

Supplementary Material

Geographic transitions of domestic cats in urban areas through animal adoption centers and the implications for population dynamics

D. T. Tyler Flockhart¹, Sophie M. Moore, Samuel T. Decker, R. Julia Kilgour

Corresponding author: Tyler Flockhart, ¹dt.tyler.flockhart@gmail.com

Table S1. Full candidate model list and AICc for intake counts. Offset of households is applied in each model.

Model	K	AICc	ΔAICc	L_i	W_i	LL	ΣW_i
Season + Income x Distance x Land use	16	7052.1	0	1	1	-3509.86	1
Season + Income x Distance + Land use	10	7064.0	11.96	0	0	-3521.94	1
Season + Income x Land use	10	7065.1	13.02	0	0	-3522.48	1
Season x Income x Distance + Land use	19	7073.7	21.63	0	0	-3517.61	1
Season + Income x Distance	8	7076.5	24.41	0	0	-3530.2	1
Income x Land use x Distance	13	7080.8	28.71	0	0	-3527.28	1
Season x Income x Land use	25	7083.4	31.28	0	0	-3516.26	1
Season x Income x Distance	17	7086.4	34.3	0	0	-3525.99	1
Season + Income + Land use	8	7088.4	36.35	0	0	-3536.16	1
Season + Income + Land use + Distance	9	7089.7	37.61	0	0	-3535.78	1
Income x Land use + Distance	8	7090.0	37.93	0	0	-3536.96	1
Season x Income + Land use	11	7091.7	39.59	0	0	-3534.75	1
Season x Income x Distance x Land use	49	7092.3	40.19	0	0	-3495.56	1
Season + Income + Distance x Land use	11	7092.7	40.6	0	0	-3535.25	1
Income x Land use	7	7092.9	40.81	0	0	-3539.4	1
Season x Income + Distance + Land use	12	7093.0	40.95	0	0	-3534.41	1
Season x Income + Distance x Land use	14	7096.1	44	0	0	-3533.9	1
Income x Distance	5	7105.0	52.92	0	0	-3547.48	1
Season + Income + Distance	7	7110.5	58.47	0	0	-3548.24	1
Income + Season	6	7112.9	60.81	0	0	-3550.41	1
Season x Income + Distance	10	7113.4	61.33	0	0	-3546.63	1
Income x Season	9	7115.5	63.38	0	0	-3548.67	1
Income + Land use	5	7116.1	64.04	0	0	-3553.04	1
Income + Land use + Distance	6	7117.4	65.28	0	0	-3552.65	1
Income + Land use x Distance	8	7120.5	68.38	0	0	-3552.18	1
Income + Distance	4	7138.7	86.63	0	0	-3565.34	1
Income	3	7141.1	89.07	0	0	-3567.56	1
Land use x Distance	7	7350.2	298.15	0	0	-3668.08	1
Land use + Season	7	7358.7	306.63	0	0	-3672.32	1
Land use x Season	13	7360.4	308.33	0	0	-3667.09	1
Land use + Distance	5	7363.8	311.74	0	0	-3676.89	1
Land use	4	7378.2	326.09	0	0	-3685.07	1
Season + Distance	6	7405.2	353.16	0	0	-3696.59	1
Season x Distance	9	7409.7	357.59	0	0	-3695.77	1
Distance	3	7425.2	373.16	0	0	-3709.61	1
Season	5	7457.1	404.99	0	0	-3723.51	1
Null	2	7475.7	423.67	0	0	-3735.87	1

Table S2. Full candidate model list and AICc for outcome counts. Offset of households is applied in each model.

Model	K	AICc	ΔAICc	L_i	W_i	LL	ΣW_i
Season + Income x Distance x Land use	16	7568.2	0	1	1	-3767.9	1
Income x Land use x Distance	13	7614.8	46.57	0	0	-3794.3	1
Season x Income x Distance x Land use	49	7615.7	47.5	0	0	-3757.4	1
Season + Income x Land use	10	7618.3	50.08	0	0	-3799.1	1
Season x Income x Land use	25	7635.8	67.65	0	0	-3792.6	1
Season + Income x Distance + Land use	10	7648.4	80.17	0	0	-3814.1	1
Income x Land use + Distance	8	7648.7	80.53	0	0	-3816.3	1
Season + Income + Distance x Land use	11	7653.4	85.17	0	0	-3815.6	1
Season x Income x Distance + Land use	19	7658.4	90.21	0	0	-3810.0	1
Season x Income + Distance x Land use	14	7659.2	91.01	0	0	-3815.5	1
Income x Land use	7	7663.4	95.16	0	0	-3824.6	1
Season + Income + Distance + Land use	9	7667.8	99.62	0	0	-3824.9	1
Season x Income + Distance + Land use	12	7673.5	105.32	0	0	-3824.7	1
Season + Income + Land use	8	7678.1	109.87	0	0	-3831.0	1
Season + Land use	7	7683.3	115.12	0	0	-3834.6	1
Season x Income + Land use	11	7683.8	115.59	0	0	-3830.8	1
Season x Land use	13	7689.0	120.76	0	0	-3831.4	1
Season + Income x Distance	8	7697.4	129.21	0	0	-3840.7	1
Income + Land use x Distance	8	7698.8	130.56	0	0	-3841.3	1
Land use x Distance	7	7705.0	136.8	0	0	-3845.5	1
Season x Income x Distance	17	7708.2	139.97	0	0	-3836.9	1
Season x Distance	9	7708.5	140.33	0	0	-3845.2	1
Season + Income + Distance	7	7708.7	140.5	0	0	-3847.3	1
Season + Distance	6	7710.0	140.87	0	0	-3848.5	1
Season + Income	6	7711.6	143.43	0	0	-3849.8	1
Season	5	7712.3	144.09	0	0	-3851.1	1
Income + Land use + Distance	6	7713.7	145.5	0	0	-3850.8	1
Season x Income + Distance	10	7714.3	146.12	0	0	-3847.1	1
Income x Season	9	7717.3	149.08	0	0	-3849.6	1
Land use + Distance	5	7719.2	150.98	0	0	-3854.6	1
Income + Land use	5	7724.0	155.8	0	0	-3857.0	1
Land use	4	7728.9	160.72	0	0	-3860.4	1
Income x Distance	5	7741.5	173.34	0	0	-3865.8	1
Income + Distance	4	7752.7	184.56	0	0	-3872.4	1
Distance	3	7753.1	184.93	0	0	-3873.6	1
Income	3	7756.0	187.78	0	0	-3875.0	1
Null	2	7756.6	188.42	0	0	-3876.3	1

Table S3. Full candidate model list and AICc for multinomial regression of intake type.

Intercept	Distance	Income	Land use	Season	Distance: Income	Distance: Land use	Income: Land use	Distance: Income: Land use	K	LL	AICc	$\Delta AICc$	Wi
+	+	+	+	+	NA	+	NA	NA	30	-4039.4	8139.3	0	0.7819
+	+	+	NA	+	NA	NA	NA	NA	18	-4053.7	8143.6	4.3	0.0896
+	+	+	+	+	+	+	NA	NA	33	-4039.0	8144.4	5.2	0.0595
+	+	+	+	+	NA	+	+	NA	36	-4036.3	8145.2	5.9	0.0403
+	+	+	+	+	+	+	+	NA	39	-4034.4	8147.5	8.2	0.0129
+	+	+	NA	+	+	NA	NA	NA	21	-4053.1	8148.3	9.0	0.0085
+	+	+	+	+	NA	NA	NA	NA	24	-4050.5	8149.2	9.9	0.0056
+	+	+	+	+	+	+	+	+	45	-4031.3	8153.4	14.1	0.0007
+	+	+	+	+	+	NA	NA	NA	27	-4050.1	8154.4	15.2	0.0004
+	+	+	+	+	NA	NA	+	NA	30	-4047.2	8154.7	15.5	0.0003
+	NA	+	NA	+	NA	NA	NA	NA	15	-4062.9	8156.0	16.7	0.0002
+	+	+	+	+	+	NA	+	NA	33	-4045.4	8157.3	18.1	<0.0001
+	NA	+	+	+	NA	NA	NA	NA	21	-4058.4	8158.9	19.7	<0.0001
+	NA	+	+	+	NA	NA	+	NA	27	-4053.9	8162.2	22.9	<0.0001
+	+	NA	+	+	NA	+	NA	NA	27	-4056.3	8166.9	27.6	<0.0001
+	+	NA	NA	+	NA	NA	NA	NA	15	-4069.7	8169.6	30.3	<0.0001
+	+	NA	+	+	NA	NA	NA	NA	21	-4066.8	8175.8	36.5	<0.0001
+	NA	NA	NA	+	NA	NA	NA	NA	12	-4080.6	8185.2	45.9	<0.0001
+	NA	NA	+	+	NA	NA	NA	NA	18	-4074.8	8185.8	46.5	<0.0001
+	+	+	+	NA	NA	+	NA	NA	21	-4084.6	8211.4	72.2	<0.0001
+	+	+	+	NA	+	+	NA	NA	24	-4084.2	8216.7	77.4	<0.0001
+	+	+	NA	NA	NA	NA	NA	NA	9	-4099.5	8217.0	77.7	<0.0001
+	+	+	+	NA	NA	+	+	NA	27	-4081.5	8217.3	78.0	<0.0001
+	+	+	+	NA	+	+	+	NA	30	-4079.6	8219.5	80.3	<0.0001
+	+	+	NA	NA	+	NA	NA	NA	12	-4098.8	8221.7	82.5	<0.0001
+	+	+	+	NA	NA	NA	NA	NA	15	-4096.3	8222.7	83.4	<0.0001
+	+	+	+	NA	+	+	+	+	36	-4076.4	8225.4	86.1	<0.0001
+	+	+	+	NA	+	NA	NA	NA	18	-4095.9	8228.0	88.7	<0.0001
+	+	+	+	NA	NA	NA	+	NA	21	-4092.9	8228.1	88.8	<0.0001
+	NA	+	NA	NA	NA	NA	NA	NA	6	-4109.0	8230.0	90.8	<0.0001
+	+	+	+	NA	+	NA	+	NA	24	-4091.1	8230.5	91.2	<0.0001
+	NA	+	+	NA	NA	NA	NA	NA	12	-4104.5	8233.1	93.8	<0.0001
+	NA	+	+	NA	NA	NA	+	NA	18	-4099.9	8236.0	96.8	<0.0001
+	+	NA	+	NA	NA	+	NA	NA	18	-4101.6	8239.4	100	<0.0001
+	+	NA	NA	NA	NA	NA	NA	NA	6	-4115.6	8243.3	104	<0.0001
+	+	NA	+	NA	NA	NA	NA	NA	12	-4112.7	8249.4	110	<0.0001
+	NA	NA	NA	NA	NA	NA	NA	NA	3	-4126.8	8259.7	120	<0.0001
+	NA	NA	+	NA	NA	NA	NA	NA	9	-4121.0	8260.1	121	<0.0001

Table S4. Multinomial intake mean and 95% confidence interval of parameter estimates from model averaging explain intake type based on based on 4000 model simulations. The conditions for intercept values are the spring season, forest land use, mean income, and mean distance. The reference response is “surrender”. Intercept refers to spring, forest land use, mean distance, mean income.

Response	Term	Mean	Lower CI	Upper CI
Return	Intercept	-2.5377	-3.4418	-1.6337
	Distance	-0.2685	-0.4126	-0.1243
	Income	1.4981 e-05	1.0611 e-05	1.9350 e-05
	Land use - High development	-3.0147	-3.4961	-2.5332
	Land use - Low development	-1.2608	-1.4450	-1.0766
	Season - Summer	-0.0680	-0.0850	-0.0509
	Season - Autumn	0.2687	0.2678	0.2697
	Season - Winter	0.1003	0.0912	0.1093
	Distance : Land use – High development	0.6258	0.6028	0.6487
	Distance : Land use – Low development	0.1588	0.1462	0.1713
	Distance : Income	-6.4661 e-07	-2.0335 e-06	7.4028 e-07
	Income : Land use - High development	-3.7627 e-06	-1.5979 e-05	8.4538 e-06
	Income : Land use - Low development	4.4280 e-06	-5.4290 e-06	1.4285 e-05
	Distance : Income : Land use - High development	6.0136 e-06	1.1482 e-06	1.0879 e-05
	Distance : Income : Land use - Low development	3.5238 e-06	-1.0984 e-06	8.1460 e-06
Seized/ Custody	Intercept	-3.4319	-3.8360	-3.0279
	Distance	0.0697	0.0557	0.0836
	Income	-7.1747 e-06	-1.9911 e-05	5.5620 e-06
	Land use - High development	0.7942	0.3901	1.1982
	Land use - Low development	-0.3609	-0.8272	0.1054
	Season - Summer	0.0420	0.0387	0.0453
	Season - Autumn	0.2610	0.2491	0.2728
	Season - Winter	0.1726	0.1637	0.1816
	Distance : Land use – High development	-0.0902	-0.1027	-0.0777
	Distance : Land use – Low development	0.0697	0.0593	0.0802
	Distance : Income	2.4268 e-07	-1.7104 e-06	2.1957 e-06
	Income : Land use - High development	2.3164 e-05	-1.7371 e-06	4.8064 e-05
	Income : Land use - Low development	2.4802 e-05	5.4034 e-07	4.9064 e-05
	Distance : Income : Land use - High development	-6.5161 e-06	-1.4853 e-05	1.8206 e-06
	Distance : Income : Land use - Low development	-5.3247 e-06	-1.3006 e-05	2.3562 e-06
Stray	Intercept	0.0331	-0.2239	0.2901
	Distance	0.0173	-0.0248	0.0595
	Income	-6.4137 e-07	-2.7787 e-06	1.4960 e-06
	Land use - High development	0.5026	0.4148	0.5904
	Land use - Low development	0.4391	0.3184	0.5598
	Season - Summer	0.5169	0.5139	0.5200
	Season - Autumn	0.3637	0.3596	0.3678
	Season - Winter	-0.1698	-0.1736	-0.1659
	Distance : Land use – High development	-0.0612	-0.0712	-0.0512
	Distance : Land use – Low development	-0.0699	-0.0743	-0.0656
	Distance : Income	-3.4877 e-07	-9.8239 e-07	2.8486 e-07
	Income : Land use - High development	2.6865 e-08	-6.4774 e-06	6.5311 e-06
	Income : Land use - Low development	4.2743 e-06	-5.1575 e-07	9.0643 e-06
	Distance : Income : Land use - High development	3.4847 e-06	1.7857 e-06	5.1837 e-06
	Distance : Income : Land use - Low development	1.8312 e-06	3.4089 e-07	3.3215 e-06

Table S5. Full candidate model list and AICc for multinomial regression of outcome type.

Intercept	Distance	Income	Land use	Season	Distance: Income	Distance: Land use	Income: Land use	Distance: Income: Land use	K	LL	AICc	Δ AICc	W _i
+	+	+	+	+	+	+	+	+	30	-2538.5	5137.4	0	1
+	+	+	+	NA	+	+	+	+	24	-2556.5	5161.2	23.8	0
+	+	+	+	+	+	+	+	NA	26	-2555.6	5163.4	25.9	0
+	+	+	+	+	NA	+	+	NA	24	-2558.0	5164.2	26.8	0
+	+	+	+	+	NA	+	NA	NA	20	-2565.2	5170.5	33.0	0
+	+	+	+	+	+	+	NA	NA	22	-2565.0	5174.1	36.7	0
+	+	+	+	NA	+	+	+	NA	20	-2573.3	5186.8	49.3	0
+	+	+	+	NA	NA	+	+	NA	18	-2575.9	5187.9	50.4	0
+	+	+	+	NA	NA	+	NA	NA	14	-2583.5	5195.1	57.6	0
+	+	+	+	NA	+	+	NA	NA	16	-2583.3	5198.7	61.3	0
+	+	+	+	+	+	NA	+	NA	22	-2585.8	5215.9	78.5	0
+	+	+	+	+	NA	NA	+	NA	20	-2591.4	5223.0	85.6	0
+	NA	+	+	+	NA	NA	+	NA	18	-2594.4	5224.9	87.4	0
+	+	+	+	+	+	NA	NA	NA	18	-2596.0	5228.1	90.7	0
+	+	+	NA	+	+	NA	NA	NA	14	-2600.1	5228.3	90.8	0
+	+	+	+	+	NA	NA	NA	NA	16	-2598.5	5229.1	91.7	0
+	+	+	NA	+	NA	NA	NA	NA	12	-2602.7	5229.5	92.0	0
+	NA	+	+	+	NA	NA	NA	NA	14	-2602.2	5232.6	95.1	0
+	NA	+	NA	+	NA	NA	NA	NA	10	-2606.9	5233.9	96.4	0
+	+	+	+	NA	+	NA	+	NA	16	-2604.1	5240.4	102.9	0
+	+	+	+	NA	NA	NA	+	NA	14	-2609.9	5247.8	110.4	0
+	+	NA	+	+	NA	+	NA	NA	18	-2606.3	5248.8	111.4	0
+	NA	+	+	NA	NA	NA	+	NA	12	-2612.5	5249.0	111.5	0
+	+	+	+	NA	+	NA	NA	NA	12	-2614.8	5253.6	116.2	0
+	+	+	NA	NA	+	NA	NA	NA	8	-2618.8	5253.7	116.2	0
+	+	+	+	NA	NA	NA	NA	NA	10	-2617.3	5254.7	117.3	0
+	+	+	NA	NA	NA	NA	NA	NA	6	-2621.5	5255.0	117.6	0
+	NA	+	+	NA	NA	NA	NA	NA	8	-2620.7	5257.5	120.0	0
+	NA	+	NA	NA	NA	NA	NA	NA	4	-2625.3	5258.7	121.3	0
+	+	NA	+	NA	NA	+	NA	NA	12	-2623.9	5272.0	134.5	0
+	+	NA	+	+	NA	NA	NA	NA	14	-2636.9	5301.9	164.4	0
+	NA	NA	+	+	NA	NA	NA	NA	12	-2642.0	5308.1	170.6	0
+	+	NA	NA	+	NA	NA	NA	NA	10	-2649.4	5318.9	181.4	0
+	+	NA	+	NA	NA	NA	NA	NA	8	-2655.0	5326.0	188.5	0
+	NA	NA	+	NA	NA	NA	NA	NA	6	-2659.7	5331.5	194.0	0
+	NA	NA	NA	+	NA	NA	NA	NA	8	-2657.8	5331.7	194.2	0

+	+	NA	NA	NA	NA	NA	NA	NA	4	-2667.2	5342.3	204.9	0
+	NA	NA	NA	NA	NA	NA	NA	NA	2	-2675.1	5354.3	216.8	0

Table S6. Multinomial outcome parameter estimates from the top model to explain intake type based on based on 4000 model simulations. The conditions for intercept values are the autumn season, forest land use, mean income, and mean distance. The reference response is “adoption”.

Response	Term	Mean	LCI_95	UCI_95
Return to owner	Intercept	-1.0536	-1.0593	-1.0480
	Distance	-0.2787	-0.2795	-0.2779
	Income	-2.7778 e-05	-4.3792 e-05	-1.1763 e-05
	Land use - High development	-1.0208	-1.0285	-1.0132
	Land use - Low development	-0.5334	-0.5374	-0.5293
	Season - Spring	0.3570	0.3570	0.3571
	Season - Summer	-0.3950	-0.3951	-0.3950
	Season - Winter	0.0022	0.0022	0.0022
	Distance : Income	4.2353 e-06	1.9733 e-06	6.4973 e-06
	Distance : Land use - High development	0.0829	0.0812	0.0845
	Distance : Land use - Low development	0.2243	0.2237	0.2249
	Income : Land use - High development	3.2060 e-05	1.5391 e-05	4.8729 e-05
	Income : Land use - Low development	7.6754 e-06	-9.3763 e-06	2.4727 e-05
	Distance : Income : Land use - High development	-5.8211 e-06	-8.4340 e-06	-3.2082 e-06
	Distance : Income : Land use - Low development	-2.3333 e-06	-4.7641 e-06	9.7493 e-08
Service out	Intercept	-3.2609	-3.2695	-3.2523
	Distance	0.3295	0.3280	0.3309
	Income	3.4033 e-05	1.7828 e-05	5.0237 e-05
	Land use - High development	1.9170	1.9023	1.9318
	Land use - Low development	1.5392	1.5334	1.5450
	Season - Spring	0.4259	0.4258	0.4259
	Season - Summer	0.5288	0.5287	0.5288
	Season - Winter	0.3251	0.3250	0.3251
	Distance : Income	-9.7792 e-06	-1.2908 e-05	-6.6501 e-06
	Distance : Land use - High development	-0.4731	-0.4758	-0.4703
	Distance : Land use - Low development	-0.2543	-0.2553	-0.2533
	Income : Land use - High development	-6.1330 e-05	-7.8131 e-05	-4.4529 e-05
	Income : Land use - Low development	-3.8521 e-05	-5.5244 e-05	-2.1799 e-05
	Distance : Income : Land use - High development	1.3988 e-05	1.0764 e-05	1.7212 e-05
	Distance : Income : Land use - Low development	8.0709 e-06	4.8487 e-06	1.1293 e-05

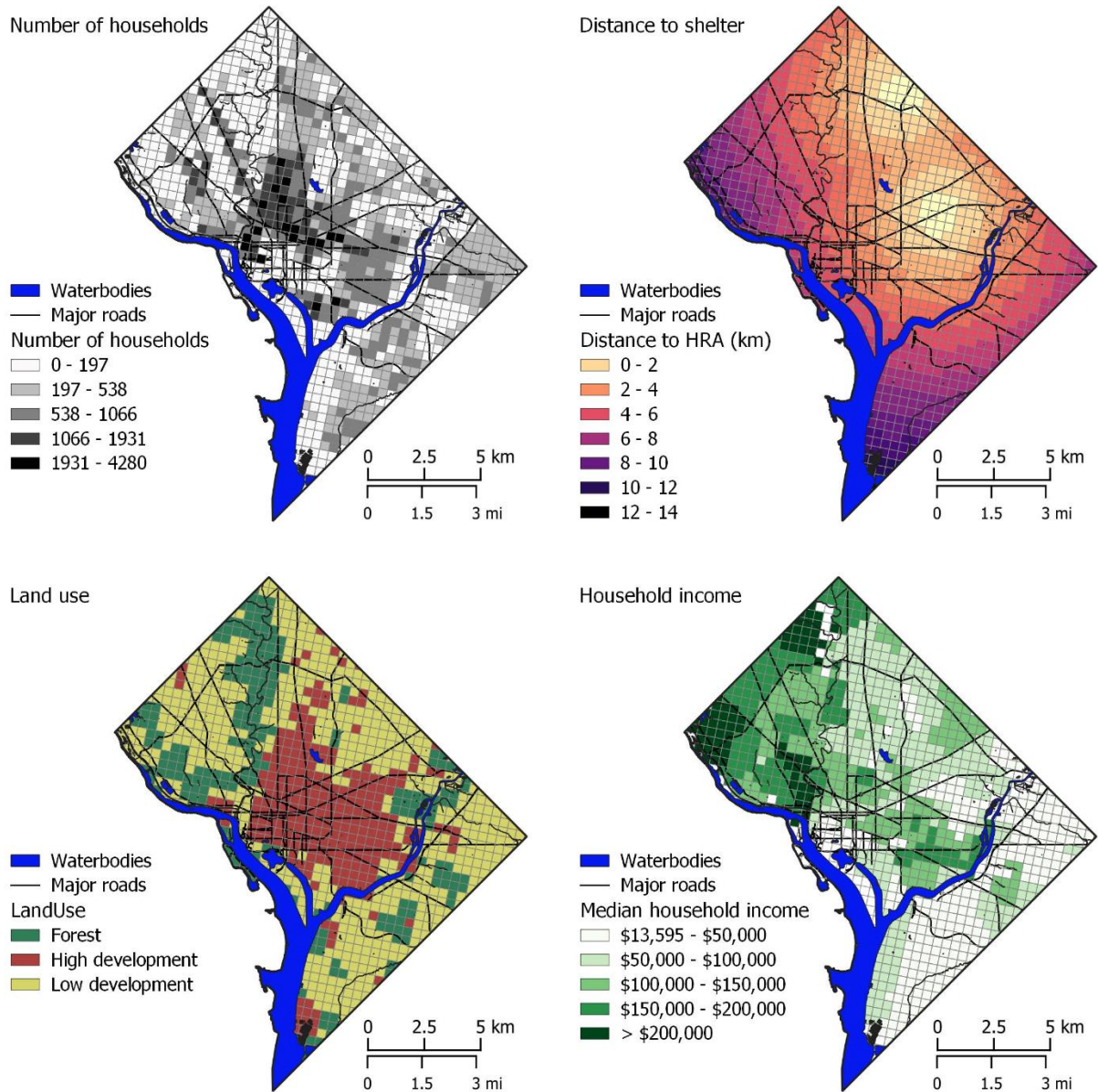


Figure S1. Spatial covariates of Washington, D.C. used to model the intake counts, outcome counts, intake probability, and outcome probability. Values are summarized at 400m by 400m grid.

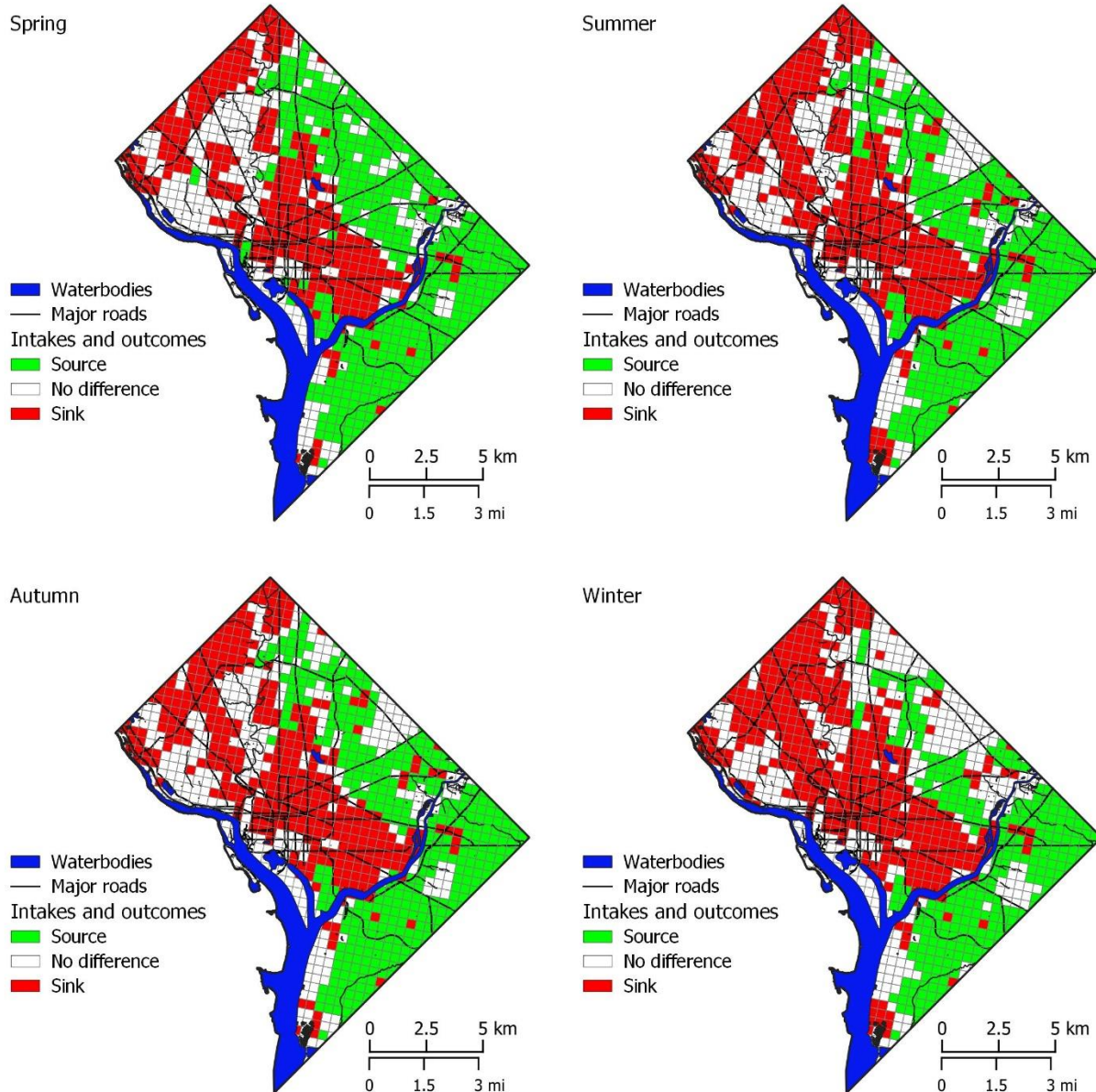


Figure S2. Balance of per household shelter intakes and outcomes in spring (top left), summer (top right), autumn (bottom left), and winter (bottom right). Red areas represent a significantly higher number of outcomes per household (sink areas) and green areas represent a significantly higher number of intakes per household (source areas) across all seasons. White areas are those that have an equal number of intakes and outcomes per household.

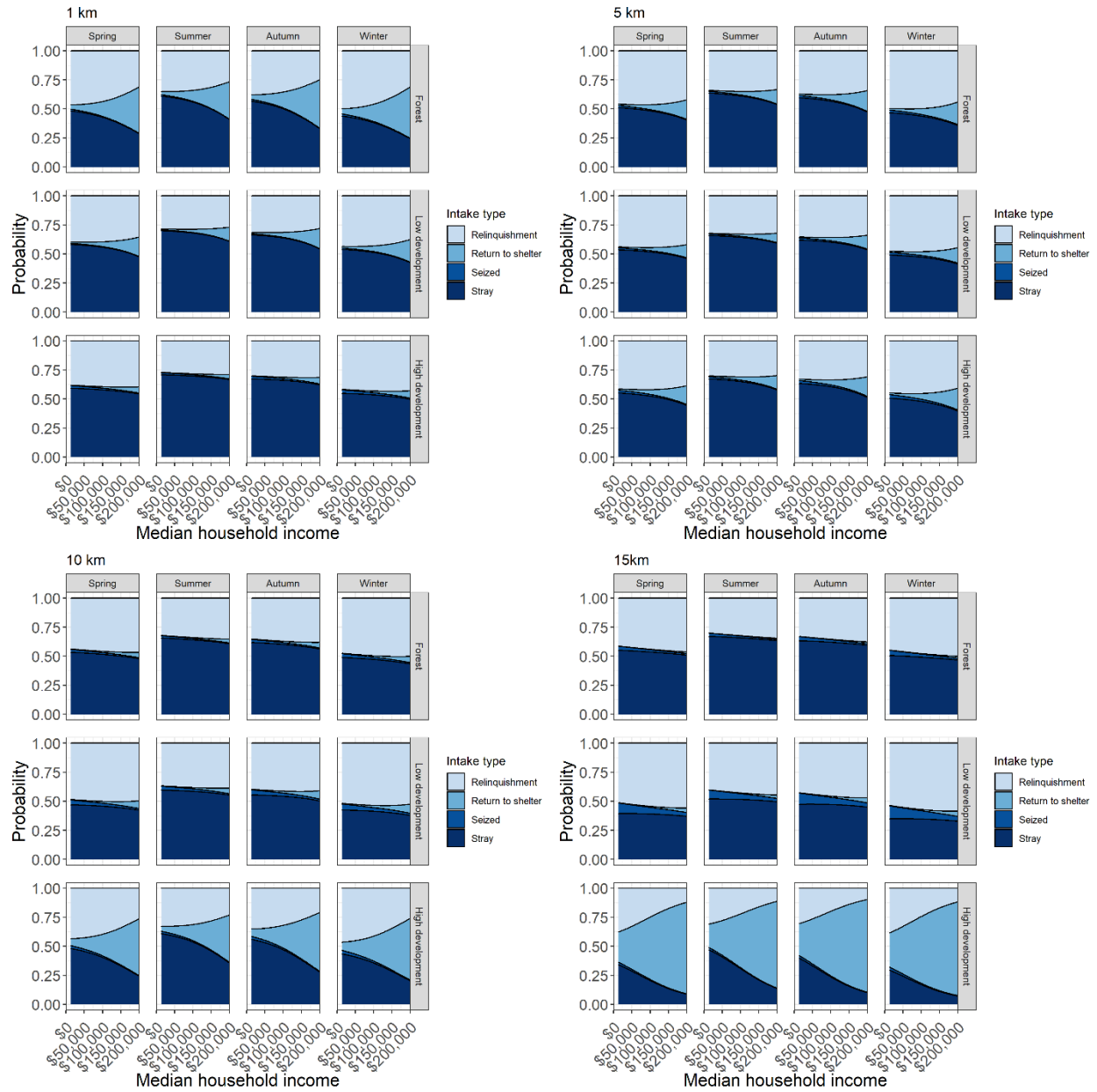


Figure S3. Predicted intake type by season, land use, household income, and distance to shelter. The distance to shelter is located at the top left of each panel.

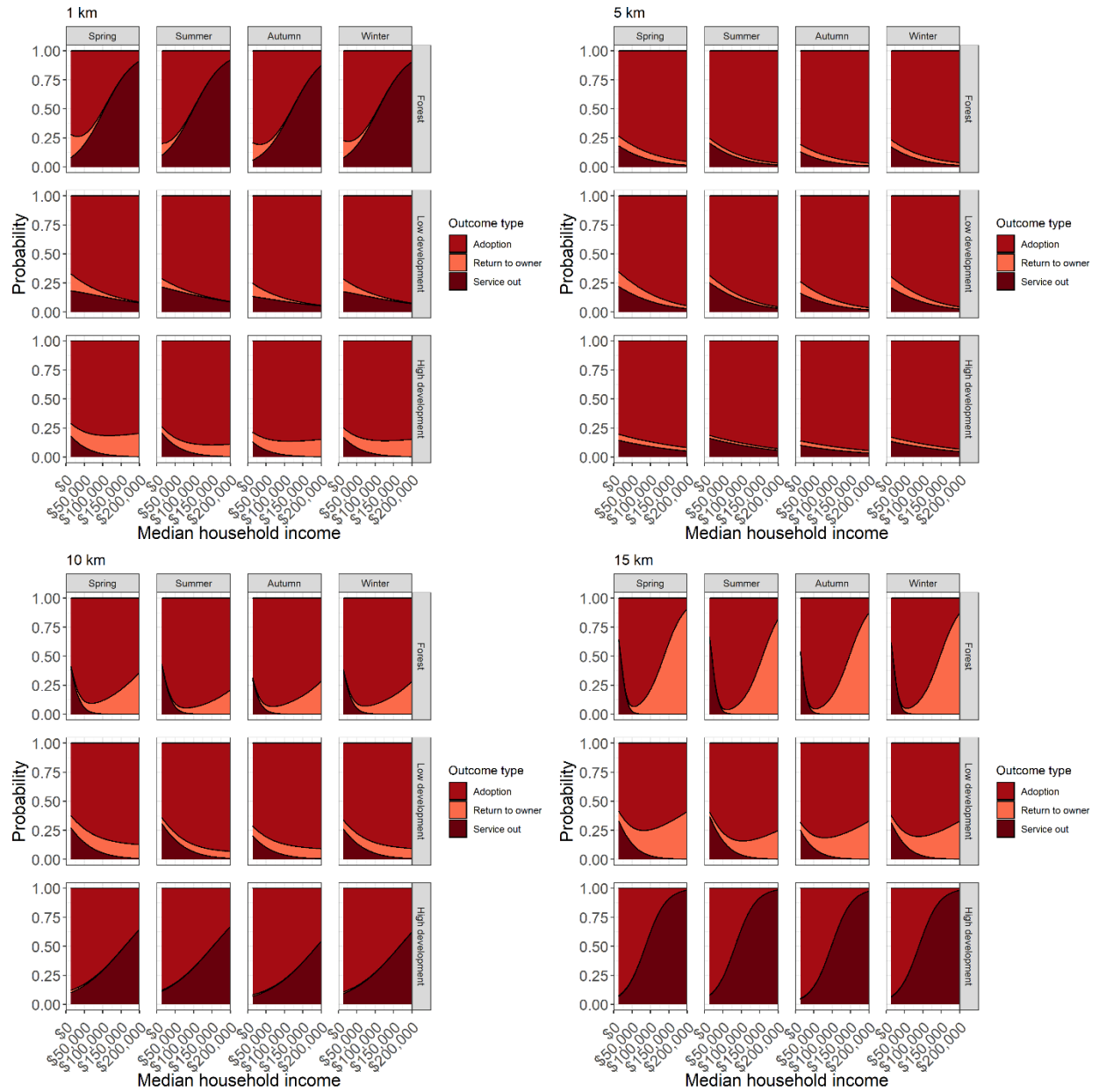


Figure S4. Predicted outcome type by season, land use, household income, and distance to shelter. The distance to shelter is located at the top left of each panel.