

Ironside, K. E., Mattson, D. J., Arundel, T. R. and Hansen, J. R. 2017. Is GPS telemetry location error screening beneficial? – Wildlife Biology 2017: wlb.00229

Appendix 1

Table A1.1. Location error in meters (m) for stationary Telonics GEN3 GPS collar randomly stratified field tests and the survey benchmark test in northern Arizona, USA, conducted from 2011–2012. Field site tests resulted in 1624 successful fix acquisitions (n) and 312 successful fix acquisitions (n) for the comparison to the benchmark site. The standard error (SE) and the standard deviation (SD) of the mean location error are provided, in addition to the range (minimum and maximum), first quartile (Q1), the median, and the third quartile (Q3) observed.

Test	n	Mean	SE	SD	Minimum	Q1	Median	Q3	Maximum
Random sites	1624	40.81	1.59	63.89	0.31	8.22	16.83	40.40	430.42
Benchmark	312	13.38	0.84	14.90	0.24	5.25	8.63	15.62	124.73

Figure A1.1. The linear relationship of average location error at a site (LN = natural logarithm transformed) versus the average PDOP for positions taken at the site. There is a weak relationship between PDOP and the location error.

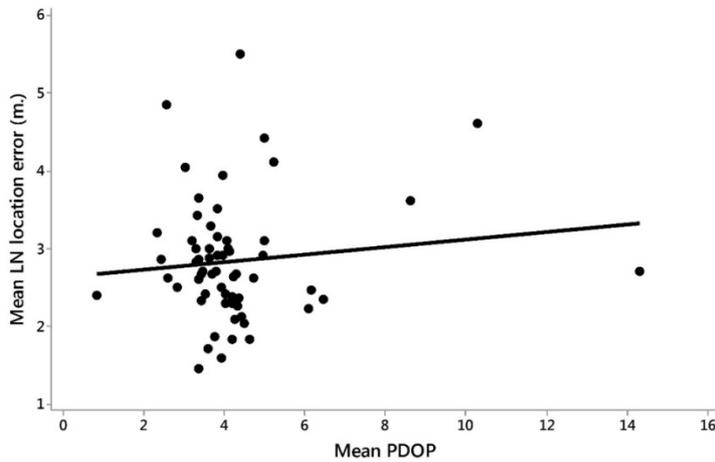


Table A1.2. Data screening options applied to seventeen Telonics GEN3 GPS downloaded collar datasets deployed on cougars, *Puma concolor*, in northern Arizona, USA. Total fix success rates (the percentage of successful fixes out of all attempted fix acquisitions) varied from 53.16% to 90.99%. The length of monitoring was also variable, ranging from 20 to 362 days. The four data screening options (Lewis et al. 2007) resulted in similar percentages in data reductions across all collar datasets with option 1 resulting in 1.06–4.55% data loss, options 2 and 3 resulting in 6.87–11.23% data loss, and option 4 resulting in 36.92–58.28% data loss.

Cougar ID	Capture no.	Start date	End date	Fix success rate	No. successful fixes	Data screening option % data reduction			
						1	2	3	4
C2	1	7/14/2003	6/15/2004	53.16%	1075	2.14%	7.07%	7.07%	48.00%
C3	1	8/3/2003	12/15/2003	63.00%	504	2.98%	7.74%	7.74%	44.64%
C4	1	8/4/2003	6/15/2004	89.09%	1682	2.14%	7.31%	7.31%	36.92%
C5	1	8/19/2004	12/7/2004	87.02%	570	3.16%	11.23%	11.23%	39.47%
C6	1	8/5/2004	6/15/2005	65.29%	1232	2.44%	9.42%	9.42%	45.05%
C7	1	12/14/2004	7/7/2005	90.99%	1121	1.43%	6.87%	6.96%	38.00%
C8	1	12/15/2004	6/4/2005	69.59%	714	2.66%	9.80%	9.80%	49.72%
	2	6/4/2005	6/1/2006	77.43%	1681	1.96%	8.80%	8.80%	52.41%
C9	1	5/16/2005	10/1/2005	85.78%	706	1.98%	7.93%	7.93%	42.78%
C10	1	5/25/2005	5/15/2006	66.11%	1196	1.76%	9.70%	9.70%	45.74%
C11	1	6/13/2005	7/3/2005	88.89%	88	4.55%	9.09%	9.09%	51.14%
C12	1	8/31/2006	4/5/2007	77.79%	1016	1.38%	8.27%	8.27%	45.37%
C13	1	9/25/2006	12/20/2006	72.67%	375	3.47%	10.40%	10.40%	44.27%
C14	1	7/19/2007	11/14/2007	66.81%	471	1.06%	8.70%	8.70%	45.86%
C15	2	6/8/2009	5/15/2010	72.22%	1479	3.18%	11.16%	11.16%	58.28%
C19	2	11/5/2010	9/22/2011	79.12%	1516	2.44%	7.98%	7.98%	46.83%
C20	1	9/29/2010	5/7/2011	81.68%	1079	2.87%	9.82%	9.82%	43.56%
					mean =	2.45%	8.90%	8.91%	45.77%

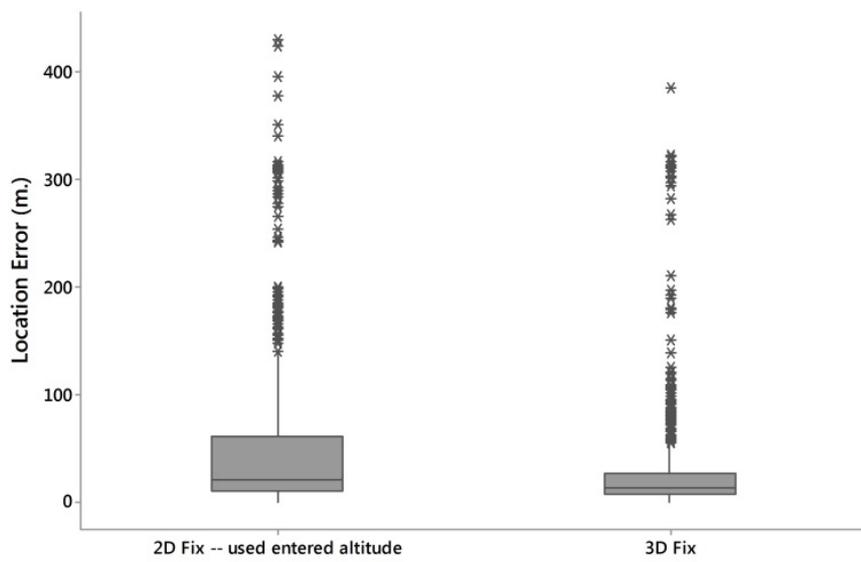


Figure A1.2. Boxplot of location error for 2D GPS Fixes and 3D GPS fixes from random field tests.

Appendix 2

Comparison between GPS collar fix centroids for a site to independent measures of location

Previous studies assessing the accuracy and location error of wildlife GPS collar fixes relied on using centroids (the average latitude and longitude of all fixes taken at a location) as the measure of the actual reference location. Our approach was to estimate the actual reference location using independent measures of location. Where GPS satellites were observable for the location the Telonics GEN3 collar was tested, we used a Trimble GeoExplorer GPS unit to calculate the location of the test collar. For sites where GPS satellites were not readily observable we heads-up-digitized the location using high resolution imagery. Though the georeferencing of the imagery does have some error associated with it, it is estimated to be smaller than the accuracy of the GPS collar fixes. Here we provide an evaluation of location error of centroid calculations compared to our measures of the location the collar was placed.

We found an inverse correlation between the fix success rate (FSR, the proportion of successful fixes out of all programmed fix attempts) and the location error of a GPS collar fix. Using Pearson's correlation coefficients, we found location error in meters to have a -0.68 correlation with FSR. This suggests the environmental conditions at test collar sites that influence the ability of the GPS receiver to obtain a position also influence the accuracy of the successful fixes. Table A2.2 below provides summary descriptive statistics on the location error of centroid calculations compared to the independent location estimates. A histogram of centroid location error is also provided in Fig. A2.1. Our dataset suggests centroid calculations can result in up to 89 m location error, which is much larger than the estimated 6 m location error in the imagery used to georeference some collar sites. Conditions that affect sky-view and therefore GPS receiver's ability to acquire GPS satellite signals reduce the number of fixes to calculate a centroid and also tend to increase the location error in centroid calculations (Fig. A2.2).

Table A2.1. Location error in meters (m) for stationary Telonics GEN3 GPS collar fix centroids for fixes collected at sites in northern Arizona, USA, in 2011–2012.

Test	n	Mean	SE	SD	Minimum	Q1	Median	Q3	Maximum
Centroid error (m)	62	12.07	2.15	16.97	1.01	4.09	7.96	11.94	89.12

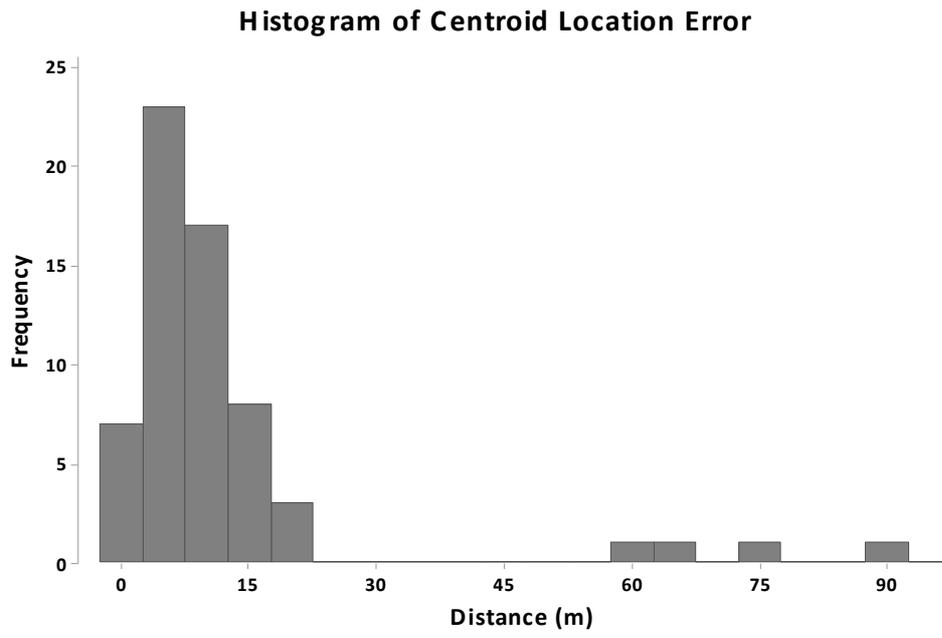


Figure A2.1. A histogram showing the distribution of location error of centroids.

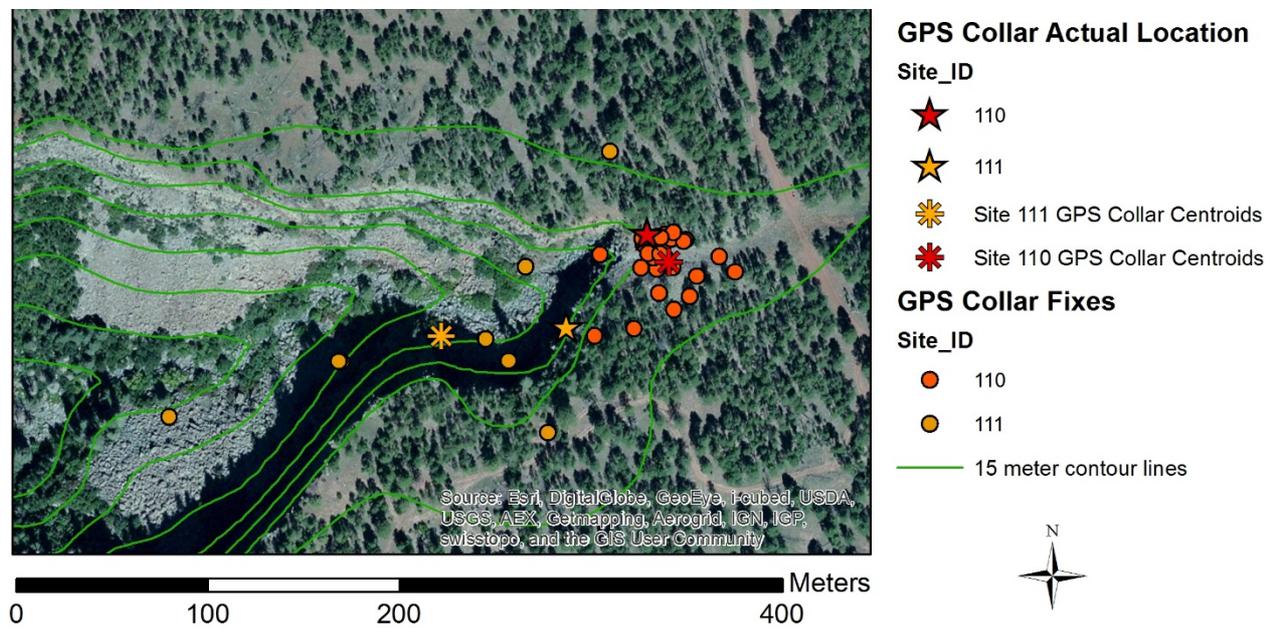


Figure A2.2. Map illustrating centroid location error and the relationship with FSRs. Site 110, located on flat terrain and within forested canopy (red star), had 100.00% FSR and an estimated centroid (red asterisk) location error of 19.18 m. Site 111 was located on the sidewall of a steep canyon and had a FSR of 20.83%. The distance between the site 111 centroid (orange asterisk) and our estimate of the true collar location (orange star) is larger at 65.10 m.