

Supplementary materials for

Four decades of inland invasion by the Formosan subterranean termite in Alabama: expansion associated with transportation infrastructure

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Table S1. Hazard ratios and p-values for variables across models with different traffic year data.

term	model	Hazard Ratio (CI)	P value
Interstate present	Reference (2011)	3.35 (1.41-7.95)	0.006
	2012	3.22 (1.38-7.52)	0.007
	2013	3.23 (1.38-7.55)	0.007
	2014	3.23 (1.38-7.56)	0.007
	2015	3.06 (1.33-7.01)	0.008
	2016	3.08 (1.34-7.09)	0.008
	2017	3.07 (1.33-7.08)	0.008
	2018	2.48 (1.07-5.77)	0.034
	2019	2.51 (1.08-5.85)	0.033
	2020	2.52 (1.08-5.85)	0.032
	2021	2.52 (1.08-5.85)	0.032
	2022	2.49 (1.07-5.79)	0.034
	2023	2.47 (1.06-5.76)	0.036
	2024	2.47 (1.06-5.76)	0.036
	2025	2.47 (1.06-5.77)	0.036
Latitude	Reference (2011)	0.48 (0.31-0.73)	<0.001
	2012	0.49 (0.32-0.74)	<0.001
	2013	0.49 (0.32-0.74)	<0.001
	2014	0.49 (0.32-0.74)	<0.001
	2015	0.49 (0.32-0.76)	0.001
	2016	0.49 (0.32-0.76)	0.001
	2017	0.49 (0.32-0.75)	0.001
	2018	0.49 (0.32-0.76)	0.001
	2019	0.49 (0.31-0.75)	0.001
	2020	0.48 (0.31-0.75)	0.001
	2021	0.48 (0.31-0.75)	0.001
	2022	0.48 (0.31-0.74)	<0.001
	2023	0.48 (0.31-0.74)	<0.001
	2024	0.48 (0.31-0.74)	<0.001
	2025	0.48 (0.31-0.74)	<0.001
Rail density	Reference (2011)	1.24 (0.80-1.91)	0.34
	2012	1.23 (0.79-1.89)	0.358
	2013	1.23 (0.79-1.90)	0.36
	2014	1.22 (0.79-1.89)	0.361
	2015	1.22 (0.79-1.88)	0.38
	2016	1.22 (0.79-1.89)	0.37
	2017	1.20 (0.78-1.85)	0.414
	2018	1.26 (0.84-1.89)	0.263
	2019	1.25 (0.83-1.87)	0.288
	2020	1.26 (0.83-1.89)	0.276
	2021	1.26 (0.83-1.89)	0.276
	2022	1.29 (0.86-1.91)	0.214
	2023	1.30 (0.88-1.94)	0.187
	2024	1.30 (0.88-1.93)	0.185
	2025	1.30 (0.88-1.93)	0.185
Road density excl. interstate	Reference (2011)	1.69 (1.06-2.71)	0.029
	2012	1.63 (1.04-2.58)	0.035
	2013	1.64 (1.04-2.60)	0.034
	2014	1.64 (1.04-2.60)	0.034
	2015	1.57 (1.01-2.43)	0.044
	2016	1.58 (1.02-2.45)	0.041
	2017	1.55 (1.00-2.42)	0.051
	2018	1.39 (0.91-2.13)	0.125
	2019	1.43 (0.94-2.19)	0.096
	2020	1.43 (0.95-2.16)	0.088
	2021	1.43 (0.95-2.16)	0.088
	2022	1.42 (0.94-2.15)	0.094
	2023	1.43 (0.94-2.16)	0.092
	2024	1.43 (0.94-2.16)	0.092
	2025	1.43 (0.94-2.16)	0.091
Population density (2024)	Reference (2011)	1.18 (0.70-1.99)	0.541
	2012	1.21 (0.72-2.02)	0.474
	2013	1.20 (0.72-2.02)	0.486
	2014	1.20 (0.72-2.01)	0.483
	2015	1.24 (0.75-2.05)	0.406
	2016	1.23 (0.74-2.04)	0.429
	2017	1.25 (0.75-2.08)	0.386
	2018	1.35 (0.85-2.15)	0.197
	2019	1.34 (0.85-2.13)	0.209
	2020	1.36 (0.87-2.13)	0.176
	2021	1.36 (0.87-2.13)	0.176
	2022	1.35 (0.87-2.11)	0.178
	2023	1.35 (0.87-2.09)	0.183
	2024	1.35 (0.87-2.09)	0.181
	2025	1.35 (0.87-2.09)	0.183

Significant variables are shown in bold.

Table S2. Comparison of model fitting across all the models.

Model	AIC	logLik	delta AIC
Exclude Pop. Density	229.3	-110.6	0.0
Population Density (2010)	230.8	-110.4	1.5
Population Density (2020)	230.8	-110.4	1.6
Traffic 2011 (reference)	230.9	-110.5	1.6
Population Density (2000)	231.0	-110.5	1.7
Traffic 2013	231.2	-110.6	1.9
Traffic 2014	231.2	-110.6	1.9
Population Density (1990)	231.2	-110.6	1.9
Traffic 2012	231.3	-110.6	2.0
Population Density (1980)	231.3	-110.6	2.0
Min Temperature	231.3	-110.6	2.0
Traffic 2016	231.5	-110.8	2.3
Traffic 2015	231.7	-110.9	2.4
Traffic 2017	232.0	-111.0	2.8
Traffic 2025	232.5	-111.3	3.2
Traffic 2024	232.5	-111.3	3.3
Traffic 2023	232.5	-111.3	3.3
Traffic 2022	232.7	-111.4	3.5
Roads with IS (2011)	233.0	-111.5	3.7
Traffic 2021	233.1	-111.5	3.8
Traffic 2020	233.1	-111.5	3.8
Traffic 2019	233.2	-111.6	3.9
Exclude Roads	233.4	-112.7	4.1
Traffic 2018	233.5	-111.7	4.2
Mean Temperature	233.5	-111.8	4.2
Roads with IS (2025)	234.0	-112.0	4.8

Table S3. Hazard ratios and p-values for variables across models for sensitivity analysis.

model	term	Hazard Ratio (CI)	P value
Exclude population density	Interstate present (2011)	3.55 (1.54-8.20)	0.003
	Latitude	0.50 (0.33-0.75)	<0.001
	Rail density (2011)	1.34 (0.94-1.91)	0.105
Exclude road density	Road density excl. interstate (2011)	1.84 (1.26-2.69)	0.002
	Interstate present (2011)	2.48 (1.13-5.47)	0.024
	Latitude	0.49 (0.31-0.77)	0.002
	Population density (2024)	1.61 (1.07-2.43)	0.023
	Rail density (2011)	1.23 (0.81-1.86)	0.339
Mean temperature	Interstate present (2011)	3.20 (1.37-7.47)	0.007
	Mean annual temperature	1.91 (1.25-2.91)	0.003
	Population density (2024)	1.13 (0.68-1.87)	0.642
	Rail density (2011)	1.23 (0.80-1.89)	0.348
	Road density excl. interstate (2011)	1.62 (1.02-2.57)	0.041
Minimum temperature	Interstate present (2011)	3.38 (1.42-8.01)	0.006
	Minimum temperature	2.05 (1.35-3.11)	<0.001
	Population density (2024)	1.14 (0.68-1.90)	0.622
	Rail density (2011)	1.25 (0.81-1.93)	0.304
	Road density excl. interstate (2011)	1.60 (1.00-2.54)	0.049
Population density (1980)	Interstate present (2011)	3.54 (1.53-8.19)	0.003
	Latitude	0.50 (0.33-0.75)	<0.001
	Population density (1980)	1.04 (0.58-1.85)	0.895
	Rail density (2011)	1.30 (0.71-2.37)	0.4
	Road density excl. interstate (2011)	1.82 (1.19-2.77)	0.006
Population density (1990)	Interstate present (2011)	3.51 (1.51-8.17)	0.003
	Latitude	0.50 (0.33-0.74)	<0.001
	Population density (1990)	1.07 (0.59-1.93)	0.82
	Rail density (2011)	1.27 (0.71-2.26)	0.416
	Road density excl. interstate (2011)	1.79 (1.15-2.79)	0.01
Population density (2000)	Interstate present (2011)	3.42 (1.46-8.02)	0.005
	Latitude	0.49 (0.32-0.74)	<0.001
	Population density (2000)	1.18 (0.65-2.15)	0.583
	Rail density (2011)	1.19 (0.68-2.06)	0.539
	Road density excl. interstate (2011)	1.72 (1.09-2.71)	0.021
Population density (2010)	Interstate present (2011)	3.35 (1.42-7.92)	0.006
	Latitude	0.48 (0.32-0.73)	<0.001
	Population density (2010)	1.23 (0.69-2.18)	0.49
	Rail density (2011)	1.18 (0.72-1.94)	0.506
	Road density excl. interstate (2011)	1.67 (1.04-2.68)	0.033
Population density (2020)	Interstate present (2011)	3.34 (1.41-7.92)	0.006
	Latitude	0.48 (0.32-0.73)	<0.001
	Population density (2020)	1.20 (0.70-2.08)	0.509
	Rail density (2011)	1.21 (0.77-1.92)	0.414
	Road density excl. interstate (2011)	1.68 (1.05-2.69)	0.031
Reference (2011)	Interstate present (2011)	3.35 (1.41-7.95)	0.006
	Latitude	0.48 (0.31-0.73)	<0.001
	popdens_2024	1.18 (0.70-1.99)	0.541
	Rail density (2011)	1.24 (0.80-1.91)	0.34
	Road density excl. interstate (2011)	1.69 (1.06-2.71)	0.029
Roads incl. interstate (2011)	Interstate present (2011)	2.58 (1.16-5.76)	0.021
	Latitude	0.48 (0.31-0.74)	<0.001
	Population density (2024)	1.32 (0.80-2.19)	0.278
	Rail density (2011)	1.13 (0.73-1.76)	0.571
	Road density incl. interstate (2011)	1.52 (0.91-2.55)	0.113
Roads incl. interstate (2025)	Interstate present (2025)	2.14 (0.94-4.87)	0.069
	Latitude	0.48 (0.31-0.75)	0.001
	Population density (2024)	1.42 (0.91-2.23)	0.122
	Rail density (2025)	1.26 (0.84-1.88)	0.267
	Road density incl. interstate (2025)	1.32 (0.80-2.17)	0.278

Table S4. The model fitting results for the 2000 traffic data.

term	Hazard Ratio (CI)	<i>P</i> (variable effect)	<i>P</i> (proportional hazard assumption)
Highway present (2000)	1.94 (0.87-4.35)	0.106	0.105
Latitude	0.40 (0.26-0.62)	<0.001	0.964
Rail feature density (2000)	0.48 (0.25-0.92)	0.026	0.06
Road feature density (2000)	4.89 (1.80-13.29)	0.002	0.032
Population density (2024)	0.93 (0.47-1.87)	0.849	0.311
Global			0.022

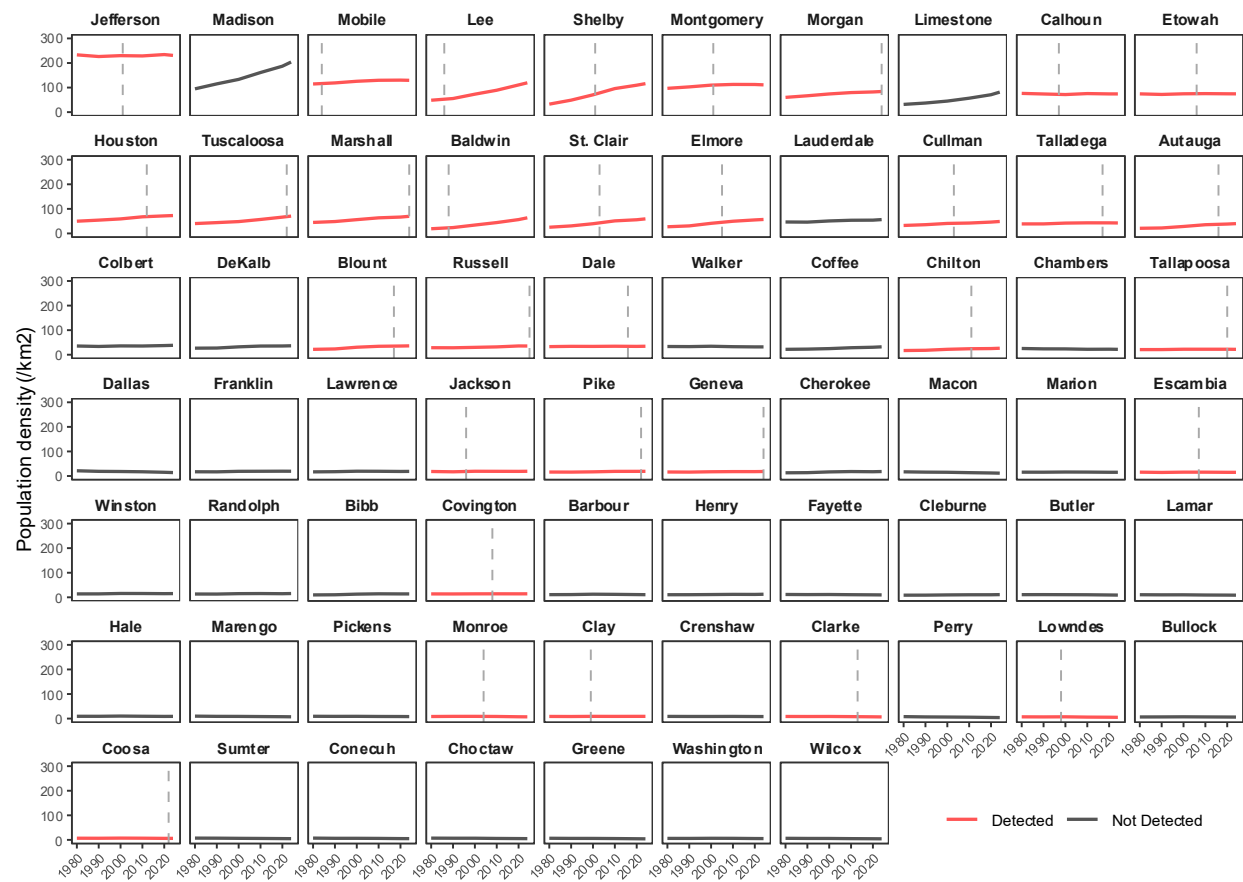


Figure S1. Time development of the population density of each county from 1980 to 2024. The order reflects the population density in 2024.

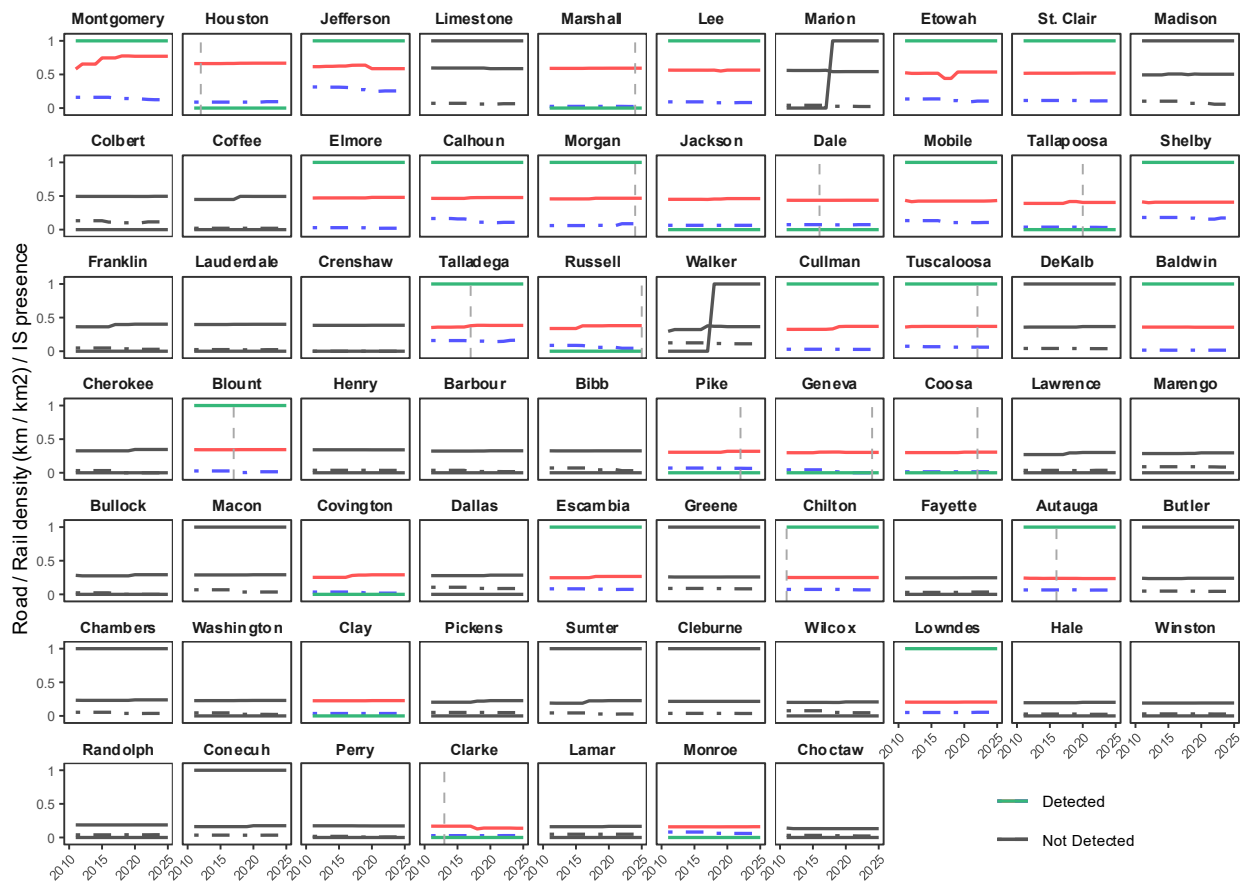


Figure S2. Time development of the traffic infrastructure from 2011 to 2025. The order reflects the road density in 2025. Red lines indicate road densities, blue (dashed) lines indicate railroad densities, and green (either 0/1) lines indicate the presence of the interstate highways (1 = present, 0 = absent).

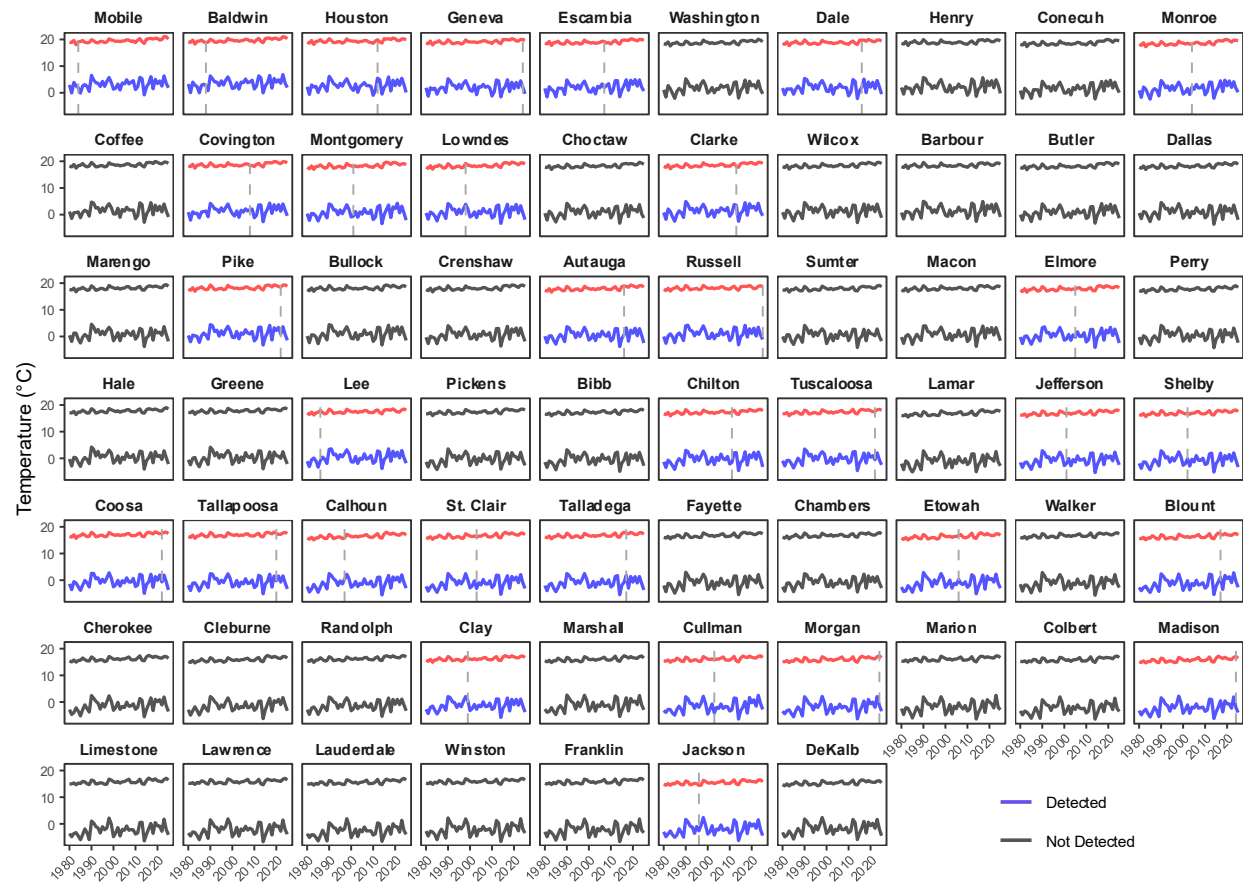


Figure. S3. Time development of the average and minimum temperature from 1980 to 2025. The order reflects the average temperature over the period. Red (top) lines indicate mean temperature, and blue (bottom) lines indicate minimum temperature.

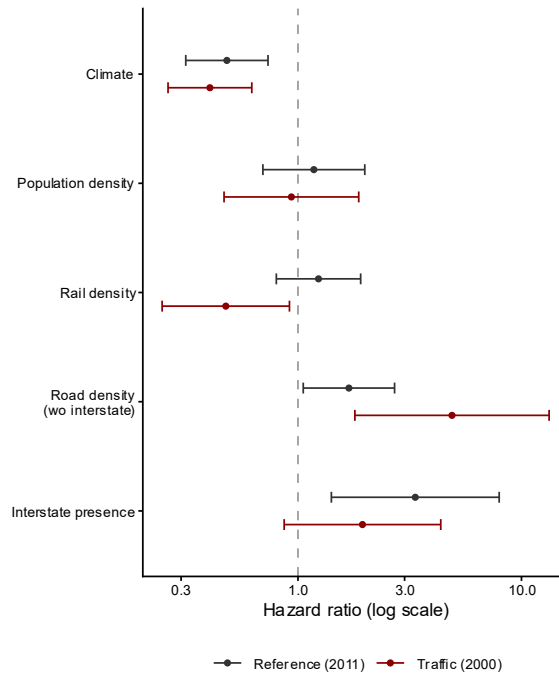


Figure. S4. The forest plot of hazard ratios $\pm$ 95% CI from the base Cox proportional hazards model for factors affecting county detection of *C. formosanus*, comparing traffic data from 2000 and 2011. The 2000 data represent the density of road and rail features, while the 2011 data represent the density measured in length per area. The 2000 data includes non-Interstate highways in the Interstate presence data. The population density was that of 2024. HR values > 1 indicate increased hazard.

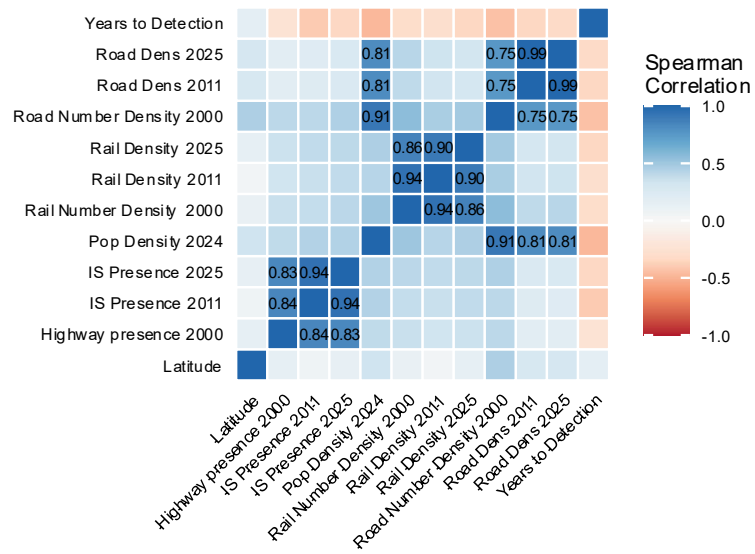


Figure. S5. The correlation matrix between the variables of the 2000 data and related variables. The correlation coefficients are shown when $p > 0.6$ or $p < -0.6$.

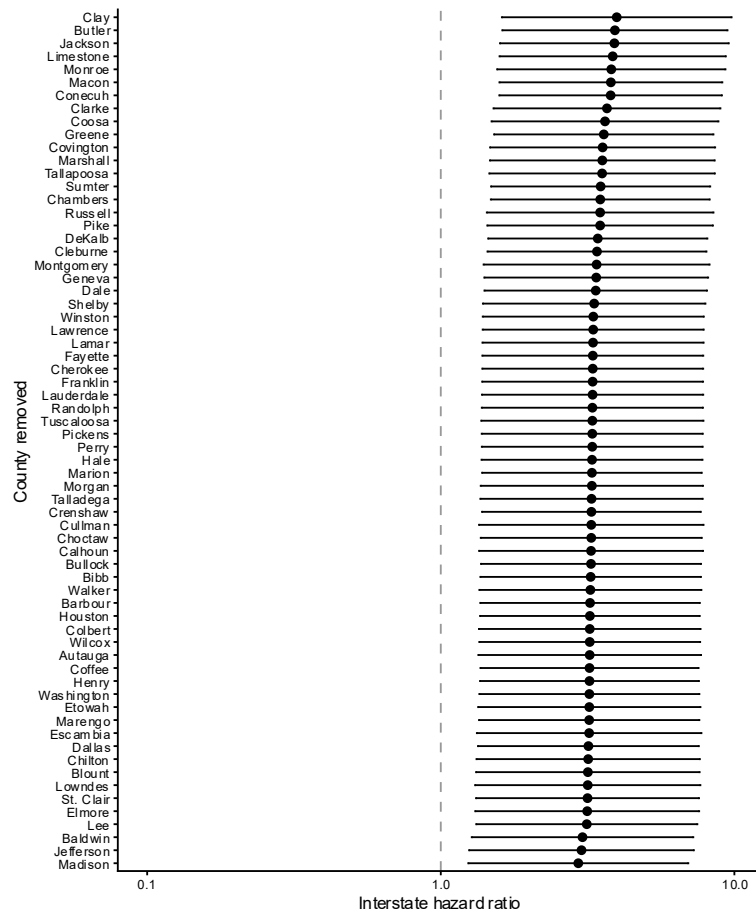


Figure. S6. The hazard ratios $\pm$ 95% CI of the presence of interstate highways, based on the reference Cox proportional hazards model (2011 traffic data), when removing one county data.