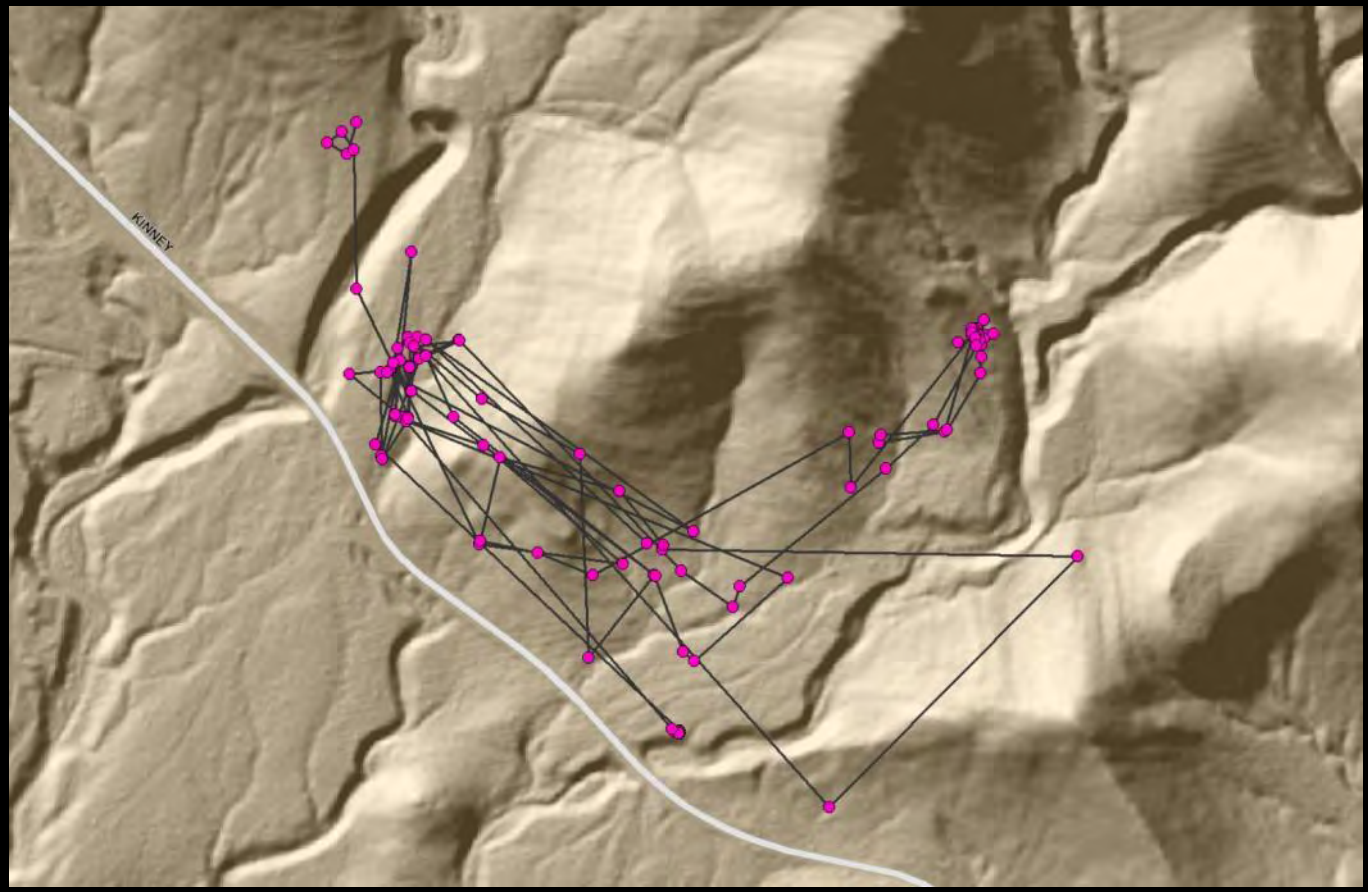
It skips interior points that could create concave segments.



Finding Each Snake's Home Range

Convex Hull Tool:

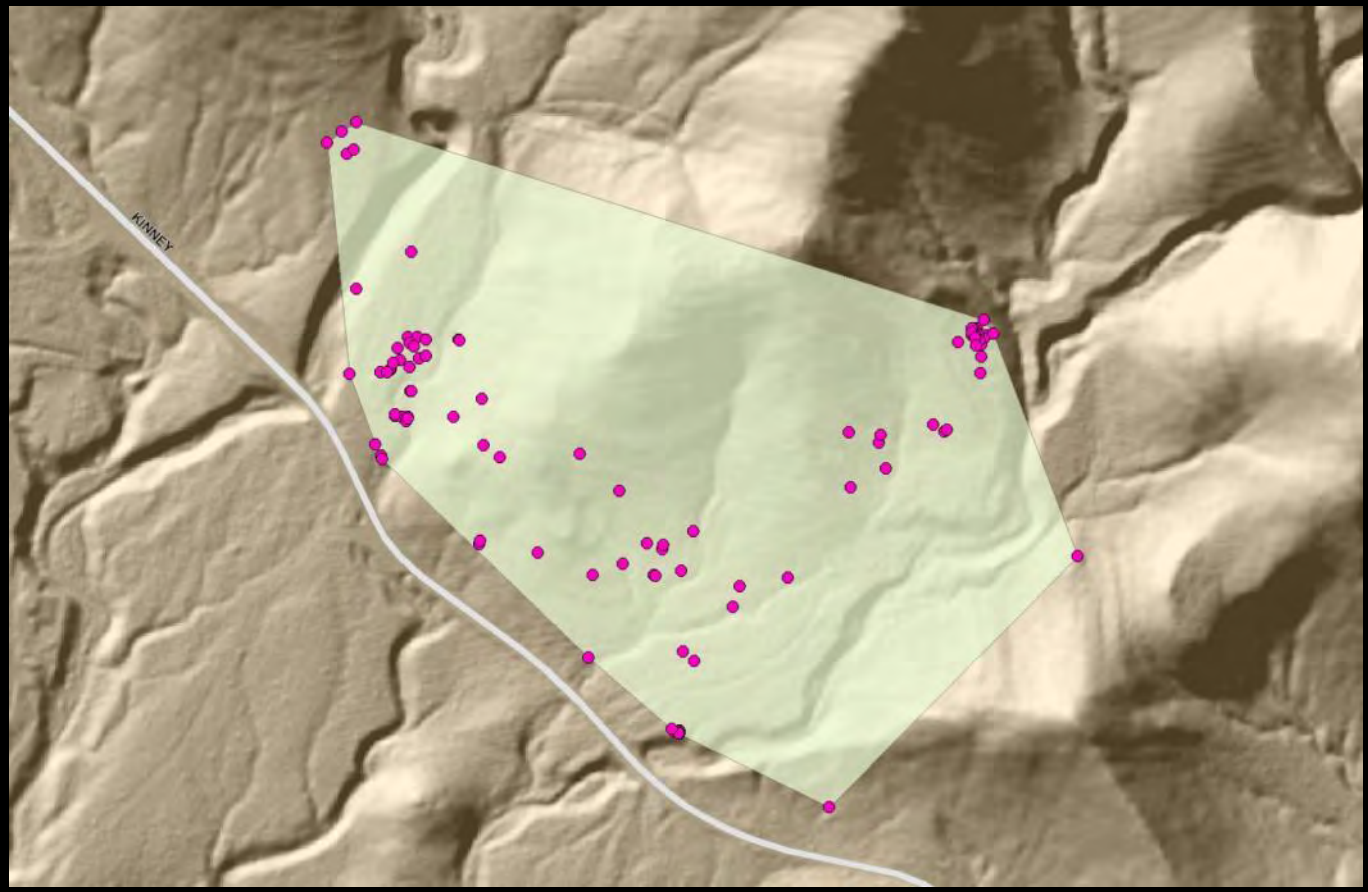
For example, Male "D" avoided a steep hillside but crawled all over the more level, crescent-shaped area that surrounded it.



Finding Each Snake's Home Range

Convex Hull Tool:

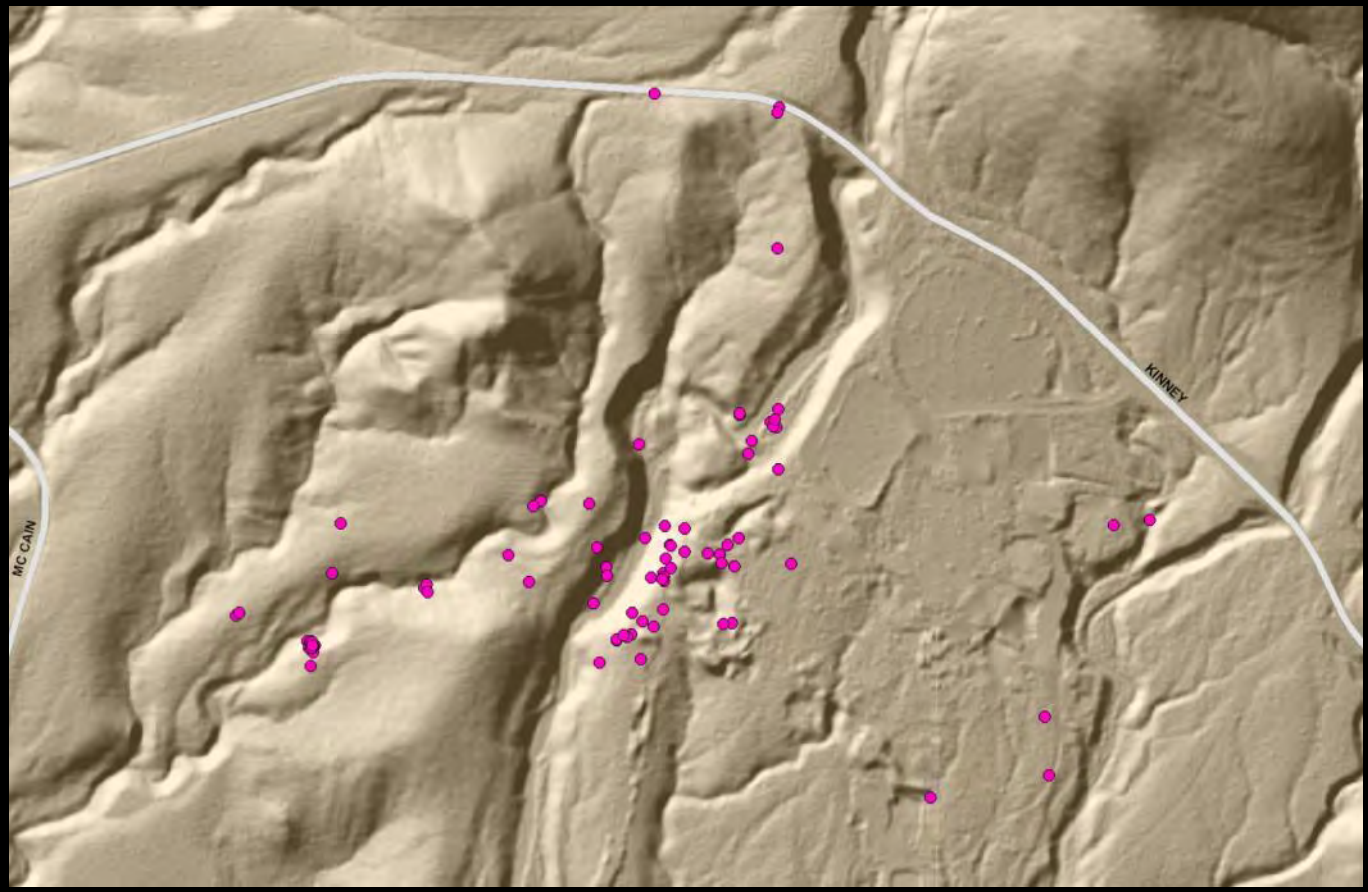
However, the Convex Hull tool included all the steep crest of the hill within the crescent—even though the snake had never "set foot" there.



Finding Each Snake's Home Range

Convex Hull Tool:

All space inside the polygon's perimeter is treated equally.

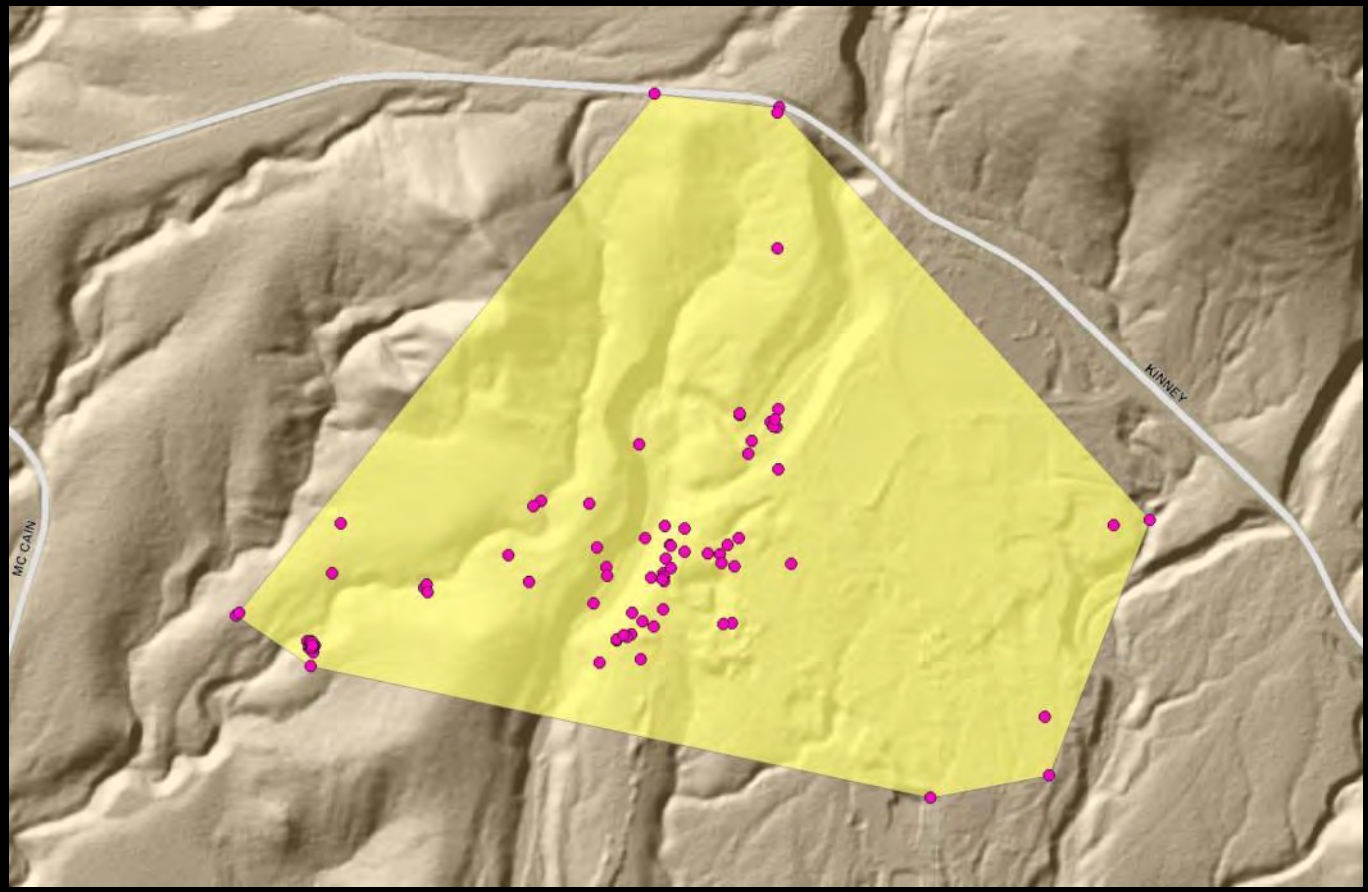


Finding Each Snake's Home Range

Convex Hull Tool:

Male snake "I" spent most of his time in a core area, with a few exploratory forays beyond his usual slithering grounds, but every square inch of territory was included by Convex Hull.

It also assumes he never travels *beyond* these outermost points.

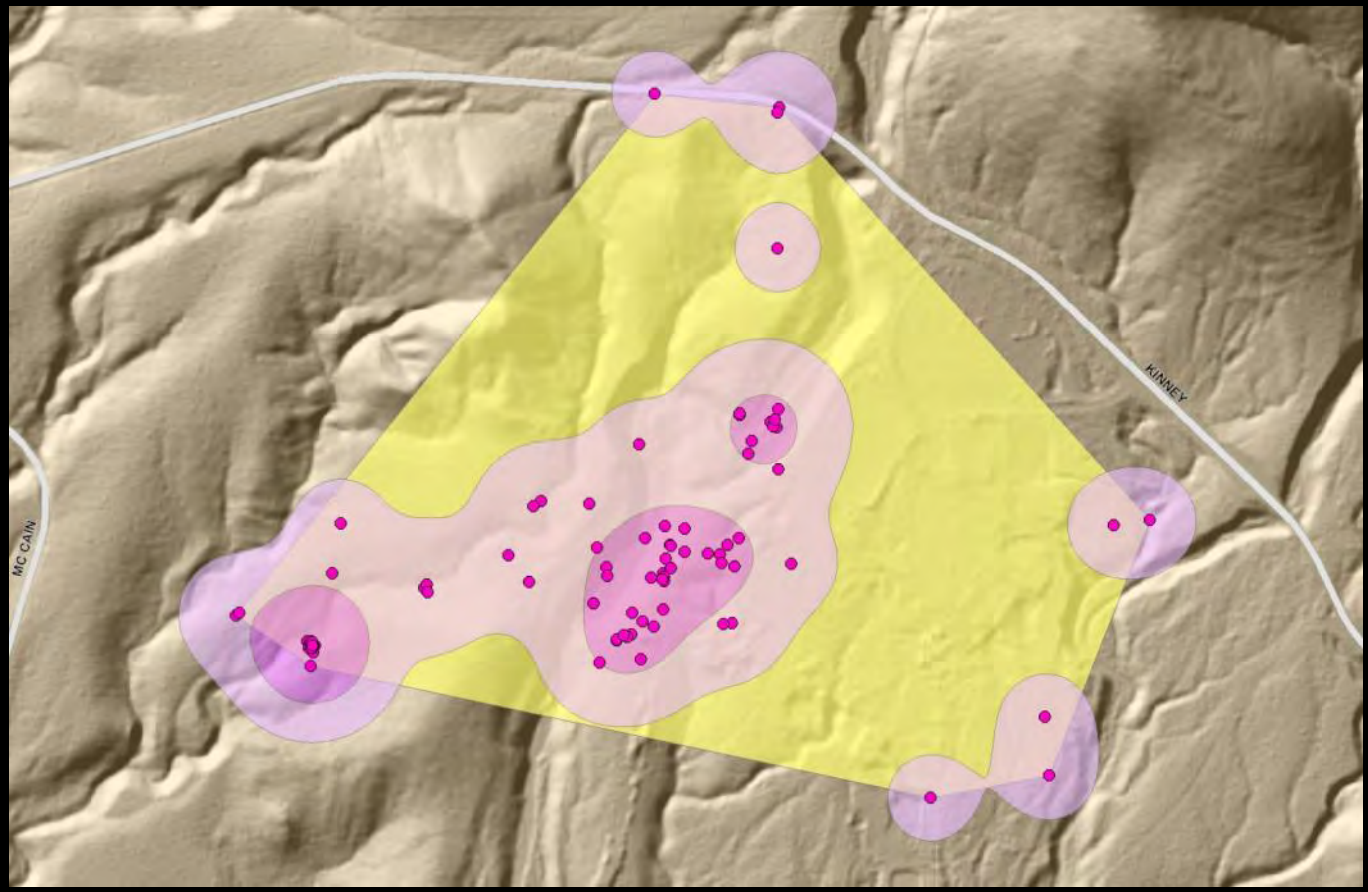


Finding Each Snake's Home Range

Hawths Fixed Kernel Density Estimator:

Another tool makes a "probability surface" by interpolating point densities; it then generates concentric polygons around different "zones of probability."

It assumes snakes *do* travel beyond the outermost points.

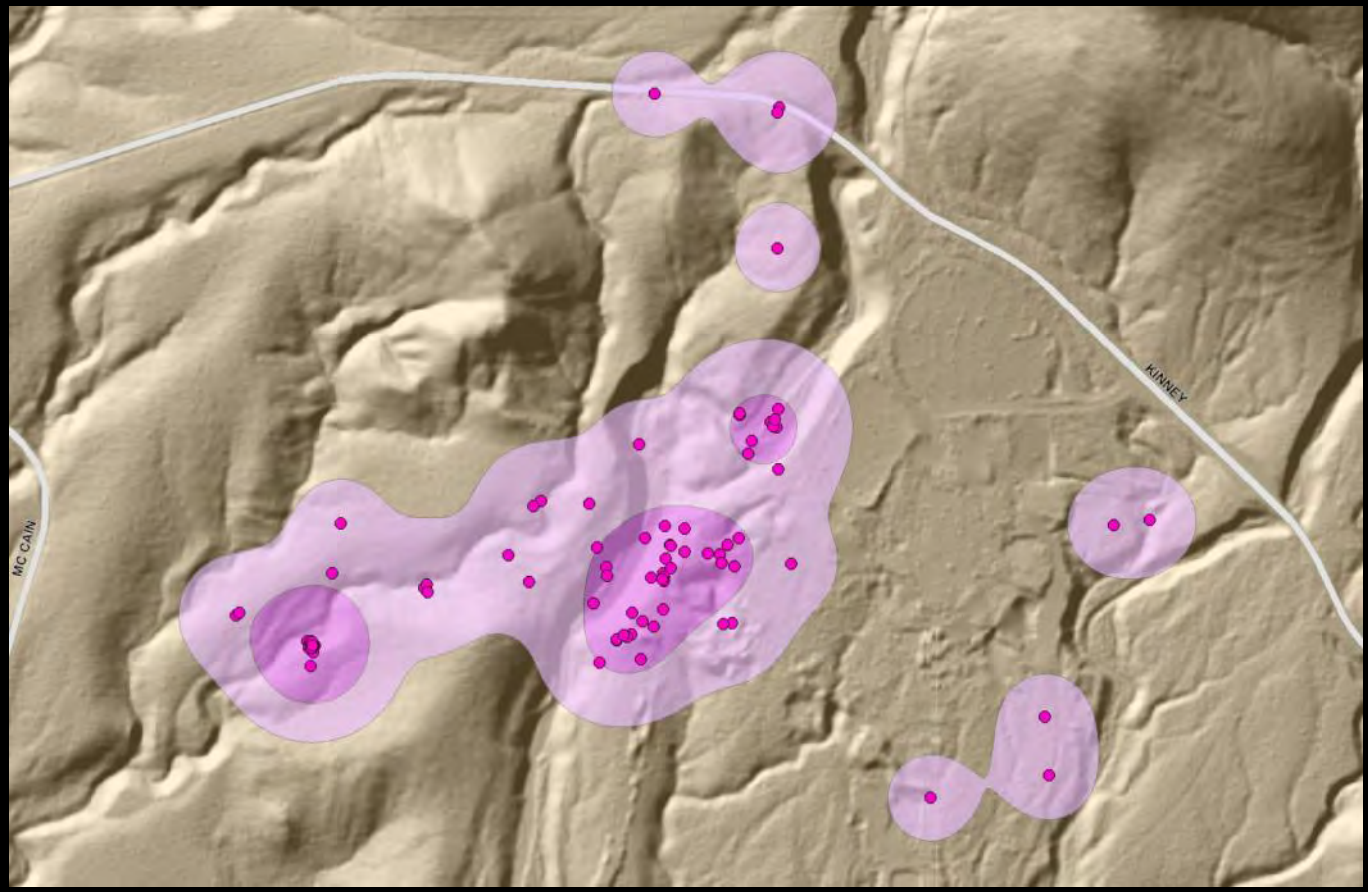


Finding Each Snake's Home Range

Hawths Fixed Kernel Density Estimator:

The probability of the snake being within any area enclosed by a polygon is 95%.

The three smaller, darker polygons are zones where the likelihood of the animal being present is 50%.



Interpreting Home Range Results

Both Hawths and Convex Hull tools are convenient for estimating home ranges.

Green columns compare results with outlier "snake I" included; yellow columns omit the outlier.

Home Range Areas Males vs Females (square feet) .xlsx

	A	B	C	D	E	F	G	H	I	J
1	Track Code	Hawths 50%		Hawths 95%		Convex Hull		Hawths 95% sans "I"		Convex Hull sans "I"
2	B	269782		1219960		879530		1219960		879530
3	D	305538		1612720		1761215		1612720		1761215
4	H	154894		885661		713260		885661		713260
5	I	332711		2030080		3676286				
6	J	193564		1130141		1026008		1130141		1026008
7	K	162772		1003725		720789		1003725		720789
8	L	208040		977389		699349		977389		699349
9	M	157425		691986		432686		691986		432686
10	N	155492		893827		809704		893827		809704
11	O	112829		770025		553403		770025		553403
12	Males: Average Sq Ft	205305		1121551		1127223		1020604		706990
13										
14	CC	103670		821050		848104		821050		848104
15	DD	132269		640002		335736		640002		335736
16	EE	148764		727460		363230		727460		363230
17	FF	286334		1359712		1117980		1359712		1117980
18	Females: Average Sq Ft	167759		887056		666262		887056		666262
19										

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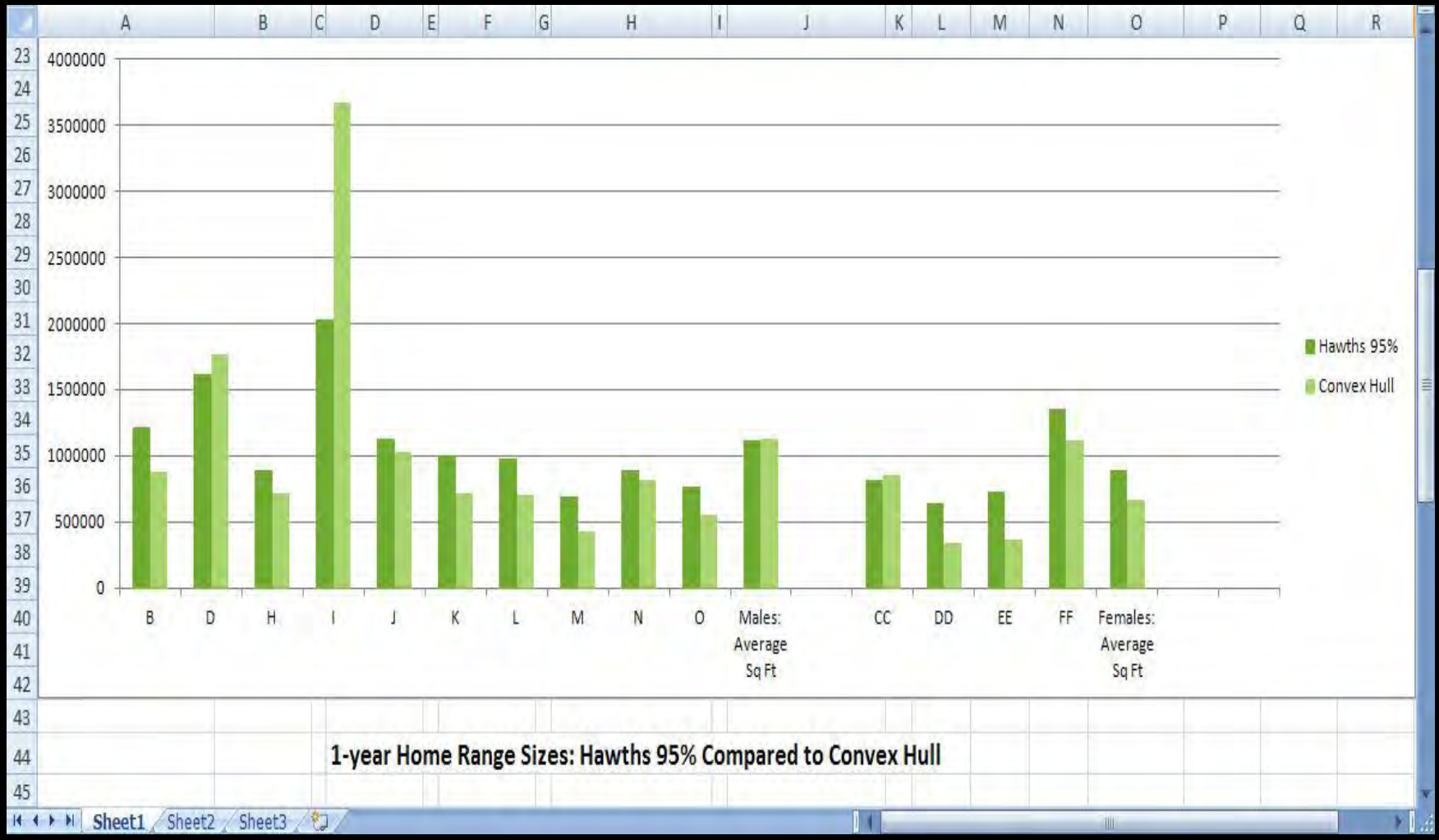
Interpreting Home Range Results

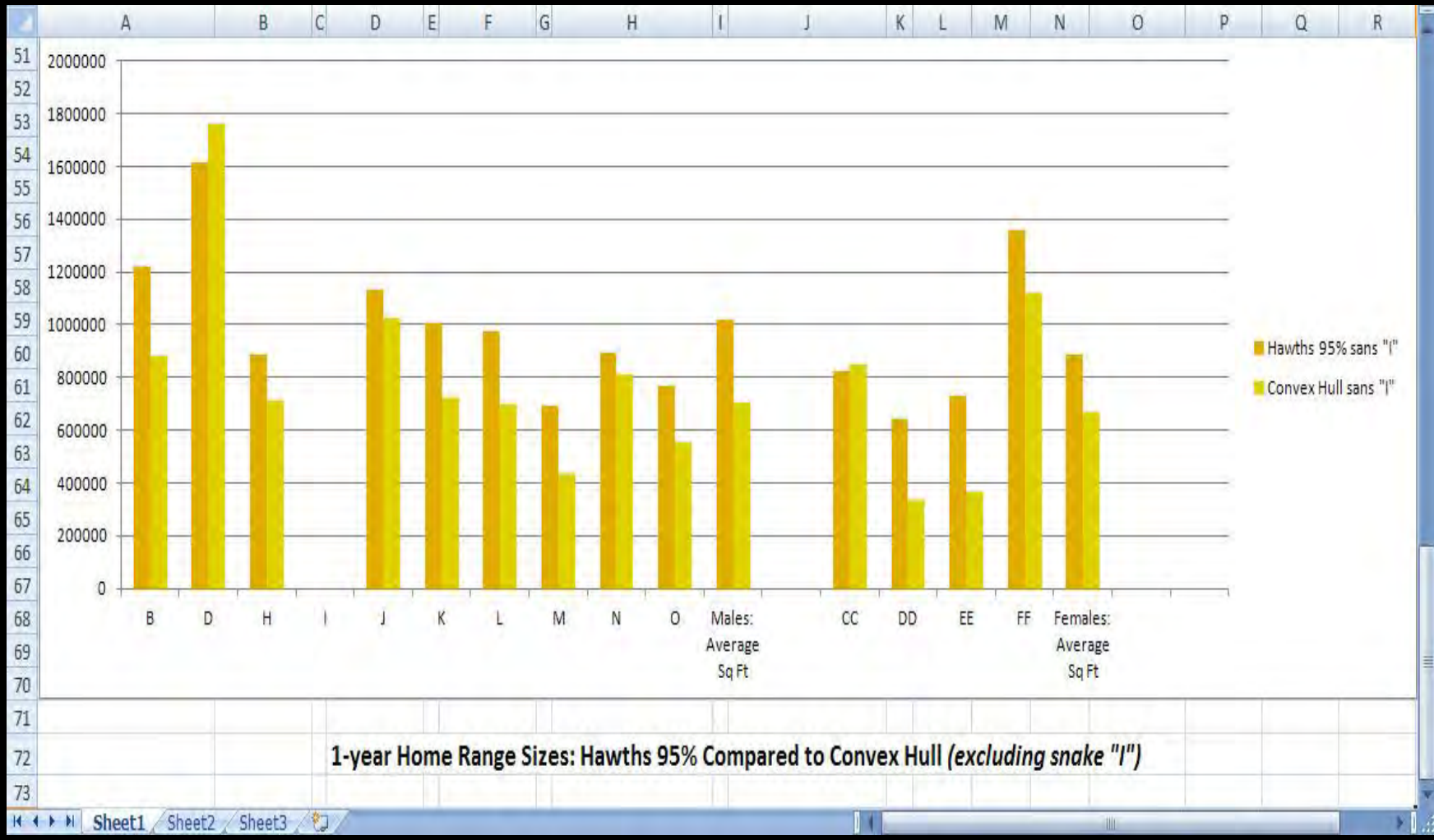
With **outlier "snake I" included, the Hawths average male range is 26% larger than the female range; the Convex Hull average male range is 69% larger than the female range:**



Interpreting Home Range Results

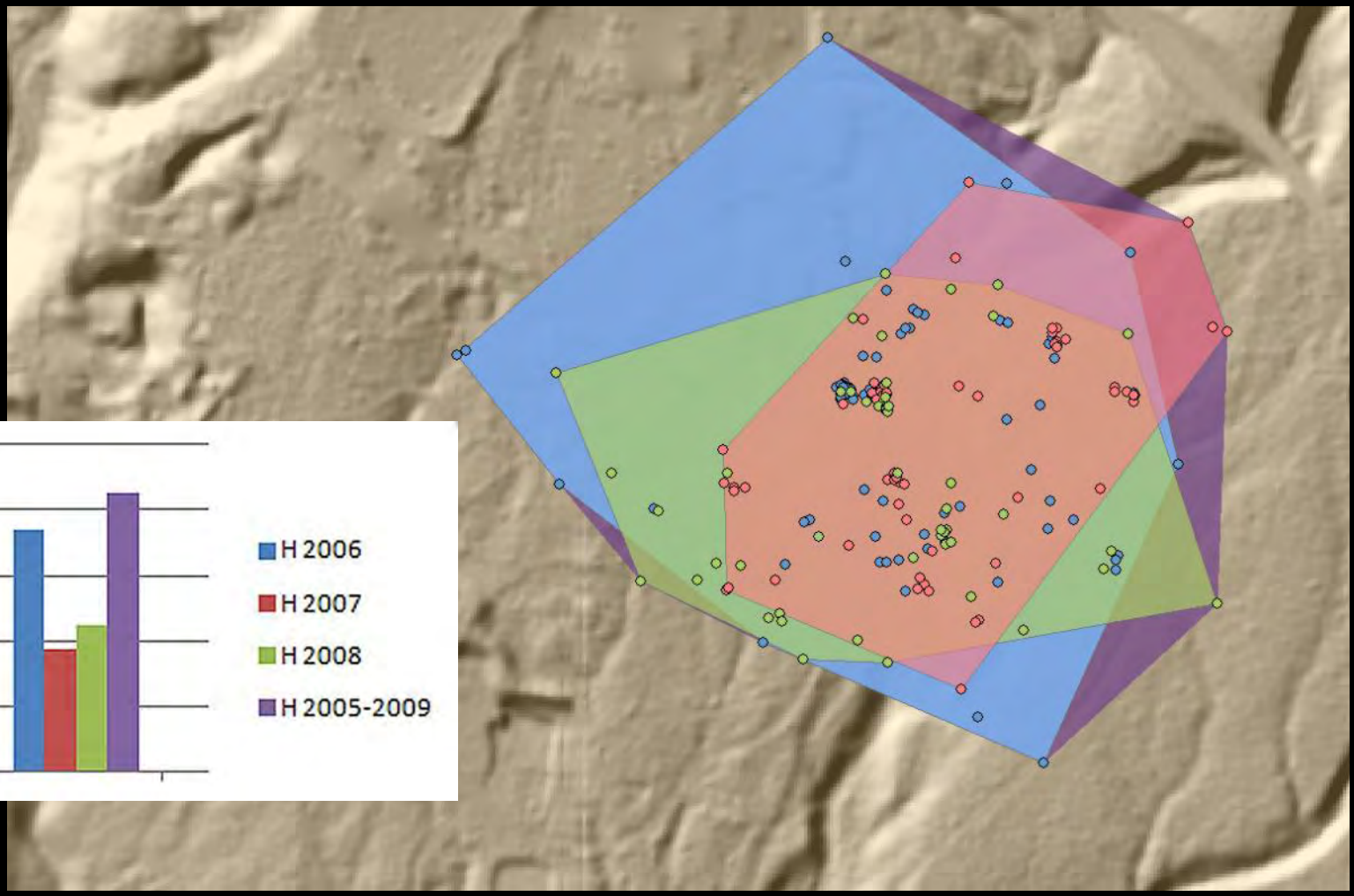
Without **outlier snake "I", the Hawths average male range is 15% larger than the female range,**

But the Convex Hull average male range is only 6% larger than the female range:



Interpreting Home Range Results

Even with normalized data, calculating ranges is not an exact science. These home ranges are all for the same snake (Male "H") in 3 different years, as well as for total duration, including partial years.



Measuring Monthly Activity Levels

The Point-to-Line tool produced separate feature classes for each snake, by year, with attributes for total distance traveled during each month.

Monthly Distance Traveled in Feet -- Males & Females compared.xlsx

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	track	Sex	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2	A	M	2005								86.98273	119.5997	90.75781	60.60435	85.73793	
3	A	M	2006	93.0129												
4	B	M	2005								1623.033	2676.855	1387.92	516.496	112.7531	
5	B	M	2006	65.48696	101.2355	190.2977	3229.091	2138.705	1419.385	1156.231	2224.244	1551.501				
6	C	M	2005							1467.641	1595.372					
7	D	M	2005								1606.769	2546.417	4106.908	1889.523	451.4155	
8	D	M	2006	265.036	134.3338	185.628	1593.941	1692.351	1683.327	1196.162	1391.127	4446.221				
9	E	M	2005							2366.388	1424.841	1524.706	2200.487	1315.202	158.1565	
10	E	M	2006	147.0015	757.7401	162.7896	2778.879									
11	F	M	2005									5630.921				
12	G	M	2005										672.2047	688.6935	69.43244	
13	G	M	2006	77.81168	42.1033	146.2464	1384.016	1831.596	1486.739							
14	H	M	2005											80.15888	70.31531	
15	H	M	2006		41.18894	86.46999	255.5616	1385.531	2459.107	2621.219	2813.65	2096.629	1472.647	89.43114	92.9138	
16	H	M	2007	51.10462	31.85035	480.9065	267.6313	897.3988	625.2221	438.9689	1152.031	791.2111	637.7252	103.2923	329.2327	
			2008	149.8858	42.66592	239.2009	125.6963	708.8216	1700.934	1064.638	794.6003	1439.638	2209.607	110.7239	25.90474	
			2009	96.54513	123.0683	310.0384										
			2006						4885.434	2515.383	2447.736	1831.664	3325.508	73.73623	156.3771	
			2007	19.12936	58.71537	1840.069	267.0928	1313.334	1156.224	3166.416			1013.413	31.43031	29.94201	
			2008	98.88612												
			2006						2283.147	2474.058	2353.066	1351.955	139.243	881.5162	246.2481	
			2007	25.51268	31.70616	98.77555	267.0928	311.1461	187.1006	2596.826	2502.027	523.0053				
			2006						1566.034	1955.725	882.4225	2423.015	1978.172	165.2013	1066.079	
			2007	235.1848	68.19078	96.8233	350.2889	1110.449	1007.907	769.1163	2246.047		732.6898	103.6253	104.586	
			2008	104.1066												
			2006											333.5767	78.54306	
			2007	34.24489	33.58594	556.129	82.57651	1291.053	1862.55	1425.539	651.0271		20.22435	52.51208	49.53621	
			2008	131.9086												
			2006											59.25757	193.4394	
			2007	118.956	37.82914	1603.303	1801.053	597.2214	914.7047	738.1134	160.2821	334.3593	407.2283	238.327	352.1637	
			2008	109.0754		19.17238	18.5443	41.46633								
			2007						394.3525	1564.814	993.1531		735.6308	422.4035	484.9839	
			2008	128.2156		592.3686	644.0315	390.2751	191.3185	777.2821	1119.912					
			2007							578.3404	688.9826	979.8728	751.2196	22.41107	179.4352	
36	O	M	2008	42.93803			569.633	666.1973	281.4956	1032.546						
37	Average			104.9496	115.7087	440.5479	909.0086	1026.825	1417.94	1573.969	1437.865	1891.723	1287.152	361.9061	216.8598	
38																

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Table

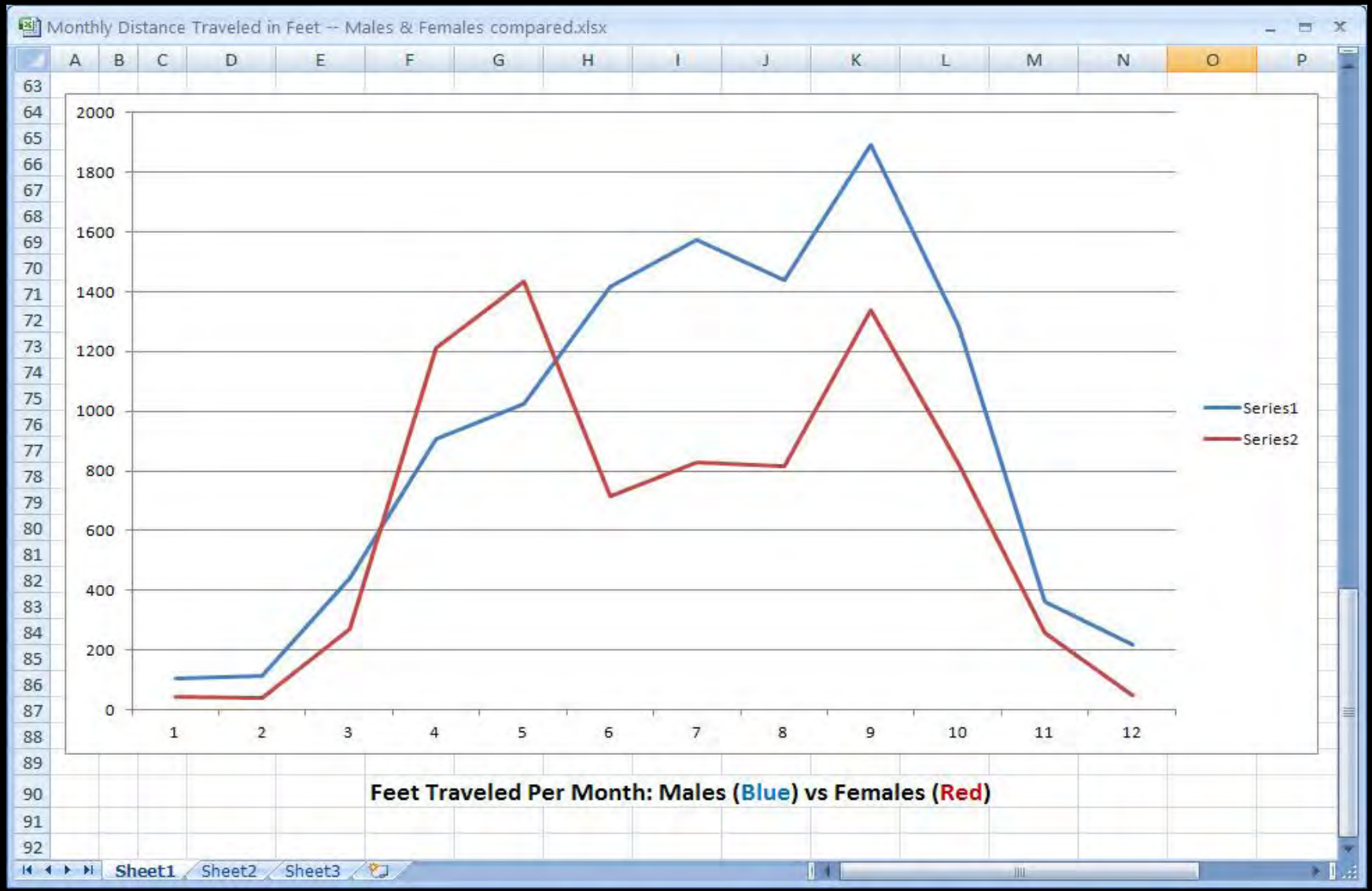
M_M_95_PointsToLine_2007

OBJECTID *	Shape *	Shape_Length	month_
1	Polyline	118.956042	1
2	Polyline	37.829141	2
3	Polyline	1603.302727	3
4	Polyline	1801.053492	4
5	Polyline	597.221418	5
6	Polyline	914.704669	6
7	Polyline	738.113419	7
8	Polyline	160.282064	8
9	Polyline	334.359277	9
10	Polyline	407.228297	10
11	Polyline	238.32699	11
12	Polyline	352.163719	12

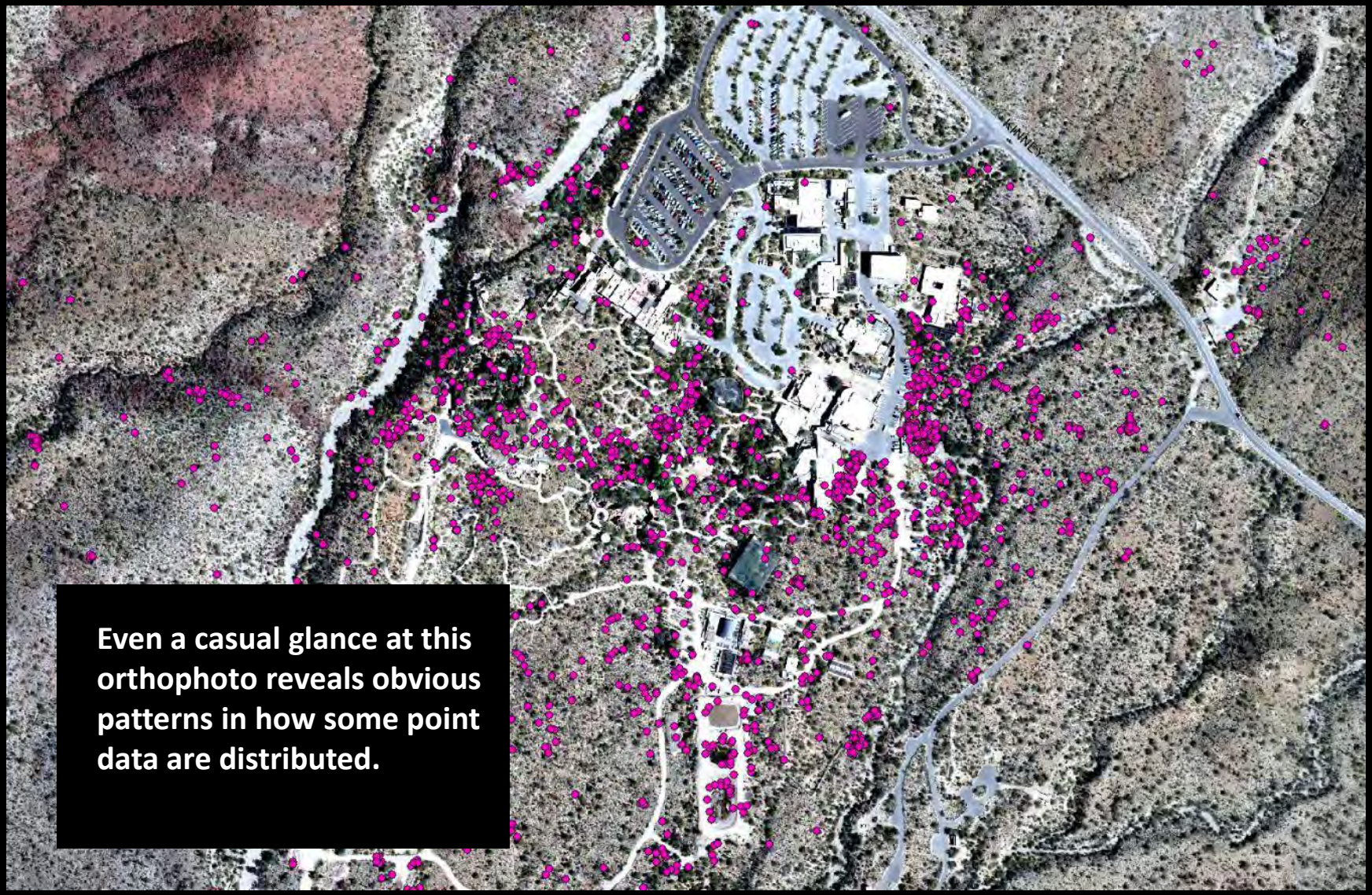
0 (0 out of 12 Selected)

M_M_95_PointsToLine_2007

Measuring Monthly Activity Levels

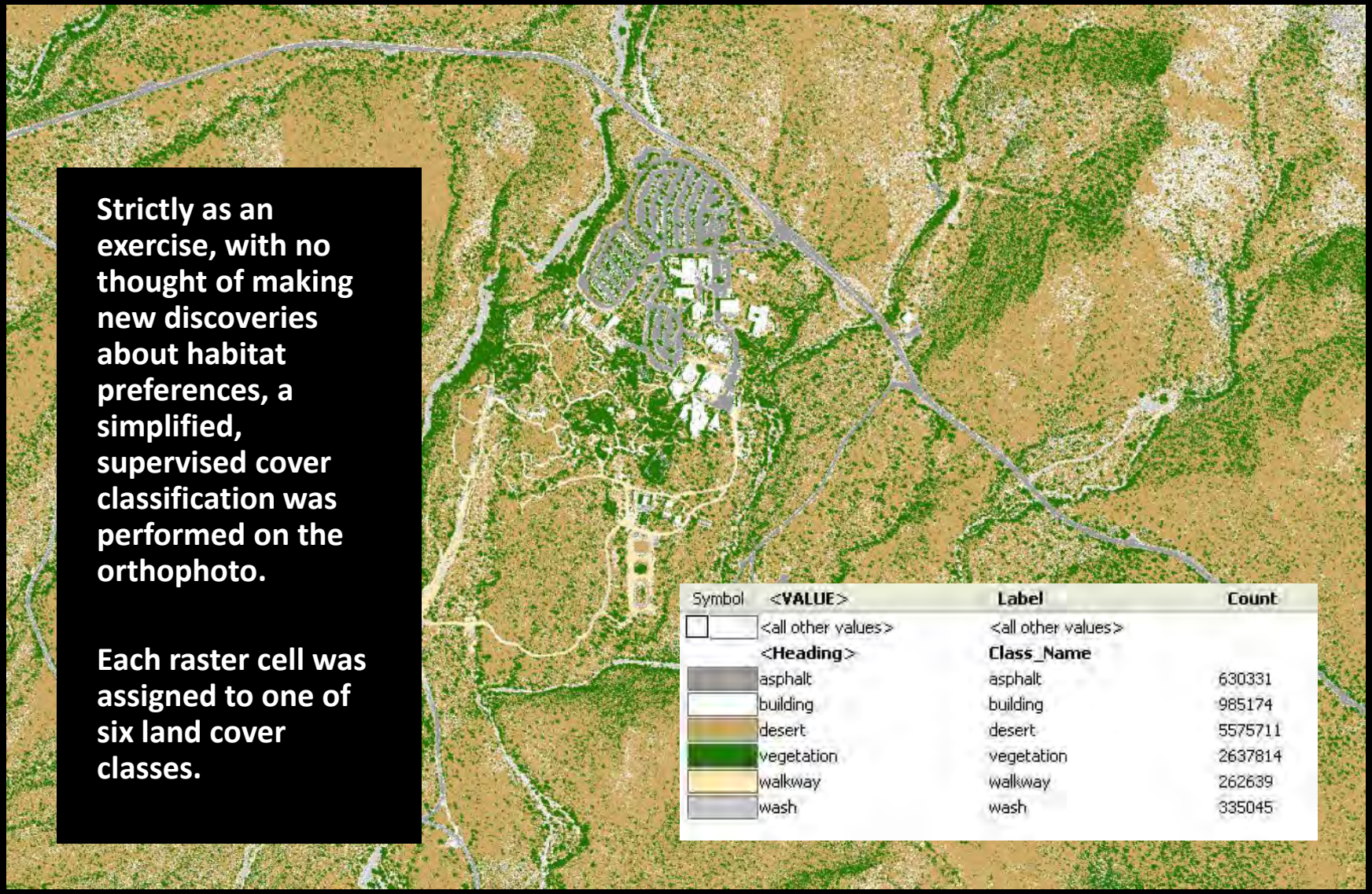


Distribution: Looking at Habitat Preferences

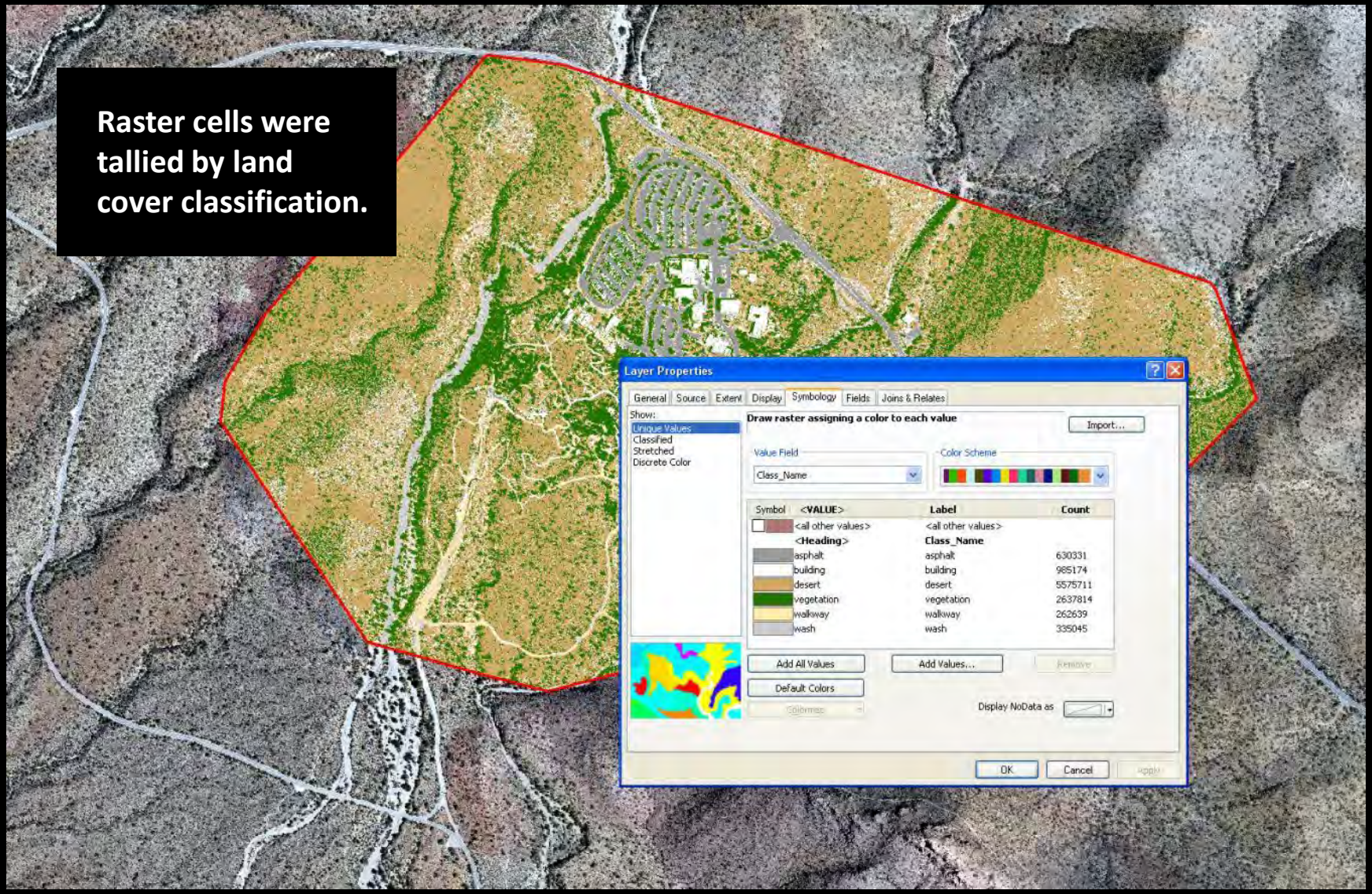


Even a casual glance at this orthophoto reveals obvious patterns in how some point data are distributed.

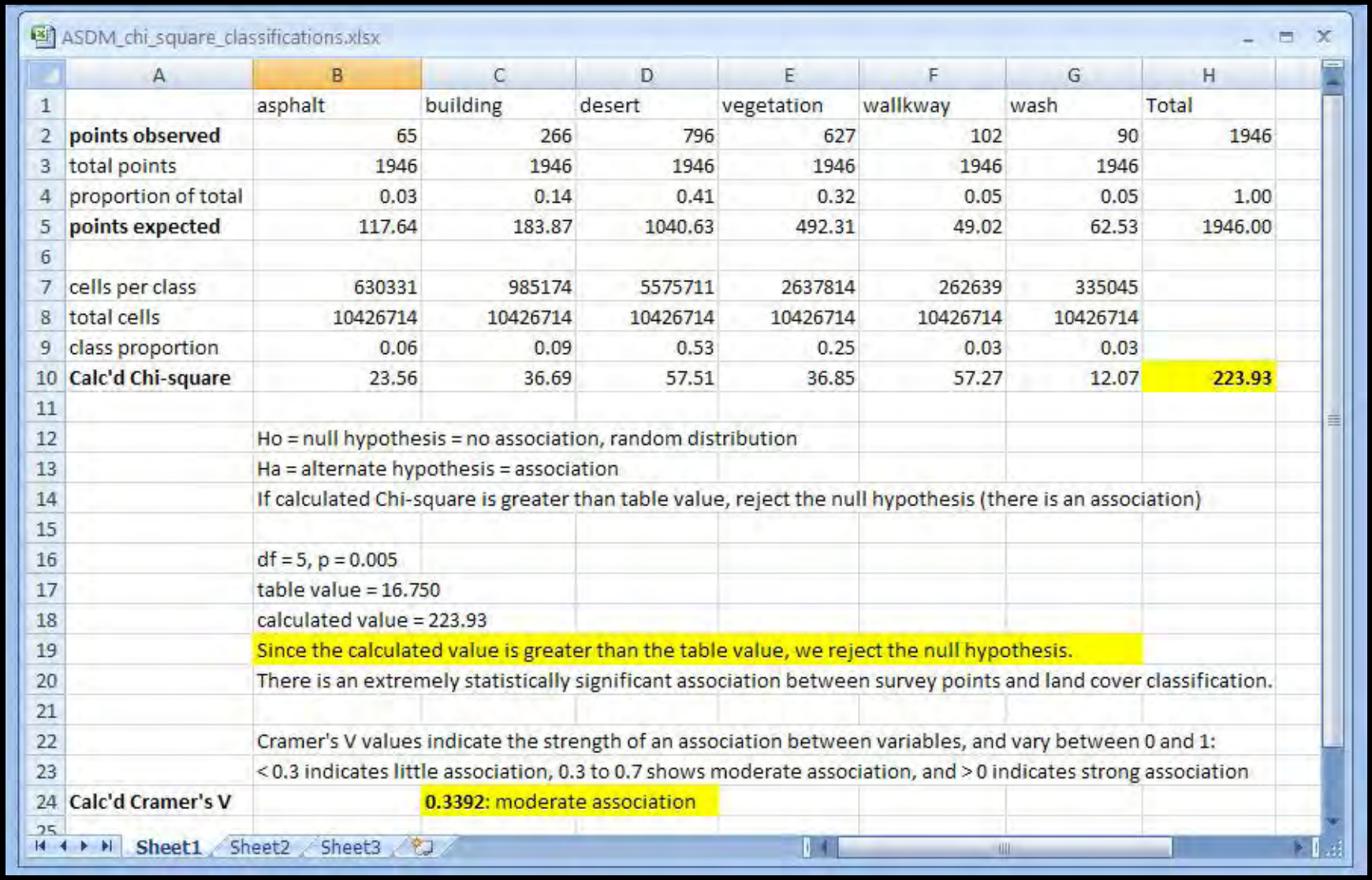
Distribution: Looking at Habitat Preferences



Distribution: Looking at Habitat Preferences



Distribution: Looking at Habitat Preferences



ASDM_chi_square_classifications.xlsx

	A	B	C	D	E	F	G	H
1		asphalt	building	desert	vegetation	wallkway	wash	Total
2	**points observed**	65	266	796	627	102	90	1946
3	total points	1946	1946	1946	1946	1946	1946	
4	proportion of total	0.03	0.14	0.41	0.32	0.05	0.05	1.00
5	**points expected**	117.64	183.87	1040.63	492.31	49.02	62.53	1946.00
6								
7	cells per class	630331	985174	5575711	2637814	262639	335045	
8	total cells	10426714	10426714	10426714	10426714	10426714	10426714	
9	class proportion	0.06	0.09	0.53	0.25	0.03	0.03	
10	**Calc'd Chi-square**	23.56	36.69	57.51	36.85	57.27	12.07	**223.93**
11								
12		Ho = null hypothesis = no association, random distribution						
13		Ha = alternate hypothesis = association						
14		If calculated Chi-square is greater than table value, reject the null hypothesis (there is an association)						
15								
16		df = 5, p = 0.005						
17		table value = 16.750						
18		calculated value = 223.93						
19		Since the calculated value is greater than the table value, we reject the null hypothesis.						
20		There is an extremely statistically significant association between survey points and land cover classification.						
21								
22		Cramer's V values indicate the strength of an association between variables, and vary between 0 and 1:						
23		< 0.3 indicates little association, 0.3 to 0.7 shows moderate association, and > 0 indicates strong association						
24	**Calc'd Cramer's V**		**0.3392**: moderate association					
25								

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Summary

- Male western diamondbacks tend to have somewhat larger home ranges than females.

- Preferred habitat contains vegetation and burrows; extensive, exposed areas tend to be avoided.

- Male snake activity levels are lowest from December through February; they increase from March through September and then drop off rapidly till November. Females show a similar overall trend, but with a period of decreased activity June through August.