Appendix S1

This appendix includes the summaries of all the parameters in each of the 18 Scenarios presented in the main text, including Scenarios 1–6 with $T = 15$ and Scenarios 7A–12A which include telemetered individuals. These results are presented in Tables S1 - S5.

Table S6 includes the average number of captures and recaptures for each scenario along with the number of simulations that did not converge according the R-hat values. We note that many of these simulations would have resulted in convergence if we had set the number of iterations higher in the MCMC settings, but this would have made the simulation study prohibitively long. For Scenarios 7-12, we ran 100,000 iterations, and in most cases γ was the parameter that did not converge due to mostly to slow mixing. In comparing the number of captured and recaptured individuals, as well as the parameter estimates and standard deviations between simulated datasets where the models converged and those that didn't, we found little to no difference.

Parameter	True	Mean	sd	median	2.5%	97.5%	Coverage
Scenario 1							
N	100.00	102.243	20.443	100.590	69.930	146.850	98
σ	0.10	0.100	0.009	0.100	0.084	0.121	93
σ_{det}	0.05	0.051	0.005	0.051	0.042	0.060	96
λ_0	3.00	3.090	0.565	3.036	2.145	4.352	95
Scenario 2							
N	100.00	100.437	17.617	99.210	69.490	138.260	96
σ	0.10	0.100	0.007	0.100	0.087	0.114	94
σ_{det}	0.10	0.100	0.004	0.100	0.092	0.109	97
λ_0	2.00	2.042	0.231	2.028	1.630	2.535	94
Scenario 3							
N	100.00	100.855	17.4124	99.660	70.220	138.19	94
σ	0.10	0.103	0.010	0.102	0.084	0.123	95
σ_{det}	0.15	0.149	0.010	0.149	0.131	0.169	99
λ_0	0.50	0.520	0.081	0.514	0.380	0.698	97
Scenario 4							
N	100.00	100.083	18.430	98.640	68.110	140.090	97
σ	0.20	0.203	0.018	0.202	0.171	0.241	91
σ_{det}	0.05	0.050	0.004	0.050	0.042	0.059	95
λ_0	3.00	3.157	0.577	3.103	2.188	4.441	91
Scenario 5							
N	100.00	101.407	15.556	100.470	73.770	134.570	95
σ	0.20	0.201	0.010	0.201	0.182	0.222	92
σ_{det}	0.10	0.099	0.004	0.099	0.091	0.108	95
λ_0	2.00	2.052	0.227	2.039	1.642	2.532	97
Scenario 6							
N	100.00	98.619	15.614	97.570	71.020	131.940	96
σ	0.20	0.200	0.014	0.200	0.173	0.230	94
σ_{det}	0.15	0.152	0.012	0.151	0.130	0.177	95
λ_0	0.50	0.507	0.090	0.500	0.350	0.704	99

Table S1: Summaries of the parameter estimates for each of the simulation scenarios of the simple random walk model (labeled as Scenarios 1 – 6 in the main text). Each scenario has $T = 25$ sampling occasions.

Parameter	True	Mean	sd	median	2.5%	97.5%	Coverage
Scenario 1 T = 15							
N	100.00	104.916	26.021	101.860	62.720	164.280	97
σ	0.10	0.102	0.014	0.101	0.078	0.133	96
σ_{det}	0.05	0.050	0.007	0.050	0.038	0.064	98
λ_0	3.00	3.246	0.799	3.141	1.992	5.106	90
Scenario 2 T = 15							
N	100.00	100.719	18.528	99.390	68.320	140.680	96
σ	0.10	0.100	0.010	0.099	0.082	0.120	95
σ_{det}	0.10	0.101	0.006	0.100	0.090	0.112	100
λ_0	2.00	2.038	0.302	2.014	1.517	2.696	94
Scenario 3 T = 15							
N	100.00	102.192	18.544	100.880	69.720	142.090	93
σ	0.10	0.102	0.015	0.102	0.075	0.133	93
σ_{det}	0.15	0.148	0.013	0.148	0.125	0.175	96
λ_0	0.50	0.538	0.110	0.527	0.354	0.783	95
Scenario 4 T = 15							
N	100.00	101.301	22.751	98.980	63.580	152.480	95
σ	0.20	0.204	0.026	0.202	0.160	0.262	96
σ_{det}	0.05	0.052	0.006	0.051	0.040	0.064	99
λ_0	3.00	3.187	0.771	3.091	1.9624	4.969	93
Scenario 5 T = 15							
N	100.00	101.814	17.016	100.650	71.750	138.300	95
σ	0.20	0.200	0.014	0.199	0.174	0.228	93
σ_{det}	0.10	0.100	0.006	0.100	0.090	0.111	92
λ_0	2.00	2.037	0.292	2.016	1.524	2.665	92
Scenario 6 T = 15							
N	100.00	97.450	17.102	96.270	67.530	134.300	93
σ	0.20	0.199	0.021	0.198	0.160	0.243	95
σ_{det}	0.15	0.154	0.016	0.153	0.126	0.189	96
λ_0	0.50	0.508	0.118	0.496	0.312	0.771	93

Table S2: Summaries of the parameter estimates for each of the simulation scenarios of the simple random walk model (labeled as Scenarios 1 – 6 in the main text). Each scenario has $T = 15$ sampling occasions in this set of simulations.

Parameter	True	Mean	sd	median	2.5%	97.5%	Coverage
Scenario 7							
N	100.00	101.376	18.114	100.060	69.820	140.480	95
σ	0.10	0.110	0.016	0.109	0.082	0.142	92
σ_{det}	0.05	0.050	0.003	0.050	0.043	0.057	99
λ_0	5.00	5.120	0.738	5.056	3.862	6.752	98
γ	0.50	0.411	0.118	0.416	0.168	0.624	97
Scenario 8							
N	100.00	99.419	15.740	98.400	71.550	133.070	96
σ	0.10	0.101	0.010	0.100	0.083	0.121	95
σ_{det}	0.10	0.100	0.003	0.100	0.094	0.107	99
λ_0	3.00	3.032	0.272	3.018	2.538	3.604	95
γ	0.50	0.489	0.074	0.492	0.335	0.624	96
Scenario 9							
N	100.00	99.561	15.331	98.540	72.350	132.310	97
σ	0.10	0.107	0.016	0.106	0.079	0.140	97
σ_{det}	0.15	0.149	0.006	0.149	0.138	0.162	93
λ_0	1.00	1.024	0.105	1.019	0.835	1.245	90
γ	0.50	0.458	0.105	0.464	0.233	0.643	97
Scenario 10							
N	100.00	101.556	16.328	100.410	73.040	136.820	96
σ	0.20	0.219	0.031	0.217	0.166	0.287	93
σ_{det}	0.05	0.049	0.004	0.049	0.043	0.056	94
λ_0	5.00	5.251	0.748	5.187	3.972	6.901	94
γ	0.50	0.416	0.121	0.425	0.161	0.625	93
Scenario 11							
N	100.00	98.839	12.860	98.040	75.820	126.160	97
σ	0.20	0.203	0.013	0.202	0.178	0.230	97
σ_{det}	0.10	0.100	0.003	0.100	0.094	0.107	94
λ_0	3.00	3.030	0.268	3.017	2.542	3.590	94
γ	0.50	0.489	0.056	0.491	0.373	0.594	95
Scenario 12							
N	100.00	99.434	13.837	98.550	74.820	128.930	97
σ	0.20	0.214	0.029	0.213	0.163	0.272	89
σ_{det}	0.15	0.147	0.012	0.146	0.127	0.172	93
λ_0	0.50	0.542	0.096	0.535	0.375	0.749	96
γ	0.50	0.443	0.102	0.448	0.229	0.626	91

Table S3: Summaries of the parameter estimates for each of the simulation scenarios of the correlated random walk model (labeled as Scenarios 7 – 12 in the main text).

Parameter	True	Mean	sd	median	2.5%	97.5%	Coverage
Scenario 7A							
N	100.00	100.538	16.740	99.290	71.350	136.640	98
σ	0.10	0.101	0.004	0.101	0.092	0.109	92
σ_{det}	0.05	0.050	0.001	0.050	0.047	0.053	93
λ_0	5.00	5.112	0.649	5.062	3.984	6.527	95
γ	0.50	0.492	0.043	0.493	0.407	0.574	94
Scenario 8A							
N	100.00	98.905	14.802	97.900	72.85	130.680	96
σ	0.10	0.100	0.006	0.100	0.089	0.112	96
σ_{det}	0.10	0.100	0.002	0.100	0.096	0.104	95
λ_0	3.00	3.035	0.228	3.025	2.616	3.508	96
γ	0.50	0.499	0.048	0.500	0.400	0.590	98
Scenario 9A							
N	100.00	100.305	14.565	99.360	74.605	131.490	96
σ	0.10	0.102	0.009	0.101	0.085	0.120	96
σ_{det}	0.15	0.150	0.004	0.150	0.143	0.157	93
λ_0	1.00	1.004	0.075	1.002	0.865	1.159	93
γ	0.50	0.485	0.066	0.487	0.348	0.605	96
Scenario 10A							
N	100.00	100.244	14.490	99.230	74.760	131.370	95
σ	0.20	0.200	0.007	0.200	0.187	0.214	97
σ_{det}	0.05	0.050	0.001	0.050	0.047	0.053	93
λ_0	5.00	5.066	0.644	5.017	3.945	6.465	96
γ	0.50	0.499	0.038	0.499	0.424	0.573	94
Scenario 11A							
N	100.00	99.159	12.086	98.440	77.620	124.78	98
σ	0.20	0.201	0.007	0.201	0.187	0.216	96
σ_{det}	0.10	0.100	0.002	0.100	0.096	0.105	92
λ_0	3.00	3.007	0.224	2.998	2.594	3.472	95
γ	0.50	0.497	0.036	0.497	0.424	0.567	99
Scenario 12A							
N	100.00	100.046	12.957	99.190	77.050	127.680	97
σ	0.20	0.203	0.011	0.202	0.182	0.225	98
σ_{det}	0.15	0.149	0.004	0.149	0.143	0.158	95
λ_0	0.50	0.511	0.053	0.508	0.413	0.621	94
γ	0.50	0.487	0.048	0.488	0.389	0.578	94

Table S4: Summaries of the parameter estimates for each of the simulation scenarios of the correlated random walk model with 10 telemetered individuals where auxilary location data are included (labeled as Scenarios 7A – 12A in the main text).

Parameter	True	Mean	sd	median	2.5%	97.5%	Coverage
Scenario 13							
N	100.00	104.707	17.262	103.580	74.240	141.740	96
σ	0.10	0.101	0.007	0.100	0.088	0.114	94
σ_{det}	0.10	0.100	0.004	0.100	0.092	0.108	97
λ_0	2.00	2.030	0.217	2.018	1.641	2.491	95
δ	0.70	0.720	0.210	0.720	0.312	1.134	93
Scenario 14							
N	100.00	102.163	17.568	100.860	71.380	139.950	95
σ	0.10	0.100	0.007	0.100	0.087	0.113	93
σ_{det}	0.10	0.100	0.004	0.100	0.092	0.108	97
λ_0	2.00	2.034	0.224	2.021	1.634	2.512	96
δ	0.30	0.304	0.214	0.304	-0.116	0.723	99
Scenario 15							
N	100.00	100.629	15.742	99.590	72.710	134.200	94
σ	0.20	0.200	0.013	0.199	0.176	0.226	95
σ_{det}	0.10	0.101	0.008	0.100	0.087	0.117	97
λ_0	1.00	1.020	0.175	1.007	0.716	1.400	97
δ	0.70	0.702	0.201	0.698	0.316	1.107	94
Scenario 16							
N	100.00	103.737	16.456	102.620	7.660	138.980	97
σ	0.20	0.199	0.013	0.199	0.176	0.226	96
σ_{det}	0.10	0.099	0.007	0.099	0.086	0.115	97
λ_0	1.00	1.046	0.178	1.033	0.737	1.432	95
δ	0.30	0.280	0.189	0.279	-0.089	0.654	90
Scenario 17							
N	100.00	104.989	18.054	103.670	73.460	143.865	93
σ	0.20	0.201	0.016	0.200	0.172	0.236	94
σ_{det}	0.05	0.051	0.004	0.051	0.043	0.060	93
λ_0	3.00	3.035	0.525	2.988	2.144	4.197	94
δ	0.70	0.679	0.228	0.673	0.245	1.140	98
Scenario 18							
N	100.00	104.178	18.509	102.720	72.030	144.335	97
σ	0.20	0.202	0.017	0.201	0.172	0.237	93
σ_{det}	0.05	0.050	0.004	0.050	0.043	0.059	95
λ_0	3.00	3.210	0.565	3.159	2.269	4.439	95
δ	0.30	0.335	0.221	0.332	-0.092	0.776	93

Table S5: Summaries of the parameter estimates for each of the simulation scenarios of the integrated Langevin-SCR model (labeled as Scenarios 13 – 18 in the main text).

Scenario	Model type	n	recaps	failed convergence
1	Simple random walk	20.94	5.81	22
2	Simple random walk	24.60	12.78	4
3	Simple random walk	25.23	7.08	16
4	Simple random walk	24.12	4.96	34
5	Simple random walk	30.23	10.49	0
6	Simple random walk	28.83	5.95	5
Scenario	**Model type**	n	**recaps**	**failed convergence**
1T15	Simple RW with T=15	17.70	4.16	19
2T15	Simple RW with T=15	22.80	8.27	0
3T15	Simple RW with T=15	23.47	4.62	30
4T15	Simple RW with T=15	19.6	3.62	28
5T15	Simple RW with T=15	26.62	7.22	0
6T15	Simple RW with T=15	24.76	4.12	4
Scenario	**Model type**	n	**recaps**	**failed convergence**
7	Correlated random walk	24.65	7.99	57
8	Correlated random walk	28.75	16.42	9
9	Correlated random walk	29.94	11.83	22
10	Correlated random walk	30.64	6.47	92
11	Correlated random walk	38.00	12.27	6
12	Correlated random walk	35.42	5.03	46
Scenario	**Model type**	n	**recaps**	**failed convergence**
7A	Correlated RW with telemetry	24.66	7.99	10
8A	Correlated RW with telemetry	28.87	16.37	4
9A	Correlated RW with telemetry	30.32	11.86	13
10A	Correlated RW with telemetry	30.68	6.25	20
11A	Correlated RW with telemetry	38.08	12.27	7
12A	Correlated RW with telemetry	35.78	4.95	8
Scenario	**Model type**	n	**recaps**	**failed convergence**
13	Langevin	27.33	12.84	4
14	Langevin	25.86	12.88	5
15	Langevin	29.41	5.74	5
16	Langevin	29.52	5.72	8
17	Langevin	26.89	4.94	39
18	Langevin	26.00	5.06	39

Table S6: For each scenario, we report the average number of individuals captured, n, the average number of recaptures, 'recaps', and the number of simulated datasets where the model did not converge based on the R-hat, 'failed convergence'. See discussion at the beginning of this appendix for more details on the convergence results.